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# Association between proximity of food retailers to schools and dietary intake and nutritional status of adolescents of Porto

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## ABBREVIATION LIST

FFQ - Food Frequency Questionnaire

CH - Carbohydrates

BMI – Body Mass Index

KSS – Kiosk and Stationary shop

VFR - Vegetables and fruit retailer

MSM - Mini and supermarkets

FFR - Fast-food and snack retailers

## RESUMO

**Introdução**: Nas últimas décadas a prevalência de excesso de peso e obesidade infantil cresceu mundialmente. Em Portugal, em 2003, a prevalência de excesso de peso/obesidade, em crianças com 7 a 9 anos, era de 31.6%. A obesidade infantil está associada a complicações de saúde a curto e a longo prazo e é uma doença de etiologia multifactorial, associada a alterações dos padrões alimentares e de prática de atividade física. As estratégias para prevenir esta doença devem incluir esforços para melhorar a oferta alimentar nas escolas e no seu espaço circundante. Diferentes associações entre os estabelecimentos de venda de alimentos que circundam as escolas e a obesidade e os hábitos alimentares foram já estabelecidas em vários estudos. O objetivo deste estudo é identificar a quantidade e o tipo de estabelecimentos de venda de alimentos que circundam as escolas que participaram no estudo de Coorte Epiteen e compreender se influenciam a ingestão energética e nutricional e o estado nutricional dos jovens.

**Métodos**: Uma amostra de 1513 adolescentes (50.9%) de 44 escolas (73.6 escolas públicas) do Porto foi avaliada. Foram aplicados questionários, que incluíam um questionário de frequência alimentar, e foi realizada uma avaliação antropométrica aos participantes.
Para estudar a adesão à dieta mediterrânica, os scores KIDMED foram calculados. Foram recolhidos todos os estabelecimentos de venda de alimentos nos 400 metros circundantes a cada uma das 44 escolas. Estes foram georreferenciados e foi aplicado um questionário que avaliava o nome, a morada, o tipo de estabelecimento e a sua atividade comercial em 2003. Foi determinado o número de estabelecimentos a 400, 200 e 100 metros de cada escola e foram criadas classes: estabelecimentos de venda de fruta e legumes, onde os adolescentes podem comprar fruta, mini e supermercados, que são estabelecimentos que vendem fruta mas também outros alimentos e estabelecimentos de *fast food*, que incluem os típicos restaurantes de *fast food* e outros estabelecimentos onde se vendem refeições rápidas, como os snack-bar e os cafés.

**Resultados**: Foram identificados 1070 estabelecimentos de venda de alimentos na proximidade de 400 metros das 44 escolas, sendo a classe Café/Padaria/Pastelaria/Bar/ Snack-bar a mais frequente (68.23%). As escolas privadas apresentaram maior oferta de *fast food* e de produtos frescos no seu espaço circundante do que as escolas públicas ($p < 0.05$). As raparigas no grupo com mais mini e supermercados a 200 e a 400 metros de distância da escola apresentaram inferior ingestão energética que, apesar de significativa, tem valores semelhantes. Para os rapazes, e considerando os 400 metros de distância da

escola, a ingestão de hidratos de carbono aumentou para o grupo com mais mini e supermercados. Os adolescentes com um estabelecimento de venda de fruta e legumes na proximidade de 100 e 200 metros da escola consumiam menos energia que os adolescentes que não tinha este estabelecimento. Esta relação foi contudo oposta ao considerar a distância de 400 metros da escola. O consumo de fibra foi inferior e o consumo de proteína superior para as raparigas com um estabelecimento de venda de fruta e legumes na proximidade de 200 metros. Considerando os estabelecimentos de venda *de fast food* a 200 metros, verificou-se um aumento do consumo de energia com o aumento do número destes estabelecimentos, havendo contudo um decréscimo de energia para mais que 6 estabelecimentos, sendo apenas estes resultados estatisticamente significativo nas raparigas. As raparigas consumiram menos doces na presença de mais estabelecimentos mas valores muito semelhantes foram encontrados. A proporção de adolescentes com uma dieta semelhante à Mediterrânica (maior KIDMED score) foi superior para adolescentes com mais estabelecimentos, sendo a diferença apenas estatisticamente significativa para raparigas. Para os rapazes houve mais adesão à dieta mediterrânica na presença de mais estabelecimentos de venda de fruta e legumes a 200 metros mas verificou-se o oposto considerando o total número destes estabelecimentos a 400 metros. O *odds* de ter sobrecarga ponderal foi 3 vezes superior para adolescentes com 2 ou mais mini e supermercados na proximidade de 200 metros da escola, OR=2.78 (95%CI: 1.02-7.56) nas raparigas e OR=3.05 (95%CI: 1.16-8.03) nos rapazes. Por outro lado, o *odds* de sobrecarga ponderal foi inferior para um menor número de estabelecimentos de *fast food* na proximidade de 200 metros.

**Conclusão:** Encontramos um número considerável de estabelecimentos no espaço circundante às escolas, nomeadamente na vizinhança de escolas privadas. Na nossa amostra, em geral, o número e o tipo de estabelecimento não revelaram associação com a ingestão alimentar. Contudo, adolescentes com mais estabelecimentos de venda de produtos frescos e mini/supermercados apresentam inferior ingestão de doces. O *odds* de obesidade foi também superior na presença de mais estabelecimentos de fast-food. É importante referir que a maioria das escolas tem estes estabelecimentos na sua proximidade, o que dificulta a compreensão da sua associação com ingestão alimentar e estado nutricional. Mais pesquisa neste campo é necessária para compreender a relação entre a proximidade dos estabelecimentos de venda de alimentos às escolas e a ingestão alimentar e estado nutricional dos adolescentes.

**Palavras-chave:** Escola, Proximidade, Obesidade, Excesso de Peso, Estado Nutricional, Estabelecimentos de venda de alimentos, Fast food, Dieta e Dieta Mediterrânica.

## ABSTRACT

**Introduction**: In the past decades the prevalence of childhood overweight and obesity has increased worldwide. In Portugal, in 2003, the prevalence of overweight/obesity, in children with 7 to 9 years old, was 31.6%. Childhood obesity is associated with serious short and long-term adverse effects on the quality of life and well being and is rather a syndrome with a multifactorial etiology, associated to major changes in childhood patterns of food and beverage intake. Strategies to address the childhood obesity epidemic include efforts to improve the food environment at schools and surrounding schools. The relationship between food retailers in the proximity of schools and obesity and food habits have been tested in different studies and some association were proved. The aim of this study is to identify the quantity and type of food retailers in the neighborhood of schools that participated in Epiteen Cohort study and to understand if such food retailers influence food habits, energy and nutritional intake and nutritional status in adolescents.

**Methods**: A sample of 1513 adolescents (50.9% females) from 44 schools (73.6% from public schools) from Porto was studied. Questionnaires, including a food frequency questionnaire, and anthropometric measures were assessed. To study the adherence to Mediterranean Diet KIDMED scores were calculated. Food retailers in 400 meters surrounding each school were identified and geo referenced with geographic coordinates. Name, address, type of food retailer and activity in 2003 were recovered. Number of food retailers at of 100, 200 and 400 meters from schools were determined and different classes were considered: Vegetables and Fruit Retailers (VFR), where adolescents can only purchase fruit; Markets and Supermarkets (MSM), which are retailers that sale fresh products, including grocery stores, vegetables, fruit retailers and supermarkets; and Fast Food Retailers (FFR), where adolescents can purchase fast-food, that include typical restaurants and other similar food served in another retailers like cafeterias.

**Results**: 1070 food retailers were identified in the proximity of 400 meters from the 44 schools, being Cafeteria/Bakery/Pastry/ Candy Shop/ bar and snack-bar the most frequent (68.23%). Private schools had higher offer of fast-food and fresh products than public schools ($p<0.05$). In girls, we found a significant lower energy intake among participants from schools with higher number of mini and supermarkets in the proximity of 200 and 400 meters. Although the difference reaches statistical significance, the difference in the amount of energy among groups was small. In boys and considering food retailers in the proximity of 400 meters from schools, the % of energy provided by carbohydrates intake per day increased with higher number of Mini and Supermarkets (MSM). Comparing with students in

schools who did not have any vegetables and fruit retailer (VFR), students from schools with this kind of retailer at 100 and 200 meters from school reported a lower energy intake. However, these relation inverts when the 400m was considered as cut-off for define proximity. Also fiber intake was lower and contribution from proteins for total energy intake higher for girls with at least one vegetable and fruit retailer at 200 meters. Regarding the availability of fast-food and snack retailers (FFR), considering a distance of 200m, we found an increase in total energy intake with the increasing of retailers. However with more than 6 retailers available the total energy intake decreased, reaching statistical significance for girls. In girls, it was found a small decrease on sweets intake among those in schools with higher number of food retailers. The proportion of adolescents with an intake more similar to the Mediterranean Diet (higher KIDMED score) was higher among adolescents enrolled at schools with more availability of food retailers, although only in girls the difference was significant. Among boys, and considering the availability of vegetables and fruit retailers (VFR) at 200 meters from school, we found a lower adherence to the Mediterranean Diet but the opposite was found when we considered the total of vegetables and fruit retailers at 400 meters. The odds to have overweight were almost three fold among adolescents at schools with two or more mini and supermarkets in the proximity of 200 meter from school, OR=2.78 (95%CI: 1.02-7.56) in girls and OR=3.05 (95%CI: 1.16-8.03) in boys. In contrary, the odds of overweight decrease with the increase of the number of fast-food and snack retailers in 200 meters proximity from school.

**Conclusions:** We found a large number of food retailers in the proximity of schools, mainly in the neighborhood of private schools. In our sample, in general, for all kind of food retailers evaluated, the number of retailers in the schools' proximity was not associated with the individual nutritional intake. However adolescents with a higher number of vegetables and fruit retailers or mini and supermarkets in the proximity of schools showed the lowest intake of sweets. Regarding nutritional status, we found an association in girls and with the availability of fast-food and snack retailers (FFR), those with lower number of fast-food and snack retailers presented lower odds of overweight and obesity.
However it is important to note that almost all schools had this kind of retailers in the proximity which makes difficult to understand the true effect of the presence of these retailers. More research to assess the relationship between food retailer's proximity to schools and student dietary practices and obesity is needed.

**Key words:** School, Proximity, Obesity, Overweight, Nutritional Status, Food retailers, Fast-food, Dietary Intake and Mediterranean Diet.

# INTRODUCTION

In the past decades the prevalence of obesity has increased worldwide, reaching epidemic proportions and becoming a serious and growing public health problem. Overweight and obesity are responsible for a large proportion of the burden of diseases in the WHO European Region: more than 1 million deaths and 12 million life-years of ill health every year.[1-2]

Attention to childhood and adolescents nutritional status is highly needed as overweight and obese children and adolescents have a higher risk to be obese in adulthood and to have other non communicable health disorders later in life.[1 3]

Childhood obesity is associated with serious short and long-term adverse effects on the quality of life and well being, self confidence, performance, and diseases such as diabetes and cardiovascular disorders, with severe effects on health and life expectancy. This brings high financial burden due to the loss of productivity and costs for health care and social systems. In view of these severe consequences, therapeutic interventions for obese children are greatly needed, but the efficacy of currently available treatment strategies is less than satisfactory. Therefore, development and implementation of strategies for effective primary prevention of obesity are particularly important.[3]

Both the level of regular physical activity and food intake are determinants for body weight and obesity risk.[1 3-5] These behaviors are learned and acquired in childhood and tend to persist into later ages. Therefore, interventions to promote healthy lifestyles a of great interest.[3 6]

School represents an ideal setting to provide healthy nutrition and to promote healthy habits. Schools' aim is education and they reach almost 100% of children of school age in the high and medium-income countries in the WHO European Region. In addition, most primary and secondary schools serve at least one meal every school day.[1]

The most negative aspect of schools in the promotion of children's and adolescents' eating habits and the prevention of obesity is linked to the presence in the school environment of unhealthy "competitive food" sold through cafeterias and vending machines. Data from the United States showed that about 10% of primary schools and 76% of secondary schools have vending machines, snack bars and canteens selling food and drinks. Several studies, mostly surveys, have shown that the presence of competitive food in the school environment can cause higher consumption of non-healthy food, rich in energy, fat and sugar, and lower intake of fruit, vegetables and milk.

Recent researches are now focusing on the balance of neighborhood food environment – i.e., the availability of both healthy and unhealthy food options. This represents a new form of public health research related to childhood obesity, although the methodological approach used to define, characterize and quantify the food environment are still very much under development.[7]

Data on the influence of the characteristics of the food environment in the neighborhood to homes and/or workplaces/schools on promoting obesity are still insufficient.[1] [8] The relationship between the availability of food and obesity needs to be studied in much more structured protocols, precisely defining proximity and the kind of food served. Also the effect of the socioeconomic conditions of the places in those associations needs to be clarified. The effect of this kind of food availability becomes particularly relevant since food outlets are spreading all over the world and children are becoming more independent in food choices and have access to money at increasingly younger ages.

Studies that analyze the proximity of food outlets to schools/workplaces and home are inexistent in Portugal, making this a necessary area of research.

The objective of this dissertation is to analyze the influence of proximity of food retailers to schools in the nutritional status and dietary intake of 13 years-old adolescents in Porto municipality.

