Overweight, obesity and food consumption: A cross-sectional analysis of the Portuguese National Health Survey.

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Título: SOBREPESO, OBESIDADE E CONSUMO ALIMENTAR: UMA ANALISE TRANSVERSAL DO INQUÉRITO NACIONAL DE SAÚDE.

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RESUMO

Introdução: A obesidade é um dos maiores desafios de saúde pública do século XXI e Portugal não é uma excepção em relação a este problema de saúde. Factores dietéticos corroboram para a obesidade e para o excesso de peso através do balanço energético; o excesso de ingestão de energia é, sem dúvida, o mais importante factor dietético na relação de ganho de peso e desenvolvimento da obesidade. É difícil medir a quantidade de comida do consumo individual diário e, determinar a ingestão de tipos específicos de alimentos é complicada. A separação dos alimentos em grupos pode ser feita levando em conta suas características físicas, químicas e nutricionais, entre outras possibilidades. A quantidade de alimento que é ingerido a partir de cada grupo de comida pode ter impacto no peso e, além disso, a abordagem do grupo alimentar ingerido pode descrever o comportamento alimentar de forma mais abrangente do que a simples ingestão de nutrientes, pois os nutrientes são consumidos através de alimentos e ocorrem em combinação. Objetivo: O objetivo deste estudo foi examinar a associação entre os grupos de alimentos ingeridos durante as refeições e os lanches com o sobrepeso e a obesidade, numa amostra representativa dos adultos da população Portuguesa, após o controle de actividade física e outros factores intervinientes. **Métodos:** A amostra usada na presente análise inclui indivíduos maiores que 19 anos (n=32644; 15463 homens e 17181 mulheres). Os participantes foram selecionados em sete regiões diferentes de Portugal (NUTS II sub-divisão). Entrevistadores treinados conduziram pessoalmente as entrevistas em cada agregado familiar e obtiveram informações de ordem social e demográficas, estilo de vida e saúde, incluindo informações sobre os grupos alimentares consumidos. Para avaliar a associação entre o consumo de grupos de alimentos e as categorias de índice de massa corporal uma análise de *regressão logística multinomial* foi realizada. Essa análise foi usada para controlar o potencial efeito de confusão de algumas variáveis (informações de cedidas por outro, gênero, idade, escolaridade, renda, tabagismo e atividade

física) e estimar os seus efeitos simultâneos sobre o risco de baixo peso, sobrepeso e obesidade. O peso normal foi considerado como referência e as outras categorias de índice de massa corporal como variáveis dependentes.

Resultados: Após o ajuste para os confundidores de estilo de vida e atividade física, consumo de alimentos, como leite / queijo / iogurte (OR: 0.802 / 95%CI: 0.775-0.833), sopa (OR: 0.74 / 95%CI: 0.72-0.76), peixe (OR: 0.75 / 95%CI: 0.73-0.77), salada / legumes (OR: 0.815 / 95%CI: 0.791-0.839) e bolos / chocolate / sobremesas (OR: 0.817 / 95%CI: 0.792-0.843) durante as refeições pareciam reduzir as chances de estar abaixo do peso quando comparados com aqueles que não comeram esses grupos de alimentos. Aqueles que consumiram mais frequentemente leite / queijo / iogurte (OR: 1.115 / 95%CI: 1.084-1.147) e Suco / Néctar (OR: 3.696 / 95%CI: 3.563 - 3.834) em lanches pareciam aumentar as chances de estar abaixo do peso quando comparados com aqueles que não o fizeram. Ainda assim, observou-se que o consumo de grupos de alimentos, como a carne (OR: 1.17 / 95%CI: 1.159-1.18) (OR: 1.226 / 95%CI: 1.212-1.241) e feijão / grãos (OR: 1.212 / 95%CI: 1.202-1.223) (OR: 1.07 / 95%CI: 1.058-1.082) durante as refeições aumentaram as chances de se tornar obesos ou com sobrepeso, respectivamente. No entanto, aqueles que consumiram sopa (OR: 0.937 / 95%CI: 0.93-0.945) (OR: 0.796 / 95%CI: 0,788-0.804), peixe (OR: 0.95 / 95%CI: 0.943-0.957) (OR: 0.831 / 95%CI: 0.823-0.839), batata / arroz / massa (OR: 0.811 / 95%CI: 0.802-0.82) (OR: 0.775 / 95%CI: 0.765-0.786), pão (OR: 0.875 / 95%CI: 0.863-0.886) (OR: 0.686 / 95%CI: 0.675-0.697), salada / legumes (OR: 0.899 / 95%CI: 0.892-0.907) (OR: 0.875 / 95%CI: 0.866-0.884), bolos / chocolate / sobremesas# (OR: 0.859 / 95%CI: 0.849-0.869) e leite / queijo / iogurte (OR: 0.933 / 95%CI: 0.923-0.943) (OR: 0.934 / 95%CI: 0.921 – 0.947) nas refeições pareciam menos prováveis de estar acima do peso ou obesos, respectivamente. Além disso, o consumo mais frequente de lanches, como SSB (OR: 1.036 / 95%CI: 1.017-1.056) e Sumo / Néctar (OR: 1.564 / 95%CI: 1,545-1.583) aumentaram as chances de estar acima do peso. No entanto, quem consumiu com maior frequência frutas (OR: 0.979 / 95%CI: 0.971-0.986), pão /

sanduíche (OR: 0.926 / 95%CI: 0.919-0,933), leite / queijo / iogurte (OR: 0.96 / 95%CI: 0,953-0.968), bolos / chocolate / sobremesas (OR: 0.774 / 95%CI: 0.764-0.783), doces (OR: 0,654 / 95%CI: 0,641-0,668) e batatas fritas (OR: 0.351 / 95%CI: 0.341-0.362) em lanches pareceu diminuir as chances de estar acima do peso. Ainda assim, aqueles que consumiram mais frequentemente SSB (OR: 1.165 / 95%CI: 1.136-1.195) e Doces (OR: 1.744 / 95%CI: 1.701-1.789) em lanches mostraram maiores chances de serem obesos. Por outro lado, os indivíduos que consumiam mais frequentemente pão / sanduíche (OR: 0.889 / 95%CI: 0.88-0.899), bolos / chocolate / sobremesas (OR: 0.733 / 95%CI: 0.72-0.747), Sumo / Néctar (OR: 0.934 / 95%CI: 0.916-0.952), outras guloseimas (OR: 0.44 / 95%CI: 0,424-0,456) e batatas fritas (OR: 0.243 / 95%CI: 0.23-0.256) em lanches parecia diminuir o chances de serem obesos.

Conclusão: O presente estudo da população Portuguesa sugeriu que os indivíduos que relataram ter comido carne, feijão / grãos no dia anterior tinham uma probabilidade mais elevada de ter excesso de peso ou obesidade. Por outro lado, o consumo de leite, queijo, iogurte, pão, arroz, batata, massas, sopas, saladas e legumes, hortícolas foi associado com uma menor chance de estar acima do peso ou obesos. Para os grupos alimentares dos lanches, o consumo de SSB eleva as chances de obesidade e sobrepeso. O consumo de leite, queijo, iogurte, pão, sanduíche, fruta, bolos, chocolates, sobremesas foi associado com uma menor chance de estar acima do peso. Além disso, o consumo de pão, sanduíches, batatas fritas, suco / Nectar, bolos, chocolates, sobremesas e outras guloseimas, diminuiu as chances de obesidade. Além disso, a maioria das mulheres com excesso de peso eram aquelas que consumiam mais frutas, leite, queijo, iogurte, e tiveram menor ingestão de doces e SSB em comparação com mulheres obesas e homens com excesso de peso ou obesidade, o que nos leva à hipotetizar que as mulheres com excesso de peso estão mais preocupadas com as escolhas alimentares mais precocemente do que os homens, após o ajuste para possíveis factores confundidores.

Palavras-Chaves: Grupos de alimentos, Obesidade, Sobrepeso, Refeições, Lanches, Ajustamento.

ABSTRACT

Introduction: Obesity is one of the greatest public health challenges of the 21st century and Portugal is not an exception regarding this health problem. Dietary factors influence obesity and overweight through the energy balance pathway; excess energy intake is arguably the most important dietary factor in relation to weight gain and the development of obesity. It is difficult quantifying the amount of food that individuals consume daily and determining the intake of specific food types is intractable. Segregation of food in groups can be made taking into account their physical, chemical and nutritional characteristics, among other possibilities. The amount of food that eaten from each food group can have impact on weight and, in addition, the food group intake approach may describe dietary behavior more comprehensively than the single nutrient intake approach because nutrients are consumed via foods and occur in combination.

Objective: The objective of this study was to examine the association between food intake during meals and snacks and overweight and obesity, in a representative sample of the adult Portuguese population, after controlling for physical activity and other confounding factors.

Methods: The sample used in the present analysis includes all subjects older than 19 years (n=32644; 15463 men and 17181 women). Participants were selected from households distributed in seven regions of Portugal (NUTS II sub-division). Trained interviewers conducted face-to-face interview in each household and obtained information on social and demographic characteristics, lifestyle and health, including information about food groups' consumption. To assess the association between consumption of food groups and BMI categories, multinomial logistic regression analysis was performed. This analysis was used to control the potential confounding effect of some variables (proxy reporting information, gender, age, education, income, smoking status and physical activity) and estimate their simultaneous effects on the risk of underweight, overweight and obesity. The normal weight was considered as reference and other body mass index categories as the dependent variables.

Results: After adjustment for lifestyle confounders and physical activity, consumption of foods, such as milk/cheese/yogurt*(OR: 0.802 / 95%CI: 0.775 – 0.833)*, soup*(OR: 0.74 / 95%CI: 0.72 – 0.76)*, fish*(OR: 0.75 / 95%CI: 0.73 – 0.77)*, salad/vegetables*(OR: 0.815 / 95%CI: 0.791 – 0.839)* and cakes/chocolate/desserts*(OR: 0.817 / 95%CI: 0.792 – 0.843)* at meals seemed to reduce the odds of being underweight when compared with those that did not eat these groups of foods. Those who consumed more frequently milk/cheese/yogurt*(OR: 1.115 / 95%CI: 1.084 – 1.147)* and Juice/Nectar*(OR: 3.696 / 95%CI: 3.563 – 3.834)* at snacks seemed to increase the odds of being underweight when compared with those that did not. Still, it was observed that the consumption of food groups such as meat*(OR: 1.17 / 95%CI: 1.159 – 1.18) (OR: 1.226 / 95%CI: 1.212 – 1.241)* and beans/grains*(OR: 1.212 / 95%CI: 1.202 – 1.223) (OR: 1.07 / 95%CI: 1.058 – 1.082)* at meals increased the odds to become overweight or obese, respectively. However, those who consumed soup*(OR: 0.937 / 95%CI: 0.93 – 0.945) (OR: 0.796 / 95%CI: 0.788 – 0.804)*, fish*(OR: 0.95 / 95%CI: 0.943 – 0.957) (OR: 0.831 / 95%CI: 0.823 – 0.839)*, potato/ rice/ pasta*(OR: 0.811 / 95%CI: 0.802 – 0.82) (OR: 0.775 / 95%CI: 0.765 – 0.786)*, bread*(OR: 0.875 / 95%CI: 0.863 – 0.886) (OR: 0.686 / 95%CI: 0.675 – 0.697)*, salad/ vegetables*(OR: 0.899 / 95%CI: 0.892 – 0.907) (OR: 0.875 / 95%CI: 0.866 – 0.884)*, cakes/ chocolate/ desserts*(OR: 0.859 / 95%CI: 0.849 – 0.869)*[#] and milk/cheese/yogurt*(OR: 0.933 / 95%CI: 0.923 – 0.943) (OR: 0.934 / 95%CI: 0.921 – 0.947)* at meals seemed less likely to be overweight or obese, respectively. In addition, more frequent consumption of snacks such as SSB*(OR: 1.036 / 95%CI: 1.017 – 1.056)* and Juice/Nectar*(OR: 1.564 / 95%CI: 1.545 – 1.583)* increased the odds of being overweight. However, who consumed more frequently fruit*(OR: 0.979 / 95%CI: 0.971 – 0.986)*, bread/ sandwich*(OR: 0.926 / 95%CI: 0.919 – 0.933)*, milk/cheese/yogurt*(OR: 0.96 / 95%CI: 0.953 – 0.968)*, cakes/chocolate/desserts*(OR: 0.774 / 95%CI: 0.764 – 0.783)*, Pastries (*OR: 0.654 / 95%CI: 0.641 – 0.668)* and French fries*(OR: 0.351 / 95%CI: 0.341 – 0.362)* at snacks seemed to decrease the odds of being overweight. Still, those who consumed more

frequently SSB*(OR: 1.165 / 95%CI: 1.136 – 1.195)* and Pastries*(OR: 1.744 / 95%CI: 1.701 – 1.789)* at snacks showed higher chances to be obese. On the other hand, individuals that consumed more frequently bread/ sandwich*(OR: 0.889 / 95%CI: 0.88 – 0.899)*, cakes/chocolate/desserts*(OR: 0.733 / 95%CI: 0.72 – 0.747)*, Juice/Nectar*(OR: 0.934 / 95%CI: 0.916 – 0.952)*, Other goodies*(OR: 0.44 / 95%CI: 0.424 – 0.456)* and French fries*(OR: 0.243 / 95%CI: 0.23 – 0.256)* at snacks seemed to decrease the odds of being obese.

