

MASTER
PUBLIC HEALTH

Eating out of home in the Portuguese Population: patterns of consumption and dietary intake

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M

2021





Dissertação de candidatura ao grau de Mestre em Saúde Pública
apresentada à Faculdade de Medicina da Universidade do Porto e ao Instituto
de Ciências Biomédicas Abel Salazar.

**EATING OUT OF HOME IN THE PORTUGUESE POPULATION:
PATTERNS OF CONSUMPTION AND DIETARY INTAKE**

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Porto, 2021

PREFÁCIO

Esta dissertação foi desenvolvida no âmbito das atividades do Departamento de Ciências da Saúde Pública e Forenses, e Educação Médica, da Faculdade de Medicina e do Instituto de Saúde Pública, da Universidade do Porto e do Grupo de Investigação em Epidemiologia da Nutrição e da Obesidade da Unidade de investigação em Epidemiologia do Instituto de Saúde Pública da Universidade do Porto (EPIUnit/UID-DTP/04750/2013).

O estudo teve por base a utilização de dados do Inquérito Alimentar Nacional e de Atividade Física (IAN-AF 2015-2016), desenvolvido por um Consórcio, envolvendo as seguintes instituições e investigadores: Faculdade de Medicina da Universidade do Porto (Carla Lopes, Andreia Oliveira e Milton Severo), Instituto de Saúde Pública da Universidade do Porto (Elisabete Ramos, Sofia Vilela), Faculdade de Ciências da Nutrição e Alimentação da Universidade do Porto (Duarte Torres, Sara Rodrigues), Instituto Nacional de Saúde Doutor Ricardo Jorge (Sofia Guiomar, Luísa Oliveira), AIDFM- Faculdade de Medicina da Universidade de Lisboa (Paulo Nicola, Violeta Alarcão), Faculdade de Desporto da Universidade do Porto (Jorge Mota), Faculdade de Motricidade Humana da Universidade de Lisboa (Pedro J. Teixeira), SilicoLife (Simão Soares) e Faculdade de Medicina da Universidade de Oslo, Noruega (Lene Andersen). Este projeto contou com o apoio institucional da Direção Geral de Saúde (DGS), das Administração Central do Sistema de Saúde (ACSS), das Administrações Regionais de Saúde, das Secretarias Regionais de Saúde dos Açores e da Madeira e da Autoridade Europeia para a Segurança dos Alimentos. Recebeu financiamento do Espaço Económico Europeu concedido pela Islândia, Liechtenstein e Noruega através do Programa EEA Grants - Iniciativas de Saúde Pública, área dos Sistemas de Informação em Saúde (PT06 - 000088SI3).

Os objetivos científicos desta tese inserem-se ainda no âmbito do projeto *“How we eat, what we eat: a portrait of meal consumption in Portugal”*, coordenado pela Universidade Católica Portuguesa, em colaboração com a Faculdade de Ciências da Nutrição e Alimentação da Universidade do Porto e o Instituto de Saúde Pública da Universidade do Porto e financiado pela Fundação Francisco Manuel dos Santos.

A presente dissertação tem por base um manuscrito no qual colaborei ativamente na definição e operacionalização das hipóteses testadas, na análise e interpretação dos dados e fui ainda responsável pela redação da sua primeira versão:

- I. Silva M, Rodrigues S, Correia D, Rei M, Severo M, Torres D, Torres, Lopes C. Eating location patterns in Portugal: characterization and effect in the dietary intake profile

AGRADECIMENTOS

À Professora Carla Lopes, minha orientadora, pela oportunidade de trabalhar consigo, sendo, para mim, uma referência a nível profissional. Agradeço todos os ensinamentos e críticas construtivas, que incentivaram à melhoria e aperfeiçoamento essenciais para o desenvolvimento deste trabalho.

À Professora Sara Rodrigues pelas suas sugestões e comentários muito pertinentes e enriquecedores. À Daniela pela disponibilidade e pelo seu contributo crucial para a análise estatística.

A toda a equipa do IAN-AF 2015-2016, assim como aos integrantes deste inquérito, uma vez que, os dados recolhidos no projeto foram a base deste trabalho.

Aos meus colegas de mestrado pelo companheirismo e às minhas colegas de trabalho pelo encorajamento e entreaajuda.

A todos os meus amigos que me têm acompanhado e apoiado em tudo o que preciso ao longo dos anos.

Por último, um agradecimento especial à minha família pelo apoio incondicional em todas as fases da minha vida.