Specific objectives are:

- identify the type of food retailers in the neighborhood of schools that participated in Epiteen Cohort study;
- Understand if the number and type of food retailers influence food intake measured by the energy and nutrients intake and by the adherence to Mediterranean diet.
- Evaluate the association between number and type of food retailers and overweight.

# STATE OF ART

To allow a better understand of the work, some definitions of terms and concepts will be presented in the following paragraphs.

- Fast-food is defined as food designed for ready availability, use or consumption and sold at eating establishments for quick availability or take-out.[9] It includes typical fast food restaurants (Mc Donald's, Pizza Hut, Telepizza) and food that usually replace a meal (sandwich, snacks …), that is sold in cafeterias, snacks, bars, etc.
- Competitive food includes food and beverages sold inside the school that compete with the nutritionally regulated school food environment.[10]

Concerning the different food retailers:

- Cafeteria/Bakery/Pastry/ Candy Shop/ bar and snack-bar are defined as a place that sell pastries, confectionery and that may also sell fast-food or snacks, even though not being that the main activity.
- Grocery store is defined as a traditional store that sells largely consumed products, including foodstuffs. Its area is lower than the area of a supermarket and a seller helps customer purchasing the products.
- Kiosk/stationary shop is defined as a place that sells office supplies, newspapers, magazines and/or tobacco and also candies, gums and other sweets.
- Supermarket is defined as a place with a minimal area of 200m², where customers can purchase food without the help of sellers, being the only moment of contact in the act of payment.
- Convenience Store is a small shop located in gas service stations.
- Vegetable and fruit retailer is similar to a grocery store but only sells fruit and vegetables.
- Fast-food restaurant is a place where only typical fast-food is sold (Mc Donald's, Pizza Hut, Tele Pizza …).

## Obesity epidemic

Obese children and adolescents suffer from stigmatization, which contributes to diminished chances of social and economic performance in adult life.[1] The health consequences of obesity can be at short, medium and large period. It include an increased risk for metabolic abnormalities, such as type 2 diabetes and non-alcoholic fatty liver disease and sleep-associated breathing disorders, such as obstructive sleep apnea syndrome.[1]

In Portugal, from 1960 to 2000, obesity more than doubled in 9 year-olds children and tripled in 10 and 11 year-olds children with greatest changes occurring between 1990 and 2000.[11] The Pro Children Survey, realized in 2003 on 11-year-old children, in Portugal was found an overweight prevalence of 26.5% among males and 17.7% among females, being the prevalence of obesity 2.2% among females and 6.2% among males (using the International Obesity Task Force (criteria).[12] Also in 2003, with a random sample of 4511 children from public schools with 7 to 9 years-old, 20.3% of overweight and 11.3% of obesity was found. These results indicate a prevalence of overweight/obesity of 31.6%.[5]

Similar results were found in the first evaluation of the EPITeen project (Epidemiological Health Investigation of Teenagers in Porto), held in 2003-2004 school-year, in which the prevalence of overweight in adolescents aged 13 years was 18.8% among females and 20.8% among males and the prevalence of obesity was 5.7% among females and 6.6% among males.[11] In the cross-sectional evaluation of the Health Behaviour in School-aged Children held in 2005-2006 the prevalence of overweight in 13-year-old adolescents was, respectively among males and females, 12.5% and 22.8% and in 15-year-old adolescents it was 14.3% and 20.8%.[10] Higher values were found in 2008 from a population-based study of Portuguese children (2-5 years) and adolescents (11-15 years) which reported that the national prevalence of overweight was 29% among children and 28% among adolescents and the estimates of obesity were 13% and 11%, respectively.[13] Thus, despite the inexistence of systematic data on body mass index (BMI) in Portugal, the data available allow to recognize that the country seems to present one of the higher prevalence of overweight/obesity in Europe and apparently increasing.[12-14] A transversal study found a significant prevalence of metabolic syndrome and cardiometabolic complications in Portuguese obese school children.[14]

Obesity results from an imbalance between the energy intake and the expenditure. It is known that obesity is not a single disease but it is instead a syndrome with a multifactorial etiology that includes metabolic, genetic, environmental, social and cultural interactions. The rapid increase of obesity prevalence cannot be attributed to genetic makeup because the

gene pool did not change substantially between 1980 and 1994; therefore the main concerns of the studies should be in the change of environmental factors that contributes to obesity.[12]
Eating behavior is also a highly complex issue and a consequence of the interplay of multiple influences across different contexts and conditions.[8] Over the past decades, the epidemic of obesity among children and adolescents has been accompanied by major changes in childhood patterns of food and beverage intake.[15]
There is a growing interest in the role of environment in the promotion of healthy eating/prevention of overweight. Several studies suggest that individual change is more likely to be facilitated and sustained if the environment supports healthful food choices.[8]

From 1977 to 1995 the percentage of meals consumed out of home and at a fast-food restaurant increased 2000% and this increase was paralleled by dramatic increases in portion sizes and soft drink consumption.[9] Meals prepared out of home and fast food has poorer nutritional quality than food prepared at home and in comparison with dietary recommendations.[4] Consequently, high frequency of eating fast food has been associated with higher intakes of energy, fat, sodium, sugar-sweetened beverages, and lower intakes of fruits, vegetables, fiber and milk in children, adolescents and adults.[4 15]

On the other and, the Mediterranean eating pattern warrants attention because it has been repeatedly associated with protection against several chronic degenerative diseases and disorders. Although it is not yet clear which components of the diet provide the greatest health benefits, it is likely that certain components, eaten together, provide a dietary pattern that is highly protective.[16]
A meta-analysis of published cohort prospective studies that investigated the effects of adherence to the Mediterranean diet on health status showed that a 2-point increase in adherence to the Mediterranean diet was associated with a significant reduction of overall mortality [relative risk (RR) = 0.92; 95% CI: 0.90, 0.94], cardiovascular incidence or mortality (RR = 0.90; 95% CI: 0.87, 0.93), cancer incidence or mortality (RR = 0.94; 95% CI: 0.92, 0.96), and neurodegenerative diseases (RR = 0.87; 95% CI: 0.81, 0.94).[13]
A Mediterranean diet includes a high proportion of fruits, vegetables, unrefined natural cereals, legumes, dried nuts, poultry, eggs (3 times per week), fish, low-fat dairy products and a small quantity of red meat. This diet has positive effects on health. The fish and fruit in the Mediterranean diet provide antioxidant vitamins (E, C) and carotenes, and prevent insufficient micronutrient intake [16] To evaluate the adherence to a Mediterranean Diet pattern several epidemiological studies use diet indexes. Diet indexes attempt to make a global evaluation of the quality of the diet based on a traditional Mediterranean reference pattern,

described as a priori, general and qualitative. The Mediterranean diet indexes, hence, summarize the diet by means of a single score that results from a function of different components, such as food, food groups or a combination of foods and nutrients.[17] A study with Portuguese population, from 2008 concluded that adherence to Mediterranean diet was poor in all Portuguese regions.[18] A study that aimed to analyze the worldwide trends of adherence to the Mediterranean diet in 1961–1965 and 2000–2003 concluded that there is a general deviation from the Mediterranean dietary pattern by the Mediterranean countries. Portugal had a decrease on Mediterranean Adequacy Index from 3.39 to 1.27,[19]

An ecological study with food availability data obtained from Food and Agriculture Organization of the United Nations, FAO, food balance sheets in 41 countries for the period 1961-1965 and 2000-2004 showed that European countries, especially those in the Mediterranean area, have experienced a 'westernization' process of food habits, and have increasingly similar patterns of food availability among them.[20]

Some studies proved that adherence to Mediterranean Diet can prevent overweight/obesity and the high waist circumference in youth.[21-22] Otherwise, high consumption of sweets food and fast food is usually related to unhealthy habits and overweight/obesity. A study that included 1976 children from Porto found that obesity was positively associated with pastry and crackers/cookies.[23]

## Neighborhood food availability and food intake

Researchers address the issue of food deserts and the influence of neighborhood environment on obesity. A food desert is defined as an area with limited access to affordable and nutritious food, particularly in lower income communities.[24]

Some studies determined how distance from food retailers to children's home determines food choices.[8]

A strong and growing social gradient in obesity has been noted, with higher rates among lower socioeconomic groups and for those living in areas of social disadvantage. Explanation for increasing rates of obesity in areas of greater socioeconomic disadvantage are likely to be multi factorial, including individuals characteristics as well as characteristics of the environment or neighborhood in which people live, work or study.[8] Researches in the USA had showed that people living in areas of low income status have poorer access to healthier foods and the foods that could be purchase were more expensive. [25-26] Ecological studies

showed that neighborhood-level deprivation is associated with the density and type of food retailers such that poorer neighborhoods have more fast food, fewer supermarkets and more convenience stores.[27] In a observational study in California, after adjusting for age, gender, ethnicity, individual-level socioeconomic status, smoking, physical activity and nutrition knowledge, it was found that adults who lived in low socioeconomic neighborhoods had a higher mean BMI than adults who lived in high socioeconomic neighborhoods.[26] A systematic review of 40 studies provided support to the relevance of the availability of food in the neighborhood showing that fast food restaurants are more prevalent in low-income and ethnic minority areas and around schools campuses[4] Higher density of small grocery stores in the neighborhood and closer proximity to supermarkets was associated with higher BMI among women.[26]

A study from 2007, in New Zealand, found that the travel distances to multinational fast-food outlets (McDonald's, Burger King, Pizza, Dunkin' Donuts, etc.) and to the remaining locally operated outlets were at least twice as far in the less socially deprived neighborhoods compared to the most deprived neighborhoods. A similar pattern was found for outlets selling healthy food such as supermarkets and smaller food outlets ($p<0.001$). These relationships were broadly linear with travel distances tending to be shorter in more-deprived neighborhoods. [28]

Studies on Canadian youth showed that neighborhood level socioeconomic status indicators are independent predictors of obesity but the mechanism of this relationship is poorly understood. One possible explanation is that greater accessibility to healthy, affordable foods within high socioeconomic status neighborhoods facilitates healthy nutritional choices. Conversely, having greater access to food of poor nutritional and high caloric value may promote unhealthy eating and obesity in low socioeconomic status neighborhoods.[27]

Otherwise, a study from United Kingdom showed that high prevalence of childhood obesity was evident in both deprived and affluent areas.[29]

There seems to be general agreement that access to healthier food choices is important to make improvements in dietary intake but these problems may be very 'localized' and access is not simply a question of proximity but may include such factors as cost and mobility. It's also important to notice that people interact with their physical environment in a multitude of ways, controlled and influenced to some extent by wider socio-economic, cultural and political forces, such as education, income, lifestyle and beliefs. Indeed 'space' is not simply an objective structure, but also a social experience.[30]

## Schools

Children and adolescents spend more time in school than in any other environment away from home. No other institution has a much continuous and intensive contact and influence on individuals during their first years of life. [10] Therefore, schools are identified as a key setting for public health strategies to lower or prevent the prevalence of overweight and obesity. [10]

Strategies to address the childhood obesity epidemic include efforts to improve the food environment at schools and surrounding areas. That include more rigorous nutrition standards for school meals and regulating what is sold in vending machines.[15] Includes the creation of an environment in which children eat healthy food, engage in regular physical activity and learn lifelong skills for healthy eating and active living. [10]

The school food environment can have a large impact on the dietary intake of children and adolescents because up to two meals and snacks can be eaten at school, comprising 10-50% of student's total dairy energy intake.[8] Food and beverages at schools fall into two many categories: school meal and also food and beverages that are sold in school cafeteria and vending machines, called competitive foods, because they compete with the nutritionally regulated school meal.[10 31] Studies have related the availability of snacks and drinks sold in schools to students' high intake of total calories, soft drinks, total fat and saturated fat, and lower intake of fruits and vegetables[10 15] A study from US analyzed the availability and consumption of competitive foods in US Public Schools and found that 40% of the children consumed one or more competitive foods on a typical school day. Consumption of competitive foods was lower in elementary schools than in middle and high schools. [31] In a large metropolitan area in Minnesota, 4764 adolescent students, from 31 secondary schools, were surveyed using a self-filled questionnaire on behavioral variables and frequency of eating in fast-food outlets, and participants' height and weight was measured. Eating in fast-food outlets was directly related to age in boys, but not in girls, in grades 7–12. Adolescents who reported eating at fast-food outlets three times or more during the past week had an energy intake about 37% higher than that of peers who ate no such meals. As to food intake, adolescents using fast-food outlets had higher intake of soft drinks and lower intake of basic food groups such as fruit, vegetables, grains and milk; nevertheless, frequent use of fast-food outlets was not associated with overweight.[1]

Competitive foods also include foods that are widely available in the proximity of schools, especially secondary schools, where students have more freedom to leave schools grounds and purchase food. [10 15]

In Portugal the only restrictions on food and beverages' sale in the proximity of schools concern to alcoholic beverages by the article 4th of 234/2007 law, of 19th June that defines that "is prohibit the drinking establishments installation where alcoholic beverages are sold for consumption on the establishment itself or outside it in the proximity of basic and secondary schools" and "the area of limitation is defined by each municipality".[32] In Porto there is no limitation to open an establishment installation with alcoholic beverages. Article 2nd of 9/2002 law of 24 January 2002 prohibit the sale or, with commercial purposes, to make available in public places, alcoholic beverages to youth under 16 years old.[33] Studies from the *Associação Portuguesa para a Defesa do Consumidor* and *Instituto da Droga e da Toxicodependência* showed that adolescents under 16 years buy and consume alcoholic beverages and that supervision of the law fails.