Conclusion: The present study of the general population in Portugal suggested that individuals who reported to have eaten meat, beans/grains in the previous day had a higher odd of being overweight or obese. On the other hand, the consumption of milk, cheese, yogurt, bread, rice, potato, pasta, soups, salads and vegetables was associated with a lower chance of being overweight or obese. For the snacks food groups, consumption of SSB raise the odds of obesity and overweight. The consumption of milk, cheese, yogurt, bread, sandwich, fruit, cakes, chocolates, desserts was associated with a lower chance of being overweight. Furthermore, consumption of bread, sandwiches, French fries, Juice/Nectar, cakes, chocolates, desserts and other goodies, decreased the odds of obesity. In addition, most overweight women were those who consumed more fruits, milk, cheese, yogurt, and had lower intake of pastries and SSB compared with obese women and men with overweight or obesity, which leads us to the hypothesis that overweight women are more concerned with the food choices earlier than men, after adjusting for potential confounders.

Keywords: Food groups, Obesity, Overweight, Meals, Snacks, Adjustment.

INDICE

ABREVIATIONS

NHS – National Health Survey

WHO – World Health Organization

NCDs – Non-Communicable Diseases

OECD – Organization for Economic Co-operation and Development

BMI – Body Mass Index

US – United States

LDL – Low Density Lipoprotein

HDL – High Density Lipoprotein

ATP – Adenosine Triphosphate

NUTS – Territorial Nomenclature Units for Statistical Purpose

INE – National Institute of Statistics

IPAQ – International Physical Activity Questionnaire

SPSS – Statistical Package for the Social Science

UW – Underweight

NW – Normal Weight

OW – Overweight

Obs. - Obesity

MLR – Multinomial Logistic Regression

OR – Odds Ratio

Adj OR – Adjusted Odds Ratio

CI – Confidence Interval

SSB – Sugar Sweetened Beverage

Kg – Kilogram

m - Meters

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1. INTRODUTION

Obesity is one of the greatest public health challenges of the 21st century (Figure I). Until 1980, fewer than one in ten people were obese, but obesity prevalence has tripled in many countries of the WHO European Region since then and the numbers of those affected continue to rise at an alarming rate[1, 2]. In 19 of the 34 Organization for Economic Co-operation and Development [3] countries, the majority of the population is now overweight or obese and projections suggest that more than two out of three people will be overweight or obese in some OECD countries by 2020[1-6].

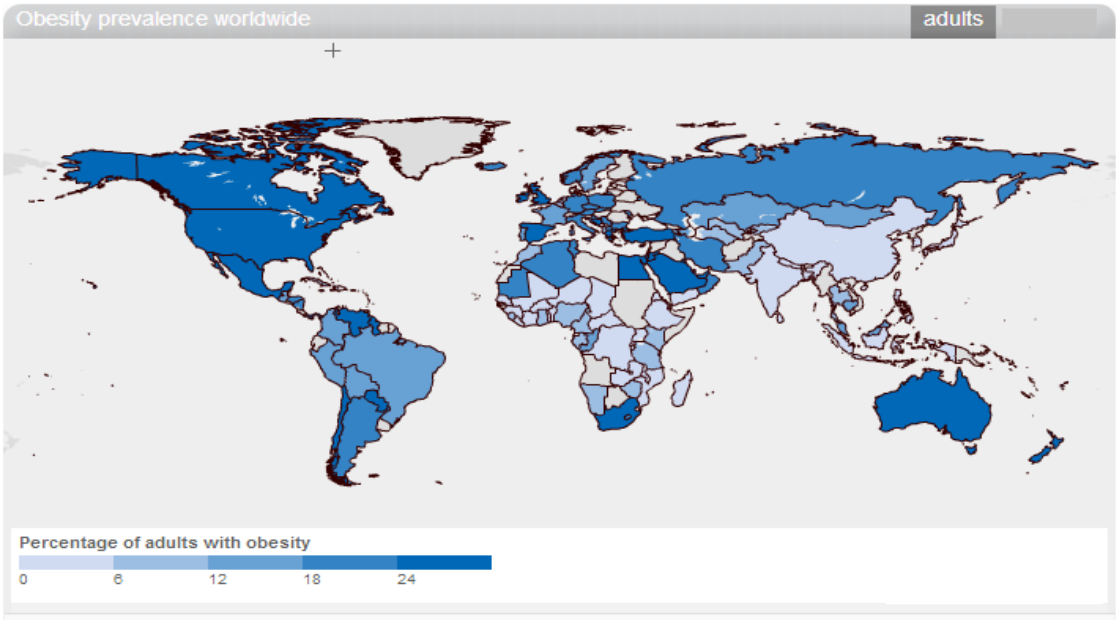

Figure I - Obesity Prevalence Worldwide Map[7]

Portugal is not an exception regarding this health problem (Figure II). In this country, several regional studies included objective assessment of obesity. Two nationwide health surveys provided self-reported overweight/obesity prevalence for the Portuguese adult population (in those over 19 years of age): the 1995–1996 and the 1998–99 National Health Surveys[8]. In both surveys, data collection was done through face-to-face interview with self-reported weight and height. The most relevant epidemiological finding coming from those two National Health Surveys was the trend found for increase in the overall overweight/obesity

prevalence for both men and women (especially when considering the short period between assessments): from 50.2% (in 1995–1996) to 54.0% (in 1998–1999) for men, and from 44.9% to 46.5% for women[8].

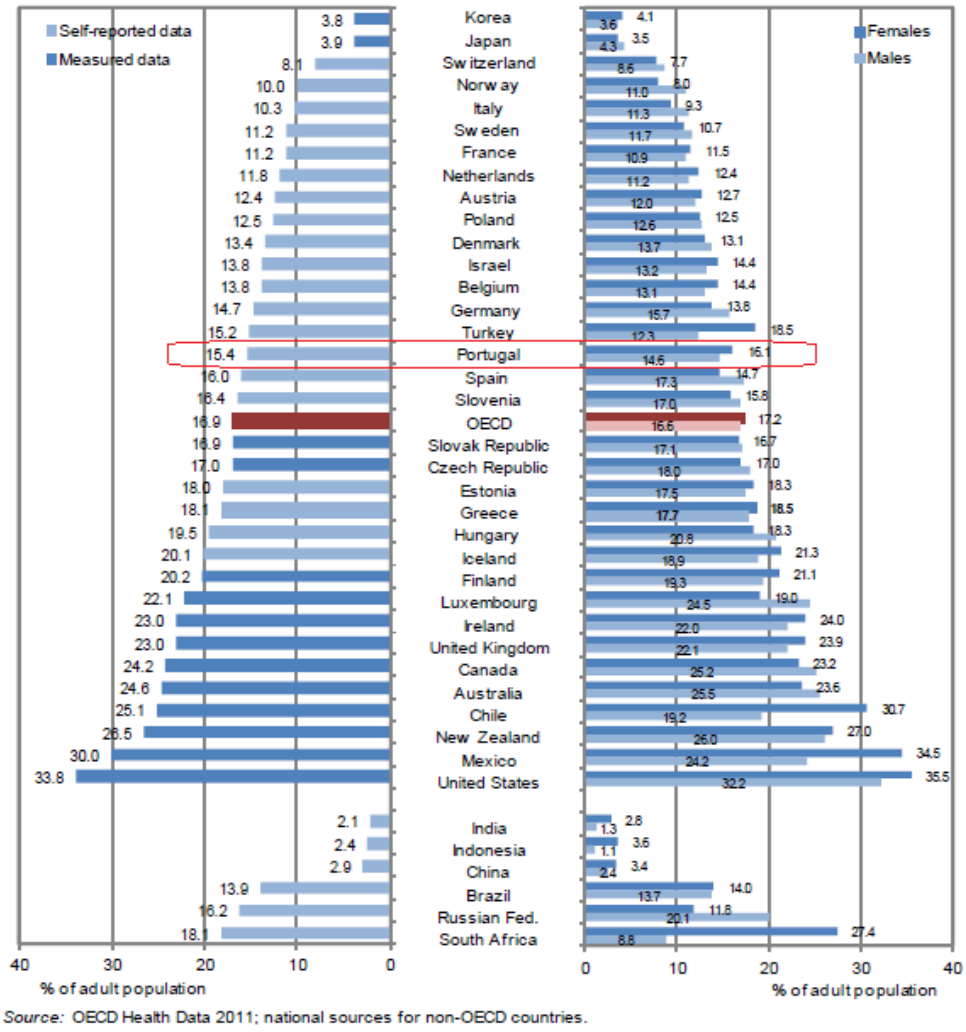

Figure II - Obesity rates among adults – OECD[3].

Furthermore, few large and nationwide representative surveys using objective anthropometric measurements have been reported. The first national representative study with objective measurement of height and weight for assessment of obesity prevalence in adults was conducted between 1995 and 1998[8]. Not surprisingly, it revealed a high prevalence of overweight and obesity in adults between 18 and 64 years of age. Those results highlighted the need to make public health authorities and society in general more aware of this problem[8]. However, Portuguese Society of Nutrition and Food Sciences (SPCNA) [9] has shown in his study that the

prevalence of obesity between 2003-05 and 2009 in the Portuguese adult population reduced from 14.2 to 10.8%. This reduction was observed both for women (13.4 to 10.4%) and men (15.0 to 11.2%). Although the prevalence of obesity seems to be decreasing, overweight is still observed in about half of the Portuguese adults. Furthermore, its proportion may even be increasing in men: while in women the global prevalence of overweight decreased from 47.8 to 38.2%, in men it increased from 60.2 to 64.5%[9].

In addition to causing various physical disabilities, musculoskeletal diseases and psychological problems, excess weight drastically increases a person's risk of developing a number of non-communicable diseases (NCDs), including cardiovascular disease, cancer and diabetes[3]. The risk of developing more than one of these diseases (co-morbidity) also increases with increasing body weight. A high body mass index (BMI) is associated with higher blood pressure and risk of hypertension, higher total cholesterol, LDL cholesterol and triglyceride levels and lower HDL cholesterol levels[10, 11]. The overall risk of coronary heart disease and stroke, therefore, increases substantially with weight gain and obesity. Gall bladder disease and the incidence of clinically symptomatic gallstones are positively related to BMI. There is evidence to suggest increased cancer risk as BMI increases, such as colorectal cancer in men, cancer of the endometrium and biliary passage in women, and breast cancer in post-menopausal women. Obese people are also at increased risk of gout, sleep apnea, obstetric and surgical complications[12].