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LIST OF ABBREVIATIONS

BMI: Body Mass Index

DALY's: Disability-Adjusted life years

EFSA: European Food Safety Authority

EPIC: European Prospective Investigation into Cancer and Nutrition

GBD: Global Burden of Disease

HECTOR project: Eating Out: Habits, Determinants and Recommendations for Consumers and the European Catering Sector

HEI: Healthy Eating Index

IAN-AF: National Food, Nutrition, and Physical Activity Survey

NCD's: Noncommunicable Diseases

SES: Socio-economic status

UL: Upper intake Level

WHO: World Health Organization

RESUMO

Contextualização

A alimentação integra o nosso quotidiano de forma incontornável e inata. Os hábitos alimentares de uma população refletem a sua identidade social e cultural, estando no centro de interesse político, cultural, económico, ambiental, gastronómico e de lazer. A resposta às questões do que comemos, quando, com quem, onde e porquê tem sofrido mudanças que refletem alterações demográficas e laborais. A transição nutricional que hoje vivenciamos revela um maior consumo de gordura animal, açúcar, e outros cereais refinados e pobres em fibra que, associado a um estilo de vida sedentário, é promotora da obesidade e doenças degenerativas. A par da ocidentalização dos hábitos alimentares portugueses, tem-se observado a tendência crescente para o consumo alimentar fora de casa, comumente associado a uma dieta de pior qualidade, com uma inadequação na ingestão de nutrientes e consumo de alimentos.

Objetivos

Caracterizar as diferenças na ingestão de nutrientes e consumo de alimentos e analisar a qualidade da dieta de padrões de consumo alimentar fora de casa na população portuguesa.

Métodos

Foram incluídos 5005 indivíduos, dos 3 aos 84 anos de idade, avaliados no âmbito do Inquérito Alimentar Nacional e de Atividade Física (IAN-AF) 2015-2016. A ingestão alimentar foi avaliada através de dois questionários às 24 horas anteriores ou diários alimentares de dois dias nas crianças de idade inferior a 10 anos. A quantificação das porções de alimentos teve por base um manual fotográfico desenvolvido para o efeito e a classificação e descrição dos alimentos foram realizadas com recurso ao sistema FoodEx2.

O consumo fora de casa foi definido como a ingestão de alimentos e/ou bebidas fora do domicílio principal, independentemente do local de preparação/confeção dos alimentos e/ou refeições. Foram definidos 4 padrões *a priori* de acordo com o local de consumo nos 2 dias: “Casa” ($\geq 80\%$ das refeições em casa), “Outras casas” ($< 80\%$ em casa e as restantes maioritariamente em casa dos avós, outros familiares ou amigos), “Escola/Trabalho” ($< 80\%$ em casa e as restantes maioritariamente na escola ou local de trabalho) e “Restaurantes/outros locais” ($< 80\%$ em casa e as restantes maioritariamente

em restaurantes ou outros locais). Com o objetivo de avaliar a qualidade da dieta em cada um dos padrões, foi criado um índice de alimentação saudável baseado em recomendações alimentares propostas pela Organização Mundial de Saúde, composto por 9 grupos alimentares pontuados de 1 a 4 de acordo com a distribuição em quartis de consumo. A alimentos considerados saudáveis foi atribuída uma pontuação mais alta sendo que pontuação final variou de 9 a 36 e uma pontuação mais elevada representou maior adequação alimentar.

A distribuição de padrões de consumo alimentar fora de casa foi analisada de acordo com variáveis sócio económicas (sexo, faixa etária, grau de urbanização, nível educacional), e índice de adequação alimentar. A ingestão média de energia, nutrientes e grupos de alimentos foi estimada por padrões de consumo alimentar fora de casa e estratificada por faixa etária e a análise das diferenças na ingestão de nutrientes e consumo de alimentos entre padrões e entre faixas etárias foi realizada através do método ANOVA. Recorreram-se a modelos de regressão linear [coeficientes de regressão (β) e respetivo intervalo de confiança a 95% (IC95%)] para estimar a associação entre a ingestão de nutrientes e consumo de alimentos e padrões de consumo ajustando para sexo, nível educacional e grau de urbanização. Foram usados modelos de regressão logística para estimar a associação entre o consumo de bebidas alcoólicas e padrões de consumo alimentar fora de casa, estratificados por faixa etária (adultos e idosos).