## Proximity of food retailers to school

An observational study from 2008, in Los Angeles, found that 23.3% and 64.8% of public schools had one or more fast food restaurants located within 400m and 800m, respectively. The percentage with one or more fast food restaurants within 400 m was highest for high schools (30.9%), intermediate among middle schools (24.3%), and lowest among elementary schools (21.7%).[15] Another study from 2009, in California, found that students with fast-food restaurants near (within 800m) their schools consumed fewer servings of fruits and vegetables, consumed more servings of soda, and were more likely to be overweight (OR (95%CI) =1.06; 1.02 - 1.10) or obese (OR (95% CI) =1.07, 1.02 - 1.12) than were youths whose schools were not near fast-food restaurants, after controlled for student and school-level characteristics.[29 34]

The potential importance of food retailers near schools has received increasing attention, but public health research and policy has focused primarily on fast food restaurants. Less is known about the relationship between overweight/obesity and other types of retailers. A study, also from California, aims to investigate the potential associations between nearby fast food restaurants, convenience stores, and supermarkets, and rates of overweight students. This study showed that the presence of a convenience store within a 10-minute walking distance of a school was associated with a higher rate of overweight students than schools without nearby convenience stores. Nearby fast food restaurants and supermarkets, however, were not associated with school rates of overweight students.[35]

A study from Philadelphia showed that more than half (53.3%) of the students participants reported shopping at corner stores every day, and another 21.9% reported shopping 2 to 4 times per week. The most frequently purchased items were energy-dense, low-nutritive foods

and beverages, such as chips, candy, and sugar sweetened beverages. The total number of calories purchased per trip was 356.6±290.3 kcal and most calories came from foods rather than from beverages.[6]

The potential importance of food retailers near schools has received increasing attention, but public health research and policy has focused primarily on fast food restaurants. Less is known about the relationship between overweight/obesity and other types of retailers. A study, also from California, showed that the presence of a convenience store within a 10-minute walking distance of a school was associated with a higher rate of overweight students than schools without nearby convenience stores. Nearby fast food restaurants and supermarkets, however, were not associated with school rates of overweight students.[35]

# METHODS

## Area of study

The area of study was the municipality of Porto, which have 41.66km$^2$ and 237 584 habitants in 2011.[36]

## Participants

This dissertation has been developed as part of the Epidemiological Health Investigation of Teenagers in Porto (EPITeen) that was designed to study growth, development and health in a population-based cohort of urban adolescents, from 13 years of age until young adulthood.
Eligible participants were urban adolescents, born in 1990 that were enrolled at public and private schools in Porto. They were recruited and evaluated during 2003/2004 school year.
The objectives and procedures involved in the study were explained to the executive boards of all 51 schools attended by 13-year-old adolescent in the region (27 public and 24 private, one including a school devoted exclusively to subjects with special learning needs). All public and 19 (79%) private schools allowed to reach the eligible students and families. According to informal contacts, in the five non-participating schools approximately 200 eligible students

were presented. However, no effort was made to contact them using alternative approaches and they remained unaware of the project.

In the 46 compliant schools we were able to identify 2787 eligible adolescents (2126 in public and 661 in private schools). Forty-four (1.6%) could not be reached because were always out of classes during the study period and 583 (20.9%) did not return the signed informed consent form and were considered refusals. Information, at least for part of the planned assessment, was provided by 2151 (1641 from public and 510 from private schools), resulting in a 77.2% overall participation.

The evaluation comprised two self-administered questionnaires (one completed at home, another at school), and a physical examination performed at school (including measurement of height and weight).

The first questionnaire was completed by the adolescents, at home, with help from their parents, and comprised information on the characteristics of the adolescents and the family namely demographic, social, behavioural, as well as information on perinatal circumstances and the overall medical history and medical care use. During the visit of the research team to the schools, children answered an additional self-administered questionnaire comprising further information on physical activity, smoking and alcohol intake. As part of the questionnaire completed at home, dietary intake was evaluated using a semi-quantitative food frequency questionnaire (FFQ).

Of the 2151 participants, 247 did not return the home questionnaire and 298 did not fill in the FFQ or were excluded because no information was provided on more than 10% of food items. A further 93 participants were not considered for the current analysis because their total energy intake was more than 3 times the interquartile range or their intake of fruit or vegetables was more than 1.5 times the interquartile range. Thus, the analysis was based on the information of 1513 participants from 44 schools of Porto being 1113 (73.6%) from public schools. Gender distribution was similar (53.7% girls).

## Food frequency questionnaire

As part of the home questionnaire, food intake was recorded using a food frequency questionnaire (FFQ) regarding the previous 12 months, completed by the adolescents at home with the help of their parents or legal guardians. The FFQ was designed according to Willett and colleagues[37] and adapted for the Portuguese population. The questionnaire was validated for the adult population by comparison with four 7 day food records (each one in a different season of the year)[38]. The FFQ was then adapted for adolescents by including foods more frequently eaten by this age group[39]. The adolescents' version comprised ninety-one

food items or beverage categories and a frequency section with nine possible responses ranging from never to six or more times daily. It also included an open-ended section for foods not listed in the questionnaire, but eaten at least once weekly.

Food intake data were obtained by multiplying the frequency of consumption of each food item by the nutrient content of the specified portion size. Seasonal variation of food consumption was also considered according to participants' replies. To estimate nutrient intake from the evaluated food intake, it was used the software Food Processor Plus version 7 (ESHA Research, Salem, OR, USA) based on values from the US Department of Agriculture. Values for typical Portuguese foods were added, based on the Portuguese tables of food composition, typical recipes and data from previous studies[40]. The nutrient content of food items which are usually eaten cooked was estimated by considering cooking and processing. For protein, fats and carbohydrates the values are presented as the % of each macronutrient contribution to daily energy intake.

## Similarity to Mediterranean Diet

KIDMED Index was calculated based on the data from the food frequency questionnaire. The KIDMED Index is a Mediterranean diet quality index constructed to evaluate the food habits of a population of 3850 children and youths aged between 2–24 years in the Enkid study[41]. The development of the KIDMED index is based on the principles of Mediterranean dietary patterns as well as the factors that undermine it. The original index was based on a 16 questions. As information about foods eaten at breakfast were not available, two items about "cereals or grains" and "a dairy product" for breakfast were eliminated. Then, questions denoting a negative connotation with respect to the Mediterranean diet were assigned a value of -1 and those with a positive aspect were scored +1.[16] The score obtained was analyzed in tertiles: ≤4; 5 to 6 and >6, being the higher value the closest to Mediterranean diet.

## Socioeconomic level

The parental educational level, measured as the number of successfully completed years of formal schooling, was used as an indicator of socioeconomic group.[42] To classify the adolescents, the information from the parent with the higher education level was used.

The parents' BMI was calculated based on self-reported weight and height. Each parent was classified as being of normal weight if BMI < 25.0 or overweight/obese if BMI ≥ 25.[43]

## Physical exercise

Physical activity was assessed using a questionnaire covering various daily activities. Sport activities were considered as regular scheduled sport activities outside school.[42] As measure of sports activity we considered practicing some sport, outside of the mandatory school curriculum, independently of the frequency or intensity. Additionally, we used the self-perception of intensity of usual leisure time activities, according to four subjective categories: mainly sitting, mainly standing, active or very active.

## Anthropometric measures

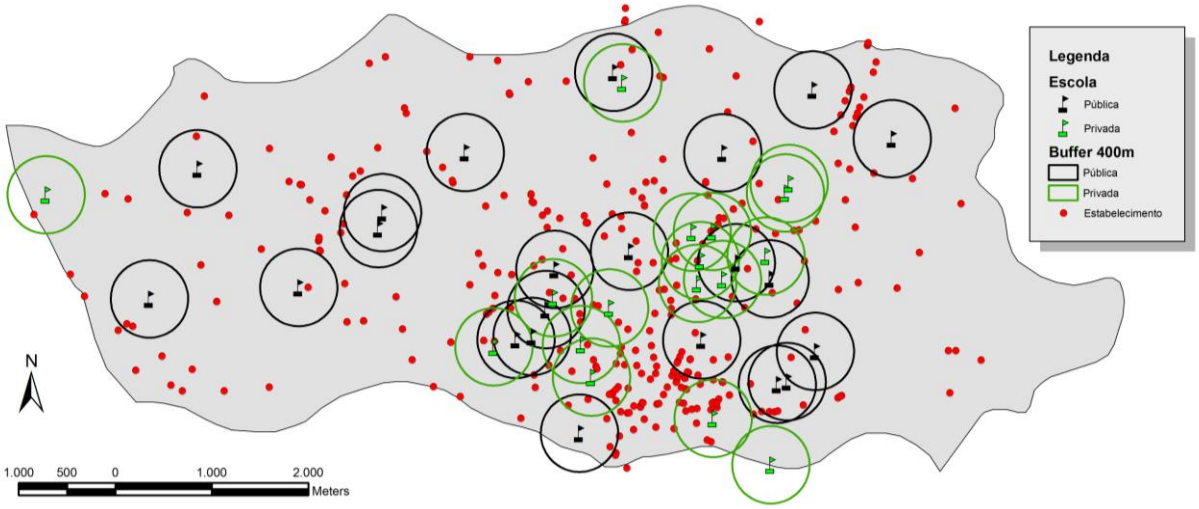
A team of health professionals carried out a physical examination that included anthropometric assessment. Weight and height were measured with the adolescents barefoot and wearing only their undergarments. Weight was measured using a Tanita® bioimpedance scale with subjects positioned in the center of the weighing platform so that their weight was evenly distributed. Height was measured with a portable stadiometer, with subjects standing with their heels together and their head positioned in the Frankfurt horizontal plane, with heels, buttocks, shoulder blades and head against the back of the stadiometer.

Body mass index (BMI) was calculated by dividing weight in kilograms by the square of height in meters and the adolescents were classified according to the distribution in percentiles for gender and age, as set out by the US Centers for Disease Control and Prevention.[44] Those with a BMI equal or above the 85$^{th}$ percentile were classified as obese/overweight.

## Food retailers

Data from food retailers were first requested to municipality. After a negative answer from municipality data was collected by telephonic lists from 2003 and geographic coordinates were geo referenced with a Geographical Information System (GIS). In the lists there were only collected restaurants, cafeterias and snack-bars. Convenience stores, supermarkets, grocery stores and stationeries, places that sell food were not collected. Some places have the name of the owner and thereby field work was needed to identify what kind of activity they have. With this method 336 food retailers were collected (figure 1)

**Figure 1 -** Map of Porto with the 44 schools and the total 336 food retailers in the proximity of 400 meters from each school, collected by telephonic lists.




It was tried to complete these data using Google Earth but a minority of the total food retailers were there represented.

All these attempts reinforce the need of the field work that was done walking through the streets, stopping in each food retailer in the 400 meters of each of the 44 schools. This field work had taken place from December 2010 to September 2011, with 16 hours/months of work approximately. This distance was chosen based on research estimating that, on average, a person can walk 400 meters in 5 minutes and because it have been used in other studies, allowing futures comparisons.[15 34] Maps for each school were made on GIS and, before walking, each map was confirmed at Google maps (figure 2).

All food retailers in one side of the street were collected and then the direction was reversed. The total time of field work, on field, had taken approximately 120 hours, with a maximum of 7 hours for a school and a minimum of one hour.

**Figure 2** - Map of two schools, Externato Ellen Key e Externato Júlio Dinis, and streets within the buffer of 400 meters.


All food retailers in one side of the street were collected and then the direction was reversed. The total time of field work, on field, had taken approximately 120 hours, with a maximum of 7 hours for a school and a minimum of one hour.

In each food retailer it was acquired the geographic coordinates with the use of a Global Positioning System (GPS) and applied a questionnaire that registered name and address, type of food retailer and activity in 2003.[15] A total of 1070 food retailers were registered (figure 3).