Obesity is responsible 10 to 13% of deaths in different parts of the European Region and 5% to 10% in the United States[4]. Mortality rates increase with BMI and they are greatly increased above a BMI of 30 kg/m^2. Severely obese people die 8-10 years sooner than those of normal weight, similar to what happens to smokers, with every 15 extra kilograms increasing risk of early death by approximately 30%[3, 12, 13].

Further, obesity is already responsible for 2 to 8% of the direct health costs[3]. Intangible costs (impaired quality of life) have not been estimated, but given the social and psychological consequences of obesity, they are likely to be enormous. The direct costs of obesity are predominantly from treating diabetes, cardiovascular diseases and hypertension. Indirect costs, which are far greater than direct costs, include workdays lost, physician visits, disability pensions and premature mortality, all of which increase as BMI increases[12-14].

1.1 DETERMINANTS OF OBESITY

Obesity is a complex, multifactorial disease that develops from the interaction between social, behavioral, cultural, physiological, metabolic, and genetic factors. However, our understanding of how and why obesity occurs is incomplete.

Many researchers have focused their concerns over this growing epidemic on the underlying factors that may support an "obesogenic environment" in westernized countries[15]. Although the increased availability and purchasing of high energy food should certainly promote weight gain, it may be that this does so through an interaction with *obesogenic* lifestyle choices that facilitate increased consumption. Evidence is emerging that links prominent behavioral patterns in the Western world - such as a tendency toward sleep deprivation, screen time exposure (television watching, for example) and excessive alcohol consumption - to increased sensitivity to food and adiposity[3, 10, 15-17].

Egger [18] has suggested that the format for identifying potential nutritional causes of obesity at a population level is based on the Epidemiological Triad where the 'hosts' are the general population, the 'vectors' are the foods and nutrients and the 'environment' includes the physical, economic, policy and socio-cultural factors external to the individual. Issues were selected based on their relevance to approaches for reducing the burden of obesity at a population level.

The rising epidemic reflects the profound changes in society and in behavioral patterns of communities over recent decades. While genes are important in determining a person's susceptibility to weight gain, energy balance is determined by energy intake and physical activity[3]. Thus, societal changes and worldwide nutrition transition are driving the obesity epidemic. Economic growth, modernization, urbanization and globalization of food markets are just some of the forces thought to underlie the epidemic[14, 17, 18]. As income rises and populations become more urban, diets high in complex carbohydrates give way to diets with a higher proportion of fats, saturated fats and sugars[15]. At the same time, a large shift towards less physically demanding jobs has been observed worldwide. This change towards less physical activity is also related with the increasing use of automated transports, technology at home, and more passive leisure pursuits[10, 11, 15].

Still, obesity is more common among the poor and the less educated and women with little education are two to three times more likely to be overweight than more educated women, but smaller or no disparities exist for men[3]. Women are more often obese than men, but male obesity rates have been growing faster than female rates in most OECD countries. Education has been found to be more clearly related to health behavior than either occupation or income. A Norwegian study found that food intake patterns were strongly associated with education in both men and women, whilst the socioeconomic position is important for the development of adult food intake patterns[3, 19-21].

Marques-Vidal et al.[22] analyzed trends of food intake in Portugal among 1987 and 1999, taking into account results from three National Health Surveys. They observed that a small but significant decrease in the average number of daily meals was found, whereas the number of snacks was increasing; where these data might had contributed to the reported increase in the prevalence of overweight and obesity in the Portuguese population. All this modifications may have health implications and an impact on BMI[8, 23].

1.2 FOOD INTAKE AND OBESITY

Overweight and obesity physiologically are the result of positive energy balance when energy intake exceeds energy expenditure. Dietary factors influence obesity through the energy balance pathway; excess energy intake is arguably the most important dietary factor in relation to weight gain and the development of obesity. High energy intakes have been associated with higher fat intakes, greater intakes of energy-dense foods, higher intakes of foods providing 'empty calories', lower intakes of foods and nutrients that may have appetite-controlling properties and meal patterns that interfere with the regulation of energy intakes (skipping meal, food components, food items, and minimum quantities required for a breakfast, snack, or lunch or supper for a specific age groups, minimum portion sizes for each meal component, and body weight, body composition, physical fitness)[24, 25].

Given the importance of energy balance to the risk of obesity, the current lack of high-quality, comparable information on energy intake in the WHO European Region limits the feasibility of evaluating relevant dietary patterns. Nationally representative and comparable dietary data of good quality need to be available for all countries in the European Region, as a basis for advice and the evaluation of dietary policies. Of the dietary factors discussed, the high proportion of energy obtained from fat in many European countries may be the most striking. For most countries, fruit and vegetable intake is below recommended levels, which is unfavorable for the energy density of the diet[26].

The increased supplies in some countries may indicate a higher consumption of processed fruit or vegetable extracts, such as juices and syrup concentrates, which usually have a higher energy density than the less processed fresh alternatives. In addition, as fibre intake is also low throughout the Region, consumption of more satiating foods – for example, wholegrain foods – should be encouraged as an additional measure to reduce the energy density of the diet. SSB have made inroads into the diet, as shown by the

significant increases in the consumption of soft drinks in many countries. To prevent obesity, efforts are therefore needed to reverse this trend[26].

Although experimental studies are able to show that both energy intake and dietary fat influence body weight change[27, 28], observational studies often found inconsistent results concerning total energy/ macronutrient intake[29, 30]. In contrast to the energy/macronutrient intake approach, the influence of specific foods and food groups on subsequent weight change has also been under investigation[31]. Although some studies found evidence that high energy and high fat food groups such as sweets and meat are related to increases in body weight[32, 33].

Still, it is important understand that daily eating is defined by eating occasions/episodes per day as meals and snacks. Although this is more sociological than a physiological definition, traditional meals are considered to be breakfast, lunch and dinner and snacks are defined as any eating occasion between meals[34-37]. However, a biological distinction between a meal and a snack has been proposed by *Chapelot et al.*[38], who considered that a meal is an eating occasion triggered by an endogenous metabolic signal and a snack is an eating episode during a usual satiety period triggered by food availability. The lack of consensus in definitions make comparisons among data referring to eating frequency and body weight obtained in different settings, impossible or hard to interpret[38].

The daily eating intake is likely to be associated with different food choices as well as lifestyle and socio-economic factors; it may thus be accompanied by changes in dietary quality. Overweight and obese individuals have been found to have different eating habits in comparison with normal-weight individuals, including morning anorexia and consumption of larger food amounts in the afternoon and evening, as well as a lower eating frequency[39].

It is difficult quantifying the amount of food that individuals consume daily and determining the intake of specific food types is intractable, thus posing significant challenges to the investigation of food intake and the development of obesity.

Segregation of food in groups can be made taking into account their physical, chemical and nutritional characteristics, among other possibilities. Usually foods are grouped considering the proportion of macronutrients in their composition. The amount of food that eaten from each food group can have impact on weight [40]. In addition, the food group intake approach may describe dietary behavior more comprehensively than the single nutrient intake approach because nutrients are consumed via foods and occur in combination. Furthermore, nutrient composition and energy density are frequently similar in foods of one food group and allow inferences on nutrient intake[31].

1.2.1 FRUIT AND VEGETABLES

Given the emphasis placed on fruit and vegetables in dietary recommendations, surprisingly few studies have reported the relationship between their consumption and weight change[41]. Fruit and vegetables tend to have low energy density and are high in fibre, which may enhance satiety[41]. Furthermore, most vegetables and fruits, even when prepared without added fats or sugars, are relatively low in calories. Eating them instead of higher calorie foods can help adults and children achieve and maintain a healthy weight[42].

Soup is an awesome example of food on the vegetables group, and its consumption has been pointed out in several studies with the lowest probability of being overweight or obese[20, 43]. A cross-sectional study of Portuguese adults[20] indicated that soup consumption is associated with a low risk of obesity. Furthermore, *Kuroda et al*[43], suggest that the intake of soup was inversely associated with obesity-related physical parameters, such as BMI, waist circumference, and waist-to-hip ratio in Japanese men. In addition, in 842 Portuguese girls aged 5 to 10 years, the

probability of being overweight increased significantly for those with low soup consumption compared to those with high consumption and these studies suggest that the intake of soup reduces the risk of obesity, either in adults and children[44].

The probable weight management benefits associated with fruit and vegetables consumption can be explained, at least partially, by their fibre content and low glycemic index[45]. There is currently particular interest in the glycaemic index of the diet. One small prospective study[46] has reported a positive association between a high glycemic index and weight gain, and experimental studies show that food with a low glycaemic index is associated with increased satiety and short-term reductions in energy intake, but longer-term intervention studies have failed to find differences in weight change on diets with a high or low glycaemic index when other dietary factors are well controlled[46-48]. Still, many epidemiological studies have shown an inverse association between fibre intake and weight gain, and intervention studies also show that a high intake of dietary fibre may assist in losing weight [45, 49].

1.2.2 GRAINS AND NUTS

Grains are a source of nutrients such as iron, magnesium, selenium, B vitamins, and dietary fiber, and besides, moderate evidence indicates that whole-grain intake may reduce the risk of cardiovascular disease and is associated with a lower body weight[42]. Many grain foods contain both whole grains and refined grains and these foods also can help people meet the whole grain recommendation, especially if a considerable proportion of the grain ingredients is whole grains. In addition, Whole grains are consumed either as a single food (wild rice or popcorn) or as an ingredient in foods (cereals, breads, and crackers)[42]. Furthermore, *Martinez-Gonzalez*[50] suggested that tree nuts or peanuts (which actually are legumes) can be a good candidate to prevent obesity and obesity-related metabolic and cardiovascular diseases and the addition of nuts to the usual diet leads to less than predicted increases in body weight or adiposity. Both of

grains and nuts are excellent sources of dietary fiber, essentials oils and proteins.

1.2.3 PULSES GRAINS

Pulses are dry leguminous grains that contain one to twelve edible seeds enclosed in a pod. High in protein, fibre and antioxidants as well as low in fat, they have been established as foods that facilitate health and well-being[51]. Still, pulse grain consumption has focused on the ability for pulses and their components to modulate clinical endpoints such as postprandial and fasting glycaemia, total cholesterol[52]. Moreover, *Marinangeli*[52] suggested that pulses could prove useful as functional foods that modulate biological processes that facilitate obesity, including thermogenesis, postprandial substrate trafficking/ oxidation, visceral adipose deposition and satiety and concluded that pulses could be useful as functional foods and food ingredients that combat obesity.

1.2.4 DAIRY PRODUCTS

In recent years there has been some interest in the relationship between the consumption of milk and other dairy products and weight change. It has been hypothesized that dairy products may exert a protective effect on body weight either by calcium binding fat in the gut or by reducing circulating calcitriol and inhibiting lipolysis[26]. Also, choosing low-fat milk products, such as skimmed milk and partly skimmed milk, seems to be a valid strategy to decrease consumption of fatty foods[42].

Several prospective cohort studies have considered the relationship between milk and other dairy products on weight change, but only one has observed a relationship in adults. In a cohort of 17 369 adults in Germany, both men and women, who lost weight over a two-year period reported a higher intake of milk and milk products than those who maintained their weight[26, 31].

1.2.5 FAST FOODS

Fast-food consumption in particular has been associated with poor diet quality and adverse dietary factors related to obesity, including higher intakes of calories, fat, saturated fat, and sugar-sweetened drinks[53]. Eating fast food may lead to overconsumption and increase the risk of obesity in part because of larger portion sizes, high–energy-dense foods, and increased variety and preferred taste of the foods. Further, is associated with higher body mass index (BMI), weight gain, and less successful weight-loss maintenance[53]. The foods in this group are grouped together because they contain important amounts of calories and fat and, with the exception of nuts, contain little protein or carbohydrates. In a free-living context, a decrease in consumption of fat and fatty foods attenuates the weight gain normally observed over time[42]. Dietary fat provides about one third of total energy intake in most high-income countries, and there has been considerable debate on its role in causing obesity because fat is readily stored as body fat with minimal energy costs of conversion[54, 55]. Fat is less satiating than isoenergetic quantities of other nutrients. Today this effect is usually ascribed to the higher energy density of these diets relative to carbohydrate or protein, rather than the fat content per se[56, 57]. Many prospective studies observe that high fat diets are associated with weight gain, while other studies found no association[58].