Resultados

Os participantes realizaram a maioria das suas refeições em casa ou na escola nas crianças e adolescentes (26,3% e 18,7%, respetivamente) ou restaurantes nos adultos e idosos (13,9% e 8,3%, respetivamente) total. Nas crianças e adolescentes, o padrão “Escola ou trabalho” foi caracterizado por um maior consumo de “Fruta, hortícolas e leguminosas” e “Cereais e tubérculos”. Os adultos consumiram mais “Carne branca, peixe e ovos”, “Carne vermelha e carnes processadas”, “Bebidas açucaradas” e “Doces”. De uma forma geral, o padrão “Restaurante e outros locais” foi associado a um maior consumo de “Snacks salgados”, “Bebidas açucaradas” e “Carne vermelha e carnes processadas”. Particularmente, os adultos, consumiram mais “Açúcar e mel” e menos “Fruta, hortícolas e leguminosas”. Comparando com o padrão “Casa”, adultos classificados com o padrão “Restaurantes e outros locais”, tinham uma maior probabilidade de consumir bebidas alcoólicas OR=1.73, 95%CI=1.17, 2.56). Comparando com o padrão “Casa”, o padrão “Escola/Trabalho” em crianças foi associado com um score maior do índice de adequação alimentar e o padrão

“Restaurantes e outros locais” com um score menor, em todos os grupos etários. As crianças e adolescentes do padrão “Escola ou trabalho” apresentaram uma ingestão maior de fibra e sódio e os adultos uma ingestão maior de calorias, açúcares livres, fibra, ácidos gordos saturados e sódio. No padrão “Restaurantes e outros locais” verificou-se uma ingestão mais elevada de energia, sódio, gordura, gordura saturada e gordura trans em todos os grupos etários, exceto para as gorduras trans em adolescentes. Os idosos apresentam uma ingestão maior de açúcares livres e gordura fora de casa.

Conclusões

O padrão “Casa” foi o mais prevalente, especialmente em mulheres, idosos e indivíduos de baixo nível educacional. Nas crianças, o padrão “Escola/Trabalho” foi caracterizado por uma dieta mais adequada com um maior consumo de “fruta, hortícolas e leguminosas”, de maior ingestão de fibra, mas também de sódio. Os adolescentes mostraram ter escolhas alimentares menos saudáveis, tanto no padrão “Outras Casas” como no de “Restaurantes e outros locais”. No caso dos adultos, todos os contextos de consumo fora de casa foram associados a uma pior adequação da dieta pelo maior consumo de “snacks salgados”, “doces”, “bebidas açucaradas” e por uma maior probabilidade de consumo de bebidas alcoólicas, nomeadamente no padrão “Restaurantes e outros locais”. Fora do ambiente doméstico, os idosos consumiram mais “carne vermelha”, “snacks salgados” e “bebidas açucaradas”.

Torna-se importante considerar a escola, o trabalho e os restaurantes como os espaços importantes para o desenvolvimento de políticas de saúde relativamente à promoção de hábitos alimentares saudáveis.

Palavras-chave: Consumo alimentar fora de casa; Ingestão alimentar; Padrões Alimentares; Adequação alimentar; Inquérito Nacional

ABSTRACT

Background

Eating is an unavoidable and innate act of our everyday life. A population eating habits are part of their social and cultural identity and are at the centre of political, cultural, economic, environmental, gastronomic and leisure interests. What we eat, when, with whom, where and why are questions that have changed, reflecting social, demographic and labour shifts. The nutritional transition that we experience today is characterized by a higher consumption of animal fat, free sugars and other refined carbohydrates and low in fibre, which associated with a sedentary lifestyle, promotes obesity and degenerative diseases. Alongside the westernization of Portuguese eating habits, there has been a growing trend towards food consumption out of home, commonly associated with a poorer diet quality, with inadequate nutrient intake and food consumption.

Aims

Describe the differences in nutrient intake and food consumption and analyse the diet adequacy of out of home eating location patterns in the Portuguese population.

Methods

The present study included 5005 individuals, from 3 to 84 years old, evaluated in the National Food, Nutrition and Physical Activity Survey (IAN-AF) 2015-2016. Dietary intake was assessed by two 24-hours recalls or food diaries in children under 10 years old. Portion sizes estimation was based on a digital-coloured food picture book and the classification and description of foods was performed through the FoodEx2 system.