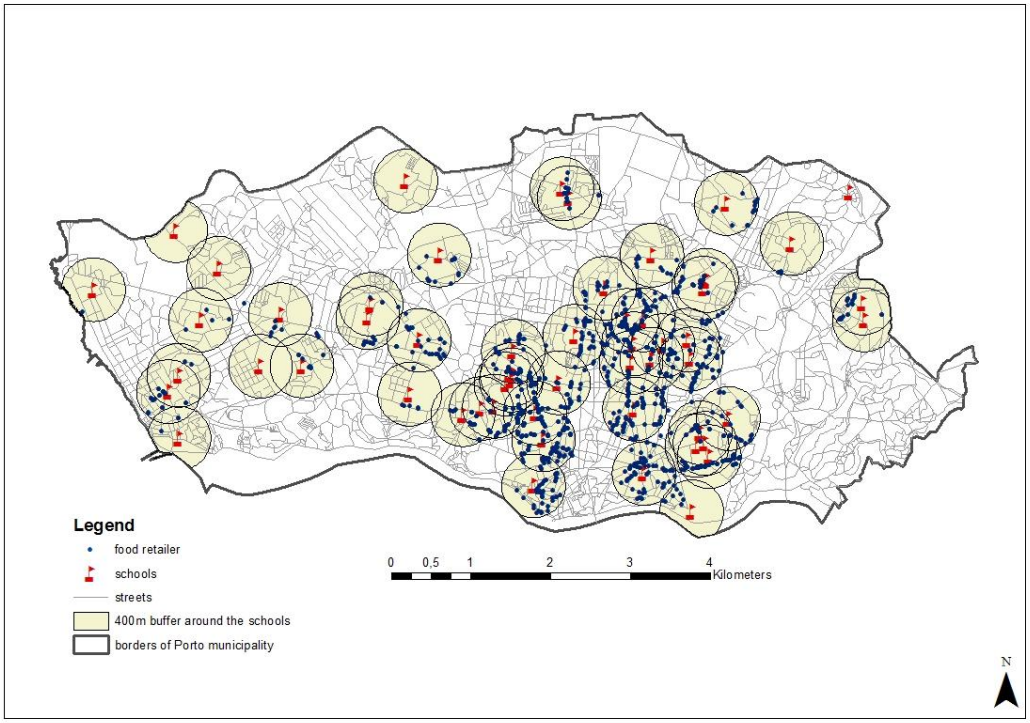


**Figure 3 -** Map of Porto with the 44 schools and the total 1070 food retailer collected in the 400 meter proximity of each school.

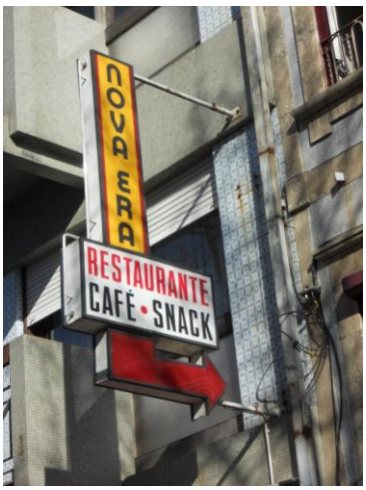
Food retailers were classified in Cafeteria/Bakery/Pastry/Candy Shop/bar and snack-bar; grocery stores; Kiosk/stationary shop (KSS), supermarket, vegetables and fruit retailer (VFR), convenience store and typical fast-food (figure 4).

**Figure 4 –** Examples of food retailers identified in the proximity of 400m from schools.


**4.1** Supermarket


**4.2** Bakery


**4.3** Stationary shop




**4.4.** Cafeteria /Snack-bar

**4.5** Grocery store

**4.6** typical fast-food


**4.7** Vegetables and fruit retailers

Food retailers only count for the sample if they were open and with the same activity in 2003. Forty eight food retailers that did not sell food in 2003 because they had other activity or were not open yet, were exclude from the sample.

With geographic coordinates, Euclidean distances from food retailers to schools were calculated. It was calculated the number and type of food retailers in the 100m, 200m and 400m proximity of schools.

Some retailers were classified in the groups: Mini and supermarkets (MSM) that included grocery stores, supermarket and vegetables/fruit retailers, places where adolescents can purchase fresh fruit and fast-food and snack retailers (FFR) that include Cafeteria/Bakery/Pastry/ Candy Shop/ bar and snack-bar and typical fast-food. Additionally, it was evaluated for each school the presence or absence of fruit sellers (vegetable and fruit retailers, grocery store and supermarkets) in the proximity of 200 meters.

## Statistical analysis

Qui-square tests were used to compare the proportions of categorical variables.
The difference in energy, macronutrients and food intake according to the number of food retailers was analyzed using the nonparametric Kruskal-Wallis and the Mann Whitney tests ($p<0.05$). For energy contribution T-test for independent samples and one-way ANOVA test were used.
Logistic regression analysis was used:

- To estimate the association between number of MSM and FFR and obesity. The best model includes number of number of MSM and FFR, parents' education and BMI, sports activity and leisure activities. Odds Ratio (OR) and the corresponding 95% confidence intervals (95% CI) were calculated and adjusted to parent's education and parent's BMI.
- To estimate the association between number of Grocery stores, supermarkets, VFR and FFR with KIDMED Score below or above 5 (median). The best model includes parental education, leisure activities and sports activities, for girls, and parental education and sports activities, for boys.

Data were analyzed using SPSS for Windows version 19. All analyses were stratified by gender.

## Ethical considerations

The Ethics Committee of the São João University Hospital, Porto, approved the study. Policies and procedures were developed to guarantee data confidentiality and protection, including the separate record of the data necessary to identify the study respondents. Written informed consent was obtained for participation in the study both from the adolescents and the parents or the legal guardian.

# RESULTS

## Distribution of food retailers

There were 1070 food retailers being Cafeteria/Bakery/Pastry/ Candy Shop/ bar and snack-bar the most frequent (68.23%), followed by grocery stores (13.96%) and Kiosk/stationary shops (10.76%). Less frequent were supermarkets (3.33%), vegetables and fruit retailer (1.89%), typical fast-food restaurants (0.46%) and convenience stores (0.26%).

The majority (82.9%) of the participants had at least one fast-food and snack retailers in the 200 meters proximity of the school. For 20.2% of the adolescents there was any retailer (Mini and supermarkets or vegetables and fruit retailer) where they could purchase fresh fruit within the 200 meters around their schools. Since 72.7% of the schools did not had a food retailer that sold fresh fruit, in the proximity of 200 meters, only 16.1% of the participants had a vegetables and fruit retailer (VFR) in a distance of 200m distance from the school (table 1).

The distribution of types of food retailers for private and public schools was statistically different. In the neighbor of private schools (proximity of 200 meters) a higher offer of fast-food than comparing to public schools was found (71.8% of private schools had 6 or more FFR in vs 17.4% for public schools ($p<0.001$). Only 4.3% of adolescents attending private schools did not have a fast-food and snack retailers in the 200 meters proximity (vs 21.7% of adolescents in public schools, $p<0.001$). Regarding vegetables and fruit retailer, 92.1% of public schools did not have any VFR in 200 meters proximity (vs 61.3% for private schools, $p<0.001$). Almost all (90.3%) of private schools have fruit sellers in the 200 meters proximity (vs 76.1% for public schools, $p<0.001$).

Of the total schools, 12 did not had a fruit seller or more in the proximity of 200 meters being all that schools located in the periphery of the city.

**Table 1-** Distribution of the different type of food retailers at 400, 200 and 100 meters, per schools and participants.

| | Number of schools | Number of adolescents |
|---|---|---|
| **Total food retailers at 400m** | | |
| ≤12 | 11 (25.0) | 460 (30.4) |
| 13-25 | 7(15.9) | 306 (20.2) |
| 26-45 | 10 (22.7) | 372 (24.6) |
| >45 | 16 (36.4) | 375 (24.8) |
| **Total food retailers at 200m** | | |
| 0-1 | 7 (15.9) | 341 (22.5) |
| 2-5 | 11 (25.0) | 425 (28.1) |
| 6-10 | 12 (27.3) | 370 (24.5) |
| >10 | 14 (31.8) | 377 (24.9) |
| **Total food retailers at 100m** | | |
| **0** | 20 (47.6) | 842 (55.7) |
| ≥1 | 22 (52.4) | 671 (44.3) |
| **Number (%) of VFR at 400m** | | |
| 0 | 28 (63.6) | 1243 (82.2) |
| ≥1 | 16 (36.4) | 270 (17.8) |
| **Number (%) of VFR at 200m** | | |
| 0 | 35 (79.5) | 1270 (83.9) |
| 1 | 9 (20.5) | 243 (16.1) |
| **Number (%) of VFR at 100m** | | |
| 0 | 42 (95.2) | 1499 (90.0) |
| ≥1 | 2 (4.8) | 14 (10.0) |
| **Number (%) of MSM at 400m** | | |
| 0-1 | 8 (18.2) | 318 (21.0) |
| 2-5 | 9 (20.5) | 399 (26.4) |
| 6-7 | 8 (18.2) | 350 (23.1) |
| >7 | 19 (43.2) | 446 (29.5) |
| **Number (%) of MSM at 200m** | | |
| 0 | 12 (27.3) | 508 (33.6) |
| 1 | 12 (27.3) | 482 (31.9) |
| ≥2 | 20 (45.5) | 523 (34.6) |
| **Number (%) of MSM at 100m** | | |
| 0 | 35 (79.5) | 1320 (87.2) |
| ≥1 | 9 (20.5) | 193 (12.8) |
| **Number (%) of FFR at 400m** | | |
| 0-7 | 9 (20.5) | 355 (23.5) |
| 8-16 | 8 (18.2) | 371 (24.5) |
| 17-28 | 9 (20.5) | 348 (23.0) |
| >28 | 18 (40.9) | 439 (29.0) |
| **Number (%) of FFR at 200m** | | |
| 0 | 6 (13.6) | 259 (17.1) |
| 1-3 | 10 (22.7) | 450 (29.7) |
| 4-6 | 13 (34.1) | 323 (21.3) |
| >6 | 15 (34.1) | 481 (31.8) |
| **Number (%) of FFR at 100m** | | |
| 0 | 23 (52.3) | 922 (60.9) |
| ≥1 | 21 (47.7) | 591 (39.1) |
| **Fruit sellers at 200 meters*** | | |
| Yes | 32 (72.7) | 1208 (79.8) |
| No | 12 (27.3) | 305 (20.2) |

VFR - Vegetables and fruit retailer; MSM - Mini and supermarkets; FFR - Fast-food and snack retailers; *Fruit sellers include grocery stores, supermarkets and fruit and vegetables retailers

## Energy and macronutrients intake

### 1. Mini and Supermarkets (MSM)

In girls, we found a significant lower energy intake among participants from schools with higher number of mini and supermarkets (MSM), although the difference reach statistical significance, the difference in the amount of energy among groups was small. No significant differences were found regarding the contribution of protein, carbohydrates and fat for total energy intake according the number of mini and supermarkets (table 2).

In boys, the percentage of energy provided by carbohydrates intake per day increased with higher number of MSM. The difference reaches statistical significance only when we considered the proximity of 400 meters (table 2).

**Table 2 -** Comparison of the Median (P25-75) total energy intake, in kcal per day, percentage of energy intake per day from proteins, carbohydrates and fat , and fiber intake per day, according to number of Mini and supermarkets **(**MSM) in a proximity of 200, 400 and 100 meters from school.

| **Females** | | | | | | |
|---|---|---|---|---|---|---|
| **Food Retailers (n)** | **Adolescents n (%)** | **Energy (Kcal/dia)** | **Proteins (% of energy)** | **Carbohydrates (% of energy)** | **Fat (% of energy)** | **Fiber (g/day)** |
| **MSM 200m** | | | | | | |
| 0 | 260 (32.0) | 2380.9 (1953.2-2880.8) | 17.3 (15.4-18.9) | 52.1 (48.0-55.8) | 32.5 (29.2-35.7) | 23.4 (18.1-30.1) |
| 1 | 243 (29.9) | 2473.0 (1960.8-3035.0) | 16.8 (15.3-18.5) | 52.7 (49.0-56.3) | 31.8 (29.0-34.5) | 24.2 (17.8-32.5) |
| ≥2 | 310 (38.1) | 2316.9 (1772.8-2828.7) | 17.1 (15.3-19.3) | 52.9 (48.5-56.7) | 31.7 (28.8-34.8) | 23.8 (16.7-29.5) |
| *p* | | **0.043** | **0.251** | **0.262** | **0.168** | **0.227** |
| **MSM 400m** | | | | | | |
| 0-1 | 176 (21.6) | 2347.7 (1917.9-2868.4) | 17.2 (15.6-18.7) | 52.2 (48.5-56.2) | 32.3 (29.5-34.9) | 24.5 (19.3-31.2) |
| 2-5 | 209 (25.7) | 2453.5 (2003.4-3054.1) | 16.8 (14.9-18.7) | 52.9 (48.4-56.2) | 31.9 (28.8-35.3) | 23.4 (17.8-31.7) |
| 6-7 | 175 (21.5) | 2469.7 (1901.8-2940.7) | 17.0 (15.0-19.0) | 52.4 (48.9-55.9) | 32.2 (29.4-35.2) | 23.4 (17.9-30.8) |
| >7 | 253 (31.1) | 2286.3 (1759.8-2807.8) | 17.2 (15.7-19.3) | 53.1 (48.6-57.0) | 31.2 (28.7-34.4) | 23.3 (15.9-29.4) |
| ***p*** | | **0.030** | **0.442** | **0.831** | **0.274** | **0.187** |
| **MSM 100m** | | | | | | |
| 0 | 718 (88.3) | 2410.5 (1915.8-2921.1) | 17.2 (15.4-19.0) | 52.4 (48.4-56.2) | 32.1 (29.0-35.0) | 23.9 (17.8-30-8) |
| 1 | 95 (11.7) | 2243.7 (1697.1-2786.4) | 16.4 (14.9-18.4) | 53.9 (50.6-56.9) | 31.4 (28.8-34.1) | 22.7 (15.1-30.2) |
| ***p*** | | **0.030** | **0.135** | **0.185** | **0.406** | **0.159** |
| **Males** | | | | | | |
| **Food Retailers (n)** | **Adolescents n (%)** | **Energy (Kcal/dia)** | **Proteins (% of energy)** | **Carbohydrates (% of energy)** | **Fat (% of energy)** | **Fiber (g/day)** |
| **MSM 200m** | | | | | | |
| 0 | 248 (35.4) | 2388.8 (1933.8-2996.0) | 17.1 (15.5-19.2) | 52.0 (48.4-55.6) | 32.0 (29.5-35.1) | 22.3 (17.6-30.6) |
| 1 | 239 (34.1) | 2597.3 (2040.7-3026.9) | 17.3 (15.5-18.9) | 52.0 (48.0-56.0) | 32.2 (29.5-34.7) | 25.5 (17.6-30.9) |
| ≥2 | 213 (30.4) | 2382.4 (1986.2-2902.9) | 17.2 (15.5-19.0) | 52.5 (48.5-55.7) | 31.9 (29.2-34.4) | 23.5 (17.7-30.5) |
| *p* | | **0.172** | **0.627** | **0.503** | **0.660** | **0.292** |
| **MSM 400m** | | | | | | |
| 0-1 | 142 (20.3) | 2485.9 (1973.0-3111.0) | 17.8 (15.8-19.8) | 51.5 (47.4-55.3) | 32.1 (29.4-34.8) | 23.2 (16.7-31.8) |
| 2-5 | 190 (27.1) | 2492.0 (2029.1-3044.2) | 17.4 (15.8-18.8) | 51.6 (48.0-55.1) | 32.4 (29.8-35.2) | 23.4 (18.1-30.5) |
| 6-7 | 175 (25.0) | 2371.0 (1997.3-2922.0) | 17.0 (15.4-18.7) | 52.7 (49.3-55.5) | 32.0 (29.6-34.2) | 23.2 (17.3-29.5) |
| >7 | 193 (27.6) | 2458.1 (1934.3-2963.4) | 17.1 (15.3-18.8) | 53.0 (48.7-56.3) | 31.8 (28.9-34.6) | 24.7 (17.9-30.9) |
| ***p*** | | **0.758** | **0.009** | **0.040** | **0.360** | **0.870** |
| **MSM 100m** | | | | | | |
| 0 | 602 (86.0) | 2456.9 (2000.8-2996.8) | 17.3 (15.6-18.9) | 52.2 (48.4-55.6) | 31.9 (29.4-34.8) | 23.8 (17.6-30.8) |
| 1 | 98 (14.0) | 2367.6 (1936.8-2959.3) | 17.1 (15.4-19.3) | 51.6 (47.9-55.9) | 32.9 (29.5-34.5) | 23.1 (17.5-30.1) |
| ***p*** | | **0.388** | **0.829** | **0.626** | **0.640** | **0.496** |