1.2.5.1 SUGAR-SWEETENED BEVERAGE (SSB)

SSB is defined as a non-alcoholic beverage, carbonated or non-carbonated, that contains added caloric sweeteners. Included in this definition are traditional sodas, sports drinks, energy drinks, fruit-flavored juices (not 100% fruit juice) and nectars. “Diet” drinks, those that contain non-caloric sweeteners such as aspartame, are not included in this definition, nor are coffee and tea drinks[59]. Woodward-Lopez[60] suggested in his study that the currently available evidence is extensive and consistently supports the hypothesis that SSB intake is a risk factor for the development of obesity and has made a substantive contribution to the obesity

epidemic experienced in the USA in recent decades. There has been interest in the consumption of SSB as a specific risk factor for obesity, since experimental studies suggest relatively poor compensation for energy consumed as drinks as opposed to solid food[61]. In short-term intervention studies, energy consumed in liquid form appears to supplement habitual food intake, leading to increases in body weight[62-64]. In addition, other study suggested that the effect of change in liquid calories on weight gain was greater than the effect of changes in calories from solid foods; where SSB were the only source of liquid calories for which change in intake was associated with weight loss[65].

Increases in fruit juice (not 100% fruit juice) consumption were also associated with weight gain[59]. In contrast, increases in so-called low- or no-calorie drinks (100% fruit juice) were associated with a reduction in weight relative to the subjects who decreased their intake of these drinks[26]. A study in Germany showed that men who either gained or lost large amounts of weight had higher intakes of soft drinks than the weight-stable group, but it included a diverse group of beverages including sugar-sweetened drinks, low- or no-calorie drinks containing artificial sweeteners, fruit juice and tap or mineral water[26].

1.2.6 SUGAR, SWEET AND STARCHY FOODS

Bread, pasta, potatoes, rice, pulses and crackers have on starch its main form of carbohydrate[66]. Also starchy vegetables (like corn and sweet potatoes) are inserting into this group because they are higher in carbohydrate than other vegetables and less fiber than other vegetables. All of these foods are grouped together, because the majority of the calories they contain come from carbohydrates, although some of these foods also contain some protein and sometimes fat[40].

Drapeau et al[67] suggest that the associations observed between sugar, sweet and starchy food intakes and some body weight and adiposity indicators are interesting because sweet foods are often rich in fat and this association is due to the combined increase in

fat and sweet intake. Some studies found that the elimination of or a decrease in the consumption of sweets represented one of the eating patterns associated with less body-weight gain or a greater weight loss[32, 68].

1.2.7 PROTEIN FOODS

Protein foods include poultry, beans and peas, nuts, seeds, meats, seafood and fish, meat substitutes (like tofu), eggs, and cheese. These foods are grouped together, because the majority of the calories they contain come from protein. However, items in this group can be high in calories. Also, meat, eggs, and cheeses in particular can be high in saturated fat and cholesterol. However, protein also is found in some foods that are classified in other food groups (e.g., milk and milk products). No association has been observed between protein intake at baseline and subsequent weight change in adults[69, 70]. In experimental studies, protein preloads are associated with reductions in subsequent intake relative to *isoenergetic* quantities of other macronutrients, suggesting that protein may act as a satiety cue[71]. Increases in satiety, which promote improved compliance with a hypo-energetic diet, may in part explain the greater early weight loss associated with an increased proportion of protein in the diet in intervention studies for the treatment of obesity[26].

Consumption of a balanced variety of protein foods can contribute to improved nutrient intake and health benefits. For example, moderate evidence indicates that eating peanuts and certain tree nuts (i.e., walnuts, almonds, and pistachios) reduces risk factors for cardiovascular disease when consumed as part of a diet that is nutritionally adequate and within calorie needs. Because nuts and seeds are high in calories, they should be eaten in small portions and used to replace other protein foods, like some meat or poultry, rather than being added to the diet[42].

1.2.8 WATER

Increasing daily water consumption is widely recognized as a weight loss strategy in the general public, yet there is surprisingly

little data supporting this practice. Epidemiological study suggest that energy intake is significantly lower in water drinkers compared with nonwater drinkers[72]. In addition, Dennis et al[73] suggested that for overweight or obese middle-aged and older adults, consuming ~2 cups of water prior to each of the three main daily meals may increase weight loss when combined with a hypocaloric diet, as compared to a hypocaloric diet alone.

1.3 SOCIOECONOMIC DETERMINANTS AND OBESITY

In the context of European countries, economic development and increased purchasing power have recently changed the food availability situation. On the other hand, socio-cultural influences may contribute, along with economic constraints, to particular food choices, which may explain the still substantial differences in food consumption across European countries. Understanding the influences of socio-economic variables on food consumption may be useful to predict the outcome of interventions, to change food behavior, and generate hypotheses concerning food consumption in diverse circumstances, as well as to explain observations in epidemiological studies[20].

In addition, obesity is more common among the poor and the less educated in most OECD countries and education has been found to be more clearly related to health behavior than either occupation or income[3].

In general, a healthy food intake pattern was related to high socio-economic position. Adherence to a traditional-western food intake pattern determined by high intakes of red meat, sauces and dressings, potato dishes, fast food, rye bread, sweets, snacks, desserts, and sugar sweetened drinks and fruit juice was more common among men with low socioeconomic status - [74], whereas adherence to a green food pattern, with high intakes of raw and cooked vegetables, fresh and dried fruit, poultry, fish, and cereal, was more common among both men and women with high SES [21].

Togo P. et al.[75] found evidence that a food intake indicated by a high score on predefined indices designed to identify a varied diet

high in fruit and vegetables, and low in meat and fat, was associated with a lower BMI. However, the scientific literature has not shown a clear relation between obesity and the intake of energy, macronutrients and specific types of food consumed. More attention has been paid to eating behavior, because this may reflect the joint effect of a number of foods and nutrients, thus increasing the likelihood of finding a link to obesity[76, 77].

1.4 PHYSICAL ACTIVITY

Physical activity is the other side of the calorie balance equation and should be considered when addressing weight management. Indeed, strong evidence supports that participation in physical activity (moderate intensity) also helps people maintain a healthy weight and prevent excess weight gain[42].

Adult maintain a balance between their energy intake and energy expenditure levels, as demonstrated by the constancy of body weight and body composition, and this can be achieved by controlling either energy intake or expenditure[78].

Individuals can change their energy intake by a factor of at least three when adapting it to the expenditure of energy. The opposite possibility of humans adapting energy expenditure to energy intake is often questioned. It has even been stated that the control of energy expenditure is contrary to what the body weight would require in such cases as hyperactivity in anorexics and hypoactivity in obesity[78].

Adaptations in both directions have been shown in studies in which energy intake is either decreased or increased through overeating or undereating, respectively, and studies in which energy expenditure is decreased or increased, through changes in physical activity. This way, an energy expenditure induces increased energy intake, thus compensating for the additional requirement, especially at higher exercise loads[78].

Still, there are two options for reversing the general population trend towards increasing body weight: reducing intake or

increasing physical activity. Preventing overeating by eating less is likely to be the most effective strategy, despite the potential for a negative effect on physical activity when a negative energy balance is reached. There is evidence that physical activity is of importance for weight maintenance, especially for the prevention of weight regains after weight loss. The weight gain observed as a consequence of a change to a more sedentary routine was explained by the absence of an equivalent reduction of energy intake[78].

Decreasing time spent in sedentary behaviors also is important as well. Strong evidence shows that more screen time, particularly television viewing, is associated with overweight and obesity in children, adolescents, and adults. Substituting active pursuits for sedentary time can help people manage their weight and provides other health benefits[42].

Additionally, a more sedentary lifestyle might give more opportunities to eat in our *obesogenic* environment. While activity-induced energy expenditure is similar in subjects with a normal weight and those with a higher body weight, an overweight condition is limiting for high-intensity physical activity and physical performance. The amount of physical activity necessary to successfully maintain a healthy body weight depends on calorie intake and varies considerably among adults, including older adults. Some adults will need a higher level of physical activity than others to achieve and maintain a healthy body weight[42, 78].

However, physical inactivity cannot be the major or sole cause for the increasing prevalence of obesity given that review studies do not show a reduction in the levels of physical activity over the years and food intake is difficult to measure in free-living conditions[79].

Furthermore, a normal weight individual can have a high food intake since he has a higher physical activity, so this relation between body weight and food intake episodes is not simple and we have to take into account the confounding effect of physical

activity. In addition, snacking is more associated with being more sedentary and high meals intake is associated with higher physical activity. However, until now, there are no certainties on causal link because snacking more frequently may lead to low physical activity or low physically active / sedentary individuals may snack more and meals may lead to higher physical activity or a high meal intake may stimulate higher physical activity[80-82].

2. OBJECTIVE

The objective of this study was to examine the association between food intake during meals and snacks and overweight and obesity, in a representative sample of the adult Portuguese population, after controlling for physical activity and other confounding factors.

3. METHODS

The IV-National Health Survey - (NHS) is a community-based cross-sectional study that evaluated a sample of the Portuguese population, representative at the national and regional (NUTS II— Territorial Nomenclature Units for Statistical Purposes, level II) levels, obtained through complex stratified and cluster sampling. People living in collective residential institutions at the time of recruitment (e.g. hotels, hospitals and military facilities) were not eligible. A sample of households was defined, using data from the 2001 Population and Housing Census, to be used as the sampling frame for household surveys conducted by the National Institute of Statistics (INE). It included 1408 geographical units with at least 240 households each, selected systematically within larger geographical strata, with a probability proportional to the number of households in each unit. A random sample of the households (secondary sampling units) was selected, and all subjects living in these households were eligible. The sample size was defined to ensure a homogeneous distribution of the participants by the seven NUTS II regions [*Norte, Centro, Lisboa e Vale do Tejo (LVT), Alentejo, Algarve, Região Autónoma da Madeira and Região Autónoma dos Açores*], and a coefficient of variation not exceeding 15% for subsamples with at least 5% of the population of any of the regions.

Between February 2005 and January 2006, trained interviewers evaluated 41193 subjects, from 15239 households, through computer-assisted personal interviews. This corresponded to a participation of 76% of the selected households. Interviews could not be accomplished in ~7% of dwellings that were not inhabited and in 5% because of refusals to participate.

In addition to the socio-demographic characterization, the questionnaire covered 17 thematic areas. The questions referring to six of these areas were applied only in one of the four trimesters, to ensure that the average duration of the interviews did not exceed 75 min/household. It included questions that were used to obtain information from all participants (either directly or

from a proxy respondent), whereas some of them could not be answered by a proxy.

Trained interviewers conducted face-to-face interviews in each household and obtained information on social and demographic characteristics, lifestyle and health, including information about daily number of meals and snacks and twelve questions related to their intake of core food groups. A quality control was conducted by re-administration (by a different interviewer) of the same questionnaire to 10% of the initial sample, three weeks after the first one.

In the purpose of identifying factors that could be related to food groups consumed during meals and snacks we examined the relationship between food groups consumed during meals and snacks and lifestyle and socio-demographic factors and physical activity.

We did the same analysis to study the association between categories of body mass index and lifestyle and socio-demographic factors, height and physical activity.

Participants:

The sample used in the present analysis includes all subjects older than 19 years (n=32644; 15463 men and 17181 women), with information on the key variables.

Anthropometric Measures:

Participants were asked to report their weight and height.

BMI (Body Mass Index) was calculated as weight (in kilograms - Kg) divided by the square of height (in meters - m). Subjects were categorized according to their BMI as[83]:

Underweight (< 18.5 kg/m^2);

Normal weight (18.5 kg/m$^2 \leq$ BMI < 25.0 kg/m^2);

Overweight (25.0 kg/m$^2 \leq$ BMI < 30.0 kg/m^2) and

Obese (≥ 30.0 kg/m^2).

