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Adolescents' Nutrition and Physical Activity Knowledge and Practices

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“Knowing is not enough; we must apply.

Willing is not enough; we must do.”

Johann Wolfgang von Goethe

To my parents and sisters,

To my grandparents,

To Ovídio

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Abstract

In the past decade the scientific community and health professionals showed a growing concern with the epidemiological data that revealed increasing prevalence of obesity in young ages. Resulting from unhealthy lifestyles, this reality concerns also the policymakers, who have been searching for ways of promoting healthy lifestyles, namely through intervention programs, that aim to reduce the risk behaviors, namely improving dietary and physical activity practices. Several intervention programs have been implemented, mainly in adults and small children, however they are scarce, particularly in adolescents, especially using attractive methodologies for this age range, as the new technologies, although these technologies proved to be effective in other health behaviors.

This work aimed to validate a questionnaire to assess adolescents' nutrition knowledge (Paper I) and a questionnaire to measure adolescents' physical activity level (Paper II), to analyze the nutrition and physical activity knowledge relation with adiposity (Paper III), and to study the relationship between knowledge and practices in nutrition and physical activity (Paper IV).

In this context, the Paper I was performed with 1315 adolescents. After content validity and questionnaire refinement, item difficulty (percentage), internal reliability (Cronbach's Alpha), test-retest reliability (Spearman correlation) and concurrent reliability (Spearman correlation) were analyzed. Paper II included a sub-sample of 222 adolescents, and after translation and cross cultural adaptation, Spearman correlation coefficient and Cohen's Kappa agreement were calculated between the questionnaire and accelerometer. A cross sectional study was performed and reported in Papers III and IV, 734 adolescents were assessed for anthropometric measurements, and for nutrition and physical activity knowledge and practices. In paper III Kruskal-Wallis and Mann Whitney U tests were performed to compare knowledge scores between groups, created according the levels of body fat percentage and moderate to vigorous physical activity engagement. In paper IV Kruskal-Wallis and Mann Whitney U tests were

performed to compare knowledge scores, physical activity and nutritional adequacy between groups; adjusted Spearman correlation tested the association between knowledge and practices, for nutrition and physical activity.

Results of Paper I revealed that the Portuguese version of the General Nutrition Knowledge Questionnaire for Adolescents is a valid ($U=22766.0$; $p<.01$) and reliable (Cronbach's alpha=.92) instrument to assess nutrition knowledge. Paper II reported that the International Physical Activity Questionnaire for Adolescents didn't correlate significantly with accelerometer for younger adolescents and girls. Paper III and IV results reflect the poor knowledge levels of the Portuguese adolescents, either for nutrition, in average with 46.5% (SD=11.82) of correct answers and for physical activity with a mean of 66.2% (SD=15.50) of correct answers. It seems important to emphasize also the reduced mean nutritional adequacy percentage (57.4; SD=10.24) and the low mean values of moderate to vigorous physical activity (47.9 $min.day^{-1}$; SD=27.49).

In addition, in Paper III, considering groups created based on physical activity engagement and body fat percentage, overfat/ low physical activity adolescents seem to be significantly ($p=.003$) less aware of the experts' nutritional recommendations, and the high physical activity adolescents are significantly ($p=.044$) more knowledgeable on physical activity.

However, paper IV present results considering the continuous variables and no association seems to exist between knowledge and practices, regarding nutrition ($\rho=-.03$; $p=.636$) and physical activity ($\rho=.12$; $p=.083$).

The main conclusions of this thesis are the following: the Portuguese version of the general nutrition knowledge questionnaire for adolescents is valid and reliable (Paper I); Portuguese adolescents' physical activity should be measured with objective methods, like accelerometers, and not by questionnaires (Paper II); overfat and low physical activity adolescents have the worse knowledge about experts' nutritional recommendations (Paper III); there is no association between knowledge and practices, in nutrition and physical activity (Paper IV).

It is therefore suggested that although necessary, knowledge seems to be insufficient to produce adequate nutrition and physical activity practices in Portuguese adolescents.

Resumo

Na última década, tem sido manifestada pela comunidade científica e pelos profissionais de saúde uma preocupação crescente com os dados epidemiológicos que revelam um aumento acentuado de patologias crónicas em idades jovens. Resultante da adoção de estilos de vida pouco saudáveis, esta realidade preocupa também os decisores políticos, que têm procurado desenhar políticas promotoras de saúde, nomeadamente através de programas de intervenção, que visam reduzir os comportamentos de risco, nomeadamente melhorando as práticas alimentares e aumentando a prática de atividade física. Vários projetos de intervenção têm sido implementados, principalmente em crianças e adultos, no entanto escasseiam os direcionados para adolescentes, nomeadamente com metodologias atrativas para esta faixa etária, como as novas tecnologias, apesar de estas terem mostrado recentemente ser ferramentas importantes em contextos de promoção da saúde.

Este trabalho objetivou validar um questionário para avaliar os conhecimentos nutricionais dos adolescentes (Artigo I) e um questionário para medir o nível de atividade física dos adolescentes (Artigo II), pretendeu também analisar a relação entre os conhecimento nutricionais e de atividade física e a adiposidade (Artigo III), e estudar a relação entre conhecimento e práticas, quer de nutrição quer de atividade física (Artigo IV).

Neste contexto, o Artigo I incluiu uma amostra de 1315 adolescentes. Após validação de conteúdo e aperfeiçoamento do questionário, avaliação do índice de dificuldade dos itens (percentagem), consistência interna (alfa de Cronbach), fiabilidade teste-reteste (correlação de Spearman) e validade concorrente (correlação de Spearman) foram testadas. O Artigo II incluiu uma subamostra de 222 adolescentes e após tradução e adaptação cultural, testes de correlação de Spearman e o teste de concordância Kappa de Cohen foram calculados entre os dados do acelerómetro e do questionário. Um estudo transversal foi desenvolvido e reportado nos artigos III e IV, onde 734 adolescentes foram avaliados relativamente aos seus dados antropométricos, e conhecimentos e

práticas nutricionais e de atividade física. No Artigo III os testes de Kruskal Wallis, Mann Whitney U foram utilizados para comparar os scores de conhecimentos entre grupos, criados de acordo com os níveis de percentagem de gordura corporal e tempo de atividade física moderada a vigorosa. No Artigo IV os testes de Kruskal Wallis, Mann Whitney U foram utilizados para comparar os scores de conhecimentos, níveis de atividade física e adequação nutricional entre grupos; a correlação de Spearman ajustada serviu para testar a associação entre conhecimentos e práticas, de nutrição e atividade física.

Os resultados do Artigo I revelam que a versão portuguesa do *General Nutrition Knowledge Questionnaire for Adolescents* é um instrumento válido ($U = 22766.0$; $p<.01$) e fiável (Cronbach's alpha=.92) para avaliar o conhecimento nutricional. O Artigo II revelou que o *International Physical Activity Questionnaire for Adolescents* não tem uma correlação significativa com a atividade física objetivamente medida com o acelerómetro.

Os resultados dos Artigos III e IV refletem que os adolescentes portugueses têm baixos conhecimentos, quer em termos de nutrição, com uma média de respostas corretas de 46.5% (SD=11.82), quer de atividade física com uma média de 66.2% (SD=15.50) de respostas corretas. Neste contexto parece importante salientar também os baixos níveis médios de adequação nutricional (57.4%; SD=10.24) e a média reduzida de atividade física moderada a vigorosa (47.9 $min.dia^{-1}$; SD=27.49).

No Artigo III os dados sugerem também que, considerando grupos criados com base na prática de atividade física e na percentagem de gordura corporal, os adolescentes com excesso de gordura e menor atividade física têm significativamente ($p=.003$) menos conhecimentos sobre as recomendações nutricionais; e os adolescentes com mais tempo de atividade física moderada a vigorosa têm significativamente ($p=.044$) mais conhecimentos de atividade física. Contudo, O artigo IV, apresenta resultados considerando as variáveis contínuas e parece não existir uma relação entre os conhecimentos e as práticas, quer em termos de nutrição ($\rho=-.03$; $p=.636$) quer de atividade física ($\rho=.12$; $p=.083$).

As principais conclusões desta tese são as seguintes: a versão portuguesa do General Nutrition Knowledge Questionnaire for Adolescents é um instrumento

válido e fiável (Artigo I); a atividade física dos adolescentes portugueses deve ser avaliada preferencialmente como métodos objetivos, como os acelerómetros (Artigo II); os adolescentes com excesso de gordura e baixos níveis de atividade física têm piores conhecimentos sobre as recomendações nutricionais dos especialistas (Artigo III); não existe associação entre conhecimentos e práticas, em termos de atividade física e nutrição (Artigo IV).

É assim sugerido que, apesar de necessário, o conhecimento parece ser insuficiente para produzir comportamentos saudáveis, quer de atividade física, quer de nutrição e alimentação, nos adolescentes portugueses.

List of abbreviations

%EI	Percentage of Energy Intake
AMDR	Acceptable Macronutrient Distribution Ranges
BFP	Body Fat Percentage
BMI	Body Mass Index
BMR	Basal Metabolic Rate
Ca	Calcium
CH	Carbohydrates
cm	Centimeters
$counts.min^{-1}$	Counts per minute
CVD	Cardiovascular diseases
EAR	Estimated Average Requirement
Fe	Iron
g	grams
GNKQ	General Nutrition Knowledge Questionnaire
GNKQA	General Nutrition Knowledge Questionnaire for Adolescents
Hz	Hertz
IPAQ	International Physical Activity Questionnaire
IPAQA	International Physical Activity Questionnaire for Adolescents
IQR	Interquartile Range
Kg	Kilograms
$Kg.m^{-2}$	Kilograms per squared meters
MET	Metabolic Equivalents
mg	Miligrams
$min.day^{-1}$	Minutes per day

MVPA	Moderate to Vigorous Physical Activity
n-6	Polyunsaturated fatty acids n-6
Na	Sodium
P	Phosphorus
PA	Physical Activity
PAKQ	Physical Activity Knowledge Questionnaire
PAL	Physical Activity Level
Prot	Protein
S1	General Nutrition Knowledge Questionnaire for Adolescents - Section one
S2	General Nutrition Knowledge Questionnaire for Adolescents - Section two
S3	General Nutrition Knowledge Questionnaire for Adolescents - Section three
S4	General Nutrition Knowledge Questionnaire for Adolescents - Section four
SD	Standard Deviation
SFA	Saturated Fatty Acids
SS	Simple Sugars
Vit	Vitamin
WHO	World Health Organization
Zn	Zinc

General Introduction

Adolescence is a life stage with unique characteristics, translating the fast evolution and bio-psycho-social changes. These transitions also translate into diet and physical activity, with negative health consequences, namely obesity.

Obesity is a major public health issue, especially for children and adolescents. The ecological model for the etiology of childhood overweight (Birch & Ventura, 2009) includes physical activity and diet as the two major modifiable factors that can contribute to reduce the burden of obesity. The correlates of dietary intake and physical activity have been widely studied and health knowledge, in particularly nutrition and physical activity knowledge have been mentioned as potential ways of inducing positive health behaviors changes.

In Portugal few studies addressed the nutrition and physical activity knowledge. Little is known about the health knowledge levels of Portuguese adolescents, and no study verified if these variables act as correlates of nutrition intake, physical activity levels and adiposity.

In this context, this thesis intends to study the nutrition and physical activity knowledge correlation with adiposity, nutrition intake and physical activity engagement.

Chapter 1. Theoretical Background

Adolescence

Definition

Adolescence is considered to be the time period that starts after childhood and ends before adulthood, however, the scientific community does not have a consensus about the exact age that corresponds to this definition. It is clinically accepted that an individual variation exists (Lee, 1980), chronological age is not the best indicator of the true maturational age (Baxter-Jones et al., 2005; Lloyd et al., 2014), making it difficult to create age cut off points. For research purposes it is broadly accepted the World Health Organization definition that considers an adolescent any young person that is between the ages of 10 and 19 years (WHO, 2013), and is frequently divided in two stages, the early adolescence, from 10 to 14 years, and the late adolescence from 15 to 19 years (Sawyer et al., 2012).

Physiological characteristics

During this life period many physiological changes happen, puberty occurs in the beginning of adolescence and, by its end, full sexual maturity is reached (Steinberg, 2005).

Several studies suggest that the puberty timing is related to adolescents' previous and present health issues, namely nutrition and dietary intake and obesity.

A recent review suggested that associations between dietary intakes and pubertal timing, such as girls with the highest intakes of vegetable protein experienced pubertal onset up to 7 months later, on the contrary the highest intakes of animal protein could lead up to a 7 months earlier pubertal onset (Cheng et al., 2012). In addition, children with high isoflavone intakes may have the onset of breast development and peak height velocity about 7–8 months later (Cheng et al., 2012).

Secular trends in the timing of puberty have been studied, and it seems that in most developed countries the age at menarche seems to be reducing (Cheng et al., 2012). Similarly, overweight seems to be increasing in the same countries (Cheng et al., 2012). There is some evidence suggesting that the early menarche

onset occurs more frequently in obese girls (Alberga et al., 2012; Davison et al., 2003; He & Karlberg, 2001; Lee et al., 2007; Tsang et al., 2012; Wattigney et al., 1999).

During puberty there is also a growth rate increase, with visible height and weight gains, at the same time as a change in body composition (Freedman et al., 2002). The first years of adolescence are associated with a substantial increase in adipocyte size and number (Alberga et al., 2012), while once pubertal maturity is attained gender differences are apparent, hormonal maturation contributes to a decrease in males body fat and an increase for females (Alberga et al., 2012; Brambilla et al., 2006; Loomba-Albrecht & Styne, 2009). Also the body distribution of fat differs, male adolescents face a bigger deposit of fat in the abdominal region, both subcutaneous and visceral fat; whereas females tend to have peripheral fat, mainly in the hips, a pattern also identified in adults (Pietrobelli et al., 2005), by the end of puberty males assume a more android body shape and females assume a more gynoid shape (Loomba-Albrecht & Styne, 2009).

In what concerns fat free mass, although males gain greater amounts of fat free mass and skeletal mass during puberty (Loomba-Albrecht & Styne, 2009), it seems that both genders face an increase of fat free mass during adolescence (Alberga et al., 2012), particularly during the growth spurt phase. The adolescent growth spurt is associated with a rapid growth and some hormonal changes. A longitudinal study suggests that experiencing an early pubertal growth spurt increase progressively more fat-free mass during the first years of puberty when compared to late-maturing peers of the same age (Buyken et al., 2011). As a result of intensive growth and muscular development, an increase in blood volume is observed, and therefore the adolescent faces elevated iron needs (Mesias et al., 2013).

During this period of great growth rates, it seems crucial to the overall health, and in particular to bone health to engage in a healthy diet. Nutrition factors such as calcium (Mesias et al., 2011; Zofkova et al., 2013), vitamin D , vitamin K, zinc, copper, fluorine, manganese, magnesium, iron and boron proved to be important for the integrity of the skeleton (Zofkova et al., 2013). Deficiency of these elements slows down the increase of bone mass during adolescence and

accelerates bone loss later in life (Zofkova et al., 2013). Also engaging in physical activity during adolescence have benefits on bone health (Duckham et al., 2014).

In short, differences between boys and girls are accentuated during puberty years, particularly differences in adiposity, fat free mass and bone mass, reflecting differences in the endocrine status (estrogens, androgens, growth hormone and IGF-1), genetic factors, ethnicity and the influence of the environment (Loomba-Albrecht & Styne, 2009).

Conceptually, pubertal maturation can be described in terms of sequence and timing. The order of the secondary sexual development has been categorized by several groups, by different authors, but the staging system applied most often is that published by Marshall and Tanner (Marshall & Tanner, 1969, 1970). This system categorizes individuals on an ordinal puberty scale from 1 to 5, development of pubic hair and breast development is used for females (Marshall & Tanner, 1969), and pubic hair and genital development for males (Marshall & Tanner, 1970). Some limitations have been pointed out to this method, namely, the scale was developed with a single ethnic group and in a relatively small sample and overweight girls will tend to be erroneously over-estimated (Blakemore et al., 2010).

Psychosocial characteristics

The psychosocial characteristics in puberty and adolescence more frequently mentioned are the abstract thinking, the increasing ability of captivating others perspectives, a greater ability of introspection, the development of personal and sexual identity (Remschmidt, 1994; Tsang et al., 2012), the development of a personal system of values, rising autonomy and independence from family, bigger significance of social recognition and peer relationships (Remschmidt, 1994; Steinberg, 2005), that frequently assume a role model position (Steinberg, 2005).

Social groups and peer relationships can influence adolescents' lifestyle options and health behaviors where friendships are usually formed around shared

behaviors (Valente et al., 2009), but also shared body images, as it seems that people look for a mate with similar body composition (Speakman et al., 2007).
In fact, body mass index and body composition are of major importance in adolescence, as in this period major changes in these measures and shapes occur, which often precipitates self-consciousness and insecurity (Alberga et al., 2012). Adolescents who reach to develop a clear and positive identity seem to advance more smoothly into adulthood (Tsang et al., 2012).
However in this phase there is not a complete psychological development and maturation, the impulse control, the anticipation of consequences, and the ability to pre-planning are not completely acquired (Steinberg, 2007).
Adolescence is also where one's interaction with the socioeconomic environment is defined (Viner et al., 2012), during this period educational opportunities are either taken up or not, depending on the individual choices, but also on the social and political context (Raphael, 2011, 2013). Hence, besides health issues that result from childhood circumstances, there should be given attention to social determinants of health such as educational and training opportunities (Viner et al., 2012).
All these bio-psycho-social characteristics make adolescence a unique phase of the life cycle with many health risks and opportunities.

Health risks

Usually people think of adolescents as healthy individuals. Despite, many premature deaths do occur due to accidents, suicide, violence, pregnancy related complications and other illnesses (WHO, 2013). A great number of adolescents suffer from chronic pathologies and disability (Demmer et al., 2013; May et al., 2012; WHO, 2013). Additionally, many adulthood health problems have their origin in an unhealthy lifestyle in adolescence, including substance use, unprotected sex, sedentary behavior, poor diet practices (Astrup, 2001; WHO, 2013), smoking and alcohol drinking (Lucas et al., 2012).
These health risks may be a consequence of the previously mentioned psychological and social characteristics. The decision making process is more influenced by social than by health consequences (Steinberg, 2005), not having

in consideration long term results. It has been mentioned that some health problems, like adolescent obesity tracks into adulthood, therefore it seems important to consider prevention efforts at this point of life (Lee et al., 2013).

The increase of psycho physiological arousal leads to an increase in risk taking behaviors, with unknown or ignored costs (Craeynest et al., 2008; Schneider & Graham, 2009; Wood et al., 2013). In fact, it has been mentioned that adolescence is the life period were people engage in more risk behaviors (Steinberg, 2007), which may negatively affect the ongoing ages (Guo & Chumlea, 1999; Singh et al., 2008; WHO, 2013).

Health opportunities

Despite all the health threats mentioned before, adolescence has also some health opportunities.

The more complex reasoning and perspective, together with the identity questioning and developing may be used with positive health outcomes (Tsang et al., 2012). The adolescent is able to think about the importance that health and specific health outcomes have to him (Tsang et al., 2012).

Social recognition and peer relationships are fundamental at this point of life (Steinberg, 2005), if an adolescent is in a group of friends with a healthy lifestyle, he is more likely to engage with similar behaviors (Viner et al., 2012).

In parallel with the group identity, it occurs as well an individual identity development (Tsang et al., 2012). The adolescent is now able to choose what he wants to do, based on his own opinion, as for physical activity and food preferences (Craeynest et al., 2008; Taylor et al., 2005), what may also be influenced from the surrounding overall environment (Anderson-Bill et al., 2011).

The health opportunities are even more evident for older adolescents, since they are more likely to possess the needed competencies for health-related instruction and behavior change (Hintze et al., 2012).

Adolescents' lifestyles

The lifestyle concept is used in health and social sciences, usually referring to the activities, interests and opinions that characterize an individual (Vyncke, 2002). It is broadly recognized that not all members of one class share the same everyday activities. Lifestyles are, apart from age, determined by the important socio-structural dimensions, education, political, economic and cultural resources (Howell & Ingham, 2001; von Normann, 2009).

It has been suggested that lifestyles are reproduced inter-generationally, teenagers follow its parents, but they often mix and rearrange the styles (von Normann, 2009), influenced by their independent environments (Anderson-Bill et al., 2011; Stahl et al., 2001).

Many studies have proved that health preventive and risk behaviors tend to cluster (Fisberg et al., 2006; Iannotti & Wang, 2013; Marques et al., 2013; Nutbeam et al., 1991; von Normann, 2009).

An international 11-country study focusing on young people's health behavior, clustered health lifestyles into two groups: a health enhancing behaviors lifestyle; and a health-compromising behaviors lifestyle. This seemed to be a consistent pattern, indicating that health-related lifestyles of adolescents may not differ greatly between countries (Nutbeam et al., 1991).

A more recent research conducted in Germany with young adolescents, described five lifestyles: the outdoor sociability group, the multimedia orientation group, the high culture group, the sports groups and the indoor secluded group. The outdoor sociable lifestyle included adolescents that preferred activities such as: stroll around, be in contact by phone or SMS, listen to music, meet someone in fast food restaurants, go to pop concerts, dance, hang around, go to the cinema, use drugs, go to youth clubs, watch videos and read the newspapers. The multimedia oriented lifestyle was based on computer activities, either on week and weekend days, such as games, internet and videos, but also watching television. The high culture lifestyle was based on theatre, to play and listen to music (either classic or pop), and visits to museums. The sports oriented lifestyle was related to practicing sports, going to sport events or being member of a club.

The indoor secluded lifestyle integrated the teenagers that preferred reading all sort of books, comics or newspapers and visiting museums (von Normann, 2009). The same research concluded that the family-oriented lifestyle influences the children's food patterns in a positive way; while the non-family-oriented lifestyles, including outdoor lifestyle, lead to less preferable food patterns (von Normann, 2009). On the contrary, a Portuguese study, revealed that everyday outdoor play and structured exercise/ sport were positively associated with healthier lifestyle patterns (Marques et al., 2013).

Another research with a nationally representative sample of 9174 American adolescents aged 11 to 16 years, concluded that behaviors clustered into three classes: Class 1 - high physical activity and high fruit and vegetable intake and low sedentary behavior and intake of sweets, soft drinks, chips, and fries; Class 2 - high sedentary behavior and high intake of sweets, soft drinks, chips, and fries; and Class 3 - low physical activity, low fruit and vegetable intake, and low intake of sweets, chips, and fries (Iannotti & Wang, 2013), the first two classes suggest that both diet and physical activity behaviors cluster, either healthy or non-healthy. Data from the Portuguese survey of Health Behaviour School-Aged Children lead to a similar conclusion (Veloso et al., 2012).

Diet and physical activity in adolescence

Adolescents' diet

In the early 2000 a review about eating practices revealed that in the past decades it were observed major changes, with an increase in energy, fat and soft drinks consumptions, and a decrease in fruit, vegetables and milk ingestion (French et al., 2001), a study revealing Portuguese trends stated that the consumption of meat, milk and vegetables increased and the consumption of soup, fish and fruit decreased in 1998–1999 relative to 1995–1996 (Marques-Vidal et al., 2006). The reported increase of eating out in restaurants, the use of food prepared away from home and the bigger food portions have an undeniable

influence on the mentioned changes (French et al., 2001; Musaiger & Al-Hazzaa, 2012). Cheese consumption also increased in the same period, as a consequence of the consumption of pizzas and other cheesy fast foods (French et al., 2001). The same authors also mentioned the possible effect on eating behavior of the increased exposure to food messages with an incentive to consumption, in all the mass media (French et al., 2001). These diet changes seem even more concerning in what concerns children and adolescents, which is why adolescents' diet and eating behavior has been the focus of innumerous studies.

It seems that the transition from childhood to adolescence results in changes in diet quality. A longitudinal study concluded that the consumption of fruit, vegetables and milk decreased while the consumption of carbonated drinks increased from childhood to adolescence (Lytle et al., 2000). Other cohort studies corroborate these results, the Norwegian Longitudinal Study showed decreased fruit consumption and increased consumption of sweetened carbonated beverages in young adulthood (Lien et al., 2001); the Bogalusa Heart Study showed that the overall diet quality decreases from childhood to young adulthood (Demory-Luce et al., 2004).

Among all the concerns with adolescents, alcohol consumption is a worrying aspect on adolescents' nutritional intake, as longitudinal findings indicate that the alcohol intake increased (Nelson et al., 2009). In Portugal, although less than 15 % of Portuguese adolescents drink alcohol on a regular basis, about a quarter of the older male adolescents assume to drink beer or spirits regularly, it seems that age and gender have a significant impact on adolescents' alcohol use (Simoes et al., 2008).

Ten to 30 % of American adolescents skip breakfast, which is associated with higher body mass index (BMI) and unhealthier diets (Rampersaud et al., 2005), the same conclusion was verified in Portugal, where 5 to 13 % adolescents skip breakfast (Mota, Fidalgo, et al., 2008).

In fact, there is a consistent association of skipping meals with an increased obesity risk in children (Koletzko & Toschke, 2010), also for Portuguese adolescents (Mota, Fidalgo, et al., 2008). The study of the association of meal

frequency and “skipping” meals on obesity in urban adolescents from Porto, Portugal showed that the proportion of overweight/obese subjects that consumed fewer than three meals was significantly higher than those reported from normal weight peers (Mota, Fidalgo, et al., 2008). Each additional meal reduced the risk of being overweight/obese (Mota, Fidalgo, et al., 2008), as German and American studies showed as well (Koletzko & Toschke, 2010).

The trends of food intake for Portuguese adolescents were studied using national data from 1987 compared with data from 1995 and 1999. It was revealed a reduction of the number of meals and the decrease in the prevalence of fish and soup intake; and an increase in the intake prevalence of meat, milk, starchy foods, vegetables and fruit (Marques-Vidal et al., 2006). A tracking of healthy food choices seems to exist, adolescents alter their behaviors over time, but that change is relative to the actions of other students, results of a follow up study revealed that quintile groups maintain relative rankings in nearly all follow up moments, the students identified in the first assessment as making more healthy food choices continued that way, and those reporting less remained low (Kelder et al., 1994).

Overall, recent population studies show that adolescents do not meet the daily recommendations for fruit, vegetable, and whole grain consumption, and over-consume energy dense, sugary and salty foods (Holman & White, 2011). A research with 13 year old Portuguese teenagers can lead us to a similar conclusion, as it was referred that the main sources of energy were starchy foods (fries and chips included), dairy products, meat and sweets/ pastry (Araujo et al., 2011). This same research had other concerning results, when we analyze protein sources, seafood contributes with only 13.6 %, after meat, dairy and starchy foods (Araujo et al., 2011). In what concerns total fat sources, fats and oils represent only 11.6 %, with meat, starchy food, sweets and pastry and dairy with higher proportions (Araujo et al., 2011).

Looking for adolescents’ nutritional intake, in Spain, Italy and Greece, it is rich in total fat, in monounsaturated fatty acids, due to a high consumption of olive oil and in saturated fatty acids (Cruz, 2000), probably due to a high meat consumption. This means that two important characteristics of the Mediterranean

diet, a low consumption of saturated fatty acids and a high intake of carbohydrates have been lost in those countries (Cruz, 2000). In Portugal, data from mid ninety's reveal that the percentage of the energy provided by fat was around 33 %, carbohydrates around 49 % and protein 18 % of the energy intake (Cruz, 2000). Regarding micronutrients, there seems to exist a risk of deficiency, particularly for calcium, iron and zinc (Cruz, 2000). More recent data about nutritional intake of Portuguese adolescents from Azores showed percentages of the energy intake similar to previously reported ones, in all three macronutrients (Abreu et al., 2012). Another study with children revealed inadequate intakes of calcium, vitamin E, folate, molybdenum and fiber, while the contribution of total fat, saturated fat and sugars were far above the recommended (Valente et al., 2010).

Some gender differences in food preferences seem to exist, a recent study revealed that males have higher preferences for ''ethnic'' foods (i.e., fajitas, tacos, etc.), ''fish and casseroles,'' and ''beef, pork, and barbeque'' than females; while females prefer ''starches and sweets'' and "fruits and vegetables" more than males (Caine-Bish & Scheule, 2009). These preferences seem to translate into different nutritional and dietary intakes, boys report to consume more fat and were less likely to meet the recommendation of 6 daily servings of vegetables and fruit than girls (Simen-Kapeu & Veugelers, 2010).

Portuguese teenager males' diet may be higher in energy, total fat, total dairy, milk, and calcium intake and lower in carbohydrates and dietary fiber, compared to female teenagers. Similar intakes between males and females for protein, sugar, yogurt, and cheese intake are reported (Abreu et al., 2012).

Adolescents' physical activity

Adolescents may have a bigger risk of energy imbalance and irregular weight gain because of their growth cessation and simultaneous declines in physical activity (Kimm et al., 2002). The results of previous studies demonstrate that younger adolescents are typically more physically active than older adolescents (Baptista et al., 2012) , and that males are more active than females in all ages (Baptista et al., 2012; Molnar & Livingstone, 2000; Mota et al., 2007; Nilsson,

Andersen, et al., 2009; Santos et al., 2009). Physical activity declines with age in both genders (Nilsson, Andersen, et al., 2009; Ortega et al., 2013), but more evidently in females (Brunet et al., 2007; Kimm et al., 2002; Molnar & Livingstone, 2000). In a study with the Portuguese population, 36 % of the subjects aged 10 to 11 years accomplished 60 minutes of moderate to vigorous physical activity, while in the 16 to 17 years old group only 4 % did so (Baptista et al., 2012). There is an abrupt decline in physical activity from childhood to adolescence (Kimm et al., 2000), and throughout adolescence, particularly from 13 to 18 years old (Sallis, 2000), adolescent students are indeed changing their behaviors over time, but that change is relative to the behavior of their peers, as it seems that groups maintain relative rankings (Kelder et al., 1994). A follow up study revealed that in almost all follow up periods, the students identified in the first assessment as measuring high in physical activity remained high, and those measuring low remained low (Kelder et al., 1994).

It has also been shown that the transition from childhood to adolescence is associated with significant increases in sitting and other inactive activities (Hardy et al., 2007). Nowadays young people use more time with sedentary behaviors such as sitting, lying down, and screen activities (French et al., 2001; Shields, 2006). In 1988, adolescents reported watching 9 hours of television per week (Shields, 2006). In 2004, time spent in front of a television increased to 10 hours but when video games and time spent in front of a computer were considered, adolescents spent 20 hours per week in sedentary activity (Shields, 2006).

More time spent with screen activities has been correlated to consuming more unhealthy snacks (Rey-Lopez et al., 2011), increasing the risk of Metabolic Syndrome (Mark & Janssen, 2008; Mota et al., 2013) and interfering with normal sleep patterns (Jordan et al., 2008; Landhuis et al., 2008), a concerning factor if we remember that short sleep duration has also been associated with obesity (Chaput et al., 2008; Landhuis et al., 2008; Padez et al., 2009; Young, 2008). Inactive transportation has increased since the early nineties, people are now less likely to walk or bike for transportation (French et al., 2001).

Recently, the American Academy of Pediatrics published a policy statement warning health professionals to monitor sedentary activity in children and

adolescents because of these well-known adverse health consequences (Mulligan et al., 2011).

Numerous mechanisms have been proposed to clarify the association between sedentary activity and unfavorable health outcomes such as the decrease of vacant time for physical activity (Nelson et al., 2006), reduced metabolic rate (Klesges et al., 1993), bigger energy intake (Van den Bulck & Van Mierlo, 2004), and the influence of media publicity on unhealthful food items selection (Zimmerman & Bell, 2010), in fact, exposure to food publicity has increased in adolescents (Powell et al., 2010). These results may explain why it is suggested that sedentary behavior and physical activity in early adolescence both influenced body mass index in late adolescence (Elgar et al., 2005), or on the other hand, physical activity decline is influenced by the previous development of obesity (Salbe et al., 2002). Other study corroborated these findings, since it concluded that a significant inverse association between time spent watching television and cardio respiratory fitness over a 2-year period (Mota, Ribeiro, Carvalho, Santos, et al., 2010).