## 2. Vegetables and fruit retailers (VFR)

Comparing with students in schools who did not have any vegetables and fruit retailer (VFR), students from schools with this kind of retailer reported a lower energy intake. However, these relation inverts when the 400m was considered as cut-off for define proximity. Also fiber intake was lower for girls with at least one vegetable and fruit retailer at 200 meters. Among girls, considering a distance of 200m, a higher contribution from proteins for total energy intake among those in schools with vegetables and fruit retailer in the proximity was also found (table 3).

**Table 3 -** Comparison of the Median (P25-75) total energy intake, in kcal per day, percentage of energy intake per day from proteins, carbohydrates and fat , and fiber intake per day, according to number of vegetable and fruit retailers (VFR) in a proximity of 200, 400 and 100 meters from school.

| **Females** | | | | | | |
|---|---|---|---|---|---|---|
| **Food Retailers (n)** | **Adolescents n (%)** | **Energy (Kcal/dia)** | **Proteins (% of energy)** | **Carbohydrates (% of energy)** | **Fat (% of energy)** | **Fiber (g/day)** |
| **VFR 200m** | | | | | | |
| 0 | 668 (82.2) | 2416.5 (1934.5-2953.7) | 16.9 (15.1-18.7) | 52.8 (48.7-56.3) | 32.0 (29.0-34.9) | 23.8 (17.8-31.6) |
| 1 | 145 (17.8) | 2219.0 (1749.6-2731.0) | 17.8 (15.9-19.6) | 52.3 (48.0-56.0) | 31.9 (29.3-34.6) | 23.1 (15.8-27.7) |
| ***p*** | | **0.002** | **0.000** | **0.150** | **0.599** | **0.023** |
| **VFR 400m** | | | | | | |
| 0 | 662 (81.4) | 2369.1 (1873.8-2866.1) | 17.1 (15.3-18.9) | 52.7 (48.6-56.3) | 31.8 (28.9-34.9) | 23.4 (17.4-30.7) |
| ≥1 | 151 (18.6) | 2450.9 (2050.0-3035.0) | 16.9 (15.4-19.1) | 52.7 (48.3-55.9) | 32.5 (29.2-35.3) | 24.9 (18.4-31.1) |
| ***p*** | | **0.074** | **0.822** | **0.415** | **0.222** | **0.285** |
| **VFR 100m** | | | | | | |
| 0 | 805 (99.0) | 2377.2 (1902.9-2909.1) | 17.1 (15.3-18.9) | 52.7 (48.5-56.2) | 32.0 (29.0-34.9) | 23.8 (17.5-30.8) |
| 1 | 8 (1.0) | 1997.5 (1175.8-2534.5) | 15.7 (15.0-19.5) | 54.6 (43.7-57.1) | 31.9 (28.7-39.1) | 21.8 (11.5-26.4) |
| ***p*** | | **0.110** | **0.430** | **0.993** | **0.684** | **0.159** |
| **Males** | | | | | | |
| **Food Retailers (n)** | **Adolescents n (%)** | **Energy (Kcal/dia)** | **Proteins (% of energy)** | **Carbohydrates (% of energy)** | **Fat (% of energy)** | **Fiber (g/day)** |
| **VFR 200m** | | | | | | |
| 0 | 602 (86.0) | 2450.0 (2005.5-2996.8) | 17.3 (15.6-18.9) | 52.0 (48.3-55.7) | 32.1 (29.5-34.8) | |
| 1 | 98 (14.0) | 2454.2 (1884.7-2952.7) | 17.3 (15.2-19.0) | 53.0 (49.0-55.6) | 31.6 (28.9-34.4) | |
| ***p*** | | **0.528** | **0.329** | **0.281** | **0.418** | |
| **VFR 400 m** | | | | | | |
| 0 | 581 (83.0) | 2437.5 (1972.5-2960.7) | 17.2 (15.5-18.9) | 52.1 (48.4-55.7) | 31.9 (29.4-34.7) | 23.4 (17.1-30.4) |
| ≥1 | 119 (17.0) | 2569.5 (2168.1-3105.1) | 17.4 (15.6-19.5) | 52.0 (47.9-55.6) | 32.3 (29.5-35.5) | 25.4 (19.5-33.6) |
| ***p*** | | **0.051** | **0.312** | **0.286** | **0.450** | **0.036** |
| **VFR 100m** | | | | | | |
| 0 | 694 (99.1) | 2453.6 (1992.6-2993.4) | 17.3 (15.5-19.0) | 52.1 (48.3-55.7) | 32.0 (29.4-34.8) | 23.7 (17.6-30.8) |
| 1 | 6 (0.9) | 1787.5 (1416.5-2374.7) | 18.0 (15.6-19.4) | 51.3 (48.7-58.3) | 32.8 (26.5-34.8) | 20.0 (11.9-23.1) |
| ***p*** | | **0.020** | **0.720** | **0.791** | **0.874** | **0.496** |

### 3. Fast-food and snacks retailers (FFR)

Regarding the availability of fast-food and snack retailers (FFR), considering a distance of 200m, we found an increase in total energy intake with the increasing of retailers was found, however in the last category (more than 6 retailers available) the total energy intake decrease. This trend it was similar in boys and girls, however only in girls reach statistical significance. In general, the contribution of macro-nutrients for the total energy intake was similar according the availability of this kind of retailers (table 4).

**Table 4 -** Comparison of the Median (P25-75) total energy intake, in kcal per day, percentage of energy intake per day from proteins, carbohydrates and fat , and fiber intake per day, according to number of fast-food and snacks retailers **(**FFR) in a proximity of 200, 400 and 100 meters from school.

| **Females** | | | | | | |
|---|---|---|---|---|---|---|
| **Food Retailers (n)** | **Adolescents n (%)** | **Energy (Kcal/day)** | **Proteins (% of energy)** | **Carbohydrates (% of energy)** | **Fat (% of energy)** | **Fiber (g/day)** |
| **FFR 200m** | | | | | | |
| 0 | 141 (17.3) | 2310.1 (1900.2-2925.4) | 17.3 (15.1-18.9) | 51.8 (48.1-55.7) | 32.2 (28.9-36.0) | 23.2 (17.8-38.5) |
| 1-3 | 220 (27.1) | 2447.3 (1944.5-2930.1) | 16.8 (15.0-18.4) | 53.3 (49.4-56.8) | 31.5 (28.8-34.7) | 23.0 (17.8-31.6) |
| 4-6 | 187 (23.0) | 2604.9 (2016.7-3063.3) | 16.8 (15.2-18.7) | 52.0 (48.0-55.9) | 32.6 (29.7-35.0) | 24.5 (17.4-29.5) |
| >6 | 265 (32,6) | 2307.2 (1795.6-2791.0) | 17.2 (15.6-19.3) | 52.8 (48.7-56.4) | 31.8 (28.6-34.5) | 24.1 (17.3-30.9) |
| ***p*** | | **0.020** | **0.040** | **0.399** | **0.095** | **0.986** |
| **FFR 400m** | | | | | | |
| 0-7 | 194 (23.9) | 2373.7 (1974.1-2813.8) | 17.2 (15.1-18.7) | 52.8 (48.7-56.7) | 31.6 (28.6-35.1) | 24.0 (19.5-31.6) |
| 8-16 | 194 (23.9) | 2462.9 (1940.6-3070.1) | 17.1 (15.0-18.9) | 52.0 (48.3-55.7) | 32.7 (29.6-35.4) | 23.5 (17.7-30.3) |
| 17-28 | 187 (29.3) | 2435.9 (1953.9-2932.6) | 16.7 (15.3-18.6) | 53.1 (48.6-56.4) | 31.8 (29.4-34.9) | 24.2 (17.8-32.1) |
| >28 | 238 (29.3) | 2288.0 (1738.1-2772.8) | 17.2 (15.5-19.3) | 52.7 (48.5-56.7) | 31.6 (28.7-34.5) | 23.2 (15.8-30.0) |
| ***p*** | | **0.019** | **0.008** | **0.172** | **0.426** | **0.156** |
| **FFR 100m** | | | | | | |
| 0 | 488 (60.0) | 2371.9 (1852.0-2928.9) | 17.1 (15.1-18.8) | 52.9 (48.5-56.7) | 31.7 (28.8-34.9) | 23.3 (17.5-31.1) |
| 1 | 325 (40.0) | 2389.2 (1970.7-2868.7) | 17.0 (15.5-19.0) | 52.3 (48.6-55.8) | 32.2 (29.4-35.0) | 24.5 (17.8-30.3) |
| ***p*** | | **0.577** | **0.328** | **0.353** | **0.510** | **0.636** |
| **Males** | | | | | | |
| **Food Retailers (n)** | **Adolescents n (%)** | **Energy (Kcal/dia)** | **Proteins (% of energy)** | **Carbohydrates (% of energy)** | **Fat (% of energy)** | **Fiber (g/day** |
| **FFR 200m** | | | | | | |
| 0 | 118 (16.9) | 2417.6 (1965.9-3048.9) | 17.2 (15.9-19.3) | 51.5 (48.3-55.3) | 32.1 (29.8-35.2) | 23.3 (17.3-32.0) |
| 1-3 | 230 (32.9) | 2446.5 (1946.7-2956.5) | 17.2 (15.3-18.8) | 52.6 (48.9-55.8) | 32.0 (29.4-34.4) | 23.1 (17.3-30.2) |
| 4-6 | 136 (19.4) | 2600.0 (2146.6-3080.1) | 17.3 (15.1-19.0) | 51.6 (47.9-55.6) | 32.3 (29.5-35.8) | 25.6 (18.5-31.2) |
| >6 | 216 (30.9) | 2384.7 (1967.0-2926.7) | 17.4 (15.8-19.3) | 52.3 (48.2-55.8) | 31.9 (29.1-34.4) | 23.4 (17.9-30.8) |
| ***p*** | | **0.243** | **0.221** | **0.355** | **0.388** | **0.624** |
| **FFR 400m** | | | | | | |
| 0-7 | 161 (23.0) | 2431.1 (1958.2-3050.9) | 17.5 (15.9-18.9) | 51.9 (48.6-55.8) | 31.9 (29.3-34.2) | 23.2 (16.3-31.4) |
| 8-16 | 177 (25.3) | 2478.9 (2010.2-3070.6) | 17.2 (15.3-19.6) | 52.0 (48.2-55.6) | 32.0 (29.6-35.4) | 23.9 (18.7-32.0) |
| 17-28 | 161 (23.0) | 2506.7 (2042.2-2838.9) | 17.1 (15.7-19.1) | 52.1 (48.3-56.1) | 32.2 (29.2-35.3) | 24.6 (18.8-29.5) |
| >28 | 201 (28.7) | 2437.5 (1936.6-2978.0) | 17.1 (15.4-18.7) | 53.7 (48.7-55.7) | 32.1 (29.5-34.5) | 23.1 (16.2-30.7) |
| ***p*** | | **0.853** | **0.014** | **0.020** | **0.052** | **0.541** |
| **FFR 100m** | | | | | | |
| 0 | 434 (62.0) | 2458.7 (1951.5-3022.5) | 17.3 (15.5-18.9) | 52.1 (48.3-55.9) | 32.0 (29.5-34.8) | 24.4 (17.8-30.9) |
| 1 | 266 (38.0) | 2437.2 (2025.9-2908.4) | 17.2 (15.5-19.2) | 52.2 (48.4-55.4) | 32.0 (29.4-34.3) | 23.2 (16.9-30.5) |
| ***p*** | | **0.855** | **0.991** | **0.846** | **0.977** | **0.196** |

## Food intake

Regarding the intake of soda, sweets and fruit, no significant differences were found according the number of mini and supermarkets available in the proximity of school, only in girls we found a small decrease on sweets intake among those in schools with higher number of mini and supermarkets. Similar result was found according the availability of vegetables and fruit retailers and according the availability of fast-food retailers (table 5).