Education:

Respondents were asked to provide information about whether they had attained further education since leaving school and, if so, the highest qualification completed and was subsequently classified into four levels of education: less than 5 years, 5-9 years, 10-12 years and more than 12 years.

Income:

Respondents were asked to estimate the total income (including pensions, allowances and investments) received by all household members in the last month and to indicate this using a single measure comprising ten narrow-ranged income categories. This measure was subsequently re-coded into four categories according the number of salaries: ≤500 euros, 501-900 euros, 901-1500 euros and more than 1500 euros.

Smoking Habits:

The questionnaire included questions about present and past tobacco consumption. Smoking habits of the participants were defined as smokers (those smoking at least one cigarette per day), non-smokers and former smokers.

Physical Activity Level:

According to the International Physical Activity Questionnaire [84] detailed questions about intensity, duration and frequency of physical activity were noted. Still, according to the guidelines for data processing and analysis of the IPAQ the subjects were then classified in three categories according to their Physical Activity Level[84] in:

High: This category was developed to describe higher levels of participation. Considering that basal activity may be considered to be equivalent to approximately 5000 steps per day, it is proposed that “high active” category be considered as those who move at

least 12,500 steps per day, or the equivalent in moderate and vigorous activities. This represents at least an hour more moderate-intensity activity over and above the basal level of activity, or half an hour of vigorous-intensity activity over and above basal levels daily.

Moderate: This category is defined as doing some activity, more than low active category. Some like “half an hour of at least moderate-intensity PA on most days”

Low: This category is simply defined as not meeting any of the criteria for either previous categories.

Physical activity data was available for only 4561 individuals.

Eating Frequency Assessment - Meals and Snacks:

The questionnaire included questions about daily frequency of meals and daily frequency of snacks episodes separately. Respondents were asked about the number (1, 2 or 3) of main eating episodes - meals - considering meals as breakfast, lunch and dinner. In another question they were asked about the other eating occasions despite meals: “Despite the three main eating episodes (breakfast, lunch and dinner), how many times do you eat during an ordinary day?” and the answer was classified as number of snacks. Total daily eating frequency corresponds to the sum of total daily snacks and meals.

Food Consumption:

Respondents were asked to answer twelve questions related to their intake of core food groups, namely milk, milk products, vegetable soup, meat, fish, vegetables, fruit, bread and starchy foods (pasta/rice/potatoes), soft drinks and juices. The consumption was recorded as a *yes* or *no* answer.

Because data was collected by interviewers within the framework of an epidemiological study not specifically designed to assess quantitative aspects of nutritional and food intake, dietary assessment method used generic classifications in food groups

rather than specifying the variety or species (fish rather than fatty fish or salmon, etc.). Also, the consumption of these food items was determined by asking "For each of the listed food items please indicate those consumed during the day before the interview": (milk, vegetable soup, meat, fish, vegetables, fruit, bread, and starchy foods – pasta, rice and potatoes) and not by quantify the amount ingested.

The core food groups were basically split according their consumption: at meals (*Milk/ Cheese/ Yogurt, Soup, Bread/ Sandwiches, Meat, Fish, Potato/ Rice/ Pasta, Beans, Salad and Vegetables, Fruit, Cakes/ Chocolate/ Desserts*) and as snacks (*Fruit, Bread/ Sandwiches, Milk/ Cheese/ Yogurt, Juice/Nectar, sugar-sweetened beverage (soft drinks), Cakes/ Chocolate/ Desserts, Other goodies, Pastries, French Fries*).

Statistical Analysis

All analyses were conducted using the Statistical Package for the Social Sciences (SPSS) software for windows, version 20.0.

Descriptive analysis was carried out to assess the association of categories of BMI and the consumption of the food groups that make up daily meals and snacks, lifestyle/socio-economic factors.

The Chi-squared (X^2) statistic score was used to analyze the importance of each factor. The statistical significance level was accepted at $P < 0.001$.

ANOVA was used to evaluate the relationship between continuous variables and BMI categories, where the *Bonferroni test* was chosen to examine each other significance. The statistical significance level was accepted at $P < 0.05$.

To assess the association between consumption of food groups and BMI categories, multinomial logistic regression analysis (MLR) was performed. This analysis was used to control the potential confounding effect of some variables and estimate their simultaneous effects on the risk of underweight, overweight and

obesity. The normal weight was considered as reference and other BMI categories as the dependent variables.

Model I (unadjusted) included the food groups consumed in meals and snacks, education and income. *Model II* included *Model I* adjusted for proxy reporting information, gender, age, education, income, smoking status, number of snacks, and number of meals. *Model III* included *Model II* adjusted for physical activity. The choice of possible confounders was based on findings reported in the literature and exploratory statistical analysis. After adjustment the final sample was reduced to 4561 individuals (2400 women).

The *Odds Ratio* (OR) and *adjusted OR* (adj OR) were estimated with 95% *Confidence Interval* (CI). A *P value* of less than 0.05 was considered statistically significant.

4. RESULTS

There were 32644 individuals (17181 women) included in this study.

The population characteristics by gender are presented in *Table I*. From the total data, 70.2% was self-reported and 29.8% was proxy reported information. The distribution of BMI categories was significantly different by gender. Stratified data by gender demonstrated that Prevalence of underweight was 0.9% to men and 3.2% to women, and overweight (42.5%) was more frequent for men than women (33%), while most women were in a range of normal weight (47.1%). Bringing together subjects who were overweight with the obese ones it was observed that there were 57.7% of overweight/obese men against 49.7% of women. Furthermore, it was observed that in the category of obese, women accounted for the majority (16.7%).

The majority of subjects have reported ages between 20 and 34 years (28.4%), less than 5 years of education (45.8%), an income between 501 and 900 euros (29%) and being non-smokers (61.7%). Only 13.5% of the total individuals reported to have more than 12 years of education, mostly women (13.9%). The moderate physical activity level (46.3%) was reported more frequently by individuals in both genders. Also it was observed that women (41.7% low intensity) were not as physically active as men. Furthermore women were older, had fewer years of education (49.2%), had lower income (26.6%) and were less frequently smokers (81.1%) than men.

Most subjects reported 4 or 5 daily eating episodes (58.7%), 3 daily meals (91.3%) and 1 daily snack (37.8%). Women had more frequently total daily eating episodes (6.4%) than men. Most of the men reported not eating any daily snack (37.9%) while the majority of women reported eating one daily snack (38.4%).

Table I – Study population characteristics by gender (percentages)

	Men	Women	*P*
	(n = 15463)	(n = 17181)	
EDUCATION			
< 5 YEARS	42,1	49,2	
5 – 9 YEARS	30,5	23,6	
10 – 12 YEARS	14,3	13,3	
> 12 YEARS	13,1	13,9	<0,001
INCOME			
≤ 500€	20,6	26,6	
501€ – 900€	29,7	28,3	
901€ – 1500€	28,1	25,8	
> 1500€	21,6	19,3	<0,001
AGE (YEARS)			
20-34	30,1	26,9	
35-49	28,5	26,7	
50-64	22,4	22,3	
> 64	19	24,1	<0,001
SMOKERS			
Current	31,8	12	
Never	40,5	81,1	
Former	27,7	6,9	<0,001
BMI (Kg/m^2)			
< 18,5	0,9	3,2	
18,5 - < 25	41,4	47,1	
25 - < 30	42,5	33	
≥ 30	15,2	16,7	<0,001
PHYSICAL ACTIVIY (IPAQ) *			
Low	37,4	41,7	
Moderate	45,5	46,9	
High	17,1	11,4	<0,001
PROXY Reporting Information			
Other	39,2	21,1	
The owner	60,8	78,9	<0,001
FOOD GROUPS INGESTED AT MEALS			
Milk, cheese, Yogurt	80,5	87,2	
Soup	65,9	69,3	
Bread	94,8	91,5	
Meat	83,5	75,9	
Fish	50,5	52,4	
Potato, Rice, Pasta	92,4	88,1	
Beans, Grain	28,3	24,9	
Salad and Vegetables	69,9	73,2	
Fruit	78,8	84	
Desserts, Cakes, Chocolate	27,2	27,6	<0,001
FOOD GROUPS INGESTED AT SNACKS			
Fruit	32,3	45,6	
Breads/ Sandwich	45,9	42,6	
Milk/ Cheese/ Yogurt	27,6	44,7	
Juice/Nectar	12,5	8,9	
Sugar-Sweetened Beverage	4,8	3,5	
Cakes/ Chocolate/ Desserts	9,7	13,3	
Other goodies	2,2	4,3	
Pastries	4,1	2,7	
French Fries	1,8	1,7	<0,001
TOTAL DAILY EATING FREQUENCY			
≤ 3	41,6	31,2	
4 – 5	54,6	62,4	
≥6	3,8	6,4	<0,001
NUMBER OF DAILY MEALS			
1	1	0,9	
2	8,5	7,2	<0,001
3	90,5	91,9	
NUMBER OF DAILY SNACKS			
0	37,9	28,2	
1	37,1	38,4	
2	20,7	26,7	<0,001
≥ 3	4,3	6,7	

***** Data available for 4561 subjects (2161 men and 2400 women)

Regarding meals, women reported more frequent consumption of milk/cheese/yogurt (87.2%), soup (69.3%), meat (75.9%), fish (52.4%), salad/vegetables (73.2%), fruit (84%) and chocolates/cakes/desserts (27.6%) than men. However, men reported higher frequency of consumption of bread (94.8%), potato/rice/pasta (92.4%) and beans/grains (28.3%) than women.

With regard to snacks, men cited a higher frequency of consumption of bread / sandwiches (45.9%), sugar-sweetened drinks (4.8%), confectionery (4.1%) and French fries (1.8%) than women. Moreover, women reported more frequent consumption of fruits (45.6%), milk / cheese / yogurt (44.7%), chocolates / cakes / desserts (13.3%) and other goodies (4.3%) than men.

Table II describes lifestyle and socioeconomic factors according BMI categories and gender.

It was observed that most underweight women had more than 12 years of education (38.3% P<0.001), income above 1500 euros(31.7% P<0.001), aged between 20 and 34 years old (53.4% P<0.001), were non-smokers (70.5% P<0.001), and had low intensity physical activity (54% P<0.001). They also reported more frequent consumption of meat (82.13% P<0.001), potato/rice/pasta (91.59% P<0.001), beans/grain (28.03% P<0.001) and fruit (82.15% P<0.001) at meals. On the other hand, most underweight men have 5 years of education (47.1% P<0.001), an income between 901 and 1500 euros (36.4% P<0.001) and consume more frequently milk/cheese/yogurt (91.76% P<0.001), soup (65.38% P<0.001) and desserts/cakes/chocolate (37.68% P<0.001) at meals.

Regarding snacks, both underweight women and men reported consuming more frequently milk/cheese/yogurt, bread/sandwiches and fruit. The less consumed foods were pastries (3.45% P<0.001) and SSB (7.46% P<0.001) for underweight women, and French fries (0,46% P<0,001) and other goodies (3.34% P<0.001) for underweight men.