The benefits of being physically active have also been pointed out. The lower BMI in boys that engage with physical activity outside school (Mota, Ribeiro, Carvalho, & Santos, 2010); the higher likelihood of being classified with high blood pressure if do not practice physical activity, either as sports or leisure time (Gaya et al., 2011; Gomes Bda & Alves, 2009); and the higher odds of having a normal waist circumference and HDL cholesterol of adolescents that use active transportation (Pizarro et al., 2013). However the major benefit seems to be that physical activity direct correlates with physical fitness (Aires et al., 2012).

The results of longitudinal studies showed a strong relationship between lower physical fitness levels and a higher risk of being overweight (Aires, Mendonca, et al., 2010; Aires et al., 2012; Aires et al., 2008), in particular cardio respiratory fitness (Aires, Mendonca, et al., 2010; Aires, Silva, et al., 2010) and abdominal strength (Aires, Mendonca, et al., 2010; Mota, Vale, et al., 2010). Even so, some normal weight adolescents seem to be unfit (Aires et al., 2008). In fact, cardio respiratory fitness seems a very important variable to consider, since it has been proved that higher cardio respiratory fitness is associated with lower prevalence

of cardio vascular disease factors in adolescents, regardless of fatness (Martins et al., 2010); as lower muscle fitness is associated with higher metabolic risk (Mota, Vale, et al., 2010).

Several variables have been strongly positively related to physical activity in adolescents including male sex, white ethnicity, parental support, support from others, sibling physical activity, perceived activity competence, intention to be active, sensation seeking, previous physical activity, community sports and opportunities to exercise (Sallis et al., 2000), as well as parental behavior (Pakpreo et al., 2004). In addition, age, depression and time spent in sedentary activity after school and on weekends were inversely related to physical activity (Sallis et al., 2000).

There are some authors suggesting that individual characteristics, such as self-efficacy, and enjoyment related to sports, can significantly predict moderate to vigorous physical activity (Silva et al., 2012). In addition, individual characteristics seem to cluster, it has been mentioned that more active teenagers are also more engaged, during leisure time, in social activities and sports; active females also spend leisure time in artistic activities (Mota, Santos, et al., 2008).

The physical activity assessment methods still need to be developed one step further, even when objective measurement is used, like accelerometers. The compliance with guidelines for physical activity of a specific population of children or adolescents depends on the cut point used to interpret data (Mota et al., 2007). This lack of a global standard cut points give us disparities in terms of epidemiological data of physical activity, for instance in Portugal teenagers practice between 28 (Mota et al., 2007), 40 (Pizarro et al., 2013), 54 (unfit adolescents), 72 (fit adolescents) (Machado-Rodrigues et al., 2011) or even 111 (Mota et al., 2007) minutes of moderate to vigorous physical activity. Which results in different percentages of physically active adolescents: 35.7 % (unfit), 61.4 % (fit) (Machado-Rodrigues et al., 2011) or around 10 % of time spent in moderate to vigorous physical activities (Nilsson, Andersen, et al., 2009).

Overall it is difficult to compare physical activity between studies, since different counts per minute cut off points are considered (Guinhouya et al., 2013). However, it is possible to considerer European multicenter studies results, were

it seems that Portuguese adolescents are less physically active than adolescents from Estonia and Norway and more physically active than adolescents from Denmark (Guinhouya et al., 2013; Nilsson, Anderssen, et al., 2009). Analyzing these behaviors, it seems that the active ones engage in activities with higher intensity, and outside of school, which reinforce the importance of schools offering physical activities, mainly for the less active teenagers, (Mota, Silva, et al., 2008) and for girls (Silva et al., 2010).

In fact, a recent review on sedentary lifestyles in the European Union revealed that Portugal has the highest prevalence (87.8 %) of sedentary behaviors (Varo et al., 2003). This seems particularly important if we remember that sport engagement has the potential to promote healthy behaviors and healthy lifestyles (Pauperio et al., 2012).

Diet and physical activity as predictors of weight outcomes

Non-communicable diseases such as cardiovascular disease, cancer and diabetes are a major public health concern, and prevention, based on controlling modifiable risk factors, is crucial. One of the key modifiable risk factors for such diseases is overweight and obesity, particularly in young ages.

Population studies have documented a stabilization of the prevalence rate of overweight/obesity (Lien et al., 2010), a decline in physical activity (Hallal et al., 2012), and an increase in caloric intake over the past years (Piernas & Popkin, 2011), particularly in children and adolescents. Such data provide an empirical rationale for targeting weight control efforts in young ages.

Most of the prospective studies measure diet and physical activity and thus are able to examine its relationships with weight outcomes. Prospective analyses clearly established a link between unhealthy diet and physical activity behaviors and adverse weight outcomes.

Several dietary components and behaviors consistently predicted adverse weight outcomes including greater fat intake (Black et al., 2013) (total or saturated) (Gupta et al., 2010), higher consumption of fast foods (Fraser et al., 2012) and sugary drinks (Hu, 2013; Newby, 2007), and lower intake of fiber and/or whole

grain food (Brauchla et al., 2012; Zanovec et al., 2010). Other dietary components found to be predictive of weight gain included greater trans-fatty acid intake (Teegala et al., 2009), higher energy density (Mendoza et al., 2010), a dietary pattern characterized as “empty calorie” (Anderson & Butcher, 2006). Some controversy exists about the snacking behavior between meals (Keast et al., 2010; Sebastian et al., 2008), and about the milk and dairy intake as some studies suggest that it is inversely related to body mass index and body fat (Abreu et al., 2012; Bradlee et al., 2010), or are factors associated with a decreased risk of being overweighed (Nasreddine et al., 2014), however some longitudinal data suggest a greater weight gain among adolescents consuming more milk (Berkey et al., 2005). Other dietary items have been associated with a positive weight outcome, some cross-sectional studies suggest that intakes of grains (Bradlee et al., 2010; Zanovec et al., 2010) and total fruits and vegetables (Bradlee et al., 2010; Serra-Majem et al., 2006) are inversely associated with obesity among adolescents.

Weight gain is consistently associated with reduced levels of physical activity (Mota, Fidalgo, et al., 2008) and fitness (Aires, Silva, et al., 2010; Ferreira & Duarte, 2013) Obesity seems to be lower in people who maintain lifelong physical activity levels (Barr, 2001; Medicine et al., 2006).

As diet and physical activity are predictors of weight outcomes, it seems important to understand what factors may act as predictors, determinants and correlates of diet and physical activity.

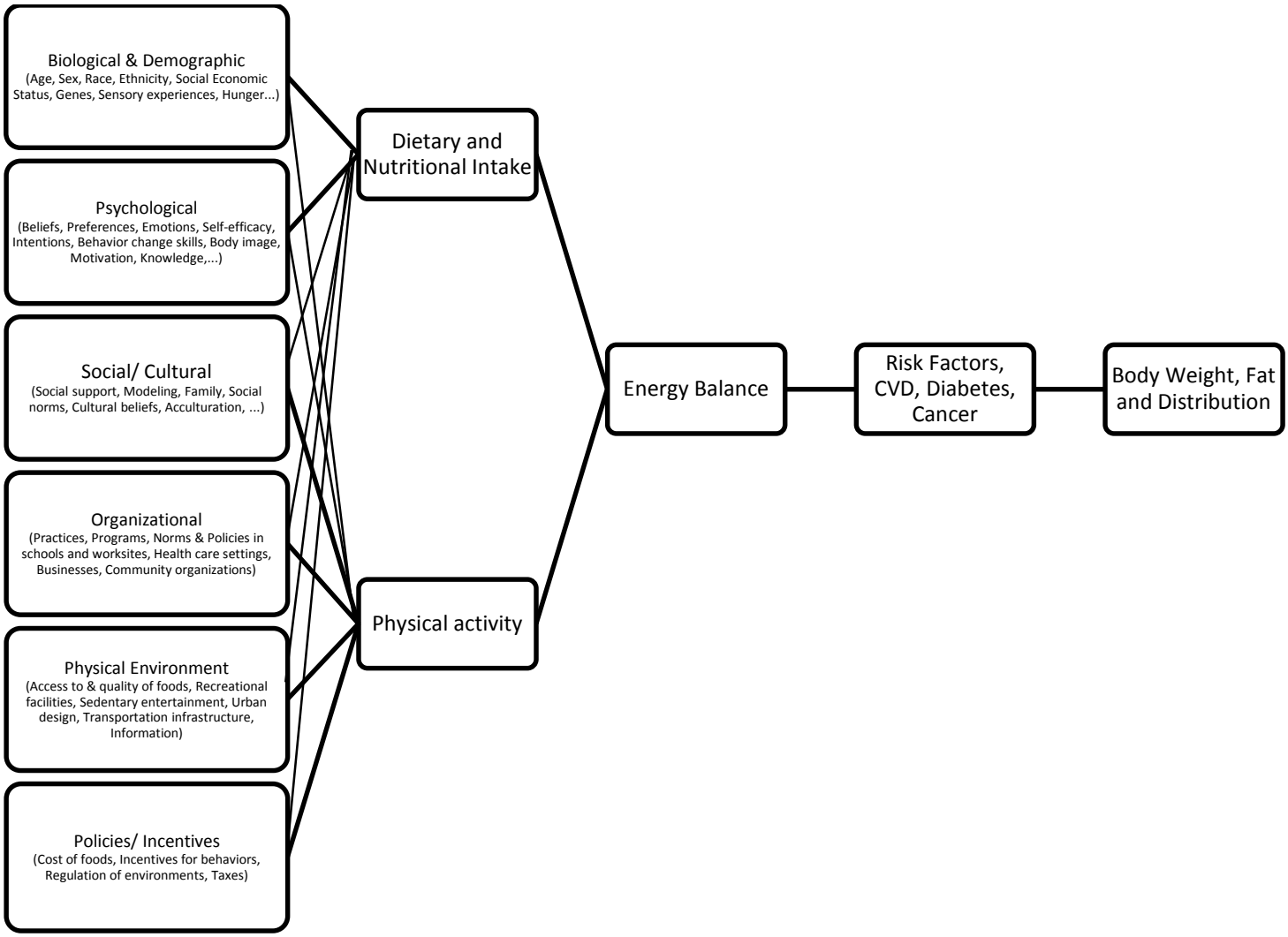
Physical activity, dietary and nutritional intake correlates

Numerous factors are somehow associated with physical activity and/or dietary behaviors, and identifying them has been a research topic in several studies. Those factors are labelled as “determinants” when a causality relation exists. However, most studies have used the word “determinant” when demonstrating associations or correlations, but in this case the more appropriate expression would be “correlates” (Bauman et al., 2002).

Overall the dietary and nutritional intake correlates coincide with the correlates for physical activity, and include all the factors that may be associated with the dietary, physical activity and sedentary behaviors. Usually they are categorized into two groups: external and internal (Hoelscher et al., 2002).

The external determinants comprise social/ cultural, organizational, physical environment and policies/ Incentives.

Figure 1. Ecological Model of Adolescents' Diet and Physical Activity



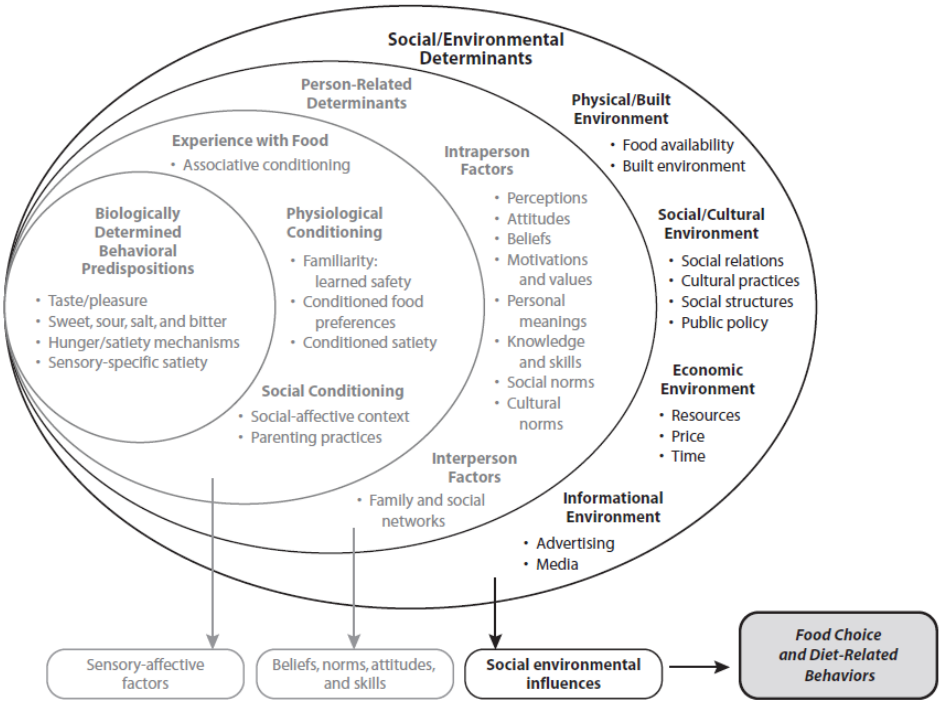
Adapted from the Ecological Model of Diet, Physical Activity and Obesity developed for the NHLBI Workshop on Predictors of Obesity, Weight Gain, Diet, and Physical Activity; August 4-5, 2004, Bethesda MD

The internal determinants include biological and demographic and psychological determinants. Figure 1 presents an ecological model of diet and physical activity and resumes the different dimensions of correlates of diet and physical activity. In order to guide the food choice of an individual or community researchers and public health professionals should have a great understanding on each of these aspects and on the interaction between them. It seems that intervening on one single determinant although important may be insufficient to produce a dietary or physical activity behavior change (Raine, 2005).

Dietary and nutritional intake correlates

Choices about food and eating have to me made several times a day, and this decision making process is a complex multifactorial procedure. As said above, the factors contributing to the diet behavior seem to coincide with the ones influencing physical activity, however some particularities have to be explored. Figure 2 resumes the different determinants of food choices.

Figure 2. Biological, personal, social and environmental determinants of food choices



In: Contento, I. R. (2011). Nutrition education linking research, theory, and practice (2nd ed.). Sudbury, Mass.: Jones and Bartlett

External correlates refer to the social and environmental aspects that although being outside the person, influence the individual behavior. In this group are included features of the physical environment, the social norms and support, organizational resolutions, economic and political issues.

It seems that public policies decisions, including food taxes and subsidies contribute to healthy consumption patterns at the population level (Thow et al., 2010), larger taxes tend to be related with more significant alterations in consumption, body weight and disease incidence (Thow et al., 2010), particularly for children and adolescents, low-socio economic status populations, and those most at risk for overweight (Powell & Chaloupka, 2009). So it has been suggested that taxes on carbonated drinks and saturated fat and subsidies on fruits and vegetables would be associated with beneficial dietary changes, with the potential for health gains (Eyles et al., 2012).

In fact, some economic theories assume that the price of food play a role in food choices. When considering the price per calorie, processed foods, high in fat and sugar are the cheapest, while the perishable products and animal protein are the more expensive ones (Drewnowski & Barratt-Fornell, 2004; Drewnowski et al., 2004). Although some cheap healthy options are available, like whole grain bread and beans, studies reveal that people with higher incomes spent the higher percentage of income in food (Putman & Allhouse, 1999), and have higher quality diets (Mancino, 2004). The household with low incomes seem to be saving money also by buying products on discount and from generic brands (Putman & Allhouse, 1999). Also for children and adolescents price is a diets' correlate (Engler-Stringer et al., 2014), as at these ages financial autonomy is greater than before (Verstraeten et al., 2014), and therefore an economic consciousness exists. Cheapness of fast food is acting as a barrier to the adoption of a healthy diet (Shepherd et al., 2006), in fact 15% of Portuguese students refer price as a barrier for an adequate dietary intake (Kearney & McElhone, 1999).

The physical environment includes the aspect of food availability and accessibility. Availability may be defined as the assortment of food items included in the food system on a consistent basis and affordable (WHO, 2014).

Accessibility refers to having sufficient resources to obtain food (WHO, 2014). It seems that sugary and fatty snacks accessibility is associated negatively with school children fruit consumption, as well as, salad bar availability and accessibility were positively associated with green vegetable consumption; and fruit and vegetables accessibility was associated positively with consumption (Terry-McElrath et al., 2014), it seems that a wider availability of healthy foods in general acts as a facilitator to a healthy diet for children and adolescents (Shepherd et al., 2006).

Some studies have been performed on the neighborhood influences in diet choices, and it seems that the availability of fruits and vegetables in the local grocery stores is correlated with a higher quality of the diet (Morland et al., 2002). A cross-sectional study from Canada revealed that the proximity to convenience stores in adolescents' home or school environments is associated with a poorer diet (He et al., 2012), similar conclusions are pointed in a recent review emphasizing a moderate association between the community and dietary intake of children and adolescents (Engler-Stringer et al., 2014).

The food items that are available in the several organizations where people spent most of the day, like schools in the case of children and adolescents, seem to determine dietary choices during the working/ school day, also because usually they are convenient and affordable (Finkelstein et al., 2008). Several descriptive and intervention studies proved that the school canteen, cafeterias and vending machines contribute greatly for the nutritional intake of children and adolescents, and are privileged places to design interventions to reduce the burden of obesity and the intake of sugar and fat, as well as increase the fruit and vegetables intake (Briefel et al., 2009).

School environment and policy changes can increase healthy eating (Belansky et al., 2013), as well as a poor school meal provision is assumed as a barrier to healthy eating (Shepherd et al., 2006). All the potential of inducing a healthy diet on adolescents in a school environment, resulted in schools being recommended as a primary setting for obesity prevention efforts in adolescence (Lee et al., 2013; WHO, 2009).

Other organizational contexts, like after-school activities (Hyland et al., 2006), sports facilities (Chaumette et al., 2009) and summer camps (Tilley et al., 2014) have also been suggested as having potential to promote adolescents healthy eating, or to act as a barrier.

Most eating events occur in the presence of other people, what enhances the effect social environments and cultural contexts have on dietary behavior. The social and cultural correlates are varied and include social support, social modelling, family context, social norms, cultural beliefs and acculturation.

Social modelling refers to the fact that people may absorb eating behaviors by observation of others (Grusec, 1992), including family, peers and social relevant people. But others may also be perceived as evaluators of the quality and quantity of food chosen and eaten (Herman et al., 2003). Particularly in adolescent girls the food choice may change to adapt to others choice (Bevelander et al., 2011), more evidently if the body size is considered, young women imitate the food intake of slim peers (Hermans et al., 2008). Also the quantity of food is biased, as evidenced by a study where the energy consumed on a breakfast by young females suffer a significant influence by the control females group (Hermans et al., 2010).

Another aspect to consider about the social modelling relies on the body image, appearance and attractiveness, in particular for adolescents the desire to take care of the appearance is referred as a facilitator to engage in a healthy diet (Shepherd et al., 2006). Body image is also a significant correlate of food choices (Bargiota et al., 2013), even after weight loss (Vieira et al., 2013).

Conclusions from studies on the social modelling evolved to researches testing positive social support and negative social pressure, contributing either to poor or nutritious eating habits.

Social support can refer either to the strategies adopted to manage the reinforcement of healthy consumptions and the discouragement of the unhealthy food choices, or from the emotional support from family and friends to engage in a certain behavior, both at home or on other social circles (Verheijden et al., 2005). A positive social support is related to positive changes in the dietary intake, it was associated with a positive progress in fruit and vegetables consumption

and with an evolution in the preparative stage for improving eating habits (Engbers et al., 2006). For children and adolescents family (Johnson et al., 2000; Shepherd et al., 2006; Stanton et al., 2007) and peers (Stanton et al., 2007; Verstraeten et al., 2014) support seems to be a strong facilitator of a healthy diet, mainly when eating with family and peers (Bargiota et al., 2013), in fact family meal frequency during adolescence has been positively associated with better meal quality and healthy meal patterns in young adulthood (Gillman et al., 2000; Larson et al., 2007) and children who eat fewer family meals are more likely to become overweight (Gable et al., 2007). Adolescents who are more involved in meal preparation (Gable et al., 2007) or who have better cooking habits and skills have better dietary habits (da Rocha Leal et al., 2011). It seems like some of the parental influence in food preferences passed on childhood is maintained through adolescence, (Pakpreo et al., 2004; Savage et al., 2007) in fact, a higher parental education seems to be associated with a higher contribution from healthier food groups to nutritional intake among Portuguese adolescents (Araujo et al., 2011). It seems that parents eating pattern have the potential of influencing their children (Contento et al., 2005; Fisher et al., 2002), furthermore children and adolescents who eat with their families have diets with higher quality (Gillman et al., 2000).

The social pressure over dietary choices during childhood and adolescence seems to be very important also later in life, as several participants of a previous study stated that the motives behind their food choices were consequence of the way they were educated early in life (Furst et al., 1996). Most participants in the mentioned research specified the influence from the social pressure applied by their families and the cultural and social norms (Furst et al., 1996), in fact, more recently, it has been mentioned that norms have a strong consistent correlation with children and adolescents eating behavior, being positively associated with fruit and vegetables consumption and associated with sweetened beverages. Peer norms and parent norms were positively associated with sweetened beverage consumption and milk norms were negatively associated with sweetened beverage consumption (McClain et al., 2009).

Time is also a correlate to consider in the food choice process. Nowadays people refer the time constraint as a limitation for several activities, including food

preparation and cooking (Mancino, 2004). The time issue can be perceived as a barrier to a healthy eating also by adolescents (Verstraeten et al., 2014) that spend most of the day away from home, therefore eating out and replacing meals for convenient snacks. It has been reported that 34 % of the European students perceive time as one of the major barriers to eat healthier (Kearney & McElhone, 1999), and among Portuguese adolescents available time was the main reason stated for the eating out frequency (Almeida et al., 2011).

Diet social correlates include out of home meals, in its several forms: traditional restaurants, fast food restaurants, cafeterias and canteens. For Greek adolescents, eating out with peers and eating from the school canteen was related with higher consumption of 'junk type of food' (Bargiota et al., 2013). Portuguese adolescents eat out often, mainly at lunch and snacks, but no information on the nutritional balance of these meals are available (Almeida et al., 2011).

The social economic status and the education level are diet related. It seems like more educated people and the ones with a higher income eat more healthfully (Mancino, 2004), reflecting the surrounding health promoting environments, but also the acculturation of the social economic class. The middle and high classes are more willing to make money, time and energy investments in their health (Mancino, 2004). A study with adolescent pointed out that disadvantaged school was significantly associated with obesity in adolescence for males and females and a disadvantaged family was significantly associated with obesity in young adulthood for females (Lee et al., 2013), in accordance mothers with a higher educational level facilitate healthier eating options (Bargiota et al., 2013).

Nowadays the social environment has a strong presence of the several sorts of media, television, radio, press and the internet. Therefore, communication is faster and ubiquitous, even nutrition communication.

The media have been mentioned as the main source of information about food, diet and nutrition (Lanigan, 2011), however quantity does not equal quality. A great amount of information available on the media is not evidence based and may result in a negative change in dietary behavior, what is of concern particularly in the case of children and adolescents. It has been suggested that efforts need

to counter inaccurate information and address the rationale for health practices (Lanigan, 2011).

Even so, when the information available is correct, it seems that media have the potential to influence positively the dietary intake, as adolescents consumption of fruit and vegetables have a positive association with the use of newspaper articles, the Internet and booklets as a source of nutrition information (Freisling et al., 2010), and exposure to television advertisements for fruit and vegetables appear to be associated with fruit and vegetables consumption among European 11-year-old adolescents, but this relationship seems to be mediated through cognitive factors such as attitudes and preferences (Klepp et al., 2007).

It is globally recognized that the marketing activities influence food choices and dietary intake (Buijzen et al., 2008; Coon & Tucker, 2002; Story & French, 2004). On one hand adolescents tend to buy and eat more products that were advertised, which generally include high sugar, fat and/or salt products, on the other hand, while exposed to television adolescents are more compelled to eat (Story & French, 2004). A study with Portuguese adolescents stated that television viewing is associated with higher consumption of fatty and sugary foods and a lower consumption of fruits and vegetables, translating into a higher intake of fat and a lower intake of minerals and vitamins (Ramos et al., 2013).

Internal determinants are inherent to the individual and are subject to its control. In this group of determinants, biological characteristics, cognitive factors and capabilities are included, like genetics, age, gender, knowledge, attitudes, beliefs, values, self-efficacy and expectations. Although the above-mentioned influence from the environment, ultimately is the individual that makes the choice of eating or not, and of what to eat.

Biological factors seem to be behind food choices, when asked most people refer the sensory perception of food (taste, flavor, smell, sight and texture) as a major correlate of their preferences and choices (Small & Prescott, 2005). The preferred flavors seem to have a biological predisposition, in particular the preference for sweet (Beauchamp & Mennella, 2011) that seems to be culturally universal and to remain during the course of life (Pepino & Mennella, 2005). The preference for

other flavors and nutrients seems to appear later in infancy (Mattes, 2009; Stein et al., 2012), and the early experiences may change the innately organization of taste preferences and aversions (Beauchamp & Mennella, 2011). The individual sensory response differences seem to be related to differences in the fungiform taste buds (Tepper & Nurse, 1998; Tepper et al., 2009), but also in food intake patters and body weight variations (Keller & Tepper, 2004). Nutrition educators should always consider the potential underneath the fact that most food preferences can be learned or conditioned (Beauchamp & Mennella, 2009; Contento, 2011), and there is strong evidence of preferences correlating to eating behavior of children and adolescents (McClain et al., 2009), either the overall taste preference (Verstraeten et al., 2014) and the preference for fast food, that was mentioned as a barrier to healthy eating (Shepherd et al., 2006). In fact for 29 % of the European students taste is mentioned as one of the major barriers to eat healthier (Kearney & McElhone, 1999), it seems like adolescents believe that healthy food is not tasty (O'Dea, 2003).

Hunger is originally the biological mechanism signalizing the need to have some energy input in the body. The physiological mechanism of hunger and satiety is complex, and it relates to the energy deposits of the body. These processes are not adapted to today's food energy density and overall environment, it seems that the weight control in the developed countries is no longer an unconscious, instinctual behavior, but instead, requires a great cognitive effort, and those who are not dedicating themselves to that effort will probably develop overweight (Peters et al., 2002). Hunger, appetite and satiety can however be influenced by several eating behaviors of the individual, as results tend to support a role of slow eating on decreased hunger and higher inter-meal satiety (Andrade et al., 2012). Besides biological internal determinants, the perceptions, expectations, beliefs, attitudes, motivations and emotions also have a powerful interaction with dietary intake. It is also important to understand why people don't engage with a healthy behavior, and the major reason seems to be the fact that 71 % of Europeans and 73% of Portuguese consumers believe they don't need to make any changes to what they eat, as they perceive it as already healthy enough (Kearney & McElhone, 1999). For children and adolescents there is a strong evidence of

intentions and the perceived modelling correlating to eating behavior (McClain et al., 2009). In addition, food choices may be influenced by personal meanings some food items have for each individual (Contento, 2011).

The social and environmental correlates mentioned before are experienced and interiorized differently by individuals in the same culture, based on their previous and forthcoming involvements. The environmental and social stimuli are processed cognitively and emotionally. For example although most people are exposed to information on the benefits of consuming more fruit and vegetables, the fact of knowing someone that suffered from obesity or someone that has kidney failure may act as a filter to this information (Contento, 2011), therefore an individual's perceptions concerning healthy eating and the perceived needs to alter eating behavior, can totally differ from those of the public and health professionals.

Food and nutrition-related behaviors are influenced by attitudes and motivations towards healthy eating. Some unfavorable attitudes can act as barriers towards the success of nutrition-information interventions. For example, an intervention study showed that consumers who were overweight, tended to have attitudes that negatively influenced the impact of a nutrition-information intervention. It showed that the attitudes of overweight consumers towards eating less fat in the intervention group was negative at the baseline and decreased even more towards the end of the intervention (12 months), leading to an ineffective intervention (Engbers et al., 2006). Will power can be a possible explanation to the failure of some behavioral change interventions, as it seems that will power is a strong facilitator to adopt a healthy diet (Shepherd et al., 2006), as well as self-efficacy (Johnson et al., 2000).

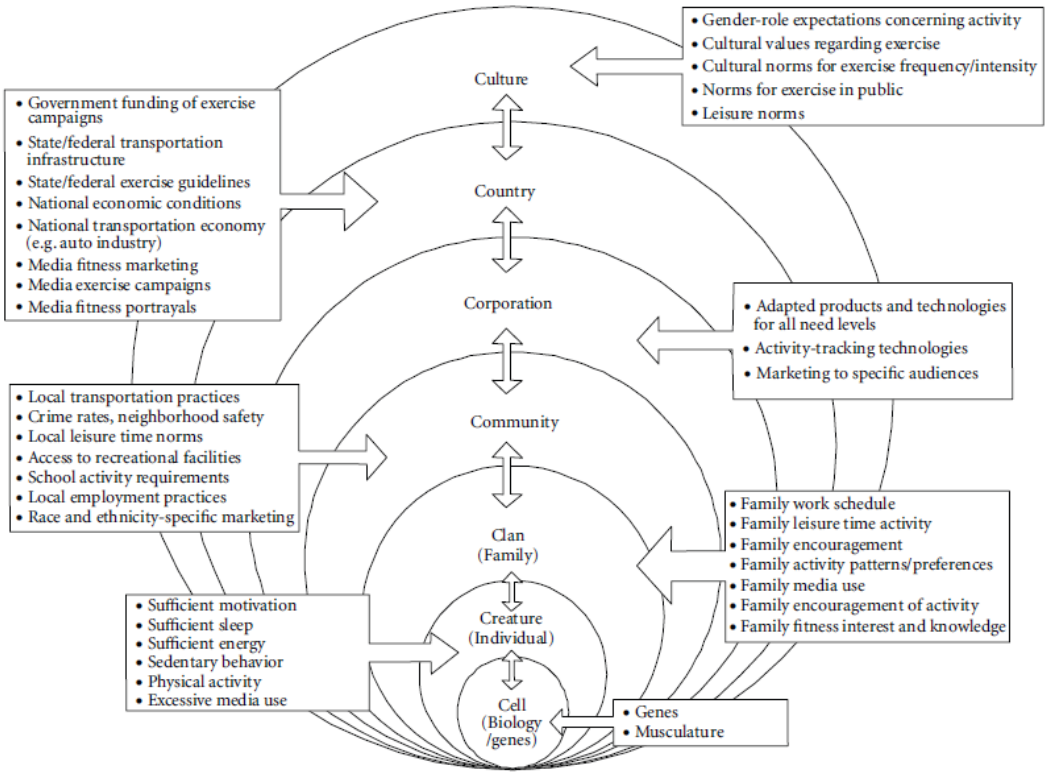
One of the most mentioned barriers to a healthy diet for adolescents is the belief that healthy food is not tasty nor convenient (O'Dea, 2003).

From all the individual correlates, nutrition knowledge is frequently mentioned in cross-sectional studies and targeted in most informational interventions and prospective studies. In this thesis the nutrition knowledge will be addressed in particular in a following section.

Physical activity correlates

Childhood obesity ecological models address physical activity and its correlates, which include individual issues, biological and psychological, as well as, social, cultural and political (Harrison et al., 2011). The 7-Cs Ecological Model (Harrison et al., 2011) was adapted, and a version that addresses physical activity across the lifespan was presented (Antonucci et al., 2012) (Figure 3)

Figure 3. The 7-Cs Ecological Model of Physical Activity



In: Antonucci, T. C., Ashton-Miller, J. A., Brant, J., Falk, E. B., Halter, J. B., Hamdemir, L., Konrath, S. H., Lee, J. M., McCullough, W. R., Persad, C. C., Seydel, R., Smith, J., & Webster, N. J. (2012). The Right to Move: A Multidisciplinary Lifespan Conceptual Framework. Current Gerontology and Geriatrics Research, 2012, 11.