Eating out of home was defined as the intake of foods or beverages out of the main home, independently of the local of food or meals preparation. Four *a priori* patterns were defined according to the local of consumption: "Home" ($\geq 80\%$ of meals at home); "Other homes" ($< 80\%$ of meals at home and the remaining ones mainly at other relatives or friend's homes); "School/Work" ($< 80\%$ of meals at home and the remaining ones mainly at school or work) and "Restaurants and other places" ($< 80\%$ of meals at home and the remaining ones mainly at the restaurants/coffee shops or others). With the purpose of assessing the diet adequacy in each pattern, a healthy eating index was created based on World Health Organization recommendations, composed by nine food groups scoring 1 to 4 according to consumption quartiles. Foods considered as healthy received higher scores and final scores ranged from 9 to 26 and a higher score represents a greater dietary adequacy.

The distribution of eating location patterns (“Home”, “Other Homes”, “School or Work”, “Restaurants and other places”) was analysed by socio-economic variables (sex, age group, degree of urbanization, educational level), and healthy eating index. Mean daily intake of energy (in kcal), nutrients (as % of total energy intake, in grams or milligrams) and food groups (in grams) was estimated by eating location patterns, stratified by age group and for both nutrients and food groups, differences between patterns and within age groups were tested using the ANOVA method. To estimate the association between mean intake of energy (in kcal), nutrients (as % of total energy intake, in grams or milligrams) and food groups (in grams), with the eating location patterns, and considering demographic, socio economic and health data, linear regression coefficients (β) and the respective 95% confidence intervals (95%CI) were assessed. The association between the consumption of alcoholic beverages and eating location patterns, stratified by age group (adults and elderly), were evaluated through odds ratios (OR) and the respective 95%CI, from logistic regression models.

Results

Most meals were performed at home (69.1%), or at school in children and adolescents (26.3% and 18.7%, respectively) and at restaurants in adults and elderly (13.9% and 8.3%, respectively). In children and adolescents, “School or Work” pattern was characterized by higher consumption of “fruit, vegetables, and pulses” and “cereals and starchy tubers”. Adults consumed more “white meat, fish, and eggs”, “red and processed meat”, “sugar sweetened beverages” and “sweets”. Globally, the “Restaurants and other places pattern” was associated with higher consumption of “salty snacks”, “sugar sweetened beverages” and “red and processed meat”. Particularly adults consumed more “sugar and honey” and less “fruit, vegetables and pulses”. When compared to “Home”, adults in “Restaurants and other places” had higher odds of drinking alcoholic beverages (OR=1.73, 95%CI=1.17, 2.56). “School or work” pattern was associated with a better diet adequacy in children and “Restaurants and other places” with a worse diet adequacy among all age groups. Children and adolescents had higher intakes of fibre and sodium in the “School or work” pattern. Adults had higher energy, free sugars, fibre, saturated fatty acids and sodium intake. Energy and sodium intake was higher in the “Restaurants and other places” pattern among children, adolescents, and adults as well as the intake of fat, trans fatty acids and saturated fatty acids, except for trans fatty acids in adolescents. The elderly consumed free sugars and fat out of home.

Conclusions

“Home” was the prevailing pattern, more frequent among women, elderly, and individuals of low education. In children, the school pattern was associated with a better adequacy than at home, with higher consumption of “fruits, vegetables, and pulses”, higher fibre intake but also sodium. Adolescents showed a pattern in transition to worse food choices outside the home, in other homes or restaurants, with subsequent worse diet adequacy. As for adults, all eating out contexts were associated with a less adequate diet and higher consumption of “sugar sweetened beverages”, “sweets”, “salty snacks”, and sugar. Also, they had a higher probability of drinking alcoholic beverages in restaurants. Outside the home environment, elderly had a worse diet adequacy and consumed more red meat, sugar, “salty snacks”, and “sugar sweetened beverages”.

It is important to consider schools, workplaces and restaurants as the target spaces to develop health policies regarding the promotion of healthy eating habits.

Keywords: Eating out of home; Dietary intake; Food patterns; Dietary adequacy; National Survey

INTRODUCTION

I. Eating Habits in Portugal

Eating is an unavoidable and innate act of our everyday life. At home, at school or work, on the road or on the street, eating is crucial to live, survive and even socialize. According to the World Health Organization (WHO), adopting a healthy diet throughout the life-course helps to prevent the development of noncommunicable diseases (NCDs) and malnutrition in all its forms(1). In 2019, and according to the Global Burden of Disease (GBD) study, inadequate eating habits were the fifth risk factor that most contributed to the loss of years of healthy life (DALY's) in Portugal(2).