Table II – Study population characteristics across BMI categories and gender

	MEN					WOMEN				
POPULATION CHARACTERISTICS	UnderWeight	Normal Weight	OverWeight	Obesity	*P*	UnderWeight	Normal Weight	OverWeight	Obesity	*P*
EDUCATION (YEARS)										
< 5 YEARS	47,10%	33,90%	45,10%	54,80%		28,50%	34,70%	60,80%	70,00%	
5 - 9 YEARS	28,20%	32,80%	30,10%	25,10%		16,60%	27,90%	20,60%	19,40%	
10 - 12 YEARS	11,00%	17,50%	13,00%	9,60%		16,50%	17,60%	10,80%	5,40%	
> 12 YEARS	13,80%	15,70%	11,70%	10,40%	<0,001	38,30%	19,80%	7,80%	5,20%	<0,001
INCOME										
< 500 €	33,00%	20,00%	20,10%	22,50%		23,70%	21,60%	29,20%	35,40%	
501 - 900 €	22,50%	30,80%	29,30%	29,40%		20,40%	27,70%	29,70%	28,90%	
901 - 1500 €	36,40%	26,40%	29,50%	28,10%		24,20%	27,40%	24,80%	24,00%	
> 1500 €	8,10%	22,80%	21,10%	20,00%	<0,001	31,70%	23,30%	16,30%	11,70%	<0,001
AGE (YEARS)										
20 - 34	48,30%	41,00%	24,20%	14,60%		53,40%	37,70%	16,30%	12,70%	
35 - 49	7,00%	25,90%	31,70%	28,00%		16,60%	29,30%	26,20%	22,50%	
50 - 64	8,20%	17,00%	23,40%	35,20%		10,60%	14,40%	29,40%	33,80%	
> 64	36,50%	16,10%	20,70%	22,20%	<0,001	19,30%	18,60%	28,10%	31,00%	<0,001
SMOKERS										
Never	36,70%	40,60%	41,00%	40,00%		70,50%	75,10%	86,80%	88,20%	
Current	36,20%	38,30%	27,80%	23,50%		26,00%	16,60%	7,40%	5,00%	
Former	27,00%	21,00%	31,20%	36,50%	<0,001	3,60%	8,20%	5,70%	6,70%	<0,001
PHYSICAL ACTIVITY (IPAQ)*										
LOW	73,00%	36,50%	35,50%	42,30%		54,00%	40,60%	40,20%	44,50%	
MODERATE	27,00%	44,60%	47,20%	45,00%		31,90%	47,80%	49,10%	43,90%	
HIGH	0,00%	19,00%	17,30%	12,70%	<0,001	14,10%	11,50%	10,70%	11,50%	<0,001
PROXY REPORTING INFO										
THE OWN	41,10%	58,20%	63,20%	67,50%		57,50%	74,40%	85,10%	85,50%	
OTHER	58,90%	41,80%	36,80%	32,50%	<0,001	42,50%	25,60%	14,90%	14,50%	<0,001
FOOD GROUPS INGESTED AT MEALS										
Milk, cheese, Yogurt	91,76%	82,55%	79,02%	78,99%		87,19%	90,06%	85,03%	83,93%	
Soup	65,38%	67,32%	64,08%	68,43%		63,78%	68,26%	71,70%	68,42%	
Bread	87,61%	94,49%	95,62%	94,13%		90,05%	91,62%	91,78%	90,90%	
Meat	74,03%	85,01%	82,80%	81,86%		82,13%	76,54%	75,64%	73,26%	
Fish	51,06%	49,77%	51,64%	51,04%		41,28%	51,52%	53,51%	53,70%	
Potato, Rice, Pasta	93,31%	93,30%	92,08%	91,08%		91,59%	88,92%	88,19%	84,69%	
Beans, Grain	20,14%	27,82%	28,13%	29,54%		28,03%	24,85%	24,69%	23,96%	
Salad and Vegetables	63,93%	68,48%	71,14%	71,24%		71,88%	75,39%	71,88%	70,27%	
Fruit	78,00%	77,05%	79,46%	81,93%		82,15%	84,59%	83,21%	83,38%	
Desserts, Cakes, Chocolate	37,68%	28,67%	26,71%	23,78%	<0,001	29,16%	32,56%	23,12%	22,09%	<0,001
FOOD GROUPS INGESTED AT SNACKS										
Fruit	25,75%	33,22%	32,31%	31,85%		35,30%	45,17%	47,04%	45,77%	
Breads/ Sandwich	57,87%	49,80%	44,22%	39,63%		43,39%	44,48%	42,75%	36,73%	
Milk/ Cheese/ Yogurt	48,39%	31,99%	25,36%	21,49%		47,85%	48,52%	41,58%	40,16%	
Juice/Nectar	12,50%	15,15%	10,89%	10,34%		18,06%	9,73%	8,31%	6,07%	
Sugar-Sweetened Beverage	6,33%	5,73%	3,74%	4,75%		7,46%	3,59%	2,87%	3,51%	
Cakes/ Chocolate/ Desserts	8,84%	11,61%	8,48%	8,38%		13,61%	16,63%	10,19%	10,18%	
Other goodies	3,34%	2,70%	2,14%	1,22%		8,41%	5,36%	3,13%	3,17%	
Pastries	5,56%	4,59%	3,34%	4,95%		3,45%	3,15%	2,21%	2,53%	
French Fries	0,46%	2,74%	1,15%	1,15%	<0,001	4,30%	1,90%	1,37%	1,27%	<0,001

* Data available for 4561 subjects (2161 men and 2400 women)

In turn, the majority of obese men and women had less than 5 years of education (54.8%men and 70%women P<0.001), were aged between 50 and 64 years old (35.2%men and 33.8%women P<0.001). In the case of obese women, it was more frequent to have an income lower or equal to 500 euros (35.4% P<0.001), to be non-smokers (88.2% P<0.001) and only 5.2%(P<0.001) had

more than 12 years of education. Both obese men and women reported more frequent moderate physical activity levels (45%men and 43.9%women P<0.001) than others BMI categories.

Overweight women and men revealed a more frequent consumption of milk/cheese/yogurt (70.02%men and 85.03%women P<0.001), bread (95.82%men and 91.78%women P<0,001), meat (82.8%men and 75.64%women P<0.001), fruit (79.46%men and 83.21%women P<0.001), potato/rice/pasta (92.08%men and 88.19%women P<0.001), soup (64.08%men and 71.7%women P<0.001) and salads/vegetables (71.14%men and 71.88%women P<0.001) than other food groups at meals. Further, overweight women and men reported consuming more frequently milk/cheese/yogurt (25.36%men and 41.58%women P<0.001), bread/sandwich (44.22%men and 42.75%women P<0.001) and fruit (32.31%men and 47.04%women P<0.001) than other food groups at snacks.

Most of the obese men reported having eaten more frequently bread (94.13% P<0.001), potato/rice/paste (91.08% P<0.001), meat (81.86% P<0.001) and fruit (81.93% P<0.001) than other food groups at meals. In addition, obese men reported less frequent consumption of desserts/cakes/chocolate (23.78% P<0.001), fish (51.04% P<0.001) and beans/grain (29.54% P<0,001). It was also observed that obese women reported less frequent consumption of soup (68.42% P<0.001), salad and vegetables (70.27% P<0.001), fruit (83.38% P<0.001), fish (53.7% P<0.001) and milk/cheese/yogurt (83.93% P<0.001) than other food groups at meals.

Obese women and men reported consuming more frequently milk/cheese/yogurt (21.49%men and 40.16%women P<0.001), fruit (31.85%men and 45.77%women P<0.001) and bread/sandwiches (39.63%men and 36.73%women P<0.001) as snacks and whilst less frequently French fries (1.15%men and 1.27%women P<0.001), pastries (4.95%men and 2.53%women P<0.001), SSB (4.75%men and 3.51%women P<0.001) and other goodies (1.22%men and 3.17%women P<0.001) than other food groups as snacks.

The associations between food intake at meals and snacks, and BMI categories, considering the adjustment for confounders in multinomial regression models, are shown in *Table III.*

Model I (unadjusted) included the food groups consumed in meals and snacks, adjusting for education and income. *Model II* included *Model I* variables, and further adjustment for proxy reporting information, gender, age, education, income, smoking status, number of snacks, and number of meals. *Model III* included *Model II,* and was also adjusted for physical activity. After adjustment for physical activity, the final sample was reduced to 4561 individuals (2400 women).

Food groups at meals

After adjustment for lifestyle confounders and physical activity, consumption of foods (Table III – *Model III*), such as milk/cheese/yogurt, soup, fish, salad/vegetables and cakes/chocolate/desserts seemed to reduce the odds of being underweight when compared with those that did not eat these groups of foods.

Focusing on the *Model III*, it was observed that the consumption of food groups such as meat and beans/grains at meals increased the odds to become overweight or obese. However, those who consumed soup, fish, potato/ rice/ pasta, bread, salad/ vegetables, cakes/ chocolate/ desserts and milk/cheese/yogurt at meals seemed less likely to be overweight or obese.

Food groups at snacks

Those who consumed more frequently milk/cheese/yogurt and Juice/Nectar at snacks seemed to increase the odds of being underweight when compared with those that did not.