**Table 5 -** Median (P25-P75) differences in soda, sweets and fruit intake (ice-creams, chocolate bars, candies and gums portions/day) according to different number and type of food retailers at 400, 200 and 100 meters from schools.

| Food retailer (n) | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| | | Soda | Sweets* | Fruits | | Soda | Sweets* | Fruits |
| **FFR (n) 400m** | **n (%)** | | | | **n (%)** | | | |
| 0-7 | 194 (23.9) | 0.6 (0.3-1.1) | 0.6 (0.3-1.3) | 2.1 (1.3-3.3) | 161 (23.0) | 0.7 (0.3-1.2) | 0.5 (0.2-1.0) | 2.0 (1.2-2.9) |
| 8-16 | 194 (23.9) | 0.7 (0.3-1.3) | 0.5 (0.2-1.0) | 2.1 (1.3-3.3) | 177 (25.3) | 0.7 (0.3-1.3) | 0.4 (0.3-0.9) | 2.1 (1.3-2.9) |
| 17-28 | 187 (29.3) | 0.5 (0.2-1.0) | 0.5 (0.2-1.0) | 2.5 (1.5-2.1) | 161 (23.0) | 0.9 (0.3-1.3) | 0.5 (0.2-0.8) | 1.8 (0.9-3.0) |
| >28 | 238 (29.3) | 0.6 (0.3-1.1) | 0.3 (0.2-1.8) | 2.0 (1.1-3.7) | 201 (28.7) | 0.8 (0.4-1.4) | 0.6 (0.3-1.1) | 1.9 (1.4-3.0) |
| ***p*** | | **0.970** | **0.042** | **0.081** | | **0.346** | **0.533** | **0.214** |
| **FFR (n) 200m** | **n (%)** | | | | **n (%)** | | | |
| 0 | 141 (17.3) | 0.6 (0.2-1.2) | 0.5 (0.3-1.1) | 2.0 (1.3-3.1) | 118 (16.9) | 0.8 (0.3-1.3) | 0.5 (0.2-0.9) | 1.9 (1.3-2.8) |
| 1-3 | 220 (27.1) | 0.6 (0.3-1.1) | 0.7 (0.3-1.4) | 2.1 (1.2-3.3) | 230 (32.9) | 0.7 (0.3-1.1) | 0.5 (0.2-1.0) | 1.9 (1.1-3.0) |
| 3-6 | 187 (23.0) | 0.6 (0.3-1.3) | 0.6 (0.3-1.3) | 2.1 (1.1-3.3) | 136 (19.4) | 0.7 (0.4-1.3) | 0.6 (0.3-1.6) | 2.1 (1.3-3.3) |
| >6 | 265 (32,6) | 0.6 (0.2-1.1) | 0.5 (0.2-0.9) | 2.1 (1.4-3.3) | 216 (30.9) | 0.7 (0.3-1.3) | 0.4 (0.2-1.3) | 2.0 (1.1-2.9) |
| ***p*** | | **0.362** | **0.000** | **0.930** | | **0.449** | **0.004** | **0.602** |
| **FFR (n) 100m** | **n (%)** | | | | **n (%)** | | | |
| 0 | 488 (60.0) | 0.6 (0.3-1.2) | 0.5 (0.2-1.1) | 2.0 (1.2-3.3) | 434 (62.0) | 0.7 (0.4-1.3) | 0.5 (0.2-1.0) | 2.0 (2.0-3.9) |
| 1 | 325 (40.0) | 0.6 (0.2-1.2) | 0.6 (0.2-1.2) | 2.2 (1.4-3.3) | 266 (38.0) | 0.7 (0.3-1.3) | 0.5 (0.2-0.9) | 2.0 (1.0-2.9) |
| ***p*** | | **0.795** | **0.739** | **0.188** | | **0.454** | **0.967** | **0.653** |
| **MSM (n) 400m** | **n (%)** | | | | **n (%)** | | | |
| 0-1 | 176 (21.6) | 0.5 (0.2-1.0) | 0.5 (0.2-1.0) | 2.0 (1.3-3.7) | 142 (20.3) | 0.7 (0.3-1.4) | 0.5 (0.3-1.1) | 1.9 (1.2-2.8) |
| 2-5 | 209 (25.7) | 0.6 (0.3-1.3) | 0.6 (0.3-1.3) | 2.1 (1.4-3.7) | 190 (27.1) | 0.7 (0.3-1.2) | 0.5 (0.2-0.8) | 2.0 (1.1-3.1) |
| 6-7 | 175 (21.5) | 0.6 (0.3-1.1) | 0.7 (0.3-1.5) | 2.2 (1.2-3.3) | 175 (25.0) | 0.9 (0.4-1.3) | 0.4 (0.2-1.1) | 2.9 (1.2-2.9) |
| >8 | 253 (31.1) | 0.6 (0.2-0.9) | 0.5 (0.2-0.9) | 2.1 (1.2-3.3) | 193 (27.6) | 0.7 (0.3-0.7) | 0.5 (0.2-0.9) | 2.1 (1.2-3.2) |
| ***p*** | | **0.071** | **0.296** | **0.432** | | **0.062** | **0.031** | **0.476** |
| **MSM (n) 200m** | **n (%)** | | | | **n (%)** | | | |
| 0 | 260 (32.0) | 0.6 (0.2-1.0) | 0.6 (0.3-1.2) | 2.1 (1.2-3.3) | 248 (35.4) | 0.7 (0.3-1.3) | 0.5 (0.2-1.0) | 1.9 (1.2-2.9) |
| 1 | 243 (29.9) | 0.6 (0.3-1.3) | 0.6 (0.3-1.3) | 2.1 (1.3-3.7) | 239 (34.1) | 0.7 (0.3-1.3) | 0.5 (0.3-1.0) | 2.0 (1.1-2.9) |
| ≥2 | 310 (38.1) | 0.6 (0.2-1.3) | 0.5 (0.2 1.0) | 2.1 (1.3-3.1) | 213 (30.4) | 0.7 (0.3-1.3) | 0.4 (0.2-0.9) | 2.1 (1.0-3.0) |
| ***p*** | | **0.192** | **0.046** | **0.812** | | **0.966** | **0.068** | **0.919** |
| **MSM (n) 100m** | **n (%)** | | | | **n (%)** | | | |
| 0 | 718 (88.3) | 0.6 (0.3-1.2) | 0.6 (0.2-1.1) | 2.1 (1.3-3.3) | 602 (86.0) | 0.7 (0.3-1.3) | 0.5 (0.2-1.0) | 2.0 (1.2-3.1) |
| 1 | 95 (11.7) | 0.6 (0.2-1.2) | 0.5 (0.2-1.0) | 1.9 (1.0-3.5) | 98 (14.0) | 0.6 (0.3-1.3) | 0.4 (0.3-0.9) | 2.0 (1.0-2.8) |
| ***p*** | | **0.840** | **0.414** | **0.328** | | **0.382** | **0.968** | **0.386** |
| **VFR (n) 400m** | **n (%)** | | | | **n (%)** | | | |
| 0 | 662 (81.4) | 0.6 (0.3-1.2) | 0.5 (0.2-1.1) | 2.1 (1.2-3.3) | 581 (83.0) | 0.7 (0.3-1.3) | 0.5 (0.2-1.0) | 2.0 (1.1-2.9) |
| ≥1 | 151 (18.6) | 0.6 (0.3-1.1) | 0.6 (0.3-1.2) | 2.1 (1.4-3.3) | 119 (17.0) | 0.7 (0.3-1.1) | 0.5 (0.3-1.0) | 2.1 (1.5-3.3) |
| ***p*** | | **0.677** | **0.145** | **0.428** | | **0.404** | **0.452** | **0.146** |
| **VFR (n) 200m** | **n (%)** | | | | **n (%)** | | | |
| 0 | 668 (82.2) | 0.6 (0.3-1.2) | 0.6 (0.3-1.2) | 2.1 (1.3-3.4) | 602 (86.0) | 0.7 (0.3-1.3) | 0.5 (0.2-1.0) | 2.0 (1.2-2.9) |
| ≥1 | 145 (17.8) | 0.5 (0.2-0.9) | 0.5 (0.2-0.9) | 1.9 (1.2-3.0) | 98 (14.0) | 0.7 (0.3-1.4) | 0.4 (0.2-0.9) | 2.0 (0.9-3.3) |
| ***p*** | | **0.955** | **0.003** | **0.053** | | **0.747** | **0.091** | **0.795** |
| **VFR (n) 100m** | **n (%)** | | | | **n (%)** | | | |
| 0 | 805 (99.0) | 0.6 (0.3-1.2) | 0.6 (0.2-1.1) | 2.1 (1.3-3.3) | 694 (99.1) | 0.7 (0.3-1.3) | 0.5 (0.2-1.0) | 2.0 (1.1-2.9) |
| 1 | 8 (1.0) | 0.4 (0.2-1.9) | 0.4 (0.2-0.7) | 1.8 (1.1-2.3) | 6 (0.9) | 0.5 (0.4-1.6) | 0.5 (0.1-2.7) | 3.0 (0.4-4.0) |
| ***p*** | | **0.735** | **0.310** | **0.366** | | **0.812** | **0.784** | **0.640** |

## Similarity to Mediterranean Diet

The proportion of adolescents with an intake more similar to the Mediterranean Diet (higher KIDMED score) was higher among adolescents enrolled at schools with more availability of mini and supermarkets (MSM), although only in girls the difference was significant. Similar results were found for girls regarding the availability of vegetables and fruit retailer (VFR) and fast-food and snack retailers (table 6). Among boys, and considering the availability of vegetables and fruit retailers (VFR), a lower adherence to the Mediterranean Diet at 200 meters was foun but the opposite was found when proximity was defined by 400m (table 6).

**Table 6 -** Comparison of the distribution of adolescents by KIDMED scores, according to availability of each type of food retailers as far as 100, 200 and 400 meters from the school.