Diet is a modifiable determinant of health and, over time, influenced by social, economic, and demographic factors that shape nutrition and consumption patterns, can change the health profile of a population – a process called nutritional transition(3). Food globalization, regulation on food production and distribution increased the knowledge on nutrition and health sciences and shifted the way the world eats; in Portugal, these changes had greater expression after 1974, with the opening to democracy and global market(4). Before this landmark, Portuguese's diet was considered “poor” since economic resources were short and foods most consumed were bread, potatoes, vegetables, and legumes to the detriment of meat and fish. From 1974 to 2011, Portugal's food profile altered with an increase in energy availability and consumption of most food groups, except for cereals and tubers, pulses and alcoholic beverages(5). In this timeline, the mean available energy increased about 670 kcal per person per day and energy contribution from protein and lipids also raised, 1,9% and 8,0% respectively.

The latest Portuguese Food Balance Sheet (BAP)(6), corresponding to the period between 2012 to 2016, showed that the greatest modifications on food availabilities were respecting to vegetables (+14,4%), fish (-13,4%), alcoholic beverages (-10,9%), milk and dairy products (-7,1%), oils and fats (-5,3%), roots and tubers (+5,2%), meat (-3,5%) and sugar (+2,9%). Comparing these results with the Portuguese Food Wheel, there are deviations regarding daily caloric intake, of 3 834 kcal vs the recommended value of 2 000 kcal. “Meat, fish, and eggs” availability is above the recommendation as opposed to “Fruits” and “Horticultural”, which is below.

In 2017, findings from the National Food, Nutrition, and Physical Activity Survey of the Portuguese General Population (IAN-AF 2015-2016), provided a picture of the national food consumption and related data(7). Until here, no information on individual food habits had been collected since 1980.

Average consumption of “Fruit, vegetables and pulses” is around 312g/day, which does not meet WHO recommendations to consume more than 400g/day; this inadequacy is relevant among 70% of children and adolescents. The elderly consume

significantly more of these foods and alongside with children, have higher consumption of soup(8). Across all age groups, meat is more consumed than fish, a difference that is distinctive in adolescents. Adolescents also have the highest consumption of "Sweets, cakes and biscuits" (90 g/day), "Soft drinks or nectars" (two servings of soft drinks per day), and "Cereals, cereal products and starchy (323 g/day), with breakfast cereals and cereal bars consumption standing out. Alcoholic beverages average consumption is of 340 g/day in men and 100 g/day in women, with wine being the most common drink; among consumers, beer has a higher mean intake(8).

Mean contributions of nutrients to daily energy intake is 19.9% from protein, 46.6% from carbohydrates and 31.4% from fat, with the latter being higher in adolescents (29,6%) and adults (26,3%). About 25% of the population has a free sugars contribution of more than 10% of total energy intake, a prevalence that increases to 40-50% in children and adolescents; these age groups have the lowest fibre intake. Regarding sodium, 63.2% of women and 88.9% of men have an intake above the tolerable upper intake level (UL) and besides table salt, bread and rusks, soup and processed are biggest contributors to this intake.

The nutritional transition that we experience today fits in the degenerative diseases pattern(9), characterized by higher consumption of animal fats, free sugars and other refined carbohydrates low in fibre. Alongside the westernization of Portuguese eating habits, there has been a growing trend towards food consumption out of home and in 2016 about 23% of the Portuguese population did at least one meal out of home(4).

II. Determinants of Out of home consumption

Research on eating out has sought explanations for the development of this phenomenon and the factors that have determined it. Two main justifications are underlined: eating out seen as an instrumental practice inherent to everyday life, of a more economic nature (work, insertion, income); or as leisure, from a more cultural perspective (norms, relationships, socialization) that brings satisfaction to those who take part in it(10).

Since the nineteen eighties, the relationship between the increased expenditure on out of home foods and the shift in family dynamics has been studied, confirming a direct relation between the first, increased income and women's entrance in the labour market. Some authors suggest that eating out emerges as a solution to the desynchronization of a society focused on remunerated work outside home with a consequent disruption of domestic eating habits. Although the common demographic of

those responsible for home food preparation is no longer dominated by women as it once was(11), female are more likely to be involved in home cooking(12)and therefore to find it more difficult to adapt work routines and to see eating out as an advantage in terms of cost benefit. The value attributed to home cooked meals can have an impact on the frequency of eating out and home, as an eating space, has lost its significance when compared to out of home eating locations. Nowadays there is an individualized way of eating, oriented towards the market and distant from family cultures(13).