External correlates for physical activity include policies, environmental and cultural issues.

International recommendations focus the urgency of governments developing and implementing policies for physical activity enhancement, mainly in children and adolescents (WHO, 2004).

Results from physical activity interventions suggest that policies that focus on increasing physical education in school, improving school environmental support and active transport/ urban design, and launching mass media/ advertising campaigns designed to increase physical activity levels in children and adolescents (Pate et al., 2011). In this context, researchers recommend that national physical activity policies for children and adolescent should include a physical education curriculum reform, the creation of extra-curricular activities, as well as approaches to environmental and social support (Mounesan et al., 2012). Other studies focus on environmental issues: in Portugal, adolescents of both sexes from rural settings are 76 % more likely to be classified as aerobically fit compared to those from urban areas (Machado-Rodrigues et al., 2011).

The ecological perspectives of physical activity consider the physical environment either as a facilitator and a barrier to physical activity (Perry et al., 2012). It has been theorized the opportunity for physical activity as the availability of sports and exercise facilities (Wong et al., 2014), supportive environments (Cleland et al., 2013), and programs (Wiecha et al., 2012). It has also been mentioned the need to address the kinds of exercise facilities and the distance to them as possibly interfering with physical activity practice (Limstrand & Rehrer, 2008).

Some research issues regarding the effectiveness of environmental interventions have been pointed: if it varies by type of access, if creating or improving access would motivate people to become active, if access would be enough to promote physical activity (Kahn et al., 2008). Other authors referred that the main influences on physical activity were physical activity promotion policy; public recreation facilities; youth sports; “walkable” communities; physical education class content and training; crime and perceived safety; as well as some school related: the use of school facilities; after school physical activity programs; availability of physical education classes; and incentives for sedentary leisure (Booth et al., 2001). When designing an intervention these are important aspects

to take in consideration in order to be successful and increase physical activity levels.

Adolescent girls report as a barrier for their participation in physical activity the feeling of unsafety in some facilities (Dwyer et al., 2006), however in Portugal this does not seem to be an issue as neighborhood safety was unrelated to the level of physical activity in previously reported data (Mota et al., 2005).

The access to facilities and programs and time spent outdoors also seem to be positively and consistently related to physical activity (Sallis et al., 2000), while inaccessibility and cost are presented as barriers to adolescent girls' physical activity (Dwyer et al., 2006). These studies emphasize the importance providing environmental supports for activity. In accordance, for Portuguese adolescents, the only variables associated with the level of physical activity were the amount of recreation facilities perceived and the aesthetics of the neighborhood (Mota et al., 2005).

Commercial physical activity facilities have also been studied and it seems to exist an association with physical activity, this association is reduced when controlling for per capita income (Powell et al., 2007).

The self-efficacy role as a mediator of the relationship between the perceived neighborhood safety, equipment accessibility, social support and physical activity was studied in adolescent girls and it seems that environments lacking in accessible equipment or perceived as unsafe may be negatively associated with self-efficacy, and consequently related to smaller levels of physical activity, but no direct effects from equipment accessibility or safety on physical activity where found; however direct effects existed from social support and self-efficacy to physical activity (Motl et al., 2007). Also a recent review indicated that for adolescents over 14 years social support was consistently associated with physical activity (Craggs et al., 2011).

It has been discussed that environments could work as mediators or moderators of physical activity, this is a neighborhood may have a new trail, which could directly increase physical activity; though, perceptions about the trail can be mediators to the change. There may also exist an interaction between the new trail and individual psychological aspects (Bauman et al., 2002).

Adolescents living in a neighborhood with several public recreation facilities and were other people are physically active (Mota, Almeida, et al., 2009; Mota, Ribeiro, et al., 2009), as well as environment aesthetics (Mota, Almeida, et al., 2009) positively influenced physical activity. But these variables seem to relate differently to males and females, girls' physical activity seems to be related to the availability of free, low cost recreational facilities in the neighborhood (Santos et al., 2009) or school sport activities (Silva et al., 2010), while for boys the presence of people being active in the neighborhood (Santos et al., 2009) or participating in sports clubs (Nilsson, Andersen, et al., 2009; Silva et al., 2010) have a stronger association.

Organizations where adolescents spend most of the day play a key role on their total physical activity, either with school policies for physical education and after school sports (Mounesan et al., 2012; Pate et al., 2011), or with the built environment they offer, for instance the availability and architectural design of elevators and stairs, it seems that if buildings are constructed with centrally located, accessible, and aesthetically pleasing staircases, a greater percentage of people will choose to take the stairs (Bassett et al., 2013).

Social and cultural influences in physical activity start within the family environment. The parental encouragement and modeling seem to be strongly correlated to adolescents' physical activity. Parental encouragement refers to all types of reinforcement for physical activity. Several studies have addressed this issue (Beets, Vogel, et al., 2007; Duncan et al., 2005).

Variables associated with encouraging a child to engage in physical activity include providing transportation and paying for physical activities (Davison et al., 2006; Hoefer et al., 2001). Another study revealed that girls who had higher encouragement from fathers had higher physical activity levels and higher levels of body satisfaction one year later, but no significant association was found with mother's encouragement (Savage et al., 2009). In coherence, results from a qualitative study indicated that the absence of parents' encouragement was a barrier to physical activity (Dwyer et al., 2006), so it is conceivable that as playing a role on physical activity enhancement, parents may as well inhibit the levels of physical activity.

It is suggested that social support (Silva et al., 2012) and parents' educational status is positively and significantly associated with being active, (Mota, Almeida, et al., 2009; Mota, Ribeiro, et al., 2009).

Parental modeling defines the parents' effort to act as a role model for an active lifestyle. In a review of physical activity correlates, parental physical activity level was found to be an important influence of adolescents physical activity, although some incoherent results of some of the studies included (Sallis et al., 2000).

Parents and children had their physical activity objectively measured and activity levels significantly and the parental engagement independently predicted the child's physical activity level beyond demographic and anthropometric variables also included in the study (Kalakanis et al., 2001). Also Portuguese adolescents seem to be more likely to participate in high physical activity when their mother and sibling(s) also participated (Seabra et al., 2011).

Among social correlates of adolescents physical activity peers play a central role. Six processes were identified through which peers and/or friends may influence adolescents physical activity including: peer and/or friend support, presence of peers and friends, peer norms, friendship quality and acceptance, peer crowds, and peer victimization (Fitzgerald et al., 2012). In effect, adolescents perceive peers as the main source of support for physical activity, and after controlling for gender and age, peer support presents a significant influence on after-school moderate to vigorous physical activity (Edwardson et al., 2013), also for Portuguese adolescents peers had a positive influence on participation in moderate and high physical activity (Seabra et al., 2011).

Biological and demographic correlates are usually mentioned as not changeable, and include physiological aspects, like age, ethnicity and gender (Seabra et al., 2008).

Several studies proved that age is negatively associated with physical activity time and intensity (Baptista et al., 2012; Nilsson, Andersen, et al., 2009; Ortega et al., 2013; Sallis, 2000; Seabra et al., 2008). The diminishment of sports participation and vigorous physical activity engagement significantly reduce with

age, while the leisure physical activity and low intensity seems to increase (Seabra et al., 2008).

The existence of a control center in the central nervous system with the capacity of regulating the physical activity engagement was proposed as a possible explanation for these age trends (Rowland, 1998). Also some endocrine aspects have been mentioned, the insufficient estrogen and low levels of noradrenalin, serotonin (Thorburn & Proietto, 2000) and a change in the dopamine system that regulates motivation for locomotion (Sallis, 2000).

However psychological, social and cultural aspects have been more widely mentioned, referring to the different parenting approaches to girls and boys, since early childhood.

Several psychological factors seem to correlate to adolescents' physical activity behavior. The perceived competence has been associated with physical activity, as did the self-efficacy (Horst et al., 2007; Sallis et al., 2000). Some controversies seem to exist for other correlates, as the enjoyment with physical activity, the perceptions of body attractiveness and overall self-worth, the mental health, the intention to be active and achievement orientation; some authors suggest these have a relationship with the practice, while others find a weak or no correlation (Horst et al., 2007; Sallis et al., 2000).

Attitude is commonly defined as an individual's evaluation of something, and may be described as having multiple dimensions like affective, cognitive, and behavioral aspects (Hagger & Chatzisarantis, 2008).

When attitude is assessed based on the affective dimension of enjoyment, it seems to be positively related to the intention for physical activity, however, intention does not seem to be associated with physical activity levels (Motl et al., 2002). Attitudes have also been measured with other psychosocial variables, like social norms, self-efficacy, and beliefs for physical activity and results appear to indicate that only self-efficacy is a key variable between obese and non-obese children (Trost et al., 2001), in fact a recent review affirms that physical activity attitude is consistently not associated with changes in the behavior (Craggs et al., 2011).

It has been suggested that individual characteristics, such as self-efficacy, and enjoyment related to sports, can significantly predict moderate to vigorous physical activity (Silva et al., 2012).

Enjoyment with physical activity has also been studied and correlational studies revealed that high scores on enjoyment of sedentary behaviors was associated with increased likelihood of being in the high-sedentary group for girls; but not for boys (Norman et al., 2005), the same was concluded using cluster analysis, as the high sedentary group reported higher levels of enjoyment for sedentary behaviors and this result differed significantly from the low and medium sedentary groups (Zabinski et al., 2007).

Self-efficacy is the evaluation a person does of his ability to overcome relevant obstacles for a certain behavior, like physical activity. Self-efficacy has been positively associated with physical activity (Craggs et al., 2011; Horst et al., 2007; Sallis et al., 2000).

A study showed that self-efficacy directly influenced physical activity in 6th grade girls, but not in 8th grade. For the younger girls, self-management some strategies, like thoughts, goals, and acts partially mediated this relationship. For the older girls, self-efficacy had indirect effects on physical activity that seemed to be interceded by self-management strategies and perceived barriers. This study suggested that the development of self-management strategies like positive thoughts, thinking about the perceived benefits, and making physical activity more enjoyable may positively impact physical activity. With older girls, strategies to overcome barriers as anxiety of humiliation and poor knowledge may be important aspects of the association between self-efficacy and physical activity (Dishman et al., 2005).

Previous authors planned an intervention with assessments of self-efficacy, outcome-expectancy, goal setting, and physical activity satisfaction. Results suggested that self-efficacy had a significant, direct effect on physical activity (Dishman et al., 2004), in accordance with other studies conclusions (Trost et al., 2003). Self-efficacy also seems to mediate the relationship between peer social support and physical activity (Beets, Pitetti, et al., 2007), and the effect of interventions on physical activity (Dishman et al., 2004). For Portuguese

adolescents self-efficacy correlates with parental social support, moderate to vigorous physical activity (P. Silva et al., 2014), and active commuting to school (K. S. Silva et al., 2014).

Motivation has consistently proved to be positively related to physical activity in adults, in particular intrinsic motivation being predictive of long-term exercise adherence (Teixeira et al., 2012). But in adolescents, although some support for self-determination theory do exist, a recent review revealed that there is a substantial heterogeneity in most the associations reported in the studies and many methodological shortcomings (Owen et al., 2014).

The physical activity correlate more deeply assessed in this thesis is physical activity knowledge, and will be addressed in the next pages.

Adolescents' nutrition and physical activity knowledge

Adolescents are confronted at every moment with the need to make decisions that will somehow influence their health: to cook or to order dinner, to ask for vegetables or chips, to walk or drive somewhere, to watch television or go for a bike ride, to go to the hospital or search the web for a medicine… Health professionals, parents, teachers or other adults are not always around when these decisions need to be made, so adolescents have to be informed, empowered and engaged to make the best possible choice (USDHHS, 2010).

Little is known about adolescents' health knowledge, but some studies on children revealed that they acquire their health knowledge through direct instruction, modeling and experiences with surrounding environments (Lanigan, 2011). The contexts in which children grow interfere with both their understanding and decisions regarding diet and physical activity, these contexts are mainly family and educational institutions (Lanigan, 2011). For adolescents also friends and peers contribute to health knowledge (Baheiraei et al., 2014; de Looze et al., 2012).

A better knowledge may not be a guarantee of a better health option, however not knowing leaves the health decisions as a random event.

Health knowledge has innumerous arms but in this thesis only nutrition and physical activity are approached, focusing on adolescents. In fact, education and information about physical activity and nutrition seems to be a way of promoting the development of positive health attitudes (WHO, 2004).

Nutrition knowledge

Nutrition knowledge can be defined as the individual cognitive process regarding diet, food and nutrition information (Axelson & Brinberg, 1992). Considering the broad range of the eating behavior, dietetics and nutritional sciences it seems insufficient to have one broad knowledge definition to include all these issues (Gleason & Rangarajan, 2000).

Several different authors attempted to find nutrition knowledge definitions to cover all the mentioned concepts. The social psychology divides the nutrition knowledge into two arms: the motivational knowledge and the instrumental knowledge (Contento et al., 1995). The motivational knowledge enhances consciousness and stimulates motivation (Contento et al., 1995), by the anticipation of the consequences or expected results (Contento et al., 2002). Instrumental knowledge is the practical knowledge of what and how to do (Contento et al., 1995).

Another concept that is explained by psychologist divides knowledge into declarative knowledge, as the knowledge of things and processes, for example knowing that a specific food item is rich/ poor in a specific nutrient or that one nutrient can prevent a disease; and procedural knowledge, as the knowledge of how to do something, for example how to choose a low salt packet of soup (Worsley, 2002).

For other authors the nutrition knowledge is divided in the knowledge about the food item and the knowledge about the effects of consuming one particular food item, therefore nutrition knowledge is not one single concept, and may interfere differently the dietary and nutritional intake (Wansink et al., 2005).

But all these definitions can be combined in a simple, but not simplistic idea, nutrition knowledge is the knowledge about nutrients and nutrition in all its

domains, hence it will accurately distinguish between experts from less informed people (Worsley, 2002).

Confusion between knowledge and beliefs is common, even among health professionals. Nutritional beliefs refers to the personal perceptions of food, diet, nutrition and health; while nutritional knowledge is a concept based in factual, evidence based information (Worsley, 2002).

Differences in nutrition knowledge across different samples have been studied.

To the best of our knowledge, the first published studies on nutrition knowledge were performed on adolescents (Goshtigian et al., 1976; Podell et al., 1975; Wagstaff, 1976), and in the eighties a study about nutrition knowledge on adolescents was performed with high school athletes and the results indicated that the female athletes had better knowledge and some significant relationships between sport forms, seasons, and nutrition knowledge and food practices were found (Douglas & Douglas, 1984).

Navy recruits nutrition knowledge was also studied, which at the time had score comparable with that of American adolescent students. Less than a half of the recruits were aware of: “how one assesses nutrient needs and whether those needs are being met”; “the four major food groups and recommended servings”; and “effects of alcohol and drugs on nutritional status” (Conway et al., 1989).

In the nineties a study with Nigerian individuals revealed a fair nutrition knowledge (Eneobong & Akosa, 1993). In the same decade, a longitudinal study with runners revealed that thy had fair nutrition knowledge scores, but over a 3-year time period, nutrition knowledge did not improve (Wiita & Stombaugh, 1996). Some years later a study with hockey players suggested little sport nutrition knowledge (Reading et al., 1999).

More recently, other authors suggest that American (DeVault et al., 2009) and British (Lakshman et al., 2010) children have good nutrition knowledge scores, prior to any intervention, but there is no consensus as other studies emphasize that the poor nutrition knowledge may be setting the stage for the obesity epidemic to continue (Zapata et al., 2008). In particular it has been emphasized that in multicultural contexts, adolescents demonstrate knowledge about the cultural and psychological aspects of nutrition, but are not able to identify the food

sources of nutrients or nutrient functions, and don't follow daily food guidelines to choose foods, although being aware of the importance of milk and vegetable consumption (Pirouznia, 2000).

Younger Taiwanese adolescents revealed a fair knowledge in nutrition basics, but poor in the "physiological function of nutrients", "relationships between diet/nutrients and disease", and the "daily serving requirement for different food groups", suggesting that they general valued the importance of nutrition, but did not concern the health benefit of foods (Lin et al., 2007).

A study from Italy with athlete and non-athlete adolescents revealed some nutritional misconceptions, but even so athletes scored significantly better, suggesting a favorable role of sport practice on nutrition knowledge (Cupisti et al., 2002), maybe a result from coaches nutrition knowledge (Juzwiak & Ancona-Lopez, 2004). Some studies revealed that large proportions of populations have misconceptions about personal dietary intake level and may misunderstand general dietary information (Zapata et al., 2008).

Results from the HELENA study, with adolescents from nine European countries, but not Portugal, state that adolescents have modest nutrition knowledge (Sichert-Hellert et al., 2011).

It is interesting to observe the evolution on the nutrition knowledge studies, however it should be emphasized the differences in the methodology, different questionnaires were used, and not all were validated instruments, so broader conclusions should be made with caution.

In Portugal no data on adolescents' nutrition knowledge was available, and a valid and reliable questionnaire to assess was inexistent prior to this thesis.

Some authors studied different correlates of the nutrition knowledge. Life experiences, social groups, role models, beliefs, physical and biological environments have been mentioned (Worsley, 2002). Higher educational level (Boulanger et al., 2002; De Vriendt et al., 2009; Parmenter et al., 2000), female gender (Heaney et al., 2011; Parmenter et al., 2000; Pirouznia, 2001; Sichert-Hellert et al., 2011), married status (Parmenter et al., 2000), also seem to positively correlate with nutrition knowledge. In addition nutrition knowledge increases with age (Sichert-Hellert et al., 2011); and being a no-smoker (De

Vriendt et al., 2009) and physically active (De Vriendt et al., 2009) also seem to be positive correlates of nutrition knowledge. Nutrition knowledge also seems to be related to socio-economic status (Boulanger et al., 2002), as individuals with higher income have better scores. However, parental health behavior , particularly regarding nutrition and physical activity seems not to be associated with adolescent knowledge (Pakpreo et al., 2004), on the contrary parental educational level is correlated, either for adolescent boys and girls (Sichert-Hellert et al., 2011). Another study suggested positive relationships among nutrition knowledge and nutrition attitude (Lin et al., 2007).

Nutrition education interventions ultimately aim to improve dietary and nutritional intake and health outcomes, like BMI. Many authors have attempted to test the association between intake and nutrition knowledge, but despite the intuitive appeal of education as a means of improving diet, many studies in this area have failed to find significant associations between nutritional knowledge and nutritional intake (Eneobong & Akosa, 1993). Since the way in which nutrition knowledge translates into dietary behavior and nutrient intake may vary among populations, it appears important to assess whether nutrition knowledge is associated with particular food choices and nutrient intakes before any nutrition intervention is initiated in a given population.

Contradictory results about nutrition knowledge and intake have been presented. Some authors refer a weak (Axelson & Brinberg, 1992; Heaney et al., 2011; Spronk et al., 2014) or no association (Bravo et al., 2006; de Jersey et al., 2013; Peltzer, 2002; Saarela et al., 2013), while others refer an association between nutrition knowledge and: the consumption of fruit and vegetable (Beydoun & Wang, 2008; De Vriendt et al., 2009; Escalon et al., 2013; Wardle et al., 2000), dairy products (Escalon et al., 2013), starchy food (Escalon et al., 2013), and fish (Escalon et al., 2013); total fat (Berg et al., 2002; Wardle et al., 2000) and fiber (Arnold & Sobal, 2000; Berg et al., 2002) intake; and the overall adherence to dietary recommendations (Sharma et al., 2008), or to the Mediterranean Diet Quality Index (Sahingoz & Sanlier, 2011)

Studies in adolescents (Bargiota et al., 2013; Lin et al., 2007), and adolescent athletes (Heaney et al., 2011) suggest that nutrition knowledge is related to

dietary behavior. Also American older adolescents presented a correlation between nutrition knowledge and food choices (Pirouznia, 2001).

Results from Italian adolescents suggest a positive relation between nutrition knowledge and several dietary and nutritional intake issues. After controlling for covariates, nutrition knowledge was positively associated with pasta/rice, fish, vegetable and fruit intakes, and negatively with sweets, snacks, fried foods and sugary drinks consumption; even more the adolescents with higher nutrition knowledge scores were less likely to have two or more snacks daily and to spend more than three hours in sedentary activities daily (Grosso et al., 2013)

Despite no consensus on the direct causal effect of nutrition knowledge on behaviors, recommendations have been made in order to enhance health curricula to devote adequate attention to promote nutrition and energy balance awareness (Budd & Volpe, 2006).

However, knowledge was not perceived as a major obstacle to trying to eat healthily, only 7 % of Europeans selected it as a barrier (Kearney & McElhone, 1999).

No consistent results exist regarding BMI relation with nutrition knowledge, some authors suggest a negative association (De Vriendt et al., 2009), while others refer that no association exist (Sichert-Hellert et al., 2011; Thakur & D'Amico, 1999).

Physical activity knowledge

Considering that health literacy has been defined as “the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” (USDHHS, 2010), physical activity knowledge can be defined as the ability to obtain, process and understand the benefits of physical activity on overall health. Public health experts have studied physical activity knowledge. A cross sectional survey was carried out in 23 countries, Portugal included, and the results emphasize that knowledge was very low, with only 40 to 60 % of university students being aware that physical activity was relevant to heart disease risk (Haase et al., 2004). Even more concerning are Portugal specific results, showing

that only 35 % recognized the association between physical activity and heart disease (Haase et al., 2004), these results are even more important when mentioning the significant reduction of students with this knowledge between 1990 (40,5 %) and 2000 (35 %) (Steptoe et al., 2002). There was a strong correlation between men and women knowledge, but significant differences were found between countries (Haase et al., 2004). Thus, it was suggested that a strong association between physical activity knowledge and economic development of a country probably exists (Haase et al., 2004).

American children aged three to five years old scored badly in a physical activity knowledge assessment, with 50 % of them being unable to score any point (Lanigan, 2011). As well a study with physical education students, from Brazil, reported most students do not have an adequate knowledge, in most items (Ribeiro et al., 2001). Also in Brazil elementary teachers obtained a medium physical activity knowledge score (Sousa et al., 2012).

However a study with urban Indigenous Australians, aged over 18, showed that they had excellent knowledge of the current physical activity guidelines, with between 66 and 92 % correct answers.(Marshall et al., 2008)

Few studies report demographic and socioeconomic correlates of physical activity guidelines knowledge. One study with kindergartens reported that high socioeconomic class and male gender had significantly higher scores, no differences were found regarding BMI (Nemet et al., 2012)

In Israel, researchers reported a physical activity knowledge score around 50 % in low socioeconomic kindergartens (Nemet et al., 2012; Nemet et al., 2013), considering it poor and significantly reduced compared to moderate and high socioeconomic children (Nemet et al., 2012).

The association of physical activity knowledge and practice has no consensus. Some authors proved significant associations between knowledge and practices, in women (Laosupap et al., 2008) and older adults (Salehi et al., 2010); knowledge was mentioned as being used to make and maintain changes in physical activity in type 2 diabetics (Rise et al., 2013). While other studies failed to prove this association, either in adults (Morrow et al., 2004), in indigenous Australians (Marshall et al., 2008) and in university students (Haase et al., 2004).

Some authors refer that there is a missing link between knowledge and practices, suggesting that the health outcome expectancy of needing more physical activity than recommended by experts is correlated with achieving more physical activity (Heinrich et al., 2011). The stage of change can be the gap between knowledge and behavior, previous results showed that knowledge and perceived benefits could predict physical activity stage of change (Salehi et al., 2010)

In what concerns physical activity preference, it seems that it is significantly correlated to physical activity knowledge, however preferences are significantly higher than knowledge (Nemet et al., 2012).

Parents' knowledge has also been referred as having a direct relationship with children's BMI z score, the "Obesity Resistance Model" showed that lower parental knowledge was associated with a higher BMI z score in children (Hendrie, Coveney, et al., 2008). However, parental behavior is not associated with adolescent knowledge (Pakpreo et al., 2004).

Despite the relation between physical activity knowledge and practices remaining a research question, recommendations have been made in order to improve health school curricula to devote adequate attention to reducing sedentary behaviors and increasing physical activity awareness (Budd & Volpe, 2006). However, if someone is planning an intervention or a research, it is important to remember that for physical activity knowledge a measurement effect has been reported (van Sluijs et al., 2006).

It has been previously mentioned that physical activity and nutrition knowledge scores are not significantly different in Israelis kindergartens (Nemet et al., 2012), but young American children demonstrated to have significantly better healthy eating knowledge compared to physical activity knowledge (Lanigan, 2011), the same result was reported from Brazilian elementary teachers (Sousa et al., 2012).

Nutrition and physical activity health interventions

Several studies and organizations (WHO, 2009) highlighted the importance of designing interventions in order to improve health behaviors, particularly diet (Barker et al., 1995) and physical activity (Pratt et al., 2008).

Early intervention and prevention are more effective and less costly (DeMattia & Lee Denney, 2008), so obesity prevention interventions are the most common, and frequently they integrate both nutrition and physical activity contents (DeVault et al., 2009).

Nutrition and physical activity school-based effective interventions include curriculum on diet and/or physical activity taught by trained teachers, supportive school environment/ policies, a physical activity program, a parental/ family component and healthy food options available through school food services: cafeteria, vending machines, etc. (WHO, 2009). School-based interventions show consistent improvements in knowledge and attitudes, behavior and/or biological/ clinical outcomes (WHO, 2009), as in schools there is a triple opportunity in the classroom, gymnasium and cafeteria (DeMattia & Lee Denney, 2008).

Parents and teachers should be actively engaged in the process of affecting and supervising policies and practices that foster a healthy school food environment (Kubik et al., 2005). Several studies proved the value of integrating teachers. In Portugal, an intervention with children and younger adolescents, using teachers previously trained reduced significantly the consumption of low nutrient energy dense foods in the intervention group (Rosario et al., 2013) and the increase in the BMI z score was lower in the same group (Rosario et al., 2012).

A nutrition knowledge intervention results suggest that there is the possibility of increasing knowledge and improving nutritional intake at the same time (Raiha et al., 2012), but few interventions examine long-term results.

School-based interactive approaches like *Top Grub,* a card game, proved to be capable of improving modestly nutrition knowledge among primary school children (Lakshman et al., 2010), but also more traditional approaches implemented by trained school teachers achieved a reduction of solid low-nutrient energy-dense foods (Rosario et al., 2013).

Message tailoring according to the extent of nutrition knowledge can represent more positive outcomes (Aldridge, 2006)

A meta-analysis of school-based physical activity interventions revealed that they seem not to be effective in improving BMI, although other beneficial health effects can be achieved (Harris et al., 2009).

Intervention studies on children (Dobbins et al., 2013; Harrell et al., 1996; Nemet et al., 2011; Nemet et al., 2013; Palmer et al., 2005; Rito et al., 2013; Sahota et al., 2001), grandparents (Kicklighter et al., 2009) and cerebral palsy patients (Maher et al., 2010) suggested positive influences simultaneously on physical activity behavior and/or fitness and knowledge; or increment in knowledge but no significant changes in moderate to vigorous physical activity practice in primary school children, both in the *Eat Well and Keep Moving* project (Gortmaker, Cheung, et al., 1999), in the *Pathways* project (Caballero et al., 2003), and in adults with intellectual disabilities (Bodde et al., 2012). There are also interventions that did not evaluate physical activity level, but revealed a significant increase in physical activity knowledge in students (McCreary et al., 2012), and in teachers (Sousa et al., 2012) or other adults (Irish Hauser et al., 2010).

In fact, a recent review reported that seven out of 11 interventions reported positive effects on physical activity knowledge; also seven out of 11 that reported positive effects on potential mediators, also reported positive outcomes on children's physical activity (Salmon et al., 2009). No study carried out a mediating analysis to attempt to recognize the mechanisms of change (Salmon et al., 2009). Interventions with minority children showed mixed results on physical activity knowledge (Slusser et al., 2013).

Also regional wide campaigns tried to improve physical activity knowledge. In Australia, there was the Premier's Physical Activity Taskforce that used the mass media to inform the population of the New South Wales state about the physical activity guidelines; results showed that physical activity knowledge increased significantly in all Australia, but more in the state with the campaign (Bauman et al., 2003). However in the Stanford Five-City Project the results showed no significant improvements in physical activity knowledge (Young et al., 1996).

There are not many interventions focusing physical activity and nutrition knowledge. The *Planet Health* was designed as an interdisciplinary curriculum designed intervention for childhood obesity reduction, however only girls showed

the expected outcome (Gortmaker, Peterson, et al., 1999). The *Sandy Lake* project for native Canadian children presented data about increased knowledge on a diet and physical activity curriculum, as well as dietary improvements (Saksvig et al., 2005). *It's All About Kids* intended to improve food choices and increase physical activity of children, and used knowledge as one of the outcomes, but no significant differences were found pre to posttest, except for significant improvements in knowledge of which food had more fat (DeVault et al., 2009), suggesting that an unknown link exists.

Adolescence is simultaneously a life period during which it seems fundamental to intervene in order to improve present and future health, and that has several psychosocial characteristics that allow to do it with positive outcomes. Wherever possible, adolescents should be supported in adopting health promoting behaviors through personal, community, and public policy supports (Raphael, 2013). Efforts must continue to shape health-related behaviors through the provision of opportunities for physical activity and a healthy diet (Raphael, 2013), for example with web-based interventions.

Web-based interventions seem to allow users to access information at their own pace (time, place, cognitive assimilation of information etc.) (Griffiths et al., 2006); permitting a better exposure and a more intensive cognitive processing (Brug et al., 2003). In particular, for adolescents also other advantages have been identified, the effect of novelty (Griffiths et al., 2006); the attractiveness of the internet to this age range (Griffiths et al., 2006); and the use of online communication as one of the main forms of communication for young people (Griffiths et al., 2006).

Moreover the use of technologies in interventions regarding health knowledge has been recommended (USDHHS, 2010), considering that personal feedback on health practices together with tailored information about the best health choices, has considerable potential to communicate a personal need to change (Moreno et al., 2008; USDHHS, 2010).

There is one web-based study with American preschoolers that presented results regarding nutrition and physical activity knowledge and referred the improvement

on both outcomes, as effective as the traditional face to face approach (Benjamin et al., 2008).

This thesis is part of a broader intervention project, the *AFINA-te*, which expects to contribute to the reduction of adolescents' obesity problem, through a website, school based intervention.

Chapter 2. Purposes and Structure

Purposes and Structure

Nutrition and dietary intake and physical activity engagement are the two main modifiable factors that can contribute to reduce the burden of obesity in adolescents. Understanding the factors underlying these two health behaviors seems fundamental to plan and promote effective heath interventions. The enhancement of nutrition and physical activity knowledge are the main focus of most interventions, which mostly follow an informative methodology, and this thesis is part of a broader intervention project, the *AFINA-te*, which intends to contribute to the reduction of adolescents' obesity burden, through a website, school based intervention.

In this context, it seems fundamental to understand if the nutrition and physical activity knowledge in Portuguese adolescents is related to their dietary and nutritional intake, physical activity engagement and anthropometric status. This was the main focus of this thesis, which is presented divided in four papers:

- **Paper I.** To adapt, update and validate the General Nutrition Knowledge Questionnaire for adolescents (GNKQA) in a Portuguese adolescent sample (Appendix I)

- **Paper II.** To validate of the Portuguese version of the International Physical Activity Questionnaire for Adolescents (IPAQA) (Appendix II)

- **Paper III.** To assess nutritional and physical activity knowledge association with body fat in adolescents

- **Paper IV.** To assess nutritional and physical activity knowledge association with practices in adolescents.

Chapter 3. Original Research

Paper I.