| Food retailers (n) | KIDMED score n (%) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Females | | | | | Males | | | | |
| | | ≤4 | 5-6 | >6 | *p* | | ≤4 | 5-6 | >6 | *p* |
| **VFR 100m** | **n (%)** | | | | | **n (%)** | | | | |
| 0 | 805 (99.0) | 307 (38.1) | 269 (33.4) | 229 (28.4) | **0.964** | 694 (99.1) | 255 (36.7) | 226 (32.6) | 213 (30.7) | **0.194** |
| 1 | 8 (1.0) | 3 (37.5) | 3 (37.5) | 2 (25.0) | | 6 (0.9) | 4 (66.7) | 2 (33.3) | 0 (0) | |
| **VFR 200m** | **n (%)** | | | | | **n (%)** | | | | |
| 0 | 668 (82.2) | 267 (40.0) | 223 (33.4) | 178 (26.6) | **0.024** | 602 (86.0) | 211 (35.0) | 203 (33.7) | 188 (31.2) | **0.029** |
| ≥1 | 145 (17.8) | 43 (29.7) | 49 (33.8) | 53 (36.6) | | 98 (14.0) | 48 (49.0) | 25 (25.5) | 25 (25.5) | |
| **VFR 400m** | **n (%)** | | | | | **n (%)** | | | | |
| 0 | 662 (81.4) | 249 (37.6) | 228 (34.4) | 185 (27.9) | **0.459** | 581 (83.0) | 226 (38.9) | 191 (32.9) | 164 (28.2) | **0.012** |
| ≥1 | 151 (18.6) | 61 (40.4) | 44 (29.1) | 46 (30.5) | | 119 (17.0) | 33 (27.7) | 37 (31.1) | 49 (41.2) | |
| **FFR 100m** | **n (%)** | | | | | **n (%)** | | | | |
| 0 | 488 (60.0) | 192 (39.3) | 164 (33.6) | 132 (27.0) | **0.527** | 434 (62.0) | 156 (35.9) | 152 (35.0) | 126 (29.0) | **0.204** |
| 1 | 325 (40.0) | 118 (36.3) | 108 (33.2) | 99 (30.5) | | 266 (38.0) | 103 (38.7) | 76 (28.6) | 87 (32.7) | |
| **FFR 200m** | **n (%)** | | | | | **n (%)** | | | | |
| 0 | 141 (17.3) | 54 (38.3) | 45 (31.9) | 42 (29.8) | | 118 (16.9) | 45 (38.1) | 38 (32.2) | 35 (29.7) | |
| 1-3 | 220 (27.1) | 100 (45.5) | 77 (35.0) | 43 (19.5) | **0.001** | 230 (32.9) | 90 (39.1) | 81 (35.2) | 59 (25.7) | **0.362** |
| 4-6 | 187 (23.0) | 75 (40.1) | 65 (34.8) | 47 (25.1) | | 136 (19.4) | 50 (36.8) | 46 (33.8) | 40 (29.4) | |
| >6 | 265 (32,6) | 81 (30.6) | 85 (32.1) | 99 (37.4) | | 216 (30.9) | 74 (34.3) | 63 (29.2) | 79 (36.6) | |
| **FFR 400m** | **n (%)** | | | | | **n (%)** | | | | |
| 0-7 | 194 (23.9) | 64 (33.0) | 75 (38.7) | 55 (28.4) | | 161 (23.0) | 64 (39.8) | 52 (32.3) | 45 (28.0) | |
| 8-16 | 194 (23.9) | 92 (47.4) | 57 (29.4) | 45 (23.2) | **0.036** | 177 (25.3) | 63 (35.6) | 57 (32.3) | 57 (32.2) | **0.791** |
| 17-28 | 187 (29.3) | 71 (38.0) | 65 (34.8) | 51 (27.3) | | 161 (23.0) | 53 (32.9) | 53 (32.9) | 55 (34.2) | |
| >28 | 238 (29.3) | 83 (34.9) | 75 (31.5) | 80 (33.6) | | 201 (28.7) | 79 (39.3) | 66 (32.8) | 56 (27.9) | |
| **MSM 100m** | **n (%)** | | | | | **n (%)** | | | | |
| 0 | 718 (88.3) | 263 (36.6) | 247 (34.4) | 208 (29.0) | **0.051** | 602 (86.0) | 226 (37.5) | 196 (32.6) | 180 (29.9) | **0.692** |
| 1 | 95 (11.7) | 47 (49.5) | 25 (26.3) | 23 (24.2) | | 98 (14.0) | 33 (33.7) | 32 (32.7) | 33 (33.7) | |
| **MSM 200m** | **n (%)** | | | | | **n (%)** | | | | |
| 0 | 260 (32.0) | 110 (42.3) | 85 (32.7) | 65 (25.0) | | 248 (35.4) | 102 (41.1) | 78 (31.5) | 68 (27.4) | |
| 1 | 243 (29.9) | 96 (39.5) | 81 (33.3) | 66 (27.2) | **0.205** | 239 (34.1) | 74 (31.0) | 86 (36.0) | 79 (33.1) | **0.172** |
| ≥2 | 310 (38.1) | 104 (33.5) | 106 (34.2) | 100 (32.2) | | 213 (30.4) | 83 (39.0) | 64 (30.0) | 66 (31.0) | |
| **MSM 400m** | **n (%)** | | | | | **n (%)** | | | | |
| 0 | 176 (21.6) | 54 (38.3) | 45 (31.9) | 42 (29.8) | | 142 (20.3) | 45 (38.1) | 38 (32.2) | 35 (29.7) | |
| 1-3 | 209 (25.7) | 100 (45.5) | 77 (35.0) | 43 (19.5) | **0.001** | 190 (27.1) | 90 (39.1) | 81 (35.2) | 59 (25.7) | **0.362** |
| 4-6 | 175 (21.5) | 75 (40.1) | 65 (34.8) | 47 (25.1) | | 175 (25.0) | 50 (36.8) | 46 (33.8) | 40 (29.4) | |
| >6 | 253 (31.1) | 81 (30.6) | 85 (32.1) | 99 (37.4) | | 193 (27.6) | 74 (34.3) | 63 (29.2) | 79 (36.6) | |
| **KSS 200m** | **n (%)** | | | | | **n (%)** | | | | |
| 0 | 368 (45.3) | 154 (41.8) | 126 (34.2) | 88 (23.9) | | 359 (51.3) | 139 (38.7) | 118 (32.9) | 102 (28.4) | |
| 1-2 | 274 (33.7) | 106 (38.7) | 90 (32.8) | 78 (28.5) | **0.010** | 190 (27.1) | 64 (33.7) | 61 (32.1) | 65 (34.2) | **0.690** |
| ≥2 | 171 (21.0) | 50 (29.2) | 56 (32.7) | 65 (38.0) | | 151 (21.6) | 56 (37.1) | 49 (32.5) | 46 (30.5) | |
| **Fruit sellers at 200 meters*** | **n (%)** | | | | | **n (%)** | | | | |
| Yes | 305 (37.5) | 188 (37.0) | 169 (33.3) | 151 (29.7) | **0.527** | 0 (0.0) | 259 (37.0) | 228 (32.6) | 213 (30.4) | **--** |
| No | 508 (62.5) | 122 (40.0) | 103 (33.8) | 80 (26.3) | | 700 (100.0) | 0 | 0 | 0 | |

In both genders, the odds to present a diet more similar with the Mediterranean Diet increase with the increase of parental education and was higher among adolescents more active (reported active or more active leisure activities or were engaged in sports activities). Regarding food retailers in the proximity of schools, only an association in girls and with the availability of fast-food and snack retailers (FFR) was found, those with lower number of fast-food and snack retailers presented a lower odds to present a Mediterranean Diet (table 7).

**Table 7 -** Estimative of risk to report a diet similar to Mediterranean Diet according to the availability (in a distance of 200 meters from schools) of each kind of food retailer, by gender.

| BMI categories | Females | | | Males | | |
|---|---|---|---|---|---|---|
| | KIDMED Score >5 | Crude OR (CI 95%) | Adjusted OR (CI 95%)* | KIDMED Score>5 | Crude OR (CI 95%) | Adjusted OR (CI 95%)** |
| **Grocery stores and Supermarkets (n) 200m** | | | | | | |
| 0 | 104 (40.0) | Reference | | 108 (43.5) | Reference | |
| 1 | 264 (47.7) | 1.37 (1.17; 1.85) | 1.35 (0.83; 2.20) | 216 (47.8) | 1.19 (0.87; 1.62) | 1.15 (0.83; 1.60) |
| ***p*** | **0.039** | | | **0.282** | | |
| **FFR (n) 200m** | | | | | | |
| 0 | 34 (25.8) | Reference | | 30 (27.0) | Reference | |
| 1-3 | 54 (25.6) | 0.77 (0.50; 1.19) | 0.57 (0.33; 0.99) | 62 (28.4) | 0.86 (0.55; 1.35) | |
| 4-6 | 32 (17.8) | 1.01 (0.65; 1.57) | 0.79 (0.40; 1.54) | 33 (25.2) | 0.91 (0.55; 1.49) | |
| >6 | 70 (27.0) | 1.71 (1.13; 2.58) | 0.94 (0.50; 1.78) | 58 (27.9) | 1.32 (0.85; 2.08) | |
| ***p*** | **0.135** | | | **0.925** | | |
| **VFR (n) 200m** | | | | | | |
| 0 | 292 (43.7) | Reference | | 284 (47.2) | Reference | |
| ≥1 | 76 (52.4) | 1.41 (0.99; 2.03) | | 40 (40.8) | 0.77 (0.50; 1.19) | |
| | **0.056** | | | **0.242** | | |
| **Parental Education** | | | | | | |
| Until 6th year | 61 (30.7) | Reference | | 44 (31.9) | Reference | |
| Until 9th year | 60 (33.9) | 1.16 (0.75; 1.79) | 1.15 (0.73; 1.81) | 45 (34.1) | 1.11 (0.67; 1.84) | 1.20 (0.71; 2.00) |
| Secondary School | 101 (48.6) | 2.14 (1.42; 3.21) | 1.88 (1.21; 2.91) | 97 (46.2) | 1.83 (1.17; 2.87) | 1.78 (1.12; 2.81) |
| College | 145 (64.7) | 4.15 (2.76; 6.24) | 3.73 (2.37; 5.88) | 134 (63.2) | 3.67 (2.33; 5.78) | 3.47 (2.18; 5.52) |
| ***p*** | **0.000** | | | **0.000** | | |
| **Leisure activities** | | | | | | |
| Mainly sitting | 96 (39.3) | Reference | | 69 (39.4) | Reference | |
| Mainly standing | 94 (40.0) | 1.03 (0.71; 1.48) | 1.26 (0.85; 1.86) | 48 (51.6) | 1.64 (0.99; 2.72) | |
| Active or very active | 165 (55.6) | 1.93 (1.37; 2.72) | 1.96 (1.35; 2.84) | 188 (47.6) | 1.40 (0.97; 2.00) | |
| ***p*** | **0.000** | | | **0.099** | | |
| **Sports Activity** | | | | | | |
| No | 183 (38.9) | Reference | | 95 (36.7) | Reference | |
| Yes | 179 (54.4) | 1.88 (1.41; 2.50) | 1.22 (0.89; 1.69) | 225 (51.8) | 1.86 (1.36; 2.55) | 1.56 (1.12; 2.17) |
| ***p*** | **0.000** | | | **0.000** | | |
| **Parent's BMI** | | | | | | |
| <25 kg/m$^2$ | 79 (42.0) | Reference | | 59 (48.0) | Reference | |
| ≥25 kg/m$^2$ | 131 (43.0) | 1.04 (0.72; 1.50) | | 138 (45.7) | 0.91 (0.60; 1.39) | |
| ***p*** | **0.829** | | | **0.670** | | |

*Adjusted for Grocery stores and Supermarkets at 200m, Fast-food retailers (FFR) at 200m; Parental Education, Leisure Activities and Sports Activities, for girls

**Adjusted for Parental Education and Sports Activities, for boys

## Overweight

Even after adjustment for parent's education and BMI, the odds to have overweight were almost three-fold among adolescents at schools with more availability of mini and supermarkets (MSM). In contrary the odds of overweight decrease with the increase of the number of fast-food and snack retailers (FFR) in the school proximity (table 8)

**Table 8 -** Estimative of risk of overweight according to the availability (in a distance of 200 meters from schools) of each kind of food retailer, by gender.

| BMI categories | Females | | | | Males | | | |
|---|---|---|---|---|---|---|---|---|
| | <85th percentiles | ≥85th percentiles | Crude OR (CI 95%) | Adjusted OR (CI 95%)* | <85th percentiles | ≥85th percentiles | Crude OR (CI 95%) | Adjusted OR (CI 95%)* |
| **MSM (n) at 200m** | | | | | | | | |
| 0 | 187 (75.4) | 61 (24.6) | Reference | | 164 (71.3) | 66 (28.7) | Reference | |
| 1 | 179 (77.5) | 52 (22.5) | 0.89 (0.58; 1.36) | 1.26 (0.58; 2.73) | 167 (72.6) | 63 (27.4) | 0.94 (0.62; 1.41) | 1.51 (0.71; 3.20) |
| ≥2 | 226 (74.6) | 77 (25.4) | 1.04 (0.71; 1.54) | 2.78 (1.02; 7.56) | 154 (74.0) | 54 (26.0) | 0.87 (0.57; 1.33) | 3.05 (1.16; 8.03) |
| ***p*** | **0.734** | | | | **0.814** | | | |
| **FFR (n) at 200m** | | | | | | | | |
| 0 | 98 (74.2) | 34 (25.8) | Reference | | 81 (73.0) | 30 (27.0) | Reference | |
| 1-3 | 157 (74.4) | 54 (25.6) | 0.99 (0.60; 1.63) | 0.70 (0.33; 1.53) | 156 (71.6) | 62 (28.4) | 1.07 (0.64; 1.79) | 0.64 (0.30; 1.35) |
| 4-6 | 148 (82.2) | 32 (17.8) | 0.62 (0.36; 1.08) | 0.23 (0.08; 0.72) | 98 (74.8) | 33 (25.2) | 0.91 (0.51; 1.62) | 0.21 (0.07; 0.62) |
| >6 | 189 (73.0) | 70 (27.0) | 1.07 (0.66; 1.72) | 0.41 (0.13; 1.27) | 150 (72.1) | 58 (27.9) | 1.04 (0.62; 1.75) | 0.35 (0.11; 1.04) |
| ***p*** | **0.135** | | | | **0.925** | | | |
| **Parental Education** | | | | | | | | |
| Until 6th year | 137 (71.7) | 54 (28.3) | Reference | | 102 (78.5) | 28 (21.5) | Reference | |
| Until 9th year | 123 (73.2) | 45 (26.8) | 0.93 (0.58; 1.48) | 1.26 (0.58; 2.73) | 86 (67.7) | 41 (32.3) | 1.74 (0.99; 3.04) | 1.04 (0.57; 1.89) |
| Secondary School | 158 (79.0) | 42 (21.0) | 0.67 (0.42; 1.07) | 0.81 (0.42; 1.57) | 137 (69.2) | 61 (30.8) | 1.62 (0.97; 2.72) | 0.68 (0.36; 1.28) |
| College | 171 (78.4) | 47 (21.6) | 0.70 (0.44; 1.10) | 0.83 (0.44; 1.60) | 137 (69.2) | 61 (30.8) | 1.20 (0.71; 2.02) | 0.74 (0.40; 1.38) |
| ***p*** | **0.232** | | | | **0.130** | | | |
| **Leisure activities** | | | | | | | | |
| Mainly sitting | 181 (77.4) | 53 (22.6) | Reference | | 111 (67.3) | 54 (32.7) | Reference | |
| Mainly standing | 160 (70.8) | 66 (29.2) | 1.41 (0.93; 2.14) | | 62 (67.4) | 30 (32.6) | 0.10 (0.58; 1.71) | |
| Active or very active | 228 (79.4) | 59 (20.6 | 0.88 (0.58; 1.34) | | 287 (76.3) | 89 (23.7) | 0.64 (0.43; 0.96) | |
| ***p*** | **0.065** | | | | **0.044** | | | |
| **Sports Activity** | | | | | | | | |
| No | 333 (74.3) | 115 (25.7) | Reference | | 178 (72.1) | 69 (27.9) | Reference | |
| Yes | 253 (78.6) | 69 (21.4) | 0.80 (0.56; 1.11) | | 303 (73.2) | 111 (26.8) | 0.95 (0.66; 1.35) | |
| ***p*** | **0.173** | | | | **0.754** | | | |
| **Parent's BMI** | | | | | | | | |
| <25 kg/m$^2$ | 152 (84.4) | 28 (15.6) | Reference | | 99 (83.9) | 19 (16.1) | Reference | |
| ≥25 kg/m$^2$ | 204 (69.9) | 88 (30.1) | 2.34 (1.46; 3.76) | 2.44 (1.46; 4.09) | 205 (71.7) | 81 (28.3) | 2.06 (1.18; 3.58) | 2.34 (1.43; 3.81) |
| ***p*** | **0.000** | | | | **0.010** | | | |

*Association of obesity and number of MSM and FFR was adjusted to parent's education and parent's BMI.