Table III – Association between BMI categories and food consumption

	MODEL I (UNADJUSTED)			MODEL II			MODEL III		
	OR	95% CI	P	Adj OR	95% CI	P	Adj OR	95% CI	P
Underweight									
MEAL									
Milk, cheese, Yogurt	**1,046**	1,030 1,063	< 0,001	**0,860**	0,846 0,874	< 0,001	**0,803**	0,775 0,833	< 0,001
Soup	**0,924**	0,915 0,935	< 0,001	**0,856**	0,846 0,866	< 0,001	**0,740**	0,720 0,760	< 0,001
Bread	**0,678**	0,667 0,690	< 0,001	**0,721**	0,708 0,733	< 0,001	**1,505**	1,429 1,585	< 0,001
Meat	**0,871**	0,859 0,883	< 0,001	**0,944**	0,931 0,958	< 0,001	**2,409**	2,310 2,513	< 0,001
Fish	**0,761**	0,753 0,770	< 0,001	**0,718**	0,710 0,726	< 0,001	**0,750**	0,730 0,770	< 0,001
Potato, Rice, Pasta	**1,281**	1,257 1,305	< 0,001	**1,465**	1,437 1,494	< 0,001	**1,338**	1,281 1,399	< 0,001
Beans, Grain	**1,102**	1,089 1,115	< 0,001	**1,309**	1,294 1,325	< 0,001	**2,042**	1,985 2,102	< 0,001
Salad and Vegetables	**0,919**	0,908 0,929	< 0,001	**0,861**	0,851 0,871	< 0,001	**0,815**	0,791 0,839	< 0,001
Fruit	**1,098**	1,083 1,113	< 0,001	**1,097**	1,082 1,112	< 0,001	**1,212**	1,173 1,253	< 0,001
Desserts, Cakes, Chocolate	**0,923**	0,912 0,934	< 0,001	**0,901**	0,890 0,912	< 0,001	**0,817**	0,792 0,843	< 0,001
SNACKS									
Fruit	**0,652**	0,645 0,659	< 0,001	**0,603**	0,596 0,610	< 0,001	**0,434**	0,422 0,447	< 0,001
Bread and Sandwich	**0,813**	0,804 0,822	< 0,001	**0,882**	0,872 0,893	< 0,001	**0,526**	0,510 0,542	< 0,001
Milk, cheese, Yogurt	**1,555**	1,537 1,573	< 0,001	**1,273**	1,258 1,288	< 0,001	**1,115**	1,084 1,147	< 0,001
Juice and Nectar	**1,526**	1,504 1,549	< 0,001	**1,556**	1,532 1,580	< 0,001	**3,696**	3,563 3,834	< 0,001
Sugar-Sweetened Beverage	**1,586**	1,553 1,619	< 0,001	**1,702**	1,667 1,739	< 0,001	***1,072***	1,007 1,141	0,030
Cakes, Chocolate and Desserts	**0,670**	0,659 0,681	< 0,001	**0,642**	0,631 0,652	< 0,001	**0,549**	0,522 0,578	< 0,001
Other goodies	**1,722**	1,688 1,757	< 0,001	**1,557**	1,525 1,590	< 0,001	***0,902***	0,844 0,964	0,002
Pastries	**0,913**	0,888 0,938	< 0,001	**0,940**	0,914 0,966	< 0,001	**0,509**	0,472 0,548	< 0,001
French Fries	**1,293**	1,255 1,331	< 0,001	**1,216**	1,179 1,253	< 0,001	**0,326**	0,291 0,367	< 0,001
Overweight									
MEAL									
Milk, cheese, Yogurt	**0,752**	0,748 0,755	< 0,001	**0,825**	0,821 0,829	< 0,001	**0,933**	0,923 0,943	< 0,001
Soup	**0,962**	0,959 0,965	< 0,001	**0,825**	0,822 0,828	< 0,001	**0,937**	0,930 0,945	< 0,001
Bread	**1,217**	1,210 1,225	< 0,001	**1,045**	1,038 1,052	< 0,001	**0,875**	0,863 0,886	< 0,001
Meat	**1,024**	1,020 1,028	< 0,001	**1,129**	1,124 1,134	< 0,001	**1,170**	1,159 1,180	< 0,001
Fish	**1,088**	1,084 1,091	< 0,001	**1,061**	1,058 1,065	< 0,001	**0,950**	0,943 0,957	< 0,001
Potato, Rice, Pasta	**0,935**	0,930 0,941	< 0,001	**0,915**	0,910 0,920	< 0,001	**0,811**	0,802 0,820	< 0,001
Beans, Grain	**1,039**	1,035 1,043	< 0,001	**0,993**	0,989 0,997	< 0,001	**1,212**	1,202 1,223	< 0,001
Salad and Vegetables	**0,977**	0,974 0,981	< 0,001	**0,985**	0,982 0,989	< 0,001	**0,899**	0,892 0,907	< 0,001
Fruit	**1,069**	1,065 1,074	< 0,001	**0,986**	0,982 0,991	< 0,001	***1,014***	1,004 1,023	0,005
Desserts, Cakes, Chocolate	**0,839**	0,836 0,842	< 0,001	**0,929**	0,926 0,933	< 0,001	***0,994***	0,986 1,003	0,170
SNACKS									
Fruit	**1,073**	1,070 1,077	< 0,001	**1,108**	1,104 1,112	< 0,001	**0,979**	0,971 0,986	< 0,001
Bread and Sandwich	**0,978**	0,974 0,981	< 0,001	**0,956**	0,952 0,959	< 0,001	**0,926**	0,919 0,933	< 0,001
Milk, cheese, Yogurt	**0,764**	0,762 0,767	< 0,001	**0,876**	0,872 0,879	< 0,001	**0,960**	0,953 0,968	< 0,001
Juice and Nectar	**0,953**	0,948 0,958	< 0,001	**1,140**	1,134 1,147	< 0,001	**1,564**	1,545 1,583	< 0,001
Sugar-Sweetened Beverage	**0,890**	0,882 0,897	< 0,001	**0,977**	0,969 0,986	< 0,001	**1,036**	1,017 1,056	< 0,001
Cakes, Chocolate and Desserts	**0,734**	0,730 0,738	< 0,001	**0,808**	0,803 0,812	< 0,001	**0,774**	0,764 0,783	< 0,001
Other goodies	**0,817**	0,810 0,825	< 0,001	**0,886**	0,877 0,894	< 0,001	***1,022***	1,001 1,043	0,038
Pastries	**0,901**	0,893 0,910	< 0,001	**0,953**	0,944 0,962	< 0,001	**0,654**	0,641 0,668	< 0,001
French Fries	**0,729**	0,720 0,739	< 0,001	**0,749**	0,739 0,759	< 0,001	**0,351**	0,341 0,362	< 0,001
Obesity									
MEAL									
Milk, cheese, Yogurt	**0,757**	0,753 0,761	< 0,001	**0,878**	0,873 0,883	< 0,001	**0,934**	0,921 0,947	< 0,001
Soup	**1,007**	1,003 1,012	0,002	**0,810**	0,806 0,814	< 0,001	**0,796**	0,788 0,804	< 0,001
Bread	**1,024**	1,016 1,032	< 0,001	**0,813**	0,807 0,820	< 0,001	**0,686**	0,675 0,697	< 0,001
Meat	**0,929**	0,924 0,934	< 0,001	**1,143**	1,137 1,150	< 0,001	**1,226**	1,212 1,241	< 0,001
Fish	**1,045**	1,041 1,050	< 0,001	**1,056**	1,052 1,061	< 0,001	**0,831**	0,823 0,839	< 0,001
Potato, Rice, Pasta	**0,757**	0,752 0,762	< 0,001	**0,760**	0,755 0,765	< 0,001	**0,775**	0,765 0,786	< 0,001
Beans, Grain	**1,060**	1,055 1,065	< 0,001	**1,019**	1,014 1,024	< 0,001	**1,070**	1,058 1,082	< 0,001
Salad and Vegetables	**0,945**	0,940 0,949	< 0,001	**0,947**	0,942 0,951	< 0,001	**0,875**	0,866 0,884	< 0,001
Fruit	**1,231**	1,224 1,238	< 0,001	**1,108**	1,102 1,115	< 0,001	**1,052**	1,038 1,065	< 0,001
Desserts, Cakes, Chocolate	**0,754**	0,750 0,758	< 0,001	**0,892**	0,888 0,897	< 0,001	**0,859**	0,849 0,869	< 0,001
SNACKS									
Fruit	**1,127**	1,122 1,132	< 0,001	**1,115**	1,110 1,120	< 0,001	***0,995***	0,986 1,005	0,364
Bread and Sandwich	**0,769**	0,765 0,772	< 0,001	**0,765**	0,761 0,769	< 0,001	**0,889**	0,880 0,899	< 0,001
Milk, cheese, Yogurt	**0,771**	0,768 0,775	< 0,001	**0,861**	0,857 0,866	< 0,001	***1,016***	1,005 1,026	0,003
Juice and Nectar	**0,805**	0,799 0,811	< 0,001	**1,124**	1,115 1,133	< 0,001	**0,934**	0,916 0,952	< 0,001
Sugar-Sweetened Beverage	**1,230**	1,217 1,243	< 0,001	**1,447**	1,431 1,463	< 0,001	**1,165**	1,136 1,195	< 0,001
Cakes, Chocolate and Desserts	**0,777**	0,771 0,782	< 0,001	**0,879**	0,872 0,885	< 0,001	**0,733**	0,720 0,747	< 0,001
Other goodies	**0,718**	0,709 0,728	< 0,001	**0,789**	0,779 0,800	< 0,001	**0,440**	0,424 0,456	< 0,001
Pastries	**1,283**	1,268 1,297	< 0,001	**1,434**	1,417 1,452	< 0,001	**1,744**	1,701 1,789	< 0,001
French Fries	**0,717**	0,705 0,730	< 0,001	**0,707**	0,694 0,720	< 0,001	**0,243**	0,230 0,256	< 0,001

OR: Odds Ratio **Adj OR:** Adjusted Odds Ratio **CI:** Confidence Interval

MODEL I: Model Unadjusted.
MODEL II: Model adjusted for proxy reporting information, gender, age, education, income, smoking status, food groups of the meals, food groups of the snacks and vice-versa.
MODEL III: Model adjusted for proxy reporting information, gender, age, education, income, smoking status, physical activity, food groups of the meals, food groups of the snacks and vice-versa.
Normal Weight was used as the reference.

In addition, focusing on the *Model III* (Table III), more frequent consumption of snacks such as SSB and Juice/Nectar increased the odds of being overweight. However, who consumed more frequently fruit, bread/ sandwich, milk/cheese/yogurt, cakes/chocolate/desserts, Pastries, Juice/Nectar and French fries at snacks seemed to decrease the odds of being overweight.

Still, those who consumed more frequently SSB and Pastries at snacks showed higher chances to be obese. On the other hand, individuals that consumed more frequently bread/ sandwich, cakes/chocolate/desserts, Juice/Nectar, Other goodies and French fries seemed to decrease the odds of being obese.

5. DISCUSSION

This study investigated the hypothesis that consumption of food groups at meals and snacks may differ according different categories of BMI. After adjustment for confounders (*Model III* on the Table III) it was observed that the consumption of some food groups at meals, namely meat and beans/grains, increased the odds to become overweight and obese (Normal weight was taken into consideration like standard). This finding may be related to the consumption of regional foods that use beans and grains, but they are also rich in fat, sausages and other processed meats, as in *Traditional Portuguese Foods* for example. *Vergnaud et. al.* [85] suggested that meat intake is positively associated with weight gain during adult life in European individuals, mainly because of its high energy density and fat content. Not convergent to our findings, *Mozaffarian et. al.*[86] suggested that the higher fiber content and slower digestion of these foods (for example beans and whole grains) would augment satiety, and that their increased consumption would also displace other more highly processed foods. However, in the present study no information is provided about the type of ingested cereals. The association between overweight/obesity and the consumption of beans and grains may be related to culinary practices and consumption characteristics of these foods, which may be rich in fat or fatty foods, such as sausages and other processed meats.

With respect to the unexpected association between the consumption of fruit with an increased odd of being obese (*Table III* – Food groups of snacks on the *Model III*), we must take into account that intervention studies are often inconclusive regarding the specific role of this food group in the prevention of overweight and obesity. In addition, other study suggested that in the diet whereby persons who eat more fruits, nuts, vegetables and whole grains would gain less weight over time[86]. Nevertheless, there is lack of evidence that high intake of fruits is associated with higher risk of obesity in adults. On the other hand, these findings could be related to the fact that obese may over-report their food intake

of high social desirable foods (such as fruit), more than their lean counterparts[34, 87, 88]. Some other reasons can be argued to explain this, such as the confounding effects of simultaneous changes in fruit and vegetable intake, the initial body weight and other lifestyle changes (changes in labor effort, PA intensity, changes in time of leisure activities) [89]. Still, One large prospective study has observed that increasing fruit and/or vegetable intake was associated with a reduced risk of major weight gain (≥ 25 kg/m^2) or becoming obese (BMI ≥ 30 kg/m^2)[90]. Another prospective study also found that increased consumption of vegetables was associated with a lower risk of obesity[33].

For the categories of overweight and obese individuals, those who reported consuming milk/ cheese/ yogurt, desserts/ cakes/ chocolates, bread, rice/ potatoes/ pasta, fish, soups and salads/vegetables were less likely to be overweight or obese than those who do not consume these foods. Higher BMI categories have been positively related to consumption of a diet characterized by higher intakes of meats, eggs, fats, and oils[91]. In several studies, inverse associations between dairy consumption and the risk of insulin resistance, the metabolic syndrome, obesity or diabetes were observed [92, 93].

In addition, data *Mozaffarian et. al.*[86] showed that yogurt was also associated with less weight gain. Another study suggested that soup has been advanced as a healthy, inexpensive and traditional way to increase vegetable and vitamin intake and to control weight[88]. Still, dietary patterns with a higher contribution from vegetables and fruits had negative associations with BMI. This seems consistent with the experimental data linking obesity with greater selection of more energy-dense food[94, 95]. According to *Bautista-Castano, I.*[96] study, a food pattern that includes bread was not associated with an increase in weight status, and that consumption of whole-grain bread is more beneficial than refined bread, especially in relation to abdominal fat distribution. However it was not possible to know the type of bread consumed in our study, particularly it was whole bread, since data from the NHS

does not differentiate between the types of foods within each food group.

To the Overweight and Obesity categories, on the *Model III*, it is difficult to explain the findings concerning the reported intake of potatoes/rice/pasta at meals and chocolate/cake/dessert at meals and snacks. It is possible to hypothesize that the lack of information concerning the size of servings consumed, the cooking mode, the ingredients used, if the consumption was associated or not with sauces or as garnishes for meat preparations, as well as the number of times per day that were consumed, may have contributed to this results. Moreover, the study was based on participants' self-reported data on kind of daily meals and snacks eaten, which is known to be influenced by various factors, such as social desirability, so we cannot exclude some classification bias. As obese individuals tend to under-report their eating frequency and energy intake (by 30-50%)[34, 39, 82, 87, 88, 97, 98], it is also possibly the same applies to some food groups, such as french fries, cakes / chocolate / desserts and bread / sandwich. Although these foods are often associated in the literature with a positive probability of being overweight or obese [42, 99, 100], all of them where negatively correlated with the probability of being overweight or obese in our study.

Frequent fish consumption at meals can also help people to decrease meat consumption with a simultaneous reduction in saturated and total fat intake while maintaining an adequate intake of high quality protein and other nutrients[101]. It is believed that a fish-based diet rather than a meat-based diet reduces the risk of obesity and diabetes[102]. Epidemiological studies indicate that ample fish consumption within a nutritionally balanced eating pattern is associated with lower body weight [100, 103].This was also shown by our study that suggested that individuals who consumed more frequently fish at meals were less likely to be overweight or obese.