ACCEPTED

Adaptation, Update and Validation of the General Nutrition Questionnaire in a Portuguese Adolescent Sample

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Adaptation, Update and Validation of the General Nutrition Questionnaire in a Portuguese Adolescent Sample

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This article describes the adaptation of the adult Portuguese version of the General Nutrition Knowledge Questionnaire (GNKQ) for adolescents, and its validation. Respondents were 1,315 adolescents, who completed the questionnaire in two phases. A subsample of 73 adolescents was used to measure test–retest reliability. Concurrent validity was tested using a sample of 32 dietetic students. The adapted version showed high internal consistency (Cronbach's alpha = 0.92), test–retest reliability (R = 0.71) and concurrent validity (U = 22766.0; p < .01). Adolescents' nutrition knowledge can now be assessed with a valid and reliable instrument. Future validation works of this or others questionnaires for children and elderly are warranted.

KEYWORDS adolescents, nutrition knowledge, questionnaire, validation

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Several eating-behavior determinants have been studied, including nutrition knowledge (Raine 2005; Taylor, Evers, and McKenna 2005; Viswanath and Bond 2007). The influence of nutrition knowledge on food behavior has no consensus (Taylor et al. 2005): Some studies found a weak association or no correlation at all (Mullaney, Corish, and Loxley 2009; Pirouznia 2001; Serra-Majem et al. 2007); others found a significant positive association (De Vriendt et al. 2009; Shah et al. 2010; Sharma, Gernand, and Day 2008), or a positive association only with fruits and vegetables (De Vriendt et al. 2009; Parmer et al. 2009; Wardle, Parmenter, and Waller 2000) or fat consumption (Wardle et al. 2000).

Reasons have been pointed out for the weak associations: (1) poor nutrition-knowledge conceptualization; (2) lack of nutrition-knowledge relevance for the studied population; (3) poor correspondence between knowledge dimensions and food-consumption domains; (4) a small sample size; (5) data analysis inaccuracies; and (6) questionnaire inadequacy (using non-validated questionnaires) (Wardle et al. 2000; Worsley 2002). Thus, it seems important to validate questionnaires, adapted to sample characteristics such as age and cultural context.

Considering that several recommendations have been made regarding the importance of planning interventions on nutrition education for children and adolescents, namely focusing nutrition knowledge (Pratt, Stevens, and Daniels 2008; WHO 2009), it seems important to validate questionnaires that allow researchers to evaluate the impact of such interventions, allowing researchers to score nutrition knowledge also in younger samples.

The General Nutritional Knowledge Questionnaire (GNKQ; Parmenter and Wardle 1999) is one of the few that tests general knowledge and not a nutrition–knowledge specific area. It includes different sections: (1) dietary recommendations, (2) nutrient content of different food items, (3) dietary best choices, and (4) health/disease issues regarding diet. GNKQ has been proven to be valid and reliable in a UK adult sample (Parmenter and Wardle 1999), in an Australian community sample (Hendrie, Cox, and Coveney 2008), in a Turkish adult Sample (Alsaffar 2012), and in a Portuguese adult sample (Almeida-de-Souza 2009). However, in Portuguese adolescents, to the best of our knowledge, no validation has been published so far for this or other general nutrition-knowledge questionnaire, and few exist for other countries.

Since GNKQ development and validation, scientific knowledge and food practices have been in constant evolution, making necessary the instrument's update according to the latest scientific evidences.

The present work aims to update the Portuguese version of the GNKQ and to determine its validity and reliability in a Portuguese adolescent sample.

METHODOLOGY

The process of adaptation, updating and validation was done in two phases. Phase 1 consisted of making minor adjustments, and adapting the language of the original version of the GNKQ questionnaire. This adapted version was pilot-tested with 603 individuals to ensure age-appropriateness. In Phase 2, some food items were included and the score of each item was revised according to the latest scientific evidence (Anderson et al. 2009; Brown et al. 2009; de Sa and Lock 2008; He and MacGregor 2009; Hoffmann et al. 2003; Kipping, Jago, and Lawlor 2008; Kushi et al. 2006; Mirmiran et al. 2009; Ruxton, Gardner, and McNulty 2010). Results of the 603 Phase 1 questionnaires were analyzed regarding item difficulty, and the questionnaire was changed in accordance. The Phase 2 questionnaire was then tested with a sample of 712 individuals.

Sample characterization data for age, sex, and grade was collected in both moments.

Participants

The sample size was clearly over the minimum 400 individuals recommended for Internal Reliability studies (Charter 2003). The minimum subsample size of 30 for test–retest reliability was also assumed (Charter 2008).

For Phase 1, 603 high school students aged 11 to 19 years (mean = 16.4 SD = 1.71), who attended three different schools in the north of Portugal, comprised the study sample.

For Phase 2, the study sample consisted of 712 high school students aged 10 to 19 years (mean = 15.0, *SD* = 2.00), from 12 different schools distributed geographically in the north and center of Portugal. In Phase 2 we aimed to have a broader age-range representation, including more students from the younger-age group, which was considered insufficient in Phase 1.

Table 1 summarizes the Phase 1 and Phase 2 sample characteristics.

Ethical Approval

This study was conducted according to the guidelines from the Declaration of Helsinki and all procedures were approved by the Research Center in Physical Activity, Health and Leisure Scientific Committee. Written informed consent was obtained from all parents.

Directors of the involved schools gave their ethical approval. Adolescents were given an opportunity to refuse participation.

There was a guarantee of anonymous and confidential data analysis, for both the paper and online versions of the questionnaire.

TABLE 1 Demographic and Academic Characteristics of Adolescents and Dietetics Students Used for Concurrent Validity

			Phase 1			Phase 2			Dietetics students
			Total	Girls	Boys	Total	Girls	Boys	Total
Age		*n* (%)	601 (87.2)	315 (45.7)	230 (33.4)	712 (100)	294 (41.3)	289 (40.6)	18 (56.3)
		Mean (*SD*)	16.37 (1.72)	16.44 (1.68)	16.06 (1.72)	15.01 (2.00)	15.28 (1.94)	14.83 (1.94)	22.3 (0.77)
Grade	*n* (%)	Total	653 (94.8)	324 (42.0)	239 (34.7)	708 (99.4)	294 (41.3)	287 (40.3)	
		< 9th grade	222 (32.2)	108 (15.7)	100 (14.5)	206 (28.9)	75 (10.5)	101 (14.2)	
		9th to 10th grade	280 (40.6)	137 (19.9)	89 (12.9)	296 (41.6)	122 (17.1)	117 (16.4)	
		> 10th grade	151 (21.9)	79 (11.5)	50 (7.3)	206 (28.9)	97 (13.6)	69 (9.7)	
		Mean (*SD*)	9.36 (1.55)	9.42 (1.56)	9.06 (1.59)	6.35 (2.58)	6.45 (2.37)	5.79 (2.27)	

Note. SD = standard deviation.

Data Collection and Analysis

Data was collected between 2009 and 2011. This time frame did not affect the results of this study.

Two versions of the questionnaire were created: a paper version (machine-readable) and an online version. The latter was developed in order to reduce the item-non-response rate, as previously suggested (Denscombe 2009).

The first author and/or the responsible teacher from each class supervised the self-administration of the questionnaire to small groups, in a classroom environment.

In Phase 1 of the study, each answer was coded numerically and converted into two scores: the original score (according to the original version; Parmenter and Wardle 1999) and the Portuguese adapted score (considering the Portuguese Healthy Eating Recommendations; Rodrigues et al. 2006).

In Phase 2, each answer was coded numerically and converted into one score (the Portuguese adapted and updated score), considering the Healthy Eating Portuguese Recommendations (Rodrigues et al. 2006) and the most recent scientific evidence (Anderson et al. 2009; Brown et al. 2009; de Sa and Lock 2008; He and MacGregor 2009; Hoffmann et al. 2003; Kipping et al. 2008; Kushi et al. 2006; Mirmiran et al. 2009; Ruxton, Gardner, and McNulty 2010).

In both phases, each correct item was scored 1 point. Incorrect or missing answers were scored 0 points. Data analysis was performed using IBM Statistical Package for Social Sciences, version 19. Statistical significance was set at $p < .05$.

Content Validity and Questionnaire Refinement

The content validity is defined as the extent to which the questionnaire covers all dimensions present in the concept it is intended to reflect (Raykov and Marcoulides 2011; Terwee et al. 2007; Thorndike 1995).

The GNKQ intends to measure nutritional knowledge in a broad range of the concept. In this adaptation and validation process, for the Portuguese adolescent population, it was decided to keep the original authors' four areas: (1) expert dietary recommendations; (2) nutrient content of food; (3) healthier food choices; and (4) diet-disease relation. The same was done in the Portuguese adult version (Almeida-de-Souza 2009).

Phase 1

For the adaptation and validation for the Portuguese adolescent population, the adult Portuguese version was used and minor adjustments were made. The translation, cross-cultural adaptation, and validation to the adult population processes are described elsewhere (Almeida-de-Souza 2009).

Adjustments were intended to guarantee the GNKQ was language appropriate to the age range of the sample, and to ensure that the instrument was coherent with the new food guide for the Portuguese population (Rodrigues et al. 2006). All adjustments were done by an expert panel consisting of dietitians/nutritionists and teachers/professors with pedagogical background.

In section 1, the question regarding fruit and vegetable consumption was scored according to the Parmenter and Wardle original score (1999) (i.e., 5 or 6 portions a day) and according to the Portuguese recommendations (Rodrigues et al. 2006) (i.e., from 6 to 10 portions a day); the question regarding the dairy-fat-content recommendation also had two different scores: the original one (i.e., lower fat) and in agreement with the Portuguese recommendations (i.e., half-skimmed).

In section 2, in the question about the fat content of different food items, the cottage cheese was replaced with a low-fat Portuguese fresh cheese, considering adolescents' limited access to cottage cheese and/or knowledge of its existence, and the significantly higher availability of the low-fat Portuguese fresh cheese.

In section 3, the question asking for a low-fat, high-fiber snack choice was scored as the original score, considering the muesli bar as the correct answer because experts considered that Portuguese food habits do not include eating a recommended portion of raisins as a snack; as such, choosing carefully between the available options, the muesli bar seemed the most adequate option.

In section 4, in the question about health problems or diseases related to fruit and vegetable consumption, besides all the possible correct answers considered by the original score, "avitaminosis," or vitamin deficits, was also considered correct. In the question regarding health problems or diseases related to fat consumption "high cholesterol" was also considered a correct answer.

Phase 2

In Phase 2, the final version of the General Nutrition Knowledge Questionnaire for Adolescents (GNKQA) was developed; some food items were included by the expert panel, in order to update the questionnaire and to guarantee that all the Portuguese healthy-eating recommendations were covered. In doing so, we expected Portuguese adolescents to more highly identify with the questionnaire. The scoring of some items was also changed in this Phase 2 in order to guarantee the update of the questionnaire to current scientific knowledge.

In section 1, in the question about healthy-eating recommendations, two items were added: beans and vegetable soup.

In section 2, French fries and a ham-and-cheese puff pastry snack, both widely consumed by Portuguese adolescents, were added to the questions about food items considered to be high in salt and fat.

In section 4, in the question regarding cancer-prevention behavior, the word "fiber" was replaced by "whole grain cereals," as mentioned in the American Cancer Society Guidelines (Kushi et al. 2006). We also added a "yes-or-no" question about eating behaviors that can contribute to obesity.

Item Difficulty

An item is not considered useful if it is answered correctly by more than 90% or less than 10% of individuals (Domino and Domino 2006).

After collecting Phase 1 data, items that did not meet these criteria were excluded, except if they were considered essential for content validity by the expert panel.

In section 1, the first question asking about experts recommendations on "starchy food" consumption, the panel considered it more appropriate to change the broader expression "Starchy Food" for "whole wheat bread," since adolescents may not knew the meaning of "starchy".

In section 2, all items met the difficulty criteria, therefore no changes were made.

Section 3 had a question on the best food choice for a low-salt diet, and this question was excluded, considering that in section 2 the salt content of several food items was addressed.

In section 4, the open-answer questions on health problems related to fruit and vegetable consumption; low–dietary fiber consumption; high sugar consumption and high fat ingestion were statistically too difficult for this age range. The expert panel considered it more appropriate to convert the open answer into a "yes-or-no" answer. To guarantee coherence in the format, the question on health problems related to salt consumption was also changed. The latest published reviews in each subject were taken into account in the definition of the health problems/diseases mentioned in each question (Anderson et al. 2009; Hoffman et al. 2003; Polonia and Martins 2009; Ruxton et al 2010).

The last question of this section regarding antioxidants did not meet the difficulty criteria, and was considered by the expert panel that it was not age appropriate and eventually was excluded.

For Phase 2 results, all items met the difficulty criteria (Domino and Domino 2006).

Internal Reliability

Internal reliability of survey instruments evaluates reliability of different items intended to measure the same concept. Cronbach's Alpha is therefore widely accepted as a good statistical method to calculate this reliability (Raykov and Marcoulides 2011; Terwee et al. 2007; Thorndike 1995).

Phase 1

The GNKQ has four different sections, each focusing on a different category of nutritional knowledge. Thus the Cronbach's Alpha was performed individually for each section and for the whole GNKQ, according to the original score. For sections 1, 3, and 4, and for the whole GNKQ, Cronbach's alpha was also calculated for the Portuguese updated score. Section 2 did not have any specific Portuguese score.

Phase 2

The original four sections were maintained in GNKQA. Cronbach's alpha was calculated separately for each section and for the total GNKQA, using the adapted and updated score.

Test–Retest Reliability

During Phase 2 a subsample of 73 students (mean age = 16.3; *SD* = 2.28) completed the questionnaire on a second occasion between one and two weeks apart, in order to determine reproducibility (Terwee et al. 2007; Thorndike 1995; Raykov and Marcoulides 2011).

After performing normality tests, a Spearman Ró correlation coefficient between scores (total score and score for sections 1, 2, 3, and 4) on both occasions was performed to verify consistency (Raykov and Marcoulides 2011; Terwee et al. 2007; Thorndike 1995).

Concurrent Validity

In order to verify if the questionnaire actually measures nutrition knowledge, concurrent validity was tested (i.e., the ability of a questionnaire to distinguish between groups, which theoretically would happen) (Raykov and Marcoulides 2011; Terwee et al. 2007; Thorndike 1995).

The GNKQA was applied to a sub sample of 32 Dietetics students from the third and fourth year of the degree, considering these should have significantly higher knowledge. Table 1 shows the characteristics of this subsample.

To assess differences between groups in GNKQA scores, the Mann-Whitney U test was performed, after testing for normality. It was expected that dietetics students had significantly higher scores than the adolescent's sample.

RESULTS

Content Validity

After all the adaptation process, the resulting GNKQA had 137 items, distributed through the four original sections: Section 1, Dietary

recommendations; section 2, Sources of nutrients; section 3, Choosing everyday foods; and section 4, Diet–disease relationship.

INTERNAL RELIABILITY

Cronbach's alpha was performed to evaluate internal reliability during Phase 1 and Phase 2. Test value ranged from 0.22 and 0.87 in Phase 1, and from 0.33 to 0.92 in Phase 2. Internal reliability was very high in relation with the GNKQA total score, and high in reference to sections 2 and 4 (table 2).

Test–Retest Reliability

Spearman Ró correlation revealed acceptable test–retest reliability for the questionnaire total score ($R = 0.71$, $p < .001$) (table 2).

Concurrent Validity

Dietetics students' scores for each section, and for the total GNKQA, were significantly higher ($p < .01$) than the ones from the adolescent sample (table 3).

Data Collection Methods

After testing for normality, Mann-Whitney U test was performed to test the differences between scores of the questionnaires filled in paper version and

TABLE 2 Internal Reliability and Test–Retest Reliability

	Score	(*N* of items/MS)	Phase 1 Cronbach's α	Phase 2 Cronbach's α	*R*
Section 1	Original score	(11/11)	0.55	–	–
	Adapted score	(11/11)	0.55	–	–
	Final score	(13/13)	–	0.63**	0.44***
Section 2	Original score	(69/69)	0.85	–	–
	Final score	(73/73)	–	0.85	0.60***
Section 3	Original score	(10/10)	0.22	–	–
	Adapted score	(10/10)	0.29	–	–
	Final score	(9/9)	–	0.33	0.43***
Section 4	Original score	(17/20)*	0.71	–	–
	Adapted score	(17/22)*	0.72	–	–
	Final score	(42/42)	–	0.88	0.65***
Total	Original score	(106/110)*	0.87	–	–
	Adapted score	(106/112)*	0.87	–	–
	Final score	(137/137)	–	0.92	0.71***

Note. MS = Maximum score.
*One item had zero variance and was removed from the internal reliability analysis.
**Could be acceptable according to some authors; previous validation considered lowest values as moderate reliability.
***$p < .001$.

TABLE 3 Score Differences between Subsamples

	Adolescents sample (n = 712)					Dietetics students sample (n = 32)					
Sections	Min	Max	Median	IQR	Mean Rank	Min	Max	Median	IQR	Mean Rank	Mann-Whitney U
S1. Dietary recommendations	0	13	7	3	357.6	8	13	12	1	704.4	22013.0**
S2. Sources of nutrients	0	62	35	13	356.6	52	72	64	7.5	727.0	22737.0**
S3. Choosing everyday foods	0	9	4	2	357.2	6	9	9	2	712.4	22267.5**
S4. Diet–disease relationship	0	34	19	11	356.7	28	42	34	7	724.1	22641.5**
GNKQA – Total Score	2	113	64	24	356.5	98	134	116	13	727.9	22766.0**
	Female (n = 294)					Male (n = 289)					
GNKQA – Total Score	12	98	65	20	323.2	3	95	58	21.5	260.3	33317.0**
	Online version (n = 230)					Paper version (n = 482)					
GNKQA – Total Score	2	113	75	21	474.1	12	108	59	21	300.4	28382.0**

Note. S = Section; Min = Minimum; Max = Maximum; IQR = Interquartile range.
**$p < .001$.

the online version. The online version had significantly higher scores than did the paper version ($p < .00$). Demographic samples were not significantly different (table 3).

Nutrition Knowledge

After testing for normality, the Mann-Whitney U test was performed to test the differences between questionnaire scores of adolescent boys and girls. Girls had significantly higher scores ($p < .00$) (table 3).

DISCUSSION

The present work adapts, updates, and validates the GNKQ to be used with Portuguese adolescents. As far as we know, there is no published work studying nutritional knowledge in Portuguese adolescents, and we believe that this is due to the inexistence of validated questionnaires. Several previous published works aimed to study the relation between health knowledge and practices, particularly nutrition related studies (De Vriendt et al. 2009; Mullaney, et al. 2009; Parmer et al. 2009; Pirouznia 2001; Raine 2005; Serra-Majem et al. 2007; Shah et al. 2010; Sharma et al 2008; Taylor, et al 2005; Viswanath and Bond 2007; Wardle et al 2000). Some critics have been made to the use of non-validated and not age specific questionnaires or to the lack of coverage of all aspects regarding nutrition knowledge (Wardle et al 2000).

The original GNKQ was developed in 1999. Since then several scientific reviews on the aspects covered in the questionnaire were published. During content validity our expert panel considered it important to change some items' scoring and to include some new items; originating a different score for the GNKQA, but keeping the original structure. As researchers, we strongly recommend that before the use of any knowledge questionnaire, an update revision to the scoring should be done.

GNKQA proved to be reliable to use as a whole, to administer sections 2 and 4 individually, if intended to evaluate only the covered nutrition aspects mentioned there.

The two sections with lower reliability were the ones with fewer items, which could in part explain the results. It is described that the test value tends to increase as the number of items increases (Thorndike 1995). In coherence, the previously validated versions of the GNKQ had lower Cronbach's alphas in these sections, comparing with sections 2 and 4 and with the total score (Hendrie et al 2008). Also, in the present work, the scores with the bigger (total GNKQA) and smaller (section 3) number of items, had the highest and lower test values, respectively.

The section 1 reliability coefficient of 0.63 could be acceptable, according to some authors; and previous validation of GNKQ considered the lower

values of Cronbach's alpha as moderate reliability indicators (Hendrie et al. 2008).

Test–retest reliability was acceptable, showing the ability of GNKQA to consistently assess knowledge over time, enhancing its aptitude to adequately evaluate changes after nutrition-education interventions.

The correlation coefficient of the Portuguese version was slightly inferior to the ones mentioned in the previous validation studies (Alsaffar 2012; Hendrie et al 2008; Parmenter and Wardle 1999), which may be explained by the age differences of the studied samples.

Concurrent validity proved that this questionnaire was able to effectively distinguish between groups with different nutrition-knowledge levels, as its previous versions did (Hendrie et al 2008; Parmenter and Wardle 1999).

Regarding the two data-collection methods, the online version had a significantly higher score than that of the paper version. Previous studies found the same results, and suggested that this finding could be related to a smaller item-non-response rate (Denscombe 2009; Kongsved et al. 2007).

As previously suggested for adults (Parmenter, Waller, and Wardle 2000), as in our adolescent sample, girls had a significantly higher total score. These results suggest that the girls' greater interest in nutrition starts early in adolescence.

We can state as a limitation to the present validation process the fact that the sample of Dietetics students included only girls, but the higher-education institution that collaborated with this research had only two boys in the selected academic years, and they refused to participate.

The length of the questionnaire was also mentioned by the expert panel and by adolescents as a negative factor. On average, it took 20 minutes for an adolescent to answer the whole questionnaire. We should highlight that comments reporting test duration as a constraint were written by the sub-sample that answered the paper version, and not by those who responded online. The possibility of administering sections 2 and 4 independently can be part of a solution, whenever it would be sufficient to assess only some aspects of nutrition knowledge.

CONCLUSION

In conclusion, Portuguese adolescents' nutrition knowledge can now be assessed with a valid and reliable instrument. The GNKQA may be of general use for researchers or dietetics and nutrition professionals working within nutrition-education interventions for adolescents; offering the possibility to evaluate the results of interventions in a reliable and consistent way.

We consider that the GNKQA can also be used in clinical contexts, and by non-experts in the nutritional sciences, as the instrument is easy to use and score—the online version, in particular. It has been suggested that

online assessment is a good methodology, as it saves resources, provides more complete answers, and facilitates data collection in follow-up studies (Kongsved et al. 2007).

The process of translating and validating this adapted version for other languages/countries would be of great benefit to the research of adolescents' diet correlates, particularly in regards to the relationship between nutrition knowledge and diet.

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Paper II.

SUBMITTED

Validation of the Portuguese version of the International Physical Activity Questionnaire for Adolescents (IPAQA)

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Validation of the Portuguese version of the International Physical Activity Questionnaire for Adolescents (IPAQA)

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Abstract

Questionnaires have been broadly used to assess physical activity in adolescents, however validation studies, although essential, are not always performed. The present work aims to determine the validity of the Portuguese version of the International Physical Activity Questionnaire for Adolescents against 3 axis Actigraph accelerometers.

A cross-sectional study was conducted, with a sample of 222 adolescents, with a mean age of 15.6 years (SD=2.05). After translation and cross cultural adaptation, data obtained from the questionnaire was correlated to accelerometers data, using Spearman correlation coefficient. Percentages of agreement of physical activity tertiles obtained by each method were tested using Cohen's Kappa. Statistical analysis was performed for the total sample, per sex and per age group.

A significant correlation between the questionnaire and accelerometer was found for older adolescent boys, for total physical activity (ρ=.372; P<.01), and for moderate to vigorous physical activity (ρ=.428; P<.01) No correlations were found for the younger adolescents and girls. A 42.3 % agreement was found for the questionnaire and accelerometer tertiles of total physical activity.

The concurrent validity proved that the questionnaire might be valid only for older adolescent boys. The authors consider that whenever available physical activity objective measurements should be used instead of questionnaires.

KEYWORDS: Motor activity, Questionnaires, Adolescent

Introduction

Regular physical activity has been widely mentioned as contributing to several health benefits in all age ranges, namely for mental health (Biddle & Asare, 2011), bone health (Boreham & McKay, 2011), diabetes (Chimen et al., 2012), cardiovascular disease (Shiroma & Lee, 2010) and obesity (Janssen & LeBlanc, 2010).

Physical activity (PA) assessment is therefore essential in surveillance, screening, programme evaluation and intervention studies. In order to obtain valid and reliable measures of PA, objective and improved methods of evaluation are recommended (Rowlands & Eston, 2007; Vanhelst et al., 2012), such as those from accelerometers, although they have a high cost and frequently are unavailable. In children and adolescents the difficulties of use have been referred (Audrey et al., 2012; Ottevaere, Huybrechts, De Meester, et al., 2011; Van Coevering et al., 2005). And considering the recommended protocols, particularly in larger sample studies, questionnaires have been used as an alternative (Araújo-Soares et al., 2009; Lacy et al., 2012; Lopes et al., 2013).

The International Physical Activity Questionnaire (IPAQ) is the more widely used and accepted questionnaire; it has proven to be valid and reliable for adults, in several countries and in different formats: long version, short version, self-reported and telephone interview (Craig et al., 2003).

Researchers detected the need to validate a PA questionnaire for adolescents, because the type and duration of activities are unique for this age group, although adolescents' PA is more similar to that of adults than of children (Janssen, 2007). Hence, adaptations and validations of IPAQ for Adolescents (IPAQA) have been published in some countries (Guedes et al., 2005; Hagstromer et al., 2008; Lachat et al., 2008; Rangul et al., 2008). Although a validation of IPAQ for Portuguese adults has been done (Marshall & Bauman, 2001), the Adolescents version, IPAQA, is not yet validated for Portuguese adolescents.

The present work aims to determine the validity of the Portuguese version of the IPAQA using GT3X+ Actigraph accelerometers.

Methods

Study Sample

A convenience sample of 222 high school students (123 girls), from two different schools in the north of Portugal, completed the questionnaire. Schools were included based on their willingness to participate, and on socioeconomic similarity; the 222 students included were the ones present at classrooms on the days of data collection and when the accelerometers were distributed. Participants had a mean age of 15.6 years (SD=2.05) and body mass index (BMI) age centile classification revealed 31.2 % of adolescents with overweight/ obesity. Tables 1 and 2 summarize sample characteristics, per age group.

Ethical Approval

This study was conducted according to the guidelines defined in the Declaration of Helsinki and all procedures involving human participants were approved by the Research Centre in Physical Activity, Health and Leisure Scientific Committee. Written informed consent was obtained from all the parents or legal guardians.
The involved schools' directors gave their ethical approval. Adolescents were given the opportunity to refuse participation.

Data collection

Data were collected between 2011 and 2013.
In the first visit to each classroom, anthropometric assessment was performed and accelerometers were distributed. Height was measured using a SECA 217 portable stadiometer, with a 0.1 cm precision. Weight was assessed with 100g precision, using TANITA BC-545 body composition analyser. This equipment was also used to determine body fat percentage. Body mass index (BMI) was calculated and categorized according to Centers for Disease Control and Prevention 2000 (Ogden et al., 2002). The minimum perimeter between the iliac crest and the rib cage corresponded to the waist circumference and the maximum protuberance of the buttocks corresponded to the hip circumference. A non-elastic tape was used to measure circumferences. For all anthropometric assessments adolescents wore light clothes.

Table 1. Descriptive data and Mann-Whitney U comparison of anthropometric characteristics and physical activity obtained by accelerometer and IPAQA, for adolescents aged 14 years or under.

		≤14y								Boys vs. Girls	
		Girls (n=33)				Boys (n=42)				Mann-Whitney U	
		Mean ± SD	Median	IQR (P25-P75)	IQR	Mean ± SD	Median	IQR (P25-P75)	IQR	Z	P-Value
	Age (years)	13.1±0.6	13.0	(13.0-14.0)	1.0	13.2±0.6	13.0	(13.0-14.0)	1.0	-.291	.771
	Height (cm)	156.9±6.0	157.0	(152.0-162.0)	10.0	158.4±7.8	158.7	(152.8-164.0)	11.3	-.887	.375
	Weight (kg)	53.2±9.4	53.0	(48.4-58.1)	9.8	52.6±12.3	50.7	(46.0-58.0)	12.0	-.806	.420
	BMI (kg.m^{-2})	21.5±3.0	21.5	(19.6-23.2)	3.6	20.9±4.2	20.6	(18.1-22.3)	4.2	-1.473	.141
	BMI Centile	72.2±22.5	79.3	(62.3-89.1)	27.8	65.2±27.8	75.3	(45.0-86.3)	41.3	-.934	.350
	Body Fat (%)	30.6±6.7	28.4	(26.1-33.9)	7.8	23.1±7.8	20.8	(17.4-26.2)	8.9	-4.606	**.000**
	Waist Circumference (cm)	71.6±7.8	69.2	(67.0-76.2)	9.2	71.6±12.8	68.0	(66.4-74.1)	7.7	-1.267	.205
	Hip Circumference (cm)	89.3±7.1	89.0	(86.0-93.5)	7.5	86.1±10.0	82.5	(80.0-89.3)	9.3	-2.720	.007
Accelerometer	Total Measured Time (min.day^{-1})	850.9±64.1	876.6	(788.6-905.6)	117.0	812.8±72.2	827.6	(776.6-868.1)	91.5	-2.177	**.029**
	Sedentary PA (min.day^{-1})	509.4±85.7	514.3	(454.9-567.8)	112.9	446.4±104.0	420.2	(371.1-510.2)	139.0	-3.213	**.001**
	Light PA (min.day^{-1})	295.3±64.1	276.0	(253.4-343.1)	89.7	315.5±61.8	313.7	(264.4-366.1)	101.7	-1.291	.197
	Moderate PA (min.day^{-1})	36.0±15.1	31.3	(26.2-49.3)	23.0	55.1±17.7	54.3	(41.7-67.4)	25.6	-4.376	**.000**
	Vigorous PA (min.day^{-1})	10.2±11.2	4.8	(2.5-17.3)	14.8	15.7±10.7	11.8	(7.2-24.3)	17.1	-3.047	**.002**
	MVPA (min.day^{-1})	46.2±22.9	41.9	(31.1-66.8)	35.6	70.8±24.8	65.3	(49.8-86.6)	36.8	-4.093	**.000**
	Total PA (counts.min^{-1})	427.3±132.6	404.2	(350.2-494.2)	144.0	584.6±145.1	590.8	(460.9-709.6)	248.7	-4.344	**.000**
	Total PA (steps.day^{-1})	14875.1±5136.9	15495.8	(10141.6-19160.3)	9018.7	16953.4±5582.1	18220.8	(12284.2-20918.1)	8633.9	-1.569	.117
IPAQA	Total Reported Time (min.day^{-1})	150.0±120.7	98.6	(77.7-208.6)	130.9	160.6±109.8	139.3	(62.7-230.4)	167.7	-.576	.564
	Motor Transportation (min.day^{-1})	19.6±20.0	19.0	(0.0-30.0)	30.0	29.4±41.9	7.1	(0.0-51.4)	51.4	-.016	.987
	Walking (min.day^{-1})	60.0±47.3	51.4	(25.4-75.0)	49.6	54.2±52.5	45.2	(8.2-90.4)	82.1	-.823	.411
	Moderate PA (min.day^{-1})	48.4±55.4	30.0	(7.1-64.3)	57.1	52.7±52.4	37.6	(10.7-83.6)	72.9	-.427	.669
	Vigorous PA (min.day^{-1})	41.6±40.9	25.7	(12.9-64.6)	51.8	53.6±43.6	36.4	(19.8-77.8)	58.0	-1.580	.114
	MVPA (min.day^{-1})	90.0±87.7	52.6	(31.4-121.8)	90.4	106.3±77.4	87.4	(39.6-167.1)	127.5	-1.185	.236
	Total PA (MET.min.day^{-1})	778.9±661.5	498.2	(313.9-1033.2)	719.3	881.6±593.7	730.6	(356.6-1282.1)	925.5	-.966	.334

Abbreviations: SD, standard deviation; IQR, Interquartile range; BMI: Body Mass Index, PA: Physical Activity; IPAQA: International Physical Activity Questionnaire for Adolescents; MVPA: Moderate to Vigorous Physical Activity; MET: Metabolic Equivalents.