# DISCUSSION

The field work was completed walking on streets in the buffer of 400 meters from schools. To walk 400 meters an adult or adolescent take, in average, 5 minutes.[15] However, adolescents should repeat the same route to come back to schools and there's no enough time for so much in a school break. For the distance of 200 meters this would be a possible option. Additionally, from all the analyses we concluded that 200 meter should be the distance to be studied because:

- In the proximity of 400 meter from schools there was a great number of food retailers of the same type, what reduces the probability of adolescents to walk so far if they had so many offer at a shorter distance;
- Associations between the number of food retailers at 200 and 400 were similar.
- At 100 meters there was a large number of schools that did not had any food retailer.

We evaluated all food retailers that sold food in the proximity of schools and not only typical fast food restaurants as many studies on this topic did. In a review of 40 studies about fast food access, 11 studies reported data exclusively on fast food restaurants and the remaining 29 studies, while having separated restaurant analyses, examined a variety of associations using other food (e.g. grocery or convenience stores) or non-food outlets (e.g. exercise facilities or bus stops)[4]. However, most of the retailers near schools, such as, cafeteria, bakery, pastry, bar and snack-bar, also sold a set of foods that could be classified as fast-food. This can have a negative influence in the dietary intake of adolescents that tend to replace the lunch for snacks/fast food, but also by the sale of pastry at a low price, leading to higher intake of sweet food. Some food retailers were difficult to classify because the denomination indicated different types of activities: pastry, cafeteria and restaurant for example.

A large number of food retailers that sold fast food in the proximity of schools was found which is in accordance with other studies. Eighty three percent of the adolescents were exposed to the presence of fast-food or food ready availability, in a cafeteria, bar, snack-bar and typical fast food restaurants in the proximity of their schools. A study in 2010, in New York City found that: at least 25% of schools had a fast food restaurant within 400 meters; high schools had more fast food clustering than elementary schools and, finally, that public

high schools had higher clustering than private counter parts, with 1.25 to 2 times as many restaurants than expected by chance.[45] However, this study only focused fast-food restaurants and not all the food retailers that surrounded schools.

In our study, students at private schools had higher availability to purchase fast-food but had also more opportunity to find fresh products in fruit sellers. A large number of private schools are located in the center of municipality, an area with high density of food retailer's offer of any type. In our study, it also had been proved that schools within the limits of municipality had less fruit sellers than schools at the city center. In other cities, like New York City, the location of public and private schools are related with the socioeconomic level of the population and it is know that among poorer neighborhoods there is more fast food, fewer supermarkets and more convenience stores.[27]

Additionally, a large number of private schools are located in the center of municipality; an area with high density of food retailers' offer of any type, while in New York City the location of public and private schools are related with the socioeconomic level of the population and it is know that among poorer neighborhoods have more fast food, fewer supermarkets and more convenience stores.[27]

In our study it seems that the existence of up to six fast-food and snack retailers in the 200m proximity from schools is determinant to increase energetic consumption, however above this number the energy intake decreased. This fact can be explained by the higher number of food retailers in the proximity of schools and probably means that the existence or not of this kind of retailers could make a difference on food intake nevertheless after a minimum of availability the number of retailers did not promote the intake.
An association was also observed with the presence of vegetable and fruit retailers, being lower the energetic, CH and fat intake when comparing with the absence of vegetable and fruit retailers. However, when the number of vegetable and fruit retailers increases the number of other food retailers get also higher and, being this a crude analysis, it is not possible to understand the real impact of such difference.
Energy and fat intake were also lower for girls that had more than 2 MSM in the proximity of schools, comparing to those that did not had any. This may be associated to the higher facility to purchase fresh fruit when the availability of MSM and VFR in the proximity of 200m from school increased. This association was only statistically different for girls. Similar result was found in a study from Lisbon: a negative association was found between healthy diet and the presence of groceries stores (include in MSM), which are more prevalent in more deprived neighborhoods. This study use data from National Health Sistem.[46]

Most studies have found a healthy diet pattern among those living near markets and supermarkets. [25] [29] In accordance with this results we found a increasing on the KIDMED score with the presence of one or more VFR, what confirm this. Although we found a lower energy intake among adolescents from schools with a higher availability of mini and supermarkets, no clear association was found with nutrients or with Mediterranean Diet. However it is important to notice that if this kind of retailers may improve the availability of healthy foods, also they sold a large set of unhealthy foods and cheaper than in other kind of retailers. In a study from UK that analyze the association between dietary habits of children with 9-10 years old and food retailers in the proximity of houses found that living further away from a supermarket increased portions of fruit and vegetables consumed and living closer to convenience stores was also associated with an increased consumption of crisps, chocolate and white bread. Density of supermarkets was associated with both an increase in vegetable intake and unhealthy food.[25]

Otherwise the presence of 2 or more MSM and 1 or more VFR in the 200 m proximity from schools was associated to lower intake of sweets, when comparing to adolescents with less than 2 MSM and without any VFR.

Considering the total of food retailers in the 200m proximity the score is higher for girls that had more than 10 food retailers comparing to those that had less ($p<0.05$) and was also higher for girls that had 6 or more FFR, normally placed in the center of Porto, a place where the total food retailers per school was higher. In a study from California students with fast-food restaurants near (within 800 meters) their schools consumed fewer servings of fruits and vegetables, consumed more servings of soda, and were more likely to be overweight (odds ratio [OR]=1.06; 95% confidence interval [CI]=1.02, 1.10) or obese (OR=1.07; 95% CI=1.02, 1.12) than were youths whose schools were not near fast-food restaurants, after controlled for student and school-level characteristics.[30] On the other hand, a study from Maine, United Sates, did not found any significant relationships between the proximity or density of food retailers around schools and student obesity risk.[47]

It is important to notice that food intake and nutritional status of adolescents can be influenced by competitive food that is sold in schools' campuses. Previous research has shown that competitive foods are widely available in schools and that many competitive foods are of low nutritional quality and can have a negative impact on the healthfulness of children's dietary intakes, as the decreased intake of fruit and vegetables and increased intakes of total fat and saturated fat.[31] A study from 2011 concluded that students obtained sugar-sweetened beverages in many locations, including school.[47] However, another study

with the same sample of our study, that analysed family and school determinants of overweight in this adolescents, observed that the prevalence of overweight (10.2%) and at risk of overweight (16.5%) was not influenced by type of school, vending machines and number of school canteen meal.[7]

In this work an FFQ was used and this method has some limitations in assessing dietary intake, such as using a predetermined food list that might not be representative of foods eaten by a specific population[48]. Nevertheless, we believe that this possible bias had a very low effect, because this FFQ was validated for the adult population[40 49] and furthermore some food or food groups eaten more frequently by this age group were included in the questionnaire. Moreover, in an open-section, adolescents were also encouraged to list foods eaten at least once per week, which were not in the FFQ. However, the non-validation of the FFQ in adolescents may have led to some bias in the assessment of dietary intake and consequently to misclassification, being expected an overestimation, particularly for fruit and vegetables, which are perceived as healthy and socially acceptable foods[50].

Another limitation of the FFQ is the reliance on participants' recall and the requirement of motivated participants, especially in self-administered questionnaires[48]. Our FFQ was self-administered, but adolescents were given oral instructions to fill it in and were also sent home written instructions, along the questionnaire. Moreover, adolescents completed it with the help of their parents or legal guardians, which may have improved the quality of information. However, the extent to which parents might have influence on overestimating healthy foods (according to what is socially acceptable) and on underestimating unhealthy foods in unknown.

Although the FFQ was filled in with the help of the parents, portion size information was not collected because Willett[48] suggest that to record information on portion size does not substantially improve the assessment of dietary intake, which may be even more relevant in adolescents that may have difficulty in estimating the portions and frequently ignore these questions when questionnaires are self-administered[51].

Apart from the exclusions by total energy intake, we also excluded those participants with an intake of fruit or vegetables equal or higher than 1.5 interquartile deviations. This decision was taken because the expected overestimation in their consumption, related with this method[52]. Moreover, fruit and vegetables intake is assessed by a long list of different items, some of them consumed only seasonally, making the evaluation of their intake more difficult and more prone to be overestimated. Additionally, as they are not energy-dense foods, overestimating them might not be reflected in a high total energy intake so those participants would not be excluded by the criteria of the total energy intake.

We found higher odds of obesity for girls in the presence of MSM in the proximity of 200 meters from schools, comparing to girls with absence of MSM in this proximity. MSM, that includes supermarkets, grocery stores and vegetables and fruits retailers, may be places where adolescents can purchase fresh fruit but also other foods, as snacks, soda, that can contribute to overweight and obesity. Otherwise, the presence of more than 6 FFR seems to have a protective effect on obesity. We know that a school that has more than 6 FFR, have also another food retailers, where adolescents can have better food options. FFR includes typical fast food, cafeteria, bakery, pastry, candy shop and bars and snack-bars, places where adolescents can purchase fast-food, but also good options: bread, milk, etc. Typical fast food restaurants, as McDonald's, Pizza Hut, etc. did not exist in a sufficient number to prove associations (0.46% of total food retailers).

Considering the total number of food retailers, the BMI was lower for girls that had 6 to 10 food retailers in the 200 meters proximity from schools, when comparing to those that had <5 food retailers and more than 10. Having a higher food offer in the proximity of schools seems to be associated to lower values of BMI. This can be explained by the better food offer if the number of food retailers is higher, may be the lowest prices of food due to the greater offer and also the higher number of private schools localized in this areas.
Our study found associations between environment and dietary intake and nutritional status of adolescents what is in concordance with another Portuguese Study that involved 7669 individuals from 143 neighborhoods of Lisbon and that suggests that the type and quality of food retail outlets, and their accessibility, are contextual determinants of diet.[46]

This study has some limitations. The field survey of food retailers was made retrospectively, which leads to loss of information, including the inability to assess establishments that no longer exist. However, this information could not be recovered by other method and this field work was necessary to understand what the activity of some stores was and what kind of food they sold. Other dimensions of the school environment that we did not observe could be important. For example, it would be useful to know whether students were allowed to leave school for lunch, because our observed relationship should be stronger for those youths. It would also be important to understand if adolescents went to each food retailer (asking adolescents or workers of food retailer) and what kind of food they purchase. It would also be useful to test the association with commercialization level of each area of Porto.
This study contributes to better understand the association between food retailers in the proximity of schools and dietary intake and obesity. We analyze different variables, like similarity to Mediterranean Diet, that other studies in this field did not focused.

# CONCLUSION

We found a large number of food retailers in the proximity of schools, mainly in the neighborhood of private schools.

The most frequent type of retailer was Cafeteria/Bakery/Pastry/ Candy Shop/ bar and snack-bar (68.2% of all retailers in the schools neighbor), followed by grocery stores (14.0%) and Kiosk/stationary shops (10.8%). Less frequent were supermarkets (3.3%), vegetables and fruit retailer (1.89%) and typical fast-food restaurants (0.46%).

In our sample, in general, for all kind of food retailers evaluated, the number of retailers in the schools' proximity was not associated with the individual nutritional intake. However adolescents with a higher number of vegetables and fruit retailers or mini and supermarkets in the proximity of schools showed the lowest intake of sweets.

The odds to have overweight were almost threefold among adolescents at schools with two or more mini and supermarkets in the proximity of the school, OR=2.78 (95%CI: 1.02-7.56) in girls and OR=3.05 (95%CI: 1.16-8.03) in boys. In contrary, the odds of overweight decrease with the increase of the number of fast-food and snack retailers in the school proximity. However it is important to note that almost all schools had this kind of retailers in the proximity which makes difficult to understand the true effect of the presence of these establishments.

More research to assess the relationship between food proximity to schools and student dietary practices and obesity is needed.

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# ANEXXE – SCIENTIFIC ARTICLE