Still on *Model III*, those who consumed more frequently SSB and Pastries at snacks showed higher chances to be overweight and

obese. According to the study about SSB Consumption and Its link to Obesity in California, Adults who drink soda occasionally (less than one a day) are 15% more likely to be overweight or obese, and adults who drink one or more sodas per day are 27% more likely to be overweight or obese than adults who do not drink SSB[104]. Furthermore, a large longitudinal study examined the association of SSB consumption at the start of the study with weight gain over the ensuing six years, where individuals whose consumption of soft drinks remained stable at one or more per day reported a weight gain of 5.8 kg[105]. Still, SSB provide insignificant nutritional benefit and probably increase weight gain, the risk of diabetes, fractures, and dental caries. Findings from prospective cohort studies conducted in adults, taken in conjunction with results from short-term feeding trials, also support a positive association between soda consumption and weight gain, obesity, or both[106]. Also, A large prospective study among women in the United States showed a significantly greater weight gain among women who increased their consumption of sugar-sweetened drinks from less than 1 to more than 1 serving per day [107]. Consumption of sugar-sweetened beverages such as soda and fruit drinks should be discouraged, and efforts to promote the consumption of other beverages such as water, low-fat milk, and small quantities of fruit juice should be made a priority[106].

Furthermore, pastries can contain a large amount of fat and carbohydrates, which reflects to this group the high energetic potential. Sweet, fatty food groups were associated with snacking and contributed considerably to energy intake. Snacking needs to be considered in obesity treatment, prevention and general dietary recommendations[82]. In general, changes in the consumption of refined or processed foods and liquid carbohydrates or alcohol were positively associated with weight gain, whereas changes in the consumption of unprocessed foods such as whole grains, fruits, nuts, and vegetables were associated with the control of weight gain[86]. Still, overweight and obese individuals show a tendency toward greater liking and selection of energy-dense

foods, which may contribute to development and maintenance of these conditions[108].

In addition, more frequent consumption of snacks (Table III – *Model III*) such as Juice/Nectar increased the odds of being overweight. *Schulze M. B. et al*[107] suggested that consumption of 100% fruit juice was associated with weight gains of smaller magnitude, possibly because these beverages may be consumed in smaller servings than are SSB or in different patterns. Still, A recent prospective cohort of adults in a Mediterranean population found a weak but significant association between weight gain and sweetened fruit juice consumption[109]. However, this finding can be supported by the hypothesis that there was difficulty in differentiating Juice/Nectar and SSB, since individuals may have responded incorrectly to this question. Another possibility is associated with the consumption of this group with other foods.

On the other hand, individuals that consumed more frequently fruit at snacks seemed to decrease the odds of being overweight and obese (Model III). These results support the evidence suggesting that consuming a healthy diet (low in fat and sugar, high in fruit and vegetables) can decrease body weight or prevent body-weight gain over time[31-33, 110]. Fruit can be more easily eaten alone as snacks or desserts, whereas vegetables are often combined with extra kilojoules such as butter, cheese, sauce or gravy, and pastry with a main dish. Also, whole fruit is likely to play a greater role in body-weight changes than are fruit juices. This suggestion is not surprising because whole fruit contains dietary fibre that could have a satiety effect[49, 111]. Some studies showed that an increase in consumption of fruit and vegetables over time was associated with a decrease in body weight[32, 68, 112].

Meanwhile, to food groups of meals on the *Model III* (Table III), the consumption of food such as milk/cheese/yogurt, soup, fish, salad/vegetables and cakes/chocolate/desserts seemed to reduce the odds of being underweight when compared with those that did not eat these groups of foods. However, those who consumed more frequently milk/cheese/yogurt and juice/nectar at snacks seemed

to increase the odds of being underweight when compared with those that did not eat these groups of foods. This finding may be explained by having been used as reference individuals with normal weight for BMI categories.

Also, who consumed more frequently milk/cheese/yogurt at snacks (model III) seemed to decrease the odds of being overweight. Several studies support this finding[86, 92, 93, 113]. Therefore, it is possible to suggest that consumption of SSB could be replaced by the consumption of low-fat milk and yogurt, to help control body weight.

In addition, in this study it was observed that obese individuals more frequently have less than 5 years of education, income lower than 901 euros, aged between 50 and 64 years, were mostly ex-smokers and practiced moderate intensity physical activity. The intensity of physical activity reported by the majority of obese individuals may have been connected with the fact that they are in search of weight loss, under the care and guidance of a professional of healthcare, or possibly a response overrated due to embarrassment. Exercise coupled with a better diet are more effective at controlling weight than either exercise or diet alone[114]. *Mozaffarian* et. al.[86] suggests that the fact of quitting smoking increases weight gain. Given the above suggestion one can only hypothesize that this fact raises the chances of obesity, which corroborates the high percentage of obese former smokers. However, it is very important to emphasize that in this study, factors such as smoking and physical activity practice were considered in the MRL to assess the independent association of food.

The links between education, income and obesity are a burden on individuals and society. The reasons behind the income and educational disparities in obesity rates are complex. The higher cost of fresh products and other nutritious foods is a barrier to healthy eating among poorer families, causing them to gravitate toward cheaper, high-calorie foods that offer limited health benefits[115]. There is general agreement among researchers that

education and income are conceptually distinct, and that they are likely to make separate and unique contributions to health-related outcomes[115-118]. Differences in food choices according to the level of education reflect that more knowledge may influence the perceived relationship between diet and health as well as the perceived outcomes of following a healthy diet[119]. Our study has converged with another survey in Portuguese population that suggested less education and lower income are associated with obesity[8].

From the general perspective of food intake and in relation to the food group of meals, it was possible to observe that overweight women consume more frequently soups, milk, cheese, yogurt, salad and vegetable than obese women or overweight men. This data sustains the hypothesis that women are more concerned about their food and nutritional status at an earlier age than men. Men are beginning to take greater care with their food but only when they already have a tendency for obesity. Still, we must consider the hedonic potential related with food decisions of overweight women, since they can be on nutritional treatment and also because of aesthetic concerns.

Obese and overweight women reported eating more frequently fruit and fish than men of the same BMI categories. Meanwhile, it is noteworthy that overweight men were those who ate more frequently bread, meat and potatoes, rice and pasta than obese men or overweight and obese women.

Interestingly obese men were those who reported consuming more beans and grains. However, a common source of bias in studies on diet and obesity is the misreporting of food intake. 'Social desirability' may influence both what subjects actually eat and what they report eating. Obese individuals tend to under-report their dietary intake[120-123].

It was also observed that overweight women were those who consumed more frequently fruits, milk, cheese, yogurt, with a lower intake of pastries and soft drinks compared with obese

women and men with overweight or obesity. Thus, we hypothesize that some overweight women may be trying to lose weight with nutritional orientation and that they are more concerned about food, nutritional status and health than men. Also, we hypothesize that apparently men take nutritional care only when they become obese. Yet we can see that the care women take with feeding and nutritional status is influenced by fashion and aesthetics.

It´s very difficult to arrive at conclusions about a gold standard eating intake pattern due to the complex physiological, behavioral and sociological factors involved in the intake behavior.

We expect that our results may contribute to overcome or, at least, minimize the risk of overweight / obesity development (gateway to other diseases) and to improve the effectiveness of health professionals involved in the treatment of those diseases.

Because the present cross-sectional study cannot differentiate cause from effect, diet and BMI warrant further investigation, particularly prospective research and intervention studies.

It is too soon to make recommendations, in particular about food groups' intake during the day and about relationship between height and BMI categories, due to the inconsistences of the current studies and the weakness of the controlled feeding trials conducted to date.

6. LIMITATIONS

This investigation is based on a large representative sample of the Portuguese population. However, the current research also included some limitations:

Initially, this is a cross-sectional study and therefore no definitive conclusion can be drawn about causality[34, 39]. For instance, eating more daily snacks can be a cause or a consequence of obesity. The obesity status of these individuals can be related to eating more frequently and controlling energy intake, as they are included in a weight reducing program or can be associated with their frequent energy-dense food intake[82].

Moreover, the study was based on participants' self-reported data on weight, height and kind of daily meals and snacks eaten, which is known to be influenced by several factors, such as social desirability, so we cannot exclude some classification bias. Obese individuals tend to under-report their eating frequency and energy intake (by 30-50%). In the future it is necessary to create mechanism or techniques that can identify a selective underreporting of eating occasions, that influence the total eating episodes frequency[34, 39, 82, 87, 88, 97, 98] and more accurate methods and techniques to identify food intake, under / over reporting and social desirability. Although such bias may have occurred in both genders and in all classes of body mass index, the reported data is very commonly used in epidemiological studies, as we did in this study[34, 124].

Further, the definitions of meal and snack used in this study were the only possible, taking into account the questions included in the Portuguese National Health Survey. Different terminology of intake episodes used in other studies makes comparisons difficult or impossible. The definition of meals and snacks is not consensual and in some studies there is not a distinction between them, which makes cross-study comparisons difficult[99, 125, 126]. Some authors considered a sociological definition[34-36, 99], while others chosen a biological / physiological one[38].

BMI is the most useful population-level measure of underweight, overweight and obesity because it covers all ages of adults and is the same independently of gender. However, we must bear in mind that subjects with the same BMI may not correspond to the same degree of fatness[83]. Also, about the data used to calculated BMI participants were self-reported weight and height. Thus before this, one must consider the difficulty of assuming the actual weight of overweight or obese individuals, the weight may have been underestimated, leading to an important bias, and also the answers about weight and height data by *Proxy*.

In addition, data from the fourth National Health Survey did not provide information about dietary composition, so we cannot observe the relationship between eating frequency and energy intake or dietary intake[34, 88, 127]. The methods for dietary assessment employed generic classifications of food groups, rather than specific varieties or species. Quantitative measures were generally not used, and only a limited number of food items were considered. As a result, we could not estimate the quantity or specific composition of food consumed. The reporting of dietary habits is known to be influenced by personal characteristics.

Howarth et al.[88], found that dietary composition accounts for approximately six times the variance in BMI than eating frequency. Thus, as food choices remain a concern, it is important to address total daily energy intake in order to synchronize it in optimal way with energy requirements[34, 88, 127]. Moreover, in the absence of snacks, meals are more caloric, leading to an increase of total daily energy intake and resulting in weight gain[37].

Lastly, one limitation of the Portuguese National Health Survey is that information on physical activity was only provided for 4561 individuals. This fact decreased the proportions of participants in the regression models.

Despite the results on the impact of food consumption on body weight groups, future researches should include information of energy, quality, quantity, size of groups of food intake at meals

and snacks on each eating occasion. At the same time a standardization of food groups would improve the assessment and impact of consumption of each food group on the BMI. The nutritional and dietary quality of the eating episode may influence total daily energy intake. If this was not taken into account there is the risk of an excessive energy intake, which is associated with weight gain and chronic disease development[128-130].

7. CONCLUSION

The present study of the general population in Portugal suggested that after adjustment for lifestyle, physical activity and socioeconomics confounders, it was observed that individuals who reported to have eaten meat, beans/grains in the previous day had a higher odd of being overweight or obese. On the other hand, the consumption of milk, cheese, yogurt, bread, rice, potato, pasta, soups, salads and vegetables was associated with a lower chance of being overweight or obese.

For the snacks food groups, consumption of SSB raise the odds of obesity and overweight. The consumption of milk, cheese, yogurt, bread, sandwich, fruit, cakes, chocolates, desserts was associated with a lower chance of being overweight. Furthermore, consumption of bread, sandwiches, French fries, Juice/Nectar, cakes, chocolates, desserts and other goodies, decreased the odds of obesity.

In addition, most overweight women were those who consumed more fruits, milk, cheese, yogurt, and had lower intake of pastries and SSB compared with obese women and men with overweight or obesity, which leads us to the hypothesis that overweight women are more concerned with the food choices earlier than men, after adjusting for potential confounders.

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