Table 2. Descriptive data and Mann-Whitney U comparison of anthropometric characteristics and physical activity obtained by accelerometer and IPAQA, for adolescents aged 15 years or over.

		≥15y								Boys vs. Girls	
		Girls (n=90)				Boys (n=57)				Mann-Whitney U	
		Mean ± SD	Median	IQR (P25-P75)	IQR	Mean ± SD	Median	IQR (P25-P75)	IQR	Z	P-Value
	Age (y)	17.0±1.2	17.0	(16.0-18.0)	2.0	16.7±1.2	17.0	(16.0-18.0)	2.0	-1.032	.302
	Height (cm)	161.8±6.9	162.0	(158.0-165.0)	7.0	171.8±7.5	171.0	(168.0-177.0)	9.0	-7.012	**.000**
	Weight Kg)	60.4±11.4	59.3	(53.8-64.1)	10.3	65.4±10.2	66.0	(56.8-72.0)	15.2	-3.313	**.001**
	BMI (kg.m^{-2})	23.0±3.5	22.5	(21.2-24.6)	3.4	22.1±2.7	22.0	(20.0-23.6)	3.6	-1.618	.106
	BMI Centile	62.7±24.4	67.5	(50.9-80.4).	29.55	57.2±25.6	56.9	(41.0-81.4)	40.4	-1.344	.179
	Body Fat (%)	28.4±6.3	27.6	(24.7-31.2)	6.6	18.3±4.4	17.4	(15.2-20.0)	4.8	-8.312	**.000**
	Waist Circumference (cm)	74.1±8.9	72.0	(69.0-77.0)	8.0	75.1±7.3	73.0	(70.5-77.5)	7.0	-1.614	.107
	Hip Circumference (cm)	96.8±8.3	95.3	(91.0-100.0)	9.0	93.4±6.0	92.0	(89.0-97.0)	8.0	-2.557	**.011**
Accelerometer	Total Measured Time (min.day^{-1})	784.7±76.7	788.6	(738.0-844.9)	106.9	821.7±85.7	842.6	(777.4-876.1)	98.7	-2.984	**.003**
	Sedentary PA (min.day^{-1})	519.6±112.2	510.3	(453.8-563.0)	109.2	530.1±137.4	504.5	(450.8-578.0)	127.2	-.119	.905
	Light PA (min.day^{-1})	254.8±68.0	245.7	(205.0-302.5)	97.5	275.8±78.0	263.6	(229.9-316.3)	86.4	-1.545	.122
	Moderate PA (min.day^{-1})	23.8±11.8	22.1	(16.7-27.6)	10.9	37.5±19.3	36.6	(22.1-47.6)	25.4	-4.632	**.000**
	Vigorous PA (min.day^{-1})	9.1±9.8	6.7	(1.9-12.6)	10.7	18.3±14.1	15.4	(8.3-24.2)	16.0	-4.876	**.000**
	MVPA (min.day^{-1})	32.9±18.7	29.4	(19.5-41.1)	21.6	55.8±29.2	52.4	(30.3-72.6)	42.4	-4.940	**.000**
	Total PA (counts.min^{-1})	354.9±130.9	343.1	(268.1-412.6)	144.5	474.8±169.1	441.5	(352.4-592.9)	240.5	-4.560	**.000**
	Total PA (steps.day^{-1})	8116.8±3534.3	7280.9	(5822.1-9584.7)	3762.6	11494.9±6216.3	10122.8	(6800.2-13930.3)	7130.1	-3.526	**.000**
IPAQA	Total Reported Time (min.day^{-1})	133.2±111.7	99.3	(47.5-197.9)	150.4	122.8±86.2	101.4	(63.6-185.4)	121.8	-.014	.989
	Motor Transportation (min.day^{-1})	34.3±36.6	25.7	(5.7-42.9)	37.1	36.0±41.5	22.9	(6.4-50.0)	43.6	-.307	.759
	Walking (min.day^{-1})	71.6±60.5	60.0	(21.4-108.2)	86.8	51.4±46.9	35.7	(15.4-76.4)	61.1	-1.757	.079
	Moderate PA (min.day^{-1})	40.1±49.3	20.0	(8.6-60.0)	51.4	34.9±39.2	21.4	(5.7-44.3)	38.6	-.058	.954
	Vigorous PA (min.day^{-1})	21.5±24.5	17.1	(4.3-25.7)	21.4	36.4±35.5	30.0	(10.7-53.6)	42.9	-2.796	**.005**
	MVPA (min.day^{-1})	61.6±66.7	32.9	(20.0-88.8)	68.8	71.3±59.9	51.4	(27.1-104.3)	77.1	-1.641	.101
	Total PA (MET.min.day^{-1})	133.2±111.7	99.3	(47.5-197.9)	150.4	122.8±86.2	101.4	(63.6-185.4)	121.8	-.014	.989

Abbreviations: SD, standard deviation; IQR, Interquartile range; BMI: Body Mass Index, PA: Physical Activity; IPAQA: International Physical Activity Questionnaire for Adolescents; MVPA: Moderate to Vigorous Physical Activity; MET: Metabolic Equivalents.

The adolescents used the Actigraph GT3X+ accelerometers during 7 consecutive days, according to previously suggested protocols (Rowlands & Eston, 2007). Students and parents received written information on how to use the accelerometer, before giving written consent. On the eighth day the accelerometers were collected and students completed IPAQA.

The first author and/or the responsible teacher from each class supervised the self-administration of IPAQA in small groups, in a classroom environment.

IPAQA analysis was performed according to original version guidelines (Hagstromer et al., 2008). Minutes at each intensity were limited to a maximum of 180 minutes per day, and a minimum of 10 minutes per activity was assumed, whenever adolescents indicated having engaged in that activity in the past week.

Translation and Cross Cultural Adaptation of the IPAQA

Three individuals proficient in English with a pedagogical background independently translated the IPAQA into Portuguese. The individuals are the first author and two high school English teachers. The authors compared the three translated versions and combined them into one collaborative-pooled Portuguese version.

A backward translation (Portuguese to English) was prepared by a native English speaker who was unaware of the original version and not familiar with PA subject area.

The backward translation was compared to the original questionnaire and all the authors approved the Portuguese version.

The original version remained unchanged during the translation process. The Portuguese version of IPAQA maintained the four original domains of PA (Rowlands & Eston, 2007): (1) School related Physical Activity; (2) Transportation; (3) Housework; and (4) Leisure time.

Concurrent Validity

Concurrent validity is a form of criterion validity, that uses a correlation with a criterion, ideally a gold standard, that is administered simultaneously (Thomas et

al., 2011). In this study, the accelerometers were used as criterion and the IPAQA completed regarding the same time period.

The Actigraph GT3X+ considers acceleration in 3 axes: vertical, medio-lateral and antero-posterior. This device measures and records time varying accelerations ranging in magnitude from +/- 6g, which are subsequently digitized by a 12-bit analogue-to-digital converter at a rate between 30 and 100 Hz. The raw data are stored for subsequent analysis.

The accelerometer was used with an elastic belt in the waistline, positioned in the anterior axillary line of the non-dominant side. The device was initialized, selecting the 3-second epoch. Adolescents received both verbal and written information on how to use the accelerometer, based on previous researches (Rowlands & Eston, 2007); instructions on use were given during 7 consecutive days, starting immediately after waking up and until going to bed, except for water activities (bath and swimming).

After usage, accelerometer data were processed using Actilife (version 6.9, Actigraph, Florida). The data was reduced to one-minute periods (epochs) and wear and non-wear time was determined according to previous recommendations (Choi et al., 2011). Time periods with at least 90 consecutive minutes of zero counts recorded were excluded from analysis assuming that the monitor was not worn. A minimum recording of 8-hours/day (480-minutes/day) was the criteria to accept daily PA data as valid, as previously suggested (Hobin et al., 2014; Ottevaere, Huybrechts, De Bourdeaudhuij, et al., 2011). Participants were required to have a minimum of 3 days recorded data, in accordance with previous researchers (Ottevaere, Huybrechts, De Bourdeaudhuij, et al., 2011; Luís B. Sardinha et al., 2008).

The outcome variables were time (min/day) spent in each of the following categories: sedentary PA (0-100 Counts/min); light activity (101-2295 Counts/min); moderate activity (2296-4011 Counts/min) or vigorous activity (≥ 4012 Counts/min), according to Evenson cut-points (Evenson et al., 2008), as previously suggested for studies with adolescents (Trost et al., 2011). Moderate-to-vigorous PA (MVPA) was defined as the sum of Moderate PA and Vigorous PA.

Statistical Analysis

Descriptive statistics [mean, standard deviation, inter-quartile range (IQR) and frequencies] were used to describe the sample characteristics and the main outcomes of IPAQA and accelerometer.

After performing Kolmogorov-Smirnov normality tests, with Lilliefors significance correction, Mann-Whitney U test was used to compare differences between boys and girls, and between the two age groups: early adolescents, from 10 to 14 years, and the late adolescents from 15 to 19 years (Sawyer et al., 2012). Spearman correlation coefficient was performed to assess the relation between time spent at each intensity level and total PA obtained by IPAQA and the accelerometer (Raykov & Marcoulides, 2011).

Finally, tertiles of IPAQA and accelerometer total PA and moderate to vigorous PA were calculated and the agreement between the two measurements was tested using Cohen's Kappa (Raykov & Marcoulides, 2011).

Data analysis was performed using IBM Statistical Package for Social Sciences, version 22 (SPSS Inc; Chicago, IL, USA). Statistical significance was set at $P<0.05$.

Results

The 222 adolescents included mainly females (123; 55.4%) and adolescents above 15 years of age (147; 66.2%). The mean BMI was 22.2 (SD=3.47) kg/m2, with 77.0% having normal weight for height, age and gender (Ogden et al., 2002). There were no statistically significant differences in the younger age group (≤ 14 years) between boys and girls, regarding height, weight, BMI, and waist circumference (Table 1). In older age group (15 years or older), boys had a significantly higher weight ($Z=-3.313$; $P<0.001$) and height ($Z=-7.012$; $P<0.001$), but no significant differences were found for BMI (Table 2).

According to IPAQA, adolescents engaged on average 138.2 minutes (SD=106.95) in total PA daily. The total daily PA was divided up into 42.4 minutes (SD=48.61) moderate PA, 34.4 minutes (SD=36.07) vigorous PA, and in 61.4 minutes (SD=54.26) walking. No statistical differences between boys and girls were found in the reported PA for adolescents aged 14 years or under (Table 1),

and for the older adolescents differences were significant (Z=-2.796; P<0,01) only for the time reported in vigorous PA, with boys reporting more time than girls (Table 2).

The accelerometer was used on average for 809.4 (SD=79.63) minutes/ day; sedentary, vigorous, moderate and light activity represented on average 506.9 (SD=117.61), 12.9 (SD=12.01), 35.1 (SD=19.27) and 277.7 (SD=72.40) minutes per day, respectively. In both age groups, boys spent significantly more time in vigorous and moderate PA than girls (Tables 1 and 2).

Considering accelerometer measured time, younger boys (Z=-4.450; P<0.001) and girls (Z=-4.244; P<0.001) spent significantly more time in moderate PA than older boys and girls. The same was observed for MVPA: younger boys (Z=-2.733; P<0.01) and younger girls (Z=-3.054; P<0.01) spent more time in that intensity when compared to the older adolescents.

Spearman correlations between reported PA time (IPAQA) and measured time (accelerometer) revealed that, for the total sample (Table 3): the total time reported with IPAQA had no significant correlation to the total time assessed with accelerometer; the minutes per day reported in vigorous PA according to IPAQA was poorly correlated to the time measured with accelerometer in the same intensity level (ρ=0.214; P<0.01), and moderately correlated to the time spent in moderate PA (ρ=0.338; P<0.01); reported and measured time in MVPA had a poor correlation (ρ=0.250; P<0.01); and the total PA (MET/day) according to IPAQA was significantly correlated (ρ=0.237; P<0.01) to the total PA (counts/min) according to accelerometer, however this was a poor correlation.

Younger adolescent girls (Table 4) show moderate correlations between measured MVPA time and walking time reported with IPAQA (ρ=0.407; P<0.05). In this group, walking time had also a moderate correlation with total PA counts from the accelerometer (ρ=0.412; P<0.05).

There were no meaningful correlations in the younger boys group (Table 4).

For adolescent girls 15 years and older, the total PA (steps/day) measured with accelerometer was significantly correlated with walking time (ρ=0.323; P<0.01), with vigorous PA (ρ=0.286; P<0.01), with MVPA (ρ=0.251; P<0.05) and with IPAQA total PA (ρ=0.286; P<0.01) (Table 4).

Table 3. Spearman's Rank correlation coefficient of physical activity measured by the accelerometer and reported with IPAQA, for the total sample.

		Accelerometer							
		Total Measured Time (min.day^{-1})	**Sedentary PA (min.day^{-1})**	**Light PA (min.day^{-1})**	**Moderate PA (min.day^{-1})**	**Vigorous PA (min.day^{-1})**	**MVPA (min.day^{-1})**	**Total PA (counts.min^{-1})**	**Total PA (steps.day^{-1})**
IPAQA	**Total Reported Time (min.day^{-1})**	.131	-.067	.174**	.184**	.143*	.185**	.205**	.226**
	Motor Transportation (min.day^{-1})	-.047	.098	-.108	-.121	.042	-.069	-.085	-.121
	Walking (min.day^{-1})	.063	-.05	.099	.067	.084	.085	.116	.072
	Moderate PA (min.day^{-1})	.103	-.078	.192**	.157*	.072	.126	.148*	.223**
	Vigorous PA (min.day^{-1})	.222**	-.042	.184**	.338**	.214**	.319**	.300**	.381**
	Total Reported Time (min.day^{-1})	.131	-.067	.174**	.184**	.143*	.185**	.205**	.226**
	MVPA (min.day^{-1})	.184**	-.064	.218**	.268**	.169*	.250**	.252**	.328**
	Total PA (MET.min.day^{-1})	.163*	-.063	.195**	.233**	.162*	.226**	.237**	.280**

Abbreviations: PA: Physical Activity; IPAQA: International Physical Activity Questionnaire for Adolescents; MVPA: Moderate to Vigorous Physical Activity; MET: Metabolic Equivalents.

* Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed).

In the older adolescent boys group, the minutes per day reported in vigorous PA according to IPAQA were significantly correlated to the time measured with accelerometer on the same intensity level (ρ=0.428; P<0.01), and in the moderate intensity (ρ=0.363; P<0.01); when considering MVPA, the time per day according to IPAQA was significantly correlated (ρ=0.428; P<0.01) to the one measured with accelerometer; the total PA (MET.min.day-1) according to IPAQA was significantly correlated (ρ=0.372; P<0.01) to the total PA (counts/min) according to accelerometer, though this was a poor correlation; there was no significant correlation between moderate PA level obtained by the two methods, however reported moderate PA was correlated with measured vigorous PA (ρ=0.321; P<0.05) (Table 4).

The tertiles agreement (Table 5) between the accelerometer and the questionnaire for total PA was 42.3% (K=0.135; P<0.01); and for MVPA tertiles there was a 39.6% agreement (K=0.094; P<0.05).

Table 4. Spearman's Rank correlation coefficient of physical activity measured by the accelerometer and reported with IPAQA, by age group and gender.

		Accelerometer															
		≤ 14 years								≥ 15 years							
		Total Measured Time (min.day^{-1})	Sedentary PA (min.day^{-1})	Light PA (min.day^{-1})	Moderate PA (min.day^{-1})	Vigorous PA (min.day^{-1})	MVPA (min.day^{-1})	Total PA (counts.min^{-1})	Total PA (Steps.day^{-1})	Total Measured Time (min.day^{-1})	Sedentary PA (min.day^{-1})	Light PA (min.day^{-1})	Moderate PA (min.day^{-1})	Vigorous PA (min.day^{-1})	MVPA (min.day^{-1})	Total PA (counts.min^{-1})	Total PA (steps.day^{-1})
IPAQA, Girls	Total PA (min.day^{-1})	.025	-.380*	.434*	.313	.146	.273	.363*	.199	.077	-.053	.139	.113	.122	.109	.153	.291**
	Motor Transportation (min.day^{-1})	.146	.297	-.227	-.243	.190	-.092	-.177	.004	-.005	0	-.010	.058	.065	.088	.026	-.057
	Walking (min.day^{-1})	.150	-.187	.332	.421*	.170	.407*	.412*	.142	.072	-.100	.188	.131	.142	.147	.217*	.323**
	Moderate PA (min.day^{-1})	-.043	-.413*	.415*	.182	.055	.094	.186	.152	.109	-.011	.154	.050	.087	.050	.076	.182
	Vigorous PA (min.day^{-1})	.038	-.245	.279	.037	.035	.038	.158	.002	.146	.060	.028	.190	.115	.134	.095	.286**
	MVPA (min.day^{-1})	-.024	-.376*	.366*	.109	.048	.072	.200	.135	.137	.002	.145	.114	.108	.091	.110	.251*
	Total PA (MET.min.day^{-1})	.027	-.367*	.387*	.250	.108	.212	.317	.169	.097	-.029	.129	.129	.114	.107	.139	.286**
IPAQA, Boys	Total PA (min.day^{-1})	-.054	-.100	.028	-.077	-.054	-.082	-.011	-.175	.24	.086	.050	.311*	.478**	.396**	.346**	.376**
	Motor Transportation (min.day^{-1})	-.121	-.089	-.106	.146	.183	.16	.296	.152	.095	.071	.034	-.169	-.037	-.141	-.111	-.038
	Walking (min.day^{-1})	.041	-.051	.140	.099	-.008	.062	.105	-.164	.102	.022	-.020	.220	.345**	.281*	.256	.244
	Moderate PA (min.day^{-1})	-.109	-.181	.013	.060	-.079	.028	.109	.075	.237	.026	.132	.209	.321*	.224	.182	.315*
	Vigorous PA (min.day^{-1})	.037	.049	-.005	-.328*	-.089	-.277	-.253	-.239	.257	.086	.178	.363**	.428**	.425**	.397**	.434**
	MVPA (min.day^{-1})	-.097	-.117	-.038	-.156	-.062	-.138	-.071	-.12	.313*	.077	.179	.352**	.489**	.428**	.375**	.463**
	Total PA (MET.min.day^{-1})	-.042	-.086	.026	-.146	-.05	-.131	-.065	-.185	.281*	.104	.110	.334*	.489**	.420**	.372**	.418**

Abbreviations: PA: Physical Activity; IPAQA: International Physical Activity Questionnaire for Adolescents; MVPA: Moderate to Vigorous Physical Activity; MET: Metabolic Equivalents.; * Correlation is significant at the 0.05 level (2-tailed); ** Correlation is significant at the 0.01 level (2-tailed)

Table 5. Tertiles classification percentage of agreement and Cohen's Kappa statistics, between IPAQA and Accelerometer.

	% Agreement	K	P-value
Total PA (MET.min.day^{-1} – Steps.day^{-1})	41.9	.128	**.007**
Total PA (MET.min.day^{-1} – Counts.min^{-1})	42.3	.135	**.004**
MVPA (min.day^{-1})	39.6	.094	**.047**

Abbreviations: IPAQA: International Physical Activity Questionnaire for Adolescents; PA: Physical Activity; MET: Metabolic Equivalents MVPA: Moderate to Vigorous Physical Activity.

Discussion

The present paper describes the translation and validation for the IPAQA in Portuguese adolescents. The original IPAQA was developed in 2008, in an international study including several countries, but not Portugal (Hagstromer et al., 2008). Although some Portuguese investigation has been carried out with adolescents using this questionnaire (Araújo-Soares et al., 2009; Lopes et al., 2013), its validation has not been performed in Portuguese adolescents yet.

The authors and the translation experts felt no need to change the content and structure of the questionnaire, finding it suitable for the age range and culture.

As with previous research on PA questionnaire validation, the accelerometers were used for concurrent validity (Boon et al., 2010; Guedes et al., 2005; Hagstromer et al., 2008; Lachat et al., 2008; Wong et al., 2006).

This study has the advantage of using a GT3X+ model, which considers acceleration in 3 axes. By doing so it guarantees the measurement of PA in the three dimensions of space, making it more accurate for PA measurement in free living conditions (Plasqui et al., 2005).

Data from the present study corroborate previous epidemiological studies (Baptista et al., 2012; Mota et al., 2007), where boys were significantly more active than girls and younger adolescents engaged significantly more time in MVPA than older adolescents, although IPAQA data failed to show these differences between sexes.

In this study no results are presented regarding the comparison between total time reported by IPAQA and measured by the accelerometer, as authors believe

that the measures are not directly equivalent. One minute of IPAQA reported PA is not directly equivalent to one minute of measured PA. In fact this same conclusion was pointed out in studies with the adults version of IPAQ (Celis-Morales et al., 2012). Additionally, the IQR also reveals that while IPAQA and accelerometer give information on physical activity, expressed in the same units, the two methods do have different scales. The present data are also in accordance with previous research that indicated that questionnaires overestimate time (Celis-Morales et al., 2012; Wong et al., 2006), particularly in the higher intensity levels (Guedes et al., 2005). Indeed, in this sample a systematic error of over-reporting seems to exist. However, a previous attempt to validate a Swedish version of IPAQA pointed out the amount of unreported time as the explanation for the non-validation of the questionnaire (Arvidsson et al., 2005). Thus, considering the systematic error on the activities duration, IPAQA should not be used to evaluate compliance with the guidelines, expressed as minutes per day in a specific intensity level.

Similarly to this study, previous attempts to validate PA reporting methods for children and adolescents have consistently mentioned weak associations with accelerometer findings, especially if considering recall methods, and for light and moderate PA levels the associations tend to be particularly weak or inexistent (Guedes et al., 2005; Hagstromer et al., 2008; Lachat et al., 2008; Wong et al., 2006).

Sports participation, consistent with MVPA intensity, seems to be consistent over time (every week on the same day, with the same duration), making it easier to report and estimate duration, which may explain the significant correlation coefficient for physical activity in this intensity level, reinforcing the results from previous studies (Guedes et al., 2005; Hagstromer et al., 2008; Lachat et al., 2008). Considering that boys and older adolescents engage more in sports activities, while younger adolescents have more moments of spontaneous movement and PA, this has been mentioned (Hagstromer et al., 2008) as a possible explanation for IPAQA having moderate correlation coefficients in the older adolescent boys group, but not in the other groups.

Difficulties in the full understanding of the concepts, as previously mentioned (Hagstromer et al., 2008), is another possible reason for the low or non-existent correlations. Studies about the cognitive development of children and adolescents referred to the difficulty of reporting time duration of a certain activity, although there is an improvement in time sensitivity throughout childhood (Droit-Volet, 2013). Considering that IPAQA asked specifically about the duration of specific physical activities, this might be one of the reasons why poor correlations were found, specifically for the younger adolescents. This notion is reinforced by research that concluded positively about the effect of motion on time perception (Kroger-Costa et al., 2013).

Also related to the IPAQA concepts misunderstanding, the authors believe that adolescents cannot successfully distinguish between moderate and vigorous PA when filling in a questionnaire, which may explain why older boys IPAQA moderate time had a significant correlation coefficient ($\rho=0.321$; $P<0.05$) with accelerometer vigorous PA, but no correlation with accelerometer moderate PA. Using a single category of moderate to vigorous physical activity (MVPA) may be useful to overcome this issue, and is in accordance with international guidelines for children and adolescents PA (USDHHS, 2008).

The concurrent validity proved that the IPAQA questionnaire might be valid when used to determine PA for older adolescent boys (≥15 years), but not with younger adolescents. The same conclusion was reached by the original version (Hagstromer et al., 2008) and by other countries validation (Guedes et al., 2005). It is important to emphasize that although there was a weak correlation coefficient, the tertiles percentage of agreement showed that IPAQA could divide a sample in groups of PA, which is of particular interest to epidemiologists that frequently use categories of PA, instead of a quantitative approach. In addition, questionnaires are often a more practical data collection method than the high non-usage rates of instruments that require several day evaluations, such as accelerometers and pedometers (Audrey et al., 2012; Ottevaere, Huybrechts, De Meester, et al., 2011; Van Coevering et al., 2005).

Conclusions

IPAQA may be used in adolescent boys 15 years of age and older, to assess PA in a daily life context. For studies with large samples and budget constraints with no accelerometers availability, IPAQA can be a valid method of data collection. However, the authors would suggest to researchers that choose to use IPAQA that instead of working with time per day in each PA level, creating tertiles of PA may be a better option. This method would enable them to distinguish between more and less active adolescents; or alternatively, it would also be valid to combine moderate and vigorous physical activities into one single category (MVPA). Nevertheless, at this point the authors strongly discourage the use of IPAQA to assess PA in girls or in adolescents under 15 years old. In fact, the authors suggest that, whenever possible and available, objective methods should be used to assess PA in all adolescents. These findings call into question the conclusions of previous studies that used this questionnaire with Portuguese adolescents of all ages and sexes, enhancing the importance of validated tools as the only way of obtaining correct conclusions.

This study confirmed the validation of the first version of IPAQA for Portuguese older adolescent boys, nevertheless, further studies and additional efforts are needed to improve IPAQA and to make it valid for girls, younger adolescents and children.

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Paper III.

SUBMITTED

Nutritional and physical activity knowledge association with body fat in adolescents

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Nutritional and physical activity knowledge association with body fat in adolescents

Vera Ferro-Lebres; Gustavo Silva, Pedro Moreira; José Carlos Ribeiro

Abstract

BACKGROUND: Knowledge enhancement has been referred as a mean to improve nutrition and physical activity, and reduce obesity. This work aimed to identify the difference of nutrition and physical activity knowledge according to body fat and physical activity levels in adolescents.

METHODS: This study was a cross sectional analysis involving 734 adolescents. Body fat was determined using electric bioimpedance, and physical activity was assessed by accelerometer. Adolescents were divided in groups according to physical activity levels (high versus low) and body fat (overfat versus non-overfat). They were then divided into four groups: “high physical activity/ non-overfat”; “high physical activity/ overfat”; “low physical activity/ non-overfat”; and “low physical activity/ overfat”. Nutrition and Physical knowledge was assessed by questionnaires.

RESULTS: Body fat percentage exposed 30.8 % overfat/ obese adolescents, and daily moderate to vigorous physical activity lasted in average 47.9 (SD=27.49) minutes. High physical activity adolescents presented higher physical activity knowledge (p=.044) and the low physical activity/overfat group scored the worst on experts’ nutritional recommendations knowledge.

CONCLUSIONS: Poor nutritional knowledge was significantly associated with the simultaneous occurrence of overfat and low physical activity levels. Interventions aimed to improve adolescents’ body composition and physical activity should address the knowledge about these two topics.

Keywords: Child & Adolescent Health; Nutrition & Diet

Background

All major health problems affecting adolescents in developed countries are lifestyle related, and the burden of these diseases can be reduced with healthy diet and physical activity [1]. Obesity is the public health issue that receives more attention from the media, health professionals and researchers, but epidemiological data are still of concern [2], particularly during adolescence, that has already been defined as a critical period in the development and persistence of obesity [3].

In this context many studies have been performed in order to identify the best approach to improve dietary and physical activity habits, and therefore reduce obesity [4-6].

Behavioral change theories, namely Banduras' Social Cognitive Theory [7], propose knowledge as an essential correlate for the engagement in healthy lifestyles, including a healthy diet and adequate physical activity patterns. Nevertheless, some criticism has been made, suggesting that knowledge is not enough for behavioral change [8-10], or for obesity reduction [11, 12]

Some studies have been performed about the relation between knowledge and health outcomes in adolescence, in particular body mass index (BMI). No consensus was found, as some authors refer no difference in knowledge between obese and non-obese [9, 13-15], while some suggest that along with an increase of knowledge, a reduction of overweight can be observed [16-18]. In addition, it must be emphasized that few is known about long term efficacy of health knowledge interventions on obesity, diet and physical activity in adolescents [9, 13, 19].

Understanding the correlates of obesity or excessive body fat in adolescence, in particular its' relations with the lack of nutrition and physical activity knowledge seems to be a crucial step for planning and developing effective health promotion interventions [20, 21]. However, although body fat percentage (BFP) has been widely mentioned as a better measure of adiposity [22] and cardiometabolic risk [23-25], particularly in a period of multiple changes in body composition [26] that may not

be measureable by BMI. No studies were found about the association of nutrition and physical activity knowledge and BFP in adolescence.

The objective of this work is to study the difference of nutrition and physical activity knowledge according body fat and physical activity levels in adolescents.

Methods

Participants

A cross sectional study was developed, with a convenience sample of 734 high school students (346, 47.1% girls), with a mean age of 15.8 (SD=1.87) years, from two different schools in the north of Portugal. A subsample of 222 adolescents used an Actigraph GT3X+ accelerometer. Data collection took place from 2011 to 2013. Table 1 summarizes sample characteristics.

Instruments

Anthropometry Weight was determined with 100g precision, using TANITA BC-545 body composition analyzer. This equipment was also used to assess body fat percentage. Height was measured using a SECA 217 portable stadiometer, with a 0.1 cm precision. For all anthropometric assessments adolescents wore light cloths.

BMI was calculated and categorized according to Centers for Disease Control and Prevention 2000 [27] and BFP in accordance to McCarthy, 2006 [28]. For statistical analysis two BFP groups were created: the non-overfat, including underfat and normal adolescents; and the overfat, including adolescents with overfat and obese BFP classification.

Table 1. Sample Characteristics and GNKQA and PAKQ Scores Differences Between Groups

		n (%)	GNKQA Total Score Percentage			PAKQ Score Percentage		
			Mean (SD)	*Mean Rank*	*p value*	Mean (SD)	Mean Rank	*p value*
Sex	Male	388 (52.9)	44.8 (11.39)	333.52	0.000	65.2 (14.53)	352.49	0.067
	Female	346 (47.1)	48.1 (11.99)	397.80		67.1 (14.43)	380.89	
School Grade								
	7th to 9th grade	285 (38.8)	44.6 (11.28)	328.11	0.000	63.7 (14.95)	329.53	0.000
	10th to 12th grade	449 (61.2)	47.8 (12.00)	392.50		67.7 (14.00)	391.60	
Family Income /month (euros)								
	Less than 1001	112 (25.0)	45.5 (11.11)	203.32		64.8 (15.30)	205.07	
	From 1001 to 2000	213 (47.5)	48.0 (11.18)	231.95		66.4 (15.46)	225.87	
	From 2001 to 3000	83 (18.5)	48.6 (11.80)	234.13	0.117	68.9 (13.71)	247.17	0.222
	From 3001 to 4000	28 (6.3)	49.9 (13.09)	248.16		66.4 (15.45)	232.84	
	More than 4001	12 (2.7)	42.3 (11.50)	168.08		66.7 (14.35)	205.33	
BMI Age Centile								
	Underweight	15 (2.0)	45.2 (13.50)	362.77		60.0 (17.72)	291.1	
	Normalweight	584 (79.6)	46.7 (11.87)	372.16	0,504	66.6 (14,47)	375.16	0.157
	Overweight	98 (13.4)	46.4 (11.78)	358.45		65.5 (15.16)	351.2	
	Obese	37 (5.0)	44.2 (10.48)	319.77		64.4 (11.06)	320.72	
Body Fat Percentage								
	Underfat	7 (1.0)	42.2 (13.95)	314.50		75.4 (8.13)	526.14	
	Normal	501 (68.3)	46.6 (11.42)	368.05	0.910	66.1 (14.31)	370.14	0.158
	Overfat	109 (14.9)	45.7 (13.60)	363.37		66.7 (16.60)	366.96	
	Obese	117 (15.9)	47.2 (11.66)	372.18		65.2 (13.37)	347.21	

GNKQA: General Nutrition Knowledge for Adolescents; PAKQ: Physical Activity Knowledge Questionnaire

General Nutrition Knowledge Nutrition knowledge was assessed with a previously validated questionnaire for Portuguese adolescents [29]. This questionnaire consists of four sections: Section 1 - Dietary recommendations (13 items); Section 2 - Sources of nutrients (73 items); Section 3 - Choosing everyday foods (9 items); and Section 4 - Diet-disease relationship (42 items). A total score of 137 points and 4 partial scores, one for each section, were calculated considering one point for each correct answer. For statistical analysis a percentage of correct answers was considered, for the total questionnaire and for each section.

Physical Activity Knowledge A questionnaire specially created for this study was used to assess physical activity knowledge. For the development of the questionnaire age specific physical activity guidelines [30] were used. The questionnaire consisted of 10 questions: 7 True or False and 3 multiple choice. For each of the 10 questions a “Don’t Know” option was included, in order to reduce the non-response rate. Each corrected answer scored one point, for a total score of 10 points. For statistical analysis a percentage of correct answers was considered.

Physical Activity Adolescents physical activity was assessed with Actigraph GT3X+ accelerometers, that were used during 7 consecutive days, according to previously suggested protocols [31]. Adolescents and their parents received written information on how to use the accelerometer, before giving written consent. Additional oral information was given individually to each adolescent with the accelerometer delivering. Instructions considered the use for 7 sequential days, starting straightaway after awakening and until going to bed, with the exception of water activities (bath and swimming). The device was used with an elastic belt in the waist line, positioned in the anterior axillary line of the non-dominant side. The accelerometer was initialized, selecting the 3 second epoch. In the 8th day researchers collected the equipment.

After usage, data were processed using Actilife (version 6.9, Actigraph, Florida), and reduced to one minute periods (epochs). Wear and non-wear time was determined in accordance to previous recommendations [32]. Time periods with at

least 10 consecutive minutes of zero counts recorded were excluded from analysis assuming that the monitor was not used. A minimum record of 8-hours/day (480-minutes/day) was set so that the data could be considered as valid. Participants were required to have used in accordance the accelerometer for a minimum of 3 days, in agreement with previous researches [33, 34].

The outcome variables reflected time measured in minutes per day (min/day) spent in each of the following intensities: sedentary activity (0-100 Counts/min); light activity (101-2295 Counts/min); moderate activity (2296-4011 Counts/min) or vigorous activity (≥ 4012 Counts/min), according to the Evenson cut-points[35], as previously suggested for studies with adolescents[36]. Moderate-to-vigorous physical activity (MVPA) was defined as the sum of moderate and vigorous activity.

MVPA tertiles, adjusted for age and sex, were calculated. Adolescents were divided in 2 groups, one group classified as "high physical activity" (HPA), including adolescents in the 3rd tertile, and one group classified as "low physical activity" (LPA), including the 1st and 2nd tertiles.

Four groups were created based on BFP and MVPA engagement: "high physical activity/ non-overfat", "high physical activity/ overfat", "low physical activity/ non-overfat" and "low physical activity/ overfat".

Procedure

In a classroom environment, with teachers' collaboration, anthropometric measurements were performed, along with the filling of the knowledge two questionnaires, one to assess nutrition knowledge and another to assess physical activity knowledge. A set of sociodemographic questions were added, to assess age, sex, school grade and monthly family income.

Data Analysis

Descriptive analysis (frequencies, mean and standard deviation) were used for sample characterization and variables description.

Tertiles for MVPA were adjusted for age and sex, and used to define high and low physical activity groups.

After testing for normal distribution, Kruskal-Wallis and Mann Whitney U tests were performed to compare knowledge scores between groups, according the levels of BFP and MVPA engagement, as previously defined.

Data analysis was performed using IBM Statistical Package for Social Sciences, version 22 (SPSS Inc; Chicago, IL, USA). Statistical significance was set at P<.05.

Results

Most adolescents included in this study enrolled from the 10th to the 12th grade (61.2%), had a monthly family income under 2000 euros (72.5%), and were classified as normal weight, according to BMI (79.6%) and BFP (68.3%) (Table1). GNKQA percentage of correct answers was in average 46.5 (SD=11.82) %, and mean scores were significantly higher in females than males (48.1 versus 44.8, p<.001), and in adolescents attending the 10th through 12th grades (7th to 9th grade=44.6; 10th to 12th grade=47.8; p=.000). No significant differences were found between different categories of family income, BMI, and BFP (Table 1).

No significant differences in the PAKQ percentage of correct answers were found between genders. Students following from 7th to the 9th grade scored significantly less than students from other grades (7th to 9th grade=63.7; 10th to 12th grade=67.7; p=.000). Family income, BMI, and BFP groups had no significant differences in the mean PAKQ score percentage. For the overall sample a mean score of 66.2 (SD=14.50) % was found.

Adolescents engaged in MVPA in average for 47.9 (SD=27.49) minutes per day. When analysing the knowledge differences between MVPA groups, the HPA group scored significantly higher in the PAKQ (HPA=69.2; LPA=64.9; p=.044), but no significant differences were found for the total GNKQA, nor for its sections (Table 2).

Table 2. GNKQA and PAKQ Scores Differences Between Physical Activity and Body Fat Percentage Groups

	MVPA							BFP							MVPA and BFP Groups												
	High physical activity			Low physical activity			P-value	Non-overfat			Overfat			P-value	High physical activity/ Non-overfat			Low physical activity/ Non-overfat			High physical activity/ Overfat			Low physical activity/ Overfat			P-value
	Mean	SD	Mean Rank	Mean	SD	Mean Rank		Mean	SD	Mean Rank	Mean	SD	Mean Rank		Mean	SD	Mean Rank	Mean	SD	Mean Rank	Mean	SD	Mean Rank	Mean	SD	Mean Rank	
GNKQA Total (%)	47.5	12.94	113.0	46.8	11.55	110.8	.806	46.6	11.46	367.3	46.4	12.63	367.9	.971	45.1	13.40	102.2	47.6	10.29	113.5	51.9	10.99	133.0	44.9	13.90	104.7	.209
GNKQA S1 (%)	61.1	17.59	116.4	59.2	17.07	109.1	.418	59.9	16.56	376.0	57.6	17.34	348.5	.101	58.0	18.16	106.5	62.5	14.42	120.2	66.9	15.19	134.7	51.7	20.04	84.42	**.003**
GNKQA S2 (%)	47.3	14.30	115.9	46.0	12.24	109.3	.471	46.3	12.10	367.4	46.1	13.23	367.8	.979	44.7	15.24	104.5	46.7	11.40	111.9	52.2	11.07	137.0	44.5	13.93	103.6	.146
GNKQA S3 (%)	49.0	17.52	119.1	46.2	16.67	107.7	.206	46.3	16.69	369.2	46.3	17.59	363.7	.740	48.5	18.10	119.3	46.98	15.68	110.2	50.0	16.70	118.6	44.5	18.75	102.3	.552
GNKQA S4 (%)	43.2	18.03	109.5	44.4	16.43	112.5	.748	42.97	18.06	365.2	43.55	19.12	372.8	.652	41.1	19.07	103.9	44.7	15.58	112.8	47.1	15.57	120.0	43.5	18.32	111.8	.760
PAKQ (%)	69.2	13.97	123.6	64.9	15.22	105.5	**.044**	66.3	14.28	372.3	65.9	15.00	356.7	.353	67.7	14.09	118.9	64.7	14.63	105.7	71.9	13.57	132.4	65.3	16.63	104.9	.185

MVPA: Moderate to Vigorous Physical Activity; BFP: Body Fat Percentage; GNKQA: General Nutrition Knowledge for Adolescents; S1: Section 1; S2: Section2; S3: Section 3; S4: Section 4; PAKQ: Physical Activity Knowledge Questionnaire

Considering the knowledge differences between two groups created from BFP classification, no significant differences were found for PAKQ score, for the total and sections GNKQA scores (Table 2).

Comparing the knowledge scores between the BFP/ MVPA four groups, significant differences were found only for the GNKQA 1st section, were the low physical activity/ overfat group scored significantly less than the other groups (p=.003).

DISCUSSION

According to our best information, this study described for the first time that poor knowledge was significantly associated with the simultaneous occurrence of overfat and low physical activity levels in adolescents, after a comparison of nutrition and physical activity knowledge between the four groups created based on BFP and MVPA engagement. Considering that significant differences were found only for the GNKQA section 1, about dietary recommendations, it seems that low physical activity/ overfat adolescents are significantly less aware of these recommendations, even after considering the adjustment effect of age and gender, and may be a target group for knowledge enhancement in obesity prevention programmes [20, 37].

These results revealed that no differences in physical activity and nutrition knowledge were found between BFP overfat and non-overfat groups. Previous studies with adults [9, 12] and younger children [14] reported similar conclusions in what regards nutrition knowledge. Even though some contrary statements were made in studies with Belgian and Italian adults, that suggest a negative association between nutrition knowledge and BMI [13, 38], and with American children, being suggested that the obesity prevention efforts need to fight inaccurate information, and in particular fill the gap on the understanding of the benefits of engaging in physical activity and a healthy diet [39]. The few studies that were previously performed with adolescents included nutrition knowledge alone, and suggest that it does not differ between obese and non-obese adolescents [11, 40].

This study showed that physical activity knowledge was significantly higher among adolescents in the “high physical activity” group. Although studies with physical activity knowledge are scarce, it was previously stated in studies with adults that a higher physical activity knowledge could be related to high levels of physical activity [41, 42]. A conclusion that is aligned with the recommendations to increase physical activity in communities, that highlight the importance of informational approaches to increase physical activity, by incrementing knowledge about exercise and physical activity benefits [20].

Additionally, data from the present study evidenced the low MVPA levels of Portuguese adolescents, far below the recommended levels [30], which may contribute to the obesity and overfat rates. Although the obesity prevalence found in the present study are under previous data with Portuguese adolescents [43, 44] when considering BMI, is still of concern to realize that more than 30% of the adolescents are classified as overfat/ obese by BFP criteria.

These results reveal that adolescents have poor nutrition knowledge with an average of less than 50% of correct answers. Previous data from young adults[45], adults [9, 38] and elderly [46] presented similar conclusions. Studies with adolescents have been performed in the USA [40, 47] and on Germany [11] and although comparisons with the present data are difficult, considering different questionnaires were used, the results revealed lack of knowledge in several aspects, as for example the recommendation for five fruits and vegetables per day [40, 47].

Physical activity knowledge had a positive, but still low, mean score, and although physical activity knowledge has not been broadly studied some comparisons can be made. Results from Australian adults revealed good knowledge of physical activity recommendations [48, 49], but among Portuguese young adults less than 40% were aware about the physical activity role in the heart disease prevention[50]. As far as we acknowledge, adolescents’ physical activity knowledge was studied only in the USA, and results were disturbing, as only 27% identified experts’ recommendations [47].

It seems that, besides numerous nutrition and physical activity interventions have been made, efficacy of knowledge is far from the desirable, and other motives beside lack of knowledge may account for the adolescence obesity rates.

Females scored significantly best for nutrition knowledge, as previously reported[14, 51, 52], but not for physical activity knowledge, also a result in accordance with previously published data[14]. What can be reflecting the typical gender interests differences, as usually females are more interested in the dietary subject, and health in general [53], mainly due to weight management issues[54].

Demographic data also revealed that nutrition and physical activity knowledge improve with school grade. What can be related to the age increase, as previous studies also stated a positive significant correlation between age and health related knowledge [51, 52, 55]. This trend can be related to health and diseases experiences, the fact that younger adolescents did not live a negative consequence of unhealthy behaviors can cause a sense of immunity, and therefore a lack of interest on health related subjects [56]. In addition adolescence presents as a period of life where the high risk behaviors become more frequent[3].

Limitations

Physical activity knowledge questionnaires are scarce, and often incomplete, no validated questionnaire for Portuguese adolescents was found, and one was specially designed for this study. The absence of validity and reliability information of this questionnaire has to be assumed as a limitation for this work. It seems important to perform a validation study in the future for this instrument.

The reduced number of accelerometers available did not allowed to have accelerometer data for all 734 adolescents, which was a limitation, however valid accelerometer information was collected for 222 adolescents.

We also considered as a limitation not considering nutritional intake in this study.

Conclusions

In conclusion, knowledge seems to play a role in body fat and physical activity in adolescence. HPA adolescents have higher PAKQ scores, and “low physical

activity/ overfat" adolescents score the worst in the experts' recommendations section.

IMPLICATIONS FOR SCHOOL HEALTH

Considering that low physical activity/ overfat adolescents scored significantly less on the knowledge on experts' nutritional recommendations, and the knowledge differences between MVPA groups revealed that the most active have greater PAKQ scores, knowledge may be a target variable to prevent excessive body fat in low physical active adolescents, and to improve MVPA engagement. Other health determinants, like preferences and availability, may play a stronger role for dietary and physical activity behaviors [57, 58], but as previously suggested by other authors [20, 37, 59], it is our believe that enhancing health curricula to devote adequate attention to physical activity enhancement and promoting nutrition and energy balance awareness and knowledge, although not sufficient as a single measure, is essential to reduce overfat and obesity particularly among the less active adolescents. Furthermore, Portuguese schools should include in physical education classes also a health component, addressing the physical activity recommendations and health advantages [30]. The implementation of the previous recommended 30 minutes of moderate to vigorous physical activity during the school day [59], should be considered as a national health and education policy. These outcomes should be used by education and public health professionals, along with planning nutrition and physical activity informative interventions, aiming knowledge enhancement, activities should be included to make every day choices coherent with experts' recommendations, as well as presenting healthy food and physical activity feasible and attractive for adolescents.

Human Subjects Approval Statement

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human subjects were approved by the Research Centre in Physical Activity, Health and Leisure Scientific Committee.

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Paper IV.

SUBMITTED

Nutritional and physical activity knowledge is not associated with practices in adolescents

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Nutritional and physical activity knowledge is not associated with practices in adolescents

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Abstract

Objective: To study the correlation between nutrition and physical activity, knowledge and practices, among adolescents.

Design: It was designed a cross-sectional study with adolescents. Socio-demographic characteristics, and nutrition and physical activity knowledge were assessed using questionnaires. Anthropometry was objectively measured. Nutritional and dietary intake was assessed with a three-day food diary. Physical activity was evaluated with Actigraph GT3X+ accelerometers.

Setting: North of Portugal.

Subjects: A sample of 734 adolescents, aged 11 to 19, was involved in the study. Food diaries were valid for 291 adolescents and it was only possible to collect accelerometer information for 222 subjects.

Results: Overall adolescents revealed poor nutritional knowledge (Mean=46.5%; SD=11.82%), low engagement in moderate to vigorous physical activity (Mean=47.9; SD=27.49 min/day) and a diet with low nutritional adequacy (Mean=57.4%; SD=10.24%). Although nutrition knowledge seems to be greater in female adolescents ($p<0.001$) and in students above the 10th grade ($p<0.05$), male adolescents reveal better values regarding nutritional adequacy of diets ($p<0.001$) and physical activity engagement ($p<0.001$), as do students below the 10th grade ($p<0.001$). No significant correlation was found between knowledge and practices regarding nutrition ($\rho=-0.03$; $p=0.636$)and physical activity ($\rho=0.12$; $p=0.083$).

Conclusions: Concerning values of nutrition knowledge, diets nutritional adequacy and physical activity engagement highlight the urgent need of efficient health behaviour interventions. Public health professionals should be made aware of these results that reinforce the concept that, although necessary,

knowledge seems to be insufficient to produce adequate nutrition and physical activity behaviours in adolescents.

KEYWORDS Nutritional Knowledge, Physical activity knowledge, Adolescents

Introduction

Obesity(1), type 2 diabetes(2) and cardiovascular diseases(3) are major health problems affecting adolescents and are well recognized as key public health issues. Diet and physical activity behaviours are strategic modifiable factors that can contribute to reduce the burden of these diseases(4).

Several epidemiological studies proved adolescents' diet is nutritionally poor(5-7). Studies with Portuguese adolescents revealed inadequate intakes of calcium, vitamin E, folate, molybdenum and fibre, while the intakes of total fat, saturated fat and sugars were far above the recommended values(8), suggesting that diet is as a major risk behaviour.

In accordance, adolescent physical activity practices are far from achieving the recommended duration and intensity in developed countries(9, 10), particularly in Portugal, where only 36% of the subjects aged 10 to 11 accomplished 60 minutes of moderate to vigorous physical activity, in the 16-17 age group the percentage is even worse, with only 4% engaging in such levels of physical activity(11).

Health literacy, namely physical activity and nutrition knowledge, has been associated with healthier behaviours. However one or more aspects of health literacy seem not to be sufficient for several population groups(12-14), suggesting the need for multidisciplinary approaches in health interventions. Reinforcing this idea an association between nutrition and physical activity knowledge was found(15).

There is no consensus regarding the relation between nutritional knowledge and practices, and few studies have been performed in adolescents. Although some authors reported no association between these variables(12, 16-18), a recent

review, including only studies with adults, referred a positive but weak association between nutrition knowledge and dietary intake(19). A greater nutrition knowledge seems to be associated with better food preferences(15), and with consumptions of fruit and vegetables(20, 21), dairy products(20), starchy food(20), and fish(20). However poor nutrition knowledge of American adolescents from Florida has been reported, with only 17.8% identifying the correct recommendation for daily fruit and vegetable consumption(14). To the best of the current knowledge, no studies with Portuguese adolescents were ever conducted assessing nutrition knowledge.

Physical activity knowledge seems to be related to physical activity preferences(15), but no consensus exists in its association with practice(16, 22, 23). It is a matter of concern to realize that only 27% of American adolescents identified the experts' recommendation for physical activity(14). No studies about Portuguese adolescent physical activity knowledge were ever performed, but a study with Portuguese university students assessed the awareness of the role of physical activity in heart disease and revealed that less than 40% knew about this association(13).

According to social cognitive theory, knowledge seems to be an essential precursor in the process of behaviour change (24), although some authors suggest it's not the only correlate, and therefore not efficient as a single factor(12, 22, 25). In addition, several health interventions that improved knowledge, successfully improved health behaviours in parallel(26-31).

Understanding diet and physical activity, including its individual variability, as well as recognizing the knowledge adolescents have about experts' recommendations and advices, seem to be a crucial step while planning and developing health promotion interventions. To date, little is known about the correlation between knowledge and practice in adolescents' nutrition and physical activity. As a matter of fact, no studies have ever been performed with Portuguese adolescents analysing the overall relation between nutrition and physical activity, concerning knowledge and behaviours.

This study aims at describing Portuguese adolescents' nutrition and physical activity knowledge, as well as their diet and physical activity behaviours, and analysing the association between knowledge and behaviours.

Experimental Methods

Design and Participants

A cross sectional study was designed, involving a sample of 734 adolescents. A subsample of 346 individuals filled a three-day food diary, and a subsample of 222 individuals wore an accelerometer for physical activity assessment.

The overall sample had a mean age of 15.8 (SD=1.87), and included 52.9% girls. Table 1 resumes the sample characteristics.

Socio-demographic characteristics

Adolescents completed a questionnaire asking age, sex, school grade, parents' educational level and monthly family income. They were instructed not to answer when they were not absolutely certain.

Anthropometric measurements

Height was measured using a SECA 217 portable stadiometer, with a 0.1 cm precision. Weight was assessed with 100g precision, using TANITA BC-545 body composition analyser. This equipment was also used to determine body fat percentage. Body mass index (BMI) was calculated and categorized according to Centers for Disease Control and Prevention (2000)(32). McCarthy (2006) criteria were used to classify groups of normal to obese subjects, considering body fat percentage(33). The minimum perimeter between the iliac crest and the rib cage corresponded to the waist circumference, which was categorized according to Taylor (2000)(34). A non-elastic tape was used for waist circumference measurements. For all anthropometric assessments adolescents wore light cloths.

General Nutrition Knowledge

Nutrition Knowledge was assessed with a previously validated questionnaire for Portuguese adolescents, the General Nutrition Knowledge Questionnaire for Adolescents (GNKQA)(35). This questionnaire has 137 items, distributed through

Table 1. Sample and subsamples Characteristics

	Total Sample n=734		Food Diary Subsample n=291		Accelerometer Subsample n=222	
	n	%	n	%	n	%
Sex						
Female	388	52.9	171	58.8	123	55.4
Male	346	47.1	120	41.2	99	44.6
School Grade						
7th to 9th grade	285	38.8	157	45.4	89	40.1
10th to 12th grade	449	61.2	189	54.6	133	59.9
Mothers' Education Level†						
Less than 5th grade	23	5.0	10	4.0	5	4.1
5th to 9th grade	118	25.8	64	25.5	38	31.1
10th to 12th grade	123	26.9	63	25.1	25	20.5
More than 12th grade	194	42.4	114	45.4	54	44.3
Fathers' Education Level‡						
Less than 5th grade	56	12.1	32	12.6	19	15.2
5th to 9th grade	139	30.1	75	29.6	42	33.6
10th to 12th grade	112	24.2	64	25.3	26	20.8
More than 12th grade	155	33.5	82	32.4	38	30.4
Family Income /month (euros)§						
Less than 1001	112	25.0	71	28.3	41	34.5
From 1001 to 2000	213	47.5	111	44.2	53	44.5
From 2001 to 3000	83	18.5	48	19.1	17	14.3
From 3001 to 4000	28	6.3	15	6.0	6	5.0
More than 4000	12	2.7	6	2.4	2	1.7
BMI Age Centile						
Underweight	15	2.0	5	1.7	4	1.8
Normalweight	584	79.6	226	77.7	171	77.0
Overweight	98	13.4	50	17.2	36	16.2
Obese	37	5.0	10	3.4	11	5.0
Waist Circumference						
Normal	615	83.8	238	81.8	184	82.9
Risk	119	16.2	53	18.2	38	17.1
Body Fat Percentage						
Under	7	1.0	1	0.3	2	0.9
Normal	501	68.3	187	64.3	148	66.7
Overfat	109	14.9	57	19.6	34	15.3
Obese	117	15.9	46	15.8	38	17.1
Nutritional Adequacy						
< 50%			40	13.7		
≥ 50%			251	86.3		
MVPA						
< 60 min/day					156	70.3
≥ 60 min/day					66	29.7

MVPA, Moderate to vigorous physical activity

† 276 missing values; ‡ 272 missing values; § 286 missing values

four sections: Section 1 - Dietary recommendations (13 items); Section 2 - Sources of nutrients (73 items); Section 3 - Choosing everyday foods (9 items); and Section 4 - Diet-disease relationship (42 items). Each correct answer scores one point, and 5 different scores are considered, a total 137 points score, and a score for each section(35). For statistical analysis a percentage of correct answers was calculated, per section and for the total GNKQA.

Physical Activity Knowledge

The Physical Activity Knowledge Questionnaire (PAKQ) was specially created for this study. For the development of the questionnaire the Global Recommendations on Physical Activity for Health(36) were used and 10 questions created, 7 True or False and 3 multiple choice. For each of the 10 questions a “Don’t Know” option was included, in order to reduce the non-response rate. Each correct answer was scored one point, for a total score of 10 points. For statistical analysis a percentage of correct answers was calculated.

Nutrition and Dietary Intake

The adolescents’ diet was evaluated with a three-day food diary, including two week days and one weekend day. Verbal and written instructions were given to each participant, together with an age appropriate example. Adolescents were asked to report every food or beverage, as detailed as possible, including cooking methods, type, brand, and portion sizes.

Food diaries of 346 adolescents were correctly filled-in and were analyzed, by a team of dietitians/ nutritionists. An interpretation and quantification manual was specially developed for this study, for bias reduction. This manual included all the food items and household measures mentioned by adolescents in the food diaries, and its objective correspondence for nutritional calculations. The analysis of the food diaries was done in order to obtain information regarding energy and nutrients intake, number of eating episodes and food portions consumed.

The Portuguese food composition table(37) was used for the calculation of the week mean energy and nutrients intake.

Usual intake was estimated using the National Research Council/ Institute of Medicine method, as described by Dodd, reducing the within and between-person variations(38).

Misreporters were identified using the Goldberg cut-off method(39), as adapted by Black(40). In short, basal metabolic rate (BMR) was estimated by sex and age specific Schofield equations(41). A ratio between the energy intake (EI) and the BMR was compared to the 95% confidence cut-offs.

The cut-offs were calculated using sample specific values for: physical activity level (PAL), within-subject coefficient of variation in energy intake, between-subject variation in physical activity and number of days of diet assessment. A figure value of 8.5% was used for the coefficient of variation of repeated BMR measurements, as previously suggested(40). Adolescents with EI: BMR below 0.844 and over 2.610 were excluded from the statistical analysis, as a result a final sample of 291 adolescents was used.

Nutritional adequacy was assessed using the Estimated Average Requirement (EAR) cut-off method(42, 43), for vitamin A, vitamin C, vitamin E, thiamin, riboflavin, niacin, vitamin B6, folate, vitamin B12, iron, magnesium, phosphorus, zinc, vitamin D and calcium(43, 44). The tolerable upper intake level was used to set adequate intake for sodium(43). For protein, carbohydrates, simple sugars, fat and linoleic acid the acceptable macronutrient distribution ranges (AMDR) were assumed(43). The maximum energy percentage from saturated fatty acids recommended by the American Heart Association was considered for this nutrient(45).

A nutritional adequacy score was calculated including all 22 nutrients, each nutrient with adequate intake scored one point, and inadequate intakes scored 0 points. For statistical analysis a nutritional adequacy percentage was used.

The number of eating episodes was measured, considering as an eating episode any eating occasion when food or drink was consumed, also including drinks (i.e. soft drinks or coffee) consumed in the absence of food. It was also considered a minimum time of 15 minutes between eating episodes, hence two eating episodes occurring within 15 minute or less period counted as a single episode(46).

Portuguese healthy eating recommendations(47) and the Portuguese standard serving portions, were considered for food portions counting.

Physical Activity

Adolescent physical activity was assessed with Actigraph GT3X+ accelerometers, that were used during 7 consecutive days, according to previously suggested protocols(48). Students and parents received written information on how to use the accelerometer, before giving written consent. Additional oral information was given individually to each adolescent. On the 8th day the accelerometers were collected.

The accelerometer was used with an elastic belt in the waistline, positioned in the anterior axillary line of the non-dominant side. The device was initialized, selecting a 3-second epoch. Adolescents received both verbal and written information on how to use the accelerometer, based on previous researches(48); instructions were given considering the use during 7 consecutive days, starting immediately after waking up and until going to bed, except for water activities (bath and swimming).

After usage, accelerometer data was processed using Actilife (version 6.9, Actigraph, Florida), data was reduced to one-minute periods (epochs), and wear and non-wear time was determined in accordance to previous recommendations(49). Time periods with at least 90 consecutive minutes of zero counts recorded were excluded from analysis assuming that the monitor was not worn. A minimum recording of 8-hours/day (480-minutes/day) was the criteria to accept daily physical activity data as valid. Participants were required to have a minimum recorded data for 3 days, a criterion in accordance with previous researches(50, 51).

The outcome variables were time (min/day) spent in each of the following categories: sedentary activity (0-100 Counts/min); light activity (101-2295 Counts/min); moderate activity (2296-4011 Counts/min) or vigorous activity (≥ 4012 Counts/min), according to the Evenson cut-points(52), as previously suggested for studies with adolescents(53). Moderate-to-vigorous physical activity (MVPA) was defined as the sum of moderate and vigorous activity.

The Trost (1998) formula was used to calculate total energy expenditure from the accelerometer data(54). PAL used for the Goldberg equation was obtained from the ratio between total energy expenditure and resting energy expenditure.

Ethical Considerations

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving human participants were approved by the Research Centre in Physical Activity, Health and Leisure Scientific Committee. Written informed consent was obtained from all the parents or legal tutors.

The schools directors involved gave their ethical approval. Adolescents were given the opportunity to refuse participation.

Statistical Analysis

Descriptive analysis (frequencies, mean, standard deviation and percentiles) was used for sample characterization and for description of the knowledge scores, physical activity engagement and nutritional and dietary intake. Adjusted quartiles were calculated for GNKQA and PAKQ scores.

After testing for normal distribution, Kruskal-Wallis and Mann Whitney U tests were performed to compare knowledge scores, physical activity and nutritional adequacy between groups.

Non-parametric adjusted partial correlation was calculated to test the association between nutritional and physical activity, knowledge and practices.

Data analysis was performed using IBM Statistical Package for Social Sciences, version 22 (SPSS Inc; Chicago, IL, USA). Statistical significance was set at $P<0.05$.

Results

The overall sample consisted of 734 adolescents, with a mean age of 15.8 (SD=1.87), and included 388 (52.9%) female and 449 (61.2%) attending grade levels 10th through 12th. The parents' educational level was predominantly above the 10th grade (43.2% of the mothers and 36.4% of the fathers) and 325 (44.3%) adolescents had a family income under 2000 euros per month. BMI Age Centile revealed that 584 (79.6%) had normal weight for height, age and gender; waist circumference results showed 615 (83.8%) with normal values and body fat percentage was normal in 501 (68.3%) of adolescents (Table 1).

The column proportions z-test revealed that the individuals returning a complete food diary (n=346) differed significantly ($p<0.05$) from the ones who did not: a

higher proportion of girls, adolescents attending grade levels 7th through 9th, individuals with a family monthly income under 1001 euros, and overweighed individuals filled-in the food diary. Adequate reporters (n=291) had a significantly lower BMI (p=0.000), waist circumference (p=0.000) and body fat percentage (p=0.003) when compared to the misreporters.

Comparing the column proportions between accelerometer users (n=222) and non-users, significant differences were found only for the family income, with a higher proportion of users reporting less than 1001 euros.

The GNKQA revealed a mean percentage of correct answers of 46.5% (SD=11.82%), with the first section scoring the best (Mean=59.2%, SD=16.82%) and section 4 the worst results (Mean=43.1%, SD=18.38%). The PAKQ had a mean of 66.2% (SD=14.50%) of correct answers (Table 2).

Nutritional adequacy percentage is over 50% for 86.3% (n=251) adolescents with a valid food diary (Table 1). The average nutritional adequacy percentage was 57.4 % (SD=10.24%) (Table 2), when analysing per nutrient. It was found that all adolescents (100%) had an adequate intake of protein; over 90% of adolescents had an adequate intake of simple sugars, thiamin, riboflavin, niacin, vitamin B6 and iron; while for vitamin D, calcium and sodium less than 10% of individuals had adequate intake. It should be emphasized the fact that 0 adolescents scored adequate for saturated fatty acids (Table 3). The mean nutritional intake of saturated fatty acid was of 12.6% (SD=1.92%) of energy intake, while for linoleic acid was 4.3% (SD= 0.98%) of energy intake. Vitamin D average intake was 3.6 (SD=2.50) µg per day, and for calcium was 3348.9 (SD=913.18) md per day (Table 3).

Accelerometer usage revealed that only 29.7% (n=66) of adolescents engage in MVPA for 60 minutes or more per day (Table 1), in fact these adolescents engaged in MVPA in average 47.9 (SD=27.49) minutes per day (Table 2).

A significant correlation was found between age and GNKQA score (ρ=0.12; p=0.002), PAKQ score (ρ=0.11; p=0.004), nutritional adequacy percentage (ρ=-0.20; p=0.001) and MVPA time (ρ=-0.334 p=0.000).

Table 2. Nutrition and physical activity knowledge percentage of correct answers, nutritional adequacy percentage and MVPA descriptive data

		GNKQA Total (%)	GNKQA Section 1 (%)	GNKQA Section 2 (%)	GNKQA Section 3 (%)	GNKQA Section 4 (%)	PAKQ (%)	Nutritional Adequacy (%)	MVPA (min/day)
n		734	734	734	734	734	734	291	222
Mean		46.5	59.2	46.3	46.3	43.1	66.2	57.4	47.9
SD		11.82	16.82	12.45	16.96	18.38	14.50	10.24	27.49
Percentiles	25	39.42	53.85	38.36	33.33	30.95	60.00	50.00	26.68
	50	47.45	61.54	47.95	44.44	45.24	68.10	54.55	41.93
	75	54.93	69.23	54.79	55.56	57.14	80.00	63.64	65.02

GNKQA, General Nutrition Knowledge Questionnaire; PAKQ, Physical Activity Knowledge Questionnaire; MVPA, Moderate to Vigorous Physical Activity; min/day, minutes per day; SD, Standard Deviation

Table 3. Nutritional mean intake and nutritional adequacy frequency, per nutrient.

	All				Girls				Boys			
	Mean	SD	n	%	Mean	SD	n	%	Mean	SD	n	%
Prot (%EI)	17.2	2.87	291	100.0	16.8	2.70	171	100.0	17.7	3.04	120	100.0
CH (%EI)	46.7	5.38	200	68.7	46.9	5.01	120	70.2	46.4	5.88	80	66.7
SS (%EI)	16.8	5.32	271	93.1	17.8	5.30	155	90.6	15.4	5.05	116	96.7
Fat (%EI)	35.0	4.43	147	50.5	35.3	4.43	81	47.4	34.5	4.40	66	55.0
n-6 (%EI)	4.3	.98	58	19.9	4.4	1.02	36	21.1	4.2	.90	22	18.3
SFA (%EI)	12.6	1.92	0	.0	12.8	1.80	0	.0	12.3	2.05	0	.0
Vit A (µg/day)	498.2	186.81	123	42.3	465.8	166.83	77	45.0	544.3	204.04	46	38.3
Vit C (mg/day)	72.0	40.58	173	59.5	67.6	31.16	101	59.1	78.2	44.43	72	60.0
Vit D (µg/day)	3.6	2.50	8	2.7	3.2	2.06	3	1.8	4.2	2.93	5	4.2
Vit E (mg/day)	9.2	2.95	57	19.6	8.6	2.57	21	12.3	10.0	3.24	36	30.0
Thiamin (mg/dy)	1.5	.45	281	96.6	1.4	.34	165	96.5	1.7	.52	116	96.7
Riboflavin (mg/day)	1.9	.61	285	97.9	1.7	.48	166	97.1	2.1	.69	119	99.2
Niacin (mg/day)	38.4	9.31	288	99.0	35.0	6.44	168	98.2	43.2	10.60	120	100.0
Vit B6 (mg/day)	2.2	.67	289	99.3	2.0	.52	169	98.8	2.4	.76	120	100.0
Vit B12 (µg/day)	4.0	1.74	280	96.2	3.6	1.34	161	94.2	4.7	2.02	119	99.2
Folate (µg/day)	237.0	79.9	47	16.2	218.0	62.1	17	9.9	264.1	93.7	30	25.0
Ca (mg/day)	756.6	252.91	24	8.2	702.9	22.13	9	5.3	833.2	274.46	15	12.5
Fe (mg/day)	11.0	3.46	264	90.7	10.1	2.51	149	87.1	12.4	4.13	115	95.8
Mg (mg/day)	251.9	63.44	80	27.5	231.0	45.95	34	19.9	281.5	72.7	46	38.3
P (mg/day)	1288.2	304.30	224	77.0	1179.2	215.30	118	69.0	1443.6	343.54	106	88.3
Zn (mg/day)	10.2	2.52	260	89.3	9.3	1.85	149	87.1	11.5	2.80	111	92.5
Na (mg/day)	3348.9	913.18	24	8.2	3043.3	671.80	18	10.5	3784.3	1030.58	6	5.0

SD, Standard Deviation; %EI, Percentage of energy intake; Prot, Protein; CH, Carbohydrates; SS, Simple Sugars; n-6, Linoleic Acid; SFA, Saturated Fatty Acids; Vit, Vitamin; Ca, Calcium; Fe, Iron; Mg, Magnesium; P, Phosphorus; Zn, Zinc; Na, Sodium

When analyzing the differences between sexes, girls scored significantly more in sections 1 (61.9% vs. 56.9%; $p<0.001$), 2 (47.6% vs. 44.7%; $p<0.001$) and 4 (45.0% vs. 41.0%; $p<0.001$), and in the total GNKQA (48.1% vs. 44.8%; $p<0.001$), but no significant differences were found in the PAKQ. However, boys were significantly more active (62.2 min/day vs. 36.5 min/day; $p<0.001$), and had a significantly higher nutritional adequacy (60.1% vs. 55.5%; $p<0.001$) (Table 4). Adolescents attending grade levels 7th through 9th grade had significantly lower scores, either in GNKQA (44.6% vs. 47.8%; $p<0.05$) or in PAKQ (63.7% vs. 67.7%; $p<0.001$), nevertheless they spent significantly more time in MVPA (62.0 min/day vs. 38.5 min/day; $p<0.001$) and had a significantly better nutritional adequacy (59.1% vs. 56.0%; $p<0.05$) (Table 4).

The adolescents' knowledge scores and time in MVPA did not differ according to their of parents' educational level, however parents with a higher level of education (above the 12th grade) had descendants with higher nutritional adequacy percentages (Table 4).

Adolescents with different monthly family income did not differ in nutritional and physical activity knowledge and in time in MVPA, but a significantly ($p<0.05$) lower nutritional adequacy (55.8%) was found in the group with the lowest income (Table 4).

Dietary intake analysis revealed that adolescents consumed, on average, less than one portion per day of vegetables, fruit, nuts and beans; and over 5 portions per day of meat. Sugary drinks are consumed in a mean of 200 ml per day. Adolescents practiced in average 4.7 eating events per day (Table5).

The mean rank differences of dietary intake per adjusted (for sex, age and school year) quartiles of GNKQA, were found only for daily portions of dairy, with the first quartile showing the higher intake (Mean Rank=170.9; $p=0.011$) (Table 5), but no significant adjusted correlations were found between nutritional knowledge and nutritional adequacy (Table 6).

Table 4. Differences between groups in GKNQA and PAKQ score percentages, MVPA and nutritional adequacy

	GNKQA (%) Total				GNKQA (%) Section 1				GNKQA (%) Section 2				GNKQA (%) Section 3				GNKQA (%) Section 4				PAKQ (%)				MVPA (min/day)				Nutritional Adequacy (%)			
	Mean	SD	*Mean Rank*		Mean	SD	Mean Rank		Mean	SD	Mean Rank		Mean	SD	Mean Rank		Mean	SD	Mean Rank		Mean	SD	Mean Rank		Mean	SD	Mean Rank		Mean	SD	Mean Rank	
Sex †																																
Male	44.8	11.39	333.5	**	56.9	18.38	340.2	**	44.7	12.17	338.3	**	45.3	16.80	357.5	**	41.0	17.84	341.1	**	65.2	14.53	352.5	**	62.2	28.31	145.0	**	60.1	10.48	166.7	**
Female	48.1	11.99	397.8		61.2	15.05	391.8		47.6	12.55	393.6		47.2	17.08	376.4		45.0	18.67	391.0		67.1	14.43	380.9		36.5	20.70	84.6		55.5	9.66	131.5	
School Grade †																																
7th to 9th grade	44.6	11.28	328.1	*	54.9	18.24	317.5	**	44.6	12.19	340.3	*	44.9	17.17	350.5	*	41.2	17.88	341.3	*	63.7	14.95	329.5	**	62.0	28.08	144.7	**	59.1	10.55	161.1	*
10th to 12th grade	47.8	12.00	392.5		61.9	15.27	399.3		47.3	12.52	384.8		47.2	16.79	378.3		44.4	18.61	384.1		67.7	14.00	391.6		38.5	22.76	89.3		56.0	9.82	134.3	
Mothers' School Grade ‡																																
Less than 5th grade	44.9	12.10	210.8		55.8	18.86	213.4		45.1	10.57	210.7		49.3	12.73	248.3		40.0	19.84	200.2		65.7	13.08	215.5		70.9	24.07	78.0		54.1	12.57	97.7	
5th to 9th grade	46.7	11.45	224.7		58.6	17.62	230.6		46.4	12.40	223.3		48.7	17.39	243.0		43.1	18.60	221.0		65.5	15.45	221.7		63.4	29.02	66.9		54.8	9.37	103.2	**
10th to 12th grade	48.0	11.45	234.1		60.3	16.20	242.4		47.8	11.59	236.1		46.3	17.87	222.5		44.7	18.77	232.3		67.1	15.40	237.2		58.0	25.46	60.8		56.9	9.30	120.2	
More than 12th grade	47.8	11.29	231.8		58.2	16.80	22.6		47.2	12.18	231.3		46.4	17.99	223.5		45.9	16.73	236.4		66.5	15.00	231.0		56.0	27.86	56.5		60.4	10.31	144.5	
Fathers' School Grade ‡																																
Less than 5th grade	46.3	11.03	222.7		61.7	15.70	259.9		45.7	11.67	218.4		49.7	18.49	258.3		41.9	18.63	216.0		66.3	13.29	230.5		68.8	25.00	77.8		56.0	10.80	108.4	
5th to 9th grade	47.9	11.71	239.5		58.6	18.27	233.6		47.8	11.66	241.3		47.3	16.83	231.5		44.8	18.45	235.8		66.0	14.97	226.8		55.5	27.80	58.6		57.2	11.09	121.2	
10th to 12th grade	45.7	12.03	208.9		56.6	17.81	216.4		46.1	12.98	218.1		46.7	18.42	230.5		41.4	18.59	207.5		65.3	16.87	224.0		57.1	31.30	60.3		56.8	8.14	119.4	*
More than 12th grade	48.3	11.03	243.8		59.2	15.26	230.3		47.4	11.92	237.1		45.8	17.34	222.5		47.1	16.83	250.6		67.4	14.45	241.5		57.5	25.44	62.3		60.4	10.48	145.5	
Family Income /month (euros) ‡																																
Less than 1001	45.5	11.11	203.3		58.4	18.89	228.0		45.1	11.67	205.0		47.3	16.39	228.6		41.8	18.03	204.6		64.8	15.30	205.1		62.2	25.66	64.7		55.8	10.10	109.2	
From 1001 to 2000	48.0	11.18	232.0		58.2	16.27	217.1		47.7	12.01	231.2		47.2	17.46	225.7		45.5	17.66	230.8		66.4	15.47	225.9		55.4	29.13	55.3		57.2	10.19	120.4	
From 2001 to 3000	48.6	11.80	234.1		60.9	14.16	236.3		48.1	12.29	233.4		48.1	19.76	228.3		45.7	19.14	234.5		68.9	13.71	247.2		66.4	28.19	68.4		60.1	10.28	146.1	*
From 3001 to 4000	49.9	13.09	248.2		61.7	16.51	243.9		49.6	13.96	250.8		47.0	15.79	220.9		47.3	17.46	240.5		66.4	15.45	232.8		54.0	33.14	53.0		63.3	6.76	173.7	
More than 4001	42.3	11.50	168.1		53.6	20.67	195.2		41.9	10.45	165.3		35.3	16.38	147.0		40.9	17.10	191.2		66.7	14.35	205.3		61.3	30.84	39.0		62.8	13.30	148.1	

GNKQA, General Nutrition Knowledge Questionnaire; PAKQ, Physical Activity Knowledge Questionnaire; MVPA, Moderate to Vigorous Physical Activity; SD, Standard Deviation; †, Mann–Whitney U test; ‡, Kruskal–Wallis Test; *p<0.05; **p<0.001

Table 5. Kruskal–Wallis comparison of dietary intake and physical activity variables between GNKQA and PAKQ adjusted quartiles.

			GNKQA Total†					PAKQ†				
			Q1	Q2	Q3	Q4	*p*-value	Q1	Q2	Q3	Q4	*p*-value
	Mean	SD	Mean Rank					Mean Rank				
Bread (portions/day)	2.0	1.35	151.4	140.2	148.3	144.8	.874	131.9	143.7	154.8	146.4	.433
Breakfast Cereals (portions/day)	.2	.30	150.1	149.6	142.5	143.0	.857	139.9	144.1	147.0	152.1	.809
Cookies (portions/day)	.3	.39	148.8	153.1	139.1	144.6	.701	141.5	144.4	146.9	150.5	.936
Vegetables (portions/day)	.3	.29	150.8	146.7	137.5	152.6	.676	147.4	146.2	141.7	152.0	.898
Vegetable Soup (portions/day)	.3	.40	137.0	152.2	136.7	155.2	.344	136.6	144.6	145.0	152.9	.746
Fruit (portions/day)	.6	.62	151.0	149.6	146.8	136.2	.737	139.1	160.0	135.5	153.6	.207
Beans (portions/day)	.1	.30	154.8	153.0	143.6	133.2	.200	160.7	154.4	138.7	135.0	.068
Dairy (portions/day)	1.1	.64	170.9	155.3	136.5	125.6	**.011**	148.1	141.0	141.6	157.7	.630
Total Fish (portions/day)	1.2	1.95	155.1	128.6	149.9	153.0	.142	145.5	160.2	140.7	138.6	.329
Fatty Fish (portions/day)	.2	.63	138.6	142.2	155.4	144.2	.096	146.5	143.8	146.2	147.8	.962
Canned Fish (portions/day)	.1	.27	142.3	145.7	145.5	150.5	.749	137.8	152.3	146.6	145.0	.299
Poultry(portions/day)	1.4	1.45	137.9	143.8	145.5	156.5	.642	139.0	132.4	156.0	151.5	.246
Total Meat (portions/day)	5.1	2.78	139.6	148.2	144.9	150.8	.893	142.7	138.9	146.6	156.6	.670
Eggs (portions/day)	.2	.37	146.6	140.7	139.4	160.9	.250	145.6	153.6	141.3	145.5	.728
Nuts (portions/day)	.0	.05	144.5	151.4	145.2	142.0	.104	144.6	146.1	144.8	149.3	.666
Olive oil (portions/day)	.7	.73	162.7	147.4	130.4	150.8	.126	156.7	144.6	141.8	145.2	.756
Savory puff pastry (portions/day)	.0	.13	146.5	155.7	136.3	147.6	.060	156.7	149.2	137.7	146.8	.085
Sugary snacks (portions/day)	.9	.78	143.2	133.7	148.4	159.8	.312	138.1	149.5	151.4	139.7	.711
Sugary drinks (ml/day)	200.6	213.42	143.6	145.7	145.7	149.0	.987	138.3	146.5	150.3	145.1	.859
Eating Events (number/day)	4.7	.93	150.2	148.8	145.4	139.7	.895	150.4	139.2	142.0	157.1	.585
Sedentary Activity (min/day)	506.9	117.61	67.2	54.9	53.2	64.9	.281	53.7	69.8	51.7	66.4	.106
Light Activity (min/day)	277.7	72.40	47.4	62.3	64.0	65.1	.097	54.2	64.4	62.6	56.1	.622
Moderate Activity (min/day)	35.1	19.26	51.8	63.2	67.1	53.5	.231	51.3	56.2	69.8	56.5	.143
Vigorous Activity (min/day)	12.9	12.01	57.8	58.7	68.6	49.6	.184	49.9	58.0	70.8	54.6	.075
MVPA (min/day)	47.9	27.49	52.5	62.6	68.2	51.6	.161	49.6	56.0	72.2	55.0	**.041**

†, Quartiles were adjusted for age, sex and school year.

Table 6. Partial correlation (adjusted for age, sex and school year) between nutrition and physical activity knowledge scores, moderate to vigorous physical activity and nutritional adequacy score

	GNKQA Section 1		GNKQA Section 2		GNKQA Section 3		GNKQA Section 4		PAKQ		MVPA		Nutritional Adequacy	
	Spearman ρ	p-value	Spearman ρ	p-value	Spearman ρ	p-value	Spearman ρ	p-value	Spearman ρ	p-value	Spearman ρ	p-value	Spearman ρ	p-value
GNKQA Total	.43	.000	.87	.000	.34	.000	.83	.000	.19	.000	.03	.718	-.03	.636
GNKQA Section 1	1.00		.33	.000	.12	.001	.23	.000	.18	.000	.06	.368	-.02	.752
GNKQA Section 2			1.00		.23	.000	.52	.000	.17	.000	.08	.227	.01	.852
GNKQA Section 3					1.00		.21	.000	.03	.435	.03	.676	.04	.505
GNKQA Section 4							1.00		.17	.000	-.03	.655	-.10	.087
PAKQ									1.00		.12	.083	.11	.069
MVPA											1.00		-.07	.448

GNKQA, General Nutrition Knowledge Questionnaire; PAKQ, Physical Activity Knowledge Questionnaire; MVPA, Moderate to Vigorous Physical Activity

The mean rank differences between the PAKQ adjusted quartiles, revealed that adolescents in the third knowledge quartile spent the highest amount of time in MVPA (Mean Rank=72.2; p=0.041) (Table 5), but adjusted partial correlation between physical activity knowledge and MVPA, had no statistical significance (ρ=0.12; p=0.083) (Table 6).

Partial correlations were adjusted for age, sex and school year, and revealed that GNKQA and PAKQ scores were significantly correlated (ρ=0.19; p=0.000). No significant correlation was found between nutritional knowledge and physical activity practice, or between physical activity knowledge and nutritional adequacy (Table 6).

Non-adjusted Spearman correlations revealed similar results, with no significant results between GNKQA and Nutritional Adequacy and PAKQ and MVPA.

Discussion

Descriptive data of this sample revealed that Portuguese adolescents have a low prevalence of nutritional adequacy for saturated fatty acids, vitamin D, vitamin E, folate, calcium and sodium, which is a matter of concern for public health professionals. A study of 2010, with Portuguese children aged 7 to 9 presented similar results for saturated fatty acids, vitamin E, folate and calcium, but no results were presented for vitamin D and sodium(8). The high intake of saturated fatty acids reflected the overconsumption of meat, whereas the low intake of calcium was an echo of the under consumption of dairy and vegetable calcium sources.

Physical activity engagement was far below recommendations for this age range(36), as previously suggested by Portuguese researchers(11).

The current data emphasized that overall adolescents' nutrition knowledge was poor, as evidenced by the 50th percentile presenting a negative percentage of correct answers (47.45%), similar conclusions were mentioned for pregnant women(12), theatre students(55), and elderly people(56).

The general nutrition knowledge questionnaire was previously used with adults, and results showed that section 1 had the best scores, while section 4 had the

worse(21, 57). The same result was observed in adolescents in this study, showing that although adolescents are better informed of experts' dietary recommendations (section 1), they are not conscious of the link between diet choices and diseases (section 4), the sources of nutrients (section 2) and are negatively scored in the ability of choosing the healthiest option in everyday foods (section 3). These results can be related to the outcomes of public health interventions, that seem to inform about the recommendations, but don't empower adolescents to make their own choices, and do not educate on health consequences.

Regarding physical activity knowledge, adolescents' mean score was above 50%. It is hard to compare this result with previous studies, since usually physical activity knowledge is poorly assessed, resorting only to one question that addresses the daily amount of physical activity recommended(58). However studies with Australian adults using a scale with more items, revealed good knowledge of physical activity guidelines(59, 60).

Female adolescents revealed greater nutrition knowledge, a result that is in accordance with previous findings in all age ranges(15, 57, 61). However, no differences were found between sexes regarding physical activity knowledge, which is consistent with results from younger children(15). It seems that girls are more interested in nutrition, therefore exposing themselves to more information on the topic. Along with this exposure females receive physical activity information as well, reflecting the fact that most of the recommendations for nutrition and for physical activity are done together. Boys, however, seem to seek reduced information or are less prone to the nutrition topics, but as a result of their interest in sports, they have reasonable physical activity knowledge, similar to that of girls.

The results from the current study suggest that nutrition and physical activity knowledge improve with age and school grade, as adolescents attending grade levels 10th through 12th had significantly higher GNKQA and PAKQ scores, the same results were observed for ballet dancers(62) and other athletes(57), and even for adults(61). It seems that interest in health topics and information seeking are scarce in the early adolescence, which can be explained by the absence of

negative consequences after unhealthy behaviours in younger ages, leading to feelings of invulnerability(63). Older adolescents probably deal with weight and body image issues, and therefore are more knowledgeable. However being better informed does not translate into healthier behaviours. Indeed, younger adolescents are more physically active and have higher nutritional adequacy percentages. This fact can be related to the greater parental influence in younger ages, while for older adolescents the decision making process is more influenced by social than by health consequences(64), and not by having in consideration long term results. The increase of psycho physiological arousal leads to an increase in risk taking behaviours, with unknown or ignored costs(65-67). In fact, it has been mentioned that adolescence is the life period were people engage in more risk behaviours(68), which may negatively affect the ongoing ages(69-71).

Just as previous studies with younger children(15), nutritional and physical activity knowledge scores were significantly correlated, adolescents who knew more about nutrition, also knew more about physical activity. This result reflects current community programmes in Portugal, that are directed to children and adolescents and focus on either the benefits of a healthy diet or the advantages of being physically active(72), as well as suggest the existence of two kinds of adolescents, the ones interested in health related subject, and the ones with no interest.

The percentage of correct answers was significantly higher in the PAKQ when compared to the GNKQA, on the contrary, children from previous studies revealed greater nutrition knowledge(15, 73), or no difference between scores(74). This can reflect the fact that adolescents' interests are more close to physical activity than to nutrition, which should be considered when planning public health interventions for these ages.

Although results from a study with physical education and non-physical education students suggested that a relation between nutrition knowledge and physical activity practice exists(75), the same was not observed in adolescents in this sample. These results propose that adolescents' engagement in physical activity occurs in settings where there is no reinforcement of nutrition information.

In general, results lead to the conclusion that knowledge is not associated with practices, in what concerns nutrition or physical activity.

Nutritional knowledge wasn't correlated to nutritional intake, a result that seem to be aligned with conclusions in South African secondary students(17) and Spanish university students(18). Other studies revealed a positive correlation with only certain food items and nutrients, like fruit and vegetables(21, 76, 77), fish(76, 77) and fibre(76) , but not with other food items or nutrients(21). The absence of a correlation in this study can also be related to the fact that the mean GNKQA score is low, reflecting that all adolescents in the sample had poor nutrition knowledge, therefore not sufficient to produce healthy nutritional intakes.

Physical activity knowledge was not correlated to time spent in MVPA, however studies with adults suggested that a positive relation between believing they needed more physical activity than recommended by experts was correlated with achieving more physical activity(58, 78). However self-reported measurements of physical activity were used in those studies, what could produce social desirability bias. In addition, when physical activity knowledge was assessed with a more complete questionnaire, no relation was found in American adults(79).

These results, besides emphasizing the need to increment the nutritional and physical activity knowledge in Portuguese adolescents, reinforce the concept that knowledge, although necessary(22), may not be sufficient, as the only factor, to engage in an adequate behaviour(12, 16, 22). Along with this conclusion dietary and physical activity education interventions should focus not only on theoretical information, but should also include ways to implement the existing knowledge, empowering adolescents to make the appropriate health decisions on day-to-day life(80). Adolescents need to perceive it as possible and feasible to implement the acquired knowledge into a healthy dietary(15) and physical activity behaviour(22). So the interventions should be multicomponent as suggested by the World Health Organization(81), including informational, behavioural, social, environmental and policy approaches(22). Nevertheless, for researchers and public health professionals it is essential to remember that ultimately individuals need to be motivated to engage in healthy behaviours(22, 82).

Previous studies stated the physical activity and dietary assessment methods as limitations to their studies(12, 58). Also the questionnaires used to assess nutrition knowledge frequently are not validated and compromise the conclusions(19). The same cannot be stated as limitations for this data, as it resulted from a validated questionnaire, the GNKQA. Gold standard measurements were used either for physical activity, with the accelerometer, or for diet, with the 3 day food diary. Although reducing the subsample size, the authors chose to eliminate misreporters, enhancing information accuracy(83). When analysing the misreporters characteristics, results were consistent with a recent review conclusion, it seems that misreporters have consistently higher adiposity measurements(83). However a limitation should be mentioned: although food diaries were distributed to all adolescents, only 346 (47.1%) returned them, what could result in non-response bias. The comparison between the respondents and non-respondents revealed that non-respondents had significantly lower BMI centile and waist circumference, but no differences in nutrition or physical activity knowledge scores.

In conclusion, in order to get adolescents to translate their nutrition and physical activity knowledge into healthy practices, multicomponent interventions should be designed, including health knowledge in association with other correlates of dietary and physical activity behaviours. Schools, parents and peers, availability, price, security, attitudes, but also knowledge should be included as aspects to be assessed and incorporated in health interventions, so that nutrition and physical activity behaviours improve.

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Chapter 4. Overall Discussion

Overall Discussion

To our awareness, nutrition and physical activity knowledge were for the first time studied in Portuguese adolescents within the work presented in this thesis.
One of the main outcomes from this thesis was the General Nutrition Knowledge Questionnaire for Adolescents (GNKQA) adaptation, update and validation, both on paper and online versions **(Paper I)**. In addition, assessment of the validity of the International Physical Activity Questionnaire for Adolescents was performed **(Paper II)**, but results suggest that questionnaires are not good tools for adolescents' physical activity assessment. The main findings outlined from the original research in **Paper III and Paper IV** support the idea that although the score of the section 1 of the GNKQA was significantly lower among overfat/ low physical activity adolescents, there seems to be no association between knowledge and practices, regarding nutrition and physical activity in adolescents.

No previous research with adolescents assessed nutrition knowledge, probably because of the inexistence of validated questionnaires. After the work in **Paper I,** GNKQA proved to be a valid and reliable tool for nutrition knowledge assessment in adolescents. This questionnaire consists of four sections covering a broad range of aspects of the nutritional sciences.
The importance of assessing nutrition knowledge has been widely mentioned, but previous authors emphasized the importance of using age specific, validated and complete questionnaires, addressing all aspects of nutrition (Wardle et al., 2000). Science and knowledge is under continuous evolution, and when researchers intend to evaluate knowledge about a certain topic, they should have the latest scientific evidences as standard. Among all the work underneath the validation of GNKQA an update was performed, in accordance with the latest scientific reviews and recommendation on nutrition (Anderson et al., 2009; Brown et al., 2009; de Sa & Lock, 2008; He & MacGregor, 2009; Hoffmann et al., 2003; Kipping et al., 2008; Kushi et al., 2006; Mirmiran et al., 2009; Ruxton et al., 2010).
The adapted Portuguese version of GNKQA showed high internal consistency either for the total score (Cronbach's alpha = 0.92), and for sections 1

(Cronbach's alpha = 0.63), 2 (Cronbach's alpha = 0.85), and 4 (Cronbach's alpha = 0.88). These results allowed concluding that the different items of GNKQA are in fact contributing to the measurement of the nutrition knowledge construct, delivering consistent scores.

Section 3 presented lower values of internal consistency (Cronbach's alpha = 0.33), which could be partially explained by the lower number of items, when compared to the other sections, as previously suggested (Towers & Allen, 2009).

The test–retest reliability (R = 0.71) proved that GNKQA assesses consistently nutrition knowledge, over time, what seems particularly important for nutrition education interventions, that aim to measure pre and post-intervention nutrition knowledge (WHO, 2009).

Concurrent validity (U = 22766.0; $p < .01$) was acceptable, in fact the GNKQA is able to distinguish two groups with previously known differences in knowledge, in this case dietetic students versus adolescents.

Previous GNKQ validation studies (Alsaffar, 2012; Hendrie, Cox, et al., 2008; Parmenter & Wardle, 1999) presented similar results.

In relation to the process of validation of IPAQA (**Paper II)**, results from the present thesis suggest that IPAQA is not a good measure of adolescents' physical activity.

Accelerometers were used for concurrent validity, as previously recommended (Boon et al., 2010; Guedes et al., 2005; Hagstromer et al., 2008; Lachat et al., 2008; Wong et al., 2006), and although using an advanced model, the GT3X+, no significant correlation was found between accelerometer and IPAQA for girls and younger boys. Therefore, it is suggested that IPAQA may be used to assess physical activity in older adolescent boys, but not younger boys or girls of any age. Previous validations of the same instrument in other countries presented similar conclusions (Guedes et al., 2005; Hagstromer et al., 2008).

Nonetheless, researchers that don't have accelerometers available, can use IPAQA, but instead of presenting data on time per day in each physical activity level, categorizing it will be a better option. It would still be possible to distinguish between more and less active adolescents. Otherwise, it would also be valid to combine moderate and vigorous physical activities into one single category

(MVPA), as it seems to exist some agreement between the two measurements of MVPA. It is believed that this association and the better older boys' results are related to the sports participation. Sports practice is easier to report as it has a timing pattern (same day, same duration), and boys seem to engage more in sports participation than girls, as previously suggested (Hagstromer et al., 2008). Also depending on the cognitive development of younger adolescents the difficulties to report the duration of an activity may vary (Droit-Volet, 2013), especially if motion is considered (Kroger-Costa et al., 2013). In addition results suggest that adolescent cannot successfully distinguish between moderate and vigorous activities.

Frequently researchers intend to evaluate if adolescents achieve sufficient physical activity, according to recommendations, that usually are expressed in minutes per day (WHO, 2010), we strongly discourage the use of IPAQA to assess it. A systematic error of misreporting time in physical activity seems to exist in adolescents, as it was mentioned before for other samples (Celis-Morales et al., 2012; Guedes et al., 2005; Wong et al., 2006), the Portuguese adolescents over report time in physical activity, while Swedish adolescents under report (Arvidsson et al., 2005).

In this context, whenever possible and available objective methods, like accelerometers, should be used to assess PA in all adolescents, as previously suggested (Rowlands & Eston, 2007; Vanhelst et al., 2012).

The findings from this study increase de complexity and controversy associated with the decision of previous researchers which used this questionnaire with Portuguese adolescents and their studies conclusions (Araújo-Soares et al., 2009; Lopes et al., 2013), emphasizing the importance of validated questionnaires or objective tools as the only way of achieving correct conclusions.

In accordance to results from studies I and II, GNKQA was used to assess nutrition knowledge and accelerometer to evaluate physical activity for studies III and IV.

Descriptive data from the GNKQA reveal poor nutrition knowledge, with a mean score of less than 50 % of correct answers, although these results are similar to results from adults of other countries (Bonaccio et al., 2013; de Jersey et al.,

2013; Lin & Lee, 2005; Vitzthum et al., 2013), it is still of concern. These data suggest that that the competences for teachers and educators should be developed to increase education standards in nutrition and physical activity, and that the public health campaigns in Portugal, in particular the school health programs are not being effective on improving nutrition knowledge.

Analyzing scores per each section of the questionnaire results showed that section 1 had the best scores, while section 4 had the worse, the same result was previously mentioned in studies using GNKQ (Morrow et al., 2004; Spendlove et al., 2012)., This demonstrates that although adolescents are better informed of experts' dietary recommendations (section 1), they are not conscious of the link between dietary choices and diseases (section 4), the food sources of nutrients (section 2) and have a low ability of choosing the healthiest option in everyday food intake (section 3). These results can be related to the outcomes of public health interventions, that seem to inform about the recommendations, but do not empower adolescents to make their own choices, and do not educate on health consequences.

Physical activity knowledge presented better results (Mean=66.2%, SD=14.5%), however still under the desirable, as previous authors suggested in an international study, where Portuguese young adults were included (Haase et al., 2004) and with American adolescents (Zapata et al., 2008).

GNKQA and PAKQ scores were significantly correlated ($\rho=0.19$; $p<0.001$) after adjusting for age, sex and school year. Adolescents who knew more about physical activity were the ones who knew more about nutrition. Previous results from younger children (Nemet et al., 2007) suggested the same. This result may be related to public health interventions that usually focus either on nutrition and physical activity, hence the adolescents exposed are scoring best at both questionnaires.

The comparison between the nutrition and physical activity knowledge obtained in this thesis and previously published work should however be considered with careful, as they used different questionnaires, what can be producing some bias.

The demographic differences in knowledge rates were similar to the ones described in the literature (Hendrie, Coveney, et al., 2008; Nemet et al., 2007;

Spendlove et al., 2012), females scored best on GNKQA, but no significant differences were found for PAKQ.

Both questionnaires presented significantly better results within the adolescents engaging in more advanced school grades, which can be related either to the age effect (Hendrie, Coveney, et al., 2008; Spendlove et al., 2012; Wyon et al., 2013), and to the cognitive and educational process (Alberga et al., 2012; Reyna & Farley, 2006).

From the accelerometer data it is visible the low engagement in PA by the Portuguese adolescents. In fact, the time in MVPA is far from the recommendations for this age range (WHO, 2010), what was previously mentioned by other Portuguese researchers (Baptista et al., 2012; Mota et al., 2007; Pizarro et al., 2013). The insufficient MVPA can contribute to the fact that more than 30 % of this sample is classified as overfat or obese, by body fat percentage.

Paper III showed that adolescents with higher physical activity levels have significantly higher PAKQ scores, hence adolescents who know more about physical activity, engage more in MVPA. Similar conclusions were previously pointed out (Heinrich et al., 2011; Laosupap et al., 2008).

Studies about the association between BMI and nutrition knowledge have contradictory results, some report no association (de Jersey et al., 2013; Nemet et al., 2007; O'Brien & Davies, 2007), while others refer a negative association (Bonaccio et al., 2013; De Vriendt et al., 2009). Results presented in **paper III**, are the first to study nutrition knowledge and adiposity, measured by body fat, and no difference seems to exist between overfat and non-overfat adolescents, however this relation can vary according to physical activity levels. Adolescents who were simultaneously overfat and less active, knew significantly less about dietary recommendations, even after adjusting for age and gender, what identifies them as a target group for knowledge enhancement interventions, particularly in programs designed to fight obesity.

These relations differences in knowledge between physical activity and adiposity groups, suggested that some association existed between knowledge and

practices concerning physical activity and nutrition, among Portuguese adolescents.

Hence, in this context, **Paper IV** analyzed nutrition and physical activity knowledge association with nutritional adequacy percentage and time spent in MVPA.

Adolescents filled in three day food diaries, a gold standard method for assessing nutritional and dietary intake, and after eliminating misreporters, data reveal a mean nutritional adequacy percentage of 57.4% (SD= 10.24), and in particularly a low prevalence of nutritional adequacy for saturated fatty acids, vitamin D, vitamin E, folate, calcium and sodium. A previous study with younger Portuguese children presented similar results for saturated fatty acids, vitamin E, folate and calcium, but no results were presented for vitamin D and sodium (Valente et al., 2010). This nutritional profile is reflecting the unbalanced and poor consumption for certain foods. Food diaries data also revealed that adolescents consumed, on average, less than one portion per day of vegetables, fruits, nuts and beans, clearly under the Portuguese recommendations for a healthy diet (Rodrigues et al., 2006). On the contrary, the mean consumption of meat was undoubtedly above the recommended (Rodrigues et al., 2006), exceeding five portions a day. Nutritional knowledge wasn't correlated to the nutritional adequacy percentage, a result that seem to be aligned with conclusions in South African adolescents (Peltzer, 2002) and Spanish younger adults (Bravo et al., 2006). Other studies revealed a positive correlation with only certain food items and nutrients, like previously mentioned in this thesis. The inexistence of a correlation can also be related to the fact that the mean GNKQA score is low, reflecting that most adolescents included in the study had poor nutrition knowledge, therefore not sufficient to produce a high nutritional adequacy percentage.

Other authors working with adults suggested that a positive relation between believing to need more physical activity than recommended by experts was correlated with engaging more in physical activity (Heinrich et al., 2011; Laosupap et al., 2008), suggesting a relation between knowledge and practices in physical activity, however the results presented in this thesis show no correlation between PAKQ score and time in MVPA, for Portuguese adolescents. These different

conclusions may reflect differences in methodologies, as self-reported measurements of physical activity were used in the studies with adults, and these measure may be vulnerable to social desirability and other bias, however in this thesis the MVPA time was objectively measured with accelerometers. In addition, the physical activity knowledge when assessed only by one question can't reflect accurately the construct being measured, as reinforced by the studies that assessed physical activity knowledge with a more complete questionnaire, and did not find any relation with practices (Morrow et al., 2004).

In general, results lead to the conclusion that nutrition and physical activity knowledge is not associated with practices, in what concerns nutritional adequacy and physical activity engagement.

Overall the conclusion seems to point that physical activity and nutrition knowledge are not enough per se to be associated with healthy dietary and physical activity behaviors, however a relation seems to exist with adiposity outcomes. So the statement is that knowledge should be considered a crucial target variable of public health interventions, but the individual must be considered as a member of a society and frequently, as a member of an obesogenic environment.

As previously suggested (Budd & Volpe, 2006; Escalon et al., 2013; USTF, 2002), improving school health curricula to dedicate adequate attention to physical activity and nutrition improvement, and to energy balance awareness and knowledge, although not sufficient as a single policy action, is essential to reduce overfat and obesity particularly among the less active adolescents. Additionally, Portuguese schools should include in physical education classes also a health module, addressing the physical activity recommendations and advantages for health and fitness (WHO, 2010). Putting into practice the recommended 30 minutes of moderate to vigorous physical activity during the school day (Budd & Volpe, 2006), should also be considered as a national health and education policy. Also investing in developing the competencies for secondary school teachers to use the energy balance concept would allow teachers to be an active part of nutrition and physical activity education focused on reducing obesity (Manore et al., 2014).

However it should be considered that in order to support the translation of adolescents' nutrition and physical activity knowledge into healthy behaviours, the interventions should be multicomponent. Interventions should continue having an informational (health knowledge) foundation, but other correlates of dietary and physical activity behaviours should also be included. Interventions should include activities to facilitate every day choices in coherence with experts' recommendations, as well as presenting healthy food and physical activity feasible and attractive for adolescents.

Chapter 5. Conclusions

Conclusions

The work included in this thesis contributes to some scientific advancements, suggesting that knowledge and practices are not related in Portuguese Adolescents. Bringing together the main conclusions from the individual scientific papers included, it should be emphasized:

- The General Nutrition Knowledge Questionnaire for Adolescents (GNKQA) is a valid and reliable instrument to assess Portuguese adolescents' nutrition knowledge;

- Objectively measurements of physical activity, for example with accelerometers, should be preferred for adolescents. The International Physical Activity Questionnaire for Adolescents (IPAQA) may be valid for older adolescent boys, but not girls or younger adolescents.

- Adolescents who are overfat and have low physical activity levels have the worse knowledge about the experts' nutritional recommendations. Knowledge is not the single factor in the obesity equation, but it seems to have the potential to contribute to the overfat and obesity reduction.

- There is no association between nutrition knowledge and diets' nutritional adequacy, and between physical activity knowledge and moderate to vigorous physical activity engagement. Knowledge seems to be insufficient to produce adequate nutrition and physical activity behaviours in Portuguese adolescents.

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Appendices

Appendix I.

General Nutrition Knowledge Questionnaire for Adolescents

ID ☐☐☐☐

Questionário sobre Nutrição

Pretendemos avaliar o que os adolescentes sabem sobre conselhos de Alimentação e aquilo que acham confuso.
Isto é um questionário, não um teste.
Não deixes nenhuma questão sem resposta. Se não souberes a resposta, escolhe "Não tenho a certeza". Por favor, não tentes adivinhar!
Responde sozinho e sê verdadeiro nas tuas respostas.
As tuas respostas não serão divulgadas a ninguém em nenhum momento.
Obrigado pela tua atenção e ajuda!

Preenche assim:	☒	**Não preenchas assim:**	☑ ☑	**Se te enganares risca completamente a opção incorrecta e escolhe a opção correcta. Assim:** ■

Os primeiros itens são sobre o que pensas que os especialistas aconselham.

1. Consideras que os especialistas de saúde recomendam que as pessoas comam mais, igual ou menos dos seguintes alimentos? *(Escolhe uma opção por alimento)*

	Mais	Igual	Menos	Não tenho a certeza
Hortícolas	☐	☐	☐	☐
Alimentos com açúcar	☐	☐	☐	☐
Carne	☐	☐	☐	☐
Pão integral	☐	☐	☐	☐
Alimentos gordos	☐	☐	☐	☐
Alimentos ricos em fibra	☐	☐	☐	☐
Fruta	☐	☐	☐	☐
Alimentos salgados	☐	☐	☐	☐
Feijão	☐	☐	☐	☐
Sopa com hortícolas	☐	☐	☐	☐

2. Quantas porções de frutas e produtos hortícolas achas que os especialistas recomendam que os adolescentes comam diariamente? *(Uma porção pode ser, por exemplo, 1 maçã ou 1 chávena de cenoura ralada)*

☐☐ Porções por dia

3. Segundo os especialistas, de qual destas gorduras é mais importante reduzir o consumo? *(Escolhe uma opção)*

a) Gorduras monoinsaturadas ☐
b) Gorduras poliinsaturadas ☐
c) Gorduras saturadas ☐
d) Não tenho a certeza ☐

4. Segundo os especialistas, que tipo de leite as pessoas devem consumir? *(Escolhe uma opção)*

a) Gordo ☐
b) Magro ☐
c) Meio Gordo ☐
d) Nenhum, não se deve beber leite ☐
e) Não tenho a certeza ☐

Os especialistas classificam os alimentos em grupos. Gostaríamos de saber se conheces os alimentos que pertencem a cada um dos grupos.

5. Pensas que estes alimentos contêm ou não açúcar adicionado? *(Escolhe uma opção por alimento)*

	Sim	Não	Não tenho a certeza
Banana	☐	☐	☐
Iogurte natural	☐	☐	☐
Gelado	☐	☐	☐
Refrigerante de laranja	☐	☐	☐
Molho *Ketchup*	☐	☐	☐
Ameixas secas	☐	☐	☐

6. Acreditas que estes alimentos são ricos ou pobres em gordura? *(Escolhe uma opção por alimento)*

	Rico	Pobre	Não tenho a certeza
Massa (sem molho)	☐	☐	☐
Manteiga magra	☐	☐	☐
Feijão cozido	☐	☐	☐
Fiambre	☐	☐	☐
Mel	☐	☐	☐
Croquete	☐	☐	☐
Nozes	☐	☐	☐
Pão	☐	☐	☐
Queijo fresco	☐	☐	☐
Margarina	☐	☐	☐
Batata Frita de Pacote	☐	☐	☐
Folhado Misto	☐	☐	☐

7. Consideras que os especialistas incluem estes alimentos no grupo dos alimentos amiláceos/ farináceos? *(Escolhe uma opção por alimento)*

	Sim	Não	Não tenho a certeza
Queijo	☐	☐	☐
Massa	☐	☐	☐
Manteiga	☐	☐	☐
Nozes	☐	☐	☐
Arroz	☐	☐	☐
Papas de cereais	☐	☐	☐

8. Achas que estes alimentos contêm ou não sal adicionado? *(Escolhe uma opção por alimento)*

	Sim	Não	Não tenho a certeza
Salsicha	☐	☐	☐
Massa	☐	☐	☐
Atum enlatado	☐	☐	☐
Carne vermelha	☐	☐	☐
Hortícolas congelados	☐	☐	☐
Queijo	☐	☐	☐
Batata Frita de Pacote	☐	☐	☐
Folhado Misto	☐	☐	☐

9. Pensas que estes alimentos são ricos ou pobres em proteína? *(Escolhe uma opção por alimento)*

	Rico	Pobre	Não tenho a certeza
Frango	☐	☐	☐
Queijo	☐	☐	☐
Fruta	☐	☐	☐
Feijão cozido	☐	☐	☐
Manteiga	☐	☐	☐
Natas	☐	☐	☐

2

10. Acreditas que estes alimentos são ricos ou pobres em fibra dietética? *(Escolhe uma opção por alimento)*

	Rico	Pobre	Não tenho a certeza
Cornflakes	☐	☐	☐
Banana	☐	☐	☐
Ovo	☐	☐	☐
Carne vermelha	☐	☐	☐
Brócolos	☐	☐	☐
Nozes	☐	☐	☐
Peixe	☐	☐	☐
Batata a murro	☐	☐	☐
Frango	☐	☐	☐
Feijão cozido	☐	☐	☐

11. Consideras que estes alimentos gordos são ricos ou pobres em gordura saturada? *(Escolhe uma opção por alimento)*

	Rico	Pobre	Não tenho a certeza
Sardinha	☐	☐	☐
Leite gordo	☐	☐	☐
Azeite	☐	☐	☐
Carne vermelha	☐	☐	☐
Margarina vegetal	☐	☐	☐
Chocolate	☐	☐	☐

12. Pensas que os especialistas consideram estes alimentos como uma alternativa saudável à carne vermelha? *(Escolhe uma opção por alimento)*

	Sim	Não	Não tenho a certeza
Patê de fígado	☐	☐	☐
Fiambre	☐	☐	☐
Feijão cozido	☐	☐	☐
Nozes	☐	☐	☐
Queijo magro	☐	☐	☐
Croquete	☐	☐	☐

13. Alguns alimentos contêm muita gordura, mas não contêm colesterol.

a) Concordo ☐
b) Discordo ☐
c) Não tenho a certeza ☐

14. Na tua opinião, um copo de sumo de fruta sem açúcar, por dia, equivale a uma porção de fruta.

a) Concordo ☐
b) Discordo ☐
c) Não tenho a certeza ☐

15. Acreditas que as gorduras saturadas são principalmente encontradas em: *(Escolhe uma opção)*

a) Óleos vegetais ☐
b) Lacticínios ☐
c) Ambas opções (a e b) ☐
d) Não tenho a certeza ☐

16. Na tua opinião, o açúcar escuro é uma alternativa mais saudável do que o açúcar branco.

a) Concordo ☐
b) Discordo ☐
c) Não tenho a certeza ☐

17. Na tua opinião, há mais proteína num copo de leite gordo do que num copo de leite magro.

a) Concordo ☐
b) Discordo ☐
c) Não tenho a certeza ☐

18. Na tua opinião, a margarina vegetal contém menos gordura que a manteiga.

a) Concordo ☐
b) Discordo ☐
c) Não tenho a certeza ☐

19. Dentre os seguintes pães, qual deles pensas que contém mais vitaminas e minerais? (*Escolhe uma opção*)

a) Branco ☐
b) Escuro ☐
c) Integral ☐
d) Não tenho a certeza ☐

20. Qual destes alimentos consideras que contém mais calorias? (*Escolhe uma opção*)

a) Manteiga ☐
b) Margarina ☐
c) Ambos têm o mesmo ☐
d) Não tenho a certeza ☐

21. Dentre os seguintes tipos de óleo, qual achas que contém principalmente gordura monoinsaturada? *(Escolhe uma opção)*

a) Óleo de coco ☐
b) Óleo de girassol ☐
c) Azeite ☐
d) Óleo de palma ☐
e) Não tenho a certeza ☐

22. Na tua opinião, há mais cálcio num copo de leite gordo do que num copo de leite magro.

a) Concordo ☐
b) Discordo ☐
c) Não tenho a certeza ☐

23. Qual destes elementos acreditas que contém mais calorias em quantidades iguais? *(Escolhe uma opção)*

a) Açúcar ☐
b) Alimentos amiláceos/ farináceos ☐
c) Fibra dietética ☐
d) Gordura ☐
e) Não tenho a certeza ☐

24. Pensas que as gorduras sólidas são mais: *(Escolhe uma opção)*

a) Monoinsaturadas ☐
b) Poliinsaturadas ☐
c) Saturadas ☐
d) Não tenho a certeza ☐

25. Consideras que as gorduras poliinsaturadas são encontradas principalmente em: *(Escolhe uma opção)*

a) Óleos vegetais ☐
b) Lacticínios ☐
c) Todos os anteriores ☐
d) Não tenho a certeza ☐

Os próximos itens são sobre as melhores escolhas alimentares.

Por favor, responde à questão colocada e não se gostas ou desgostas do alimento!

Por exemplo, supondo que fostes questionado:

"Se uma pessoa deseja reduzir o consumo de gordura, que queijo deverá preferir?"

(a) Queijo da Serra
(b) Queijo flamengo
(c) Creme de queijo
(d) Queijo fresco

Se não gostas de queijo fresco, mas sabes que é a resposta certa, deves escolher queijo fresco.

26. Qual destes alimentos é a melhor alternativa para um lanche pobre em gordura e rico em fibra? *(Escolhe uma opção)*

a) Iogurte magro de morango ☐
b) Pão integral com compota ☐
c) Croissant recheado com creme de cacau, embalado ☐
d) Bolachas integrais com queijo ☐

27. Qual destes alimentos é a melhor alternativa para uma refeição pobre em gordura e rica em fibra? *(Escolhe uma opção)*

a) Frango grelhado com massa ☐
b) Queijo com tosta integral ☐
c) Feijão com arroz ☐
d) Omelete com batata ☐

28. Qual das seguintes sandes consideras a mais saudável? *(Escolhe uma opção)*

a) Duas fatias grossas de pão recheado com uma fatia fina de queijo ☐

b) Duas fatias finas de pão recheado com uma fatia grossa de queijo ☐

29. Muitas pessoas comem esparguete à bolonhesa (massa com um molho de tomate e carne). Qual destas opções é mais saudável? *(Escolhe uma opção)*

a) Uma grande quantidade de massa com um pouco de molho por cima ☐

b) Uma pequena quantidade de massa com muito molho por cima ☐

30. Se uma pessoa quiser reduzir a quantidade de gordura na sua alimentação, qual será a melhor escolha? *(Escolhe uma opção)*

a) Bife de vitela grelhada ☐
b) Bacalhau cozido ☐
c) Frango com pele grelhado ☐
d) Costeleta de porco grelhada ☐

31. Se uma pessoa quiser reduzir a quantidade de gordura na sua alimentação, mas não quer abdicar das batatas fritas, qual será a melhor opção? *(Escolhe uma opção)*

a) Batatas fritas cortadas grossas ☐
b) Batatas fritas cortadas finas ☐
c) Batatas fritas cortadas em ondas ☐

32. Se uma pessoa desejar comer algo doce, mas quiser reduzir a quantidade de açúcar, qual será a melhor opção? *(Escolhe uma opção)*

a) Tostas com mel ☐
b) Uma barra de cereais ☐
c) Bolacha digestiva simples ☐
d) Banana com iogurte natural ☐

33. Qual destas sobremesas será a mais saudável? *(Escolhe uma opção)*

a) Maçã cozida ☐
b) Iogurte de morango ☐
c) Bolachas *crackers* integrais com queijo ☐
d) Bolo de cenoura com cobertura de creme de queijo ☐

34. Qual destes queijos será a melhor escolha, como opção magra? *(Escolhe uma opção)*

a) Fundido ☐
b) Flamengo ☐
c) Da ilha ☐
d) Da serra ☐

Esta secção é sobre problemas de saúde ou doenças.

35. Das doenças/ problemas de saúde que se seguem quais é que acreditas que possam estar relacionadas com a baixa ingestão de frutas e hortícolas? *(Responde a cada uma das opções)*

	Sim	Não	Não tenho a certeza
Doenças cardiovasculares	☐	☐	☐
Cancro	☐	☐	☐
Avitaminoses	☐	☐	☐
Mau funcionamento intestinal	☐	☐	☐
Ácido úrico elevado	☐	☐	☐

36. Das doenças/ problemas de saúde que se seguem quais é que acreditas que possam estar relacionadas com a baixa ingestão de fibra? *(Responde a cada uma das opções)*

	Sim	Não	Não tenho a certeza
Osteoporose	☐	☐	☐
Hipertensão arterial	☐	☐	☐
Diabetes	☐	☐	☐
Mau funcionamento intestinal	☐	☐	☐
Desidratação	☐	☐	☐

37. Das doenças/ problemas de saúde que se seguem quais é que acreditas que possam estar relacionadas com a elevada ingestão de açúcar? *(Responde a cada uma das opções)*

	Sim	Não	Não tenho a certeza
Doenças cardiovasculares	☐	☐	☐
Cáries dentárias	☐	☐	☐
Anemia	☐	☐	☐
Anorexia nervosa	☐	☐	☐
Acne	☐	☐	☐

38. Das doenças/ problemas de saúde que se seguem quais é que acreditas que possam estar relacionadas com a elevada ingestão de sal ou sódio? *(Responde a cada uma das opções)*

	Sim	Não	Não tenho a certeza
Diabetes	☐	☐	☐
Hipertensão arterial	☐	☐	☐
Doenças cardiovasculares	☐	☐	☐
Anorexia nervosa	☐	☐	☐
Cancro do estômago	☐	☐	☐

39. Das doenças/ problemas de saúde que se seguem quais é que acreditas que possam estar relacionadas com a elevada ingestão de gordura? *(Responde a cada uma das opções)*

	Sim	Não	Não tenho a
Hipertensão arterial	☐	☐	☐
Desidratação	☐	☐	☐
Doenças cardiovasculares	☐	☐	☐
Avitaminoses	☐	☐	☐
Obesidade	☐	☐	☐

40. Pensas que estes comportamentos ajudam a reduzir a probabilidade de vir a ter certos tipos de cancro? *(Responde a cada uma das opções)*

	Sim	Não	Não tenho a certeza
Comer mais cereais integrais	☐	☐	☐
Comer menos açúcar	☐	☐	☐
Comer menos gordura	☐	☐	☐
Comer menos sal	☐	☐	☐
Comer mais frutas e hortícolas	☐	☐	☐
Comer menos alimentos com conservantes/ aditivos	☐	☐	☐

41. Acreditas que estes comportamentos ajudam a prevenir doenças do coração? *(Responde a cada uma das opções)*

	Sim	Não	Não tenho a certeza
Comer mais fibra	☐	☐	☐
Comer menos gordura saturada	☐	☐	☐
Comer menos sal	☐	☐	☐
Comer mais frutas e hortícolas	☐	☐	☐
Comer menos alimentos com conservantes/ aditivos	☐	☐	☐

42. Qual destes nutrientes mais contribui para aumentar os níveis de colesterol do sangue das pessoas? *(Escolhe uma opção)*

a) Antioxidantes ☐
b) Gorduras poliinsaturadas ☐
c) Gorduras saturadas ☐
d) Colesterol da alimentação ☐
e) Não tenho a certeza ☐

43. Dos seguintes comportamentos, quais é que achas que contribuem para prevenir o aparecimento de obesidade? *(Responde a cada uma das opções)*

	Sim	Não	Não tenho a certeza
Comer mais hortícolas	☐	☐	☐
Não comer pequeno-almoço	☐	☐	☐
Beber menos bebidas açucaradas	☐	☐	☐
Fazer menos refeições por dia	☐	☐	☐
Comer menos fruta	☐	☐	☐

Appendix II.

International Physical Activity Questionnaire for Adolescents

ID ☐☐☐☐

Actividade Física

Caro estudante,

As questões que se seguem são sobre todas as **caminhadas e actividades físicas vigorosas e moderadas** que fizeste **pelo menos durante 10 minutos seguidos nos últimos 7 dias.**

Por favor não incluas as actividades que tenham durado menos de 10 minutos de cada vez. Considera os últimos 7 dias como 5 dias escolares e 2 dias de fim-de-semana.

As questões estão divididas em 4 grupos e perguntam sobre:

- Actividades físicas que praticaste durante o tempo escolar
- Actividades físicas que praticaste em casa e nas proximidades da tua casa, tais como tarefas domésticas ou jardinagem.
- Actividades físicas que praticaste para te deslocares de e para determinados lugares
- Actividades físicas que praticaste durante o tempo de lazer (jogos, desportos, danças, outros exercícios e competições)

Preenche assim:	☒	**Não preenchas assim:**	⧄ ☑	**Se te enganares risca completamente a opção incorrecta e escolhe a opção correcta. Assim:** ■

Ajuda-nos a conhecer-te melhor!

1. Qual é a tua escola? ☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐
☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐☐

2. Qual é o teu ano? ☐☐ 3. Qual é a tua turma? ☐☐ 4. Qual é a teu número? ☐☐

5. Qual o teu género? F ☐ M ☐ 6. Qual é a tua data de nascimento? ☐☐ / ☐☐ / ☐☐
dia mês ano

7. Das actividades abaixo indicadas, assinala com X aquelas em que participas.

Desporto Escolar ☐
Ginásio ☐
Desporto Federado ☐
Outro Treino/ Competição ☐

8. Relativamente à Acção Social Escolar, qual é a tua situação?

Sem escalão ☐
Escalão A ☐
Escalão B ☐

Parte 1: Actividade física relacionada com a escola

A parte 1 é sobre as actividades físicas que fizeste nos últimos 7 dias durante as horas de escola (durante as aulas ou intervalos). O transporte de e para a escola **NÃO** está incluído.

A. Actividade física durante as aulas

9. Quantas **aulas** (horas escolares) de educação física tiveste durante os últimos 7 dias?

☐ nenhuma ☐ 1 aula ☐ 2 aulas ☐ 3 aulas ☐ 4 aulas ☐ outra, nomeadamente ☐☐ aulas

Caso tenhas respondido "Nenhuma" avança para a questão **11**.

10. Quanto tempo passaste no TOTAL durante essas aulas de educação física em **actividades físicas**, tais como desporto, correr, jogar, dançar... Faz a soma de toda a semana, mas conta apenas as ocasiões em que estiveste activo durante 10 minutos ou mais, sem interrupções.

☐☐ horas ☐☐ minutos de actividade física nos últimos 7 dias

B. Durante os intervalos

11. Durante os últimos 7 dias, em quantos dias fizeste as actividades seguintes, nos **intervalos** da escola, **durante pelo menos 10 minutos seguidos**?
Não incluas actividades que duraram menos de 10 minutos seguidos.

11.1. ... CAMINHAR

☐ nenhum ☐ 1 dia ☐ 2 dias ☐ 3 dias ☐ 4 dias ☐ 5 dias

Caso tenhas respondido "Nenhum" avança para a questão **11.2**

11.1.1. Quanto tempo costumas gastar, durante os intervalos da escola, num dia a **caminhar**?

☐☐ horas ☐☐ minutos por dia

11.2. ... Actividade física VIGOROSA, que exige esforço físico e te deixa a respirar de forma muito mais intensa que o normal, tal como correr...

☐ nenhum ☐ 1 dia ☐ 2 dias ☐ 3 dias ☐ 4 dias ☐ 5 dias

Caso tenhas respondido "Nenhum" avança para a questão **11.3**

11.2.1. Quanto tempo costumas gastar, durante os intervalos da escola, num dia a realizar **actividades físicas vigorosas**?

☐☐ horas ☐☐ minutos por dia

11.3. ... **Actividade física MODERADA, que exige um esforço físico moderado e te deixa a respirar de forma mais intensa que o normal,** como dançar...

☐ nenhum ☐ 1 dia ☐ 2 dias ☐ 3 dias ☐ 4 dias ☐ 5 dias

Caso tenhas respondido "Nenhum" avança para a questão **12**

11.3.1. Quanto tempo costumas gastar, durante os intervalos da escola, num dia a realizar **actividades físicas moderadas**?

☐☐ horas ☐☐ minutos por dia

Parte 2: Trabalhos domésticos e jardinagem

Esta segunda parte é sobre as actividades físicas que possas ter feito nos últimos 7 dias em casa ou nas imediações.

12. Durante os últimos 7 dias, em quantos dias praticaste actividades físicas, durante pelo menos 10 minutos sem interrupção, no jardim ou na tua casa, que exigiram um esforço físico moderado e te deixaram a respirar de forma mais intensa que o normal, como por exemplo carregar objectos pesados, lavar o chão, varrer…
Não incluas actividades que tenhas feito durante menos de 10 minutos seguidos.

☐ nenhum ☐ 1 dia ☐ 2 dias ☐ 3 dias ☐ 4 dias ☐ 5 dias ☐ 6 dias ☐ 7 dias

Caso tenhas respondido "Nenhum" avança para a questão **13**.

12.1. Quanto tempo costumas passar a fazer essas actividades em casa e no jardim, em cada dia?

☐☐ horas ☐☐ minutos por dia

Parte 3: Actividade física relacionada com deslocações

Estas questões são sobre como te deslocaste entre lugares, incluindo lugares como a escola, lojas, cinemas, entre outros, durante os últimos 7 dias.

13. Durante os últimos 7 dias, em quantos dias te deslocaste durante pelo menos 10 minutos sem interrupção…
Não incluas actividades que tenham demorado menos de 10 minutos seguidos.

13.1 … Num VEÍCULO MOTORIZADO como comboio, autocarro, carro, metro ou eléctrico**?**

☐ nenhum ☐ 1 dia ☐ 2 dias ☐ 3 dias ☐ 4 dias ☐ 5 dias ☐ 6 dias ☐ 7 dias

Caso tenhas respondido "Nenhum" avança para a questão **13.2**.

13.1.1. Quanto tempo costumas passar a viajar **num veículo motorizado**, por dia?

☐☐ horas ☐☐ minutos por dia

13.2 … de BICICLETA?

☐ nenhum ☐ 1 dia ☐ 2 dias ☐ 3 dias ☐ 4 dias ☐ 5 dias ☐ 6 dias ☐ 7 dias

Caso tenhas respondido "Nenhum" avança para a questão **13.3**.

13.2.1. Quanto tempo costumas passar a andar de **bicicleta** de um lado para o outro, por dia?

☐☐ horas ☐☐ minutos por dia

13.3 … … a PÉ?

☐ nenhum ☐ 1 dia ☐ 2 dias ☐ 3 dias ☐ 4 dias ☐ 5 dias ☐ 6 dias ☐ 7 dias

Caso tenhas respondido "Nenhum" avança para a questão **14**.

13.3.1. Quanto tempo costumas passar a andar a **pé** de um lugar para o outro, por dia?

☐☐ horas ☐☐ minutos por dia

Parte 4: Recreação, desporto e actividade física de lazer

Esta secção é sobre todas as actividades físicas que praticaste nos últimos 7 dias apenas para recreação, desporto, exercício ou lazer. Por favor não incluas qualquer actividade que já tenhas mencionado!!!

14. Durante os últimos 7 dias em quantos dias praticaste, **pelo menos 10 minutos seguidos**, alguma das actividades que se seguem nos teus **tempos de lazer**?
Não incluas actividades que praticaste durante menos de 10 minutos sem interrupção.

14.1 ... **CAMINHAR**

☐ nenhum ☐ 1 dia ☐ 2 dias ☐ 3 dias ☐ 4 dias ☐ 5 dias ☐ 6 dias ☐ 7 dias

Caso tenhas respondido "Nenhum" avança para a questão **14.2**

14.1.1. Quanto tempo costumas passar a caminhar no teu tempo de lazer, por dia?

☐☐ horas ☐☐ minutos por dia

14.2. ... Actividades físicas **VIGOROSAS, que exigem um esforço físico intenso e te deixam a respirar de forma muito mais intensa que o normal,** tal como aeróbica, correr, andar de bicicleta a um ritmo rápido, nadar a um ritmo rápi-

☐ nenhum ☐ 1 dia ☐ 2 dias ☐ 3 dias ☐ 4 dias ☐ 5 dias ☐ 6 dias ☐ 7 dias

Caso tenhas respondido "Nenhum" avança para a questão **14.3**

14.2.1. Quanto tempo costumas passar em **actividades físicas vigorosas** no teu tempo livre, por dia?

☐☐ horas ☐☐ minutos por dia

14.3. ... Actividades físicas **moderadas, que exigem um esforço físico moderado e te deixam a respirar de forma ligeiramente mais intensa que o normal,** como dançar, nadar a um ritmo regular ou jogar ténis de pares...

☐ nenhum ☐ 1 dia ☐ 2 dias ☐ 3 dias ☐ 4 dias ☐ 5 dias ☐ 6 dias ☐ 7 dias

Caso tenhas respondido "Nenhum" o teu questionário termina aqui.

14.3.1. Quanto tempo costumas passar em **actividades físicas moderadas** nos teus tempos de lazer, por dia?

☐☐ horas ☐☐ minutos por dia

Obrigado por completares o questionário.