The main factors related with out of home consumption, furthered discussed, were identified by Janssen H. *et al*(14) according to the Foresight obesity system map(15), – societal influences, food environment, individual activity, socio-economic and demographic differences and food cost (Figure 1).

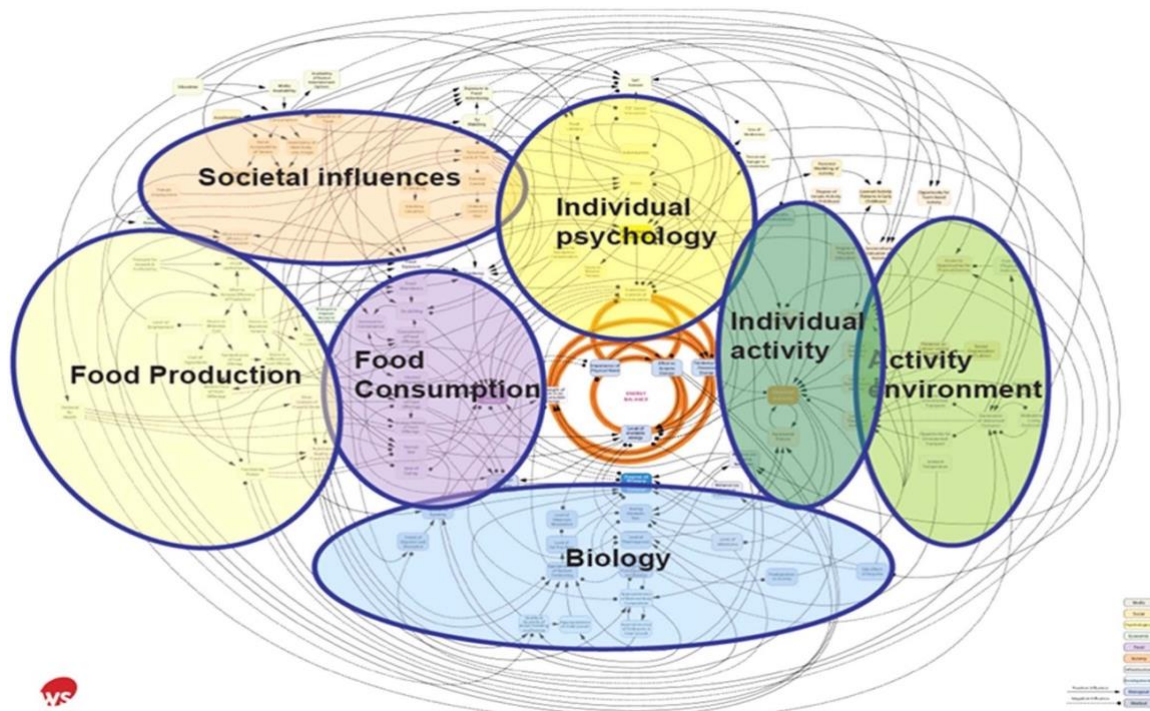


Figure 2- Foresight obesity system map with thematic clusters(14, 16)

1. Societal influences

Societal influences on out of home consumption can be discussed from three different perspectives - food marketing, peers, and social norms.

Food marketing involve the use of various persuasive techniques to influence an individual's food attitudes, preferences, and consumption. Children and adolescents are particularly susceptible and face pressure to eat and drink in very specific ways. Soft drinks and other sugary drinks, chocolates, ready to eat meals, breakfast cereals, and

sweets, cakes and biscuits are the foods most frequently advertised in young individuals(17), which encourages an obesogenic diet culture among them(18). Furthermore, fast food seems to be an important factor, that defines an adolescent's identity(19) and it's a sign of fitting in with peers(20). Eating healthy can be even considered as emotionally and socially risky, and peer pressure assumes a great importance in shaping adolescents' food choices(21).

Peers' influences assume some relevance in late childhood and pre-adolescence(22-24), especially in decision making processes(25, 26) and food consumption choices(27). General theories regarding social norms agree with this since they state that an individual's behaviour can be influenced by perceptions of members of their social group.

Social norms can influence someone's behaviour in different manners(28) and can be classified in injunctive norms – perception of what other group members consider proper behaviour – and descriptive norms – perception of what most groups members do. Children's and adolescents' food choices, taste preferences and eating behaviour are influenced by descriptive norms(29-31). In younger ages, eating is considered a social occasion, and the people they eat with – friends, siblings, family – as well as children's and adolescents' perception of others eating behaviours mould their own preferences and eating behaviours(32). In adolescents, friends eating behaviours, healthy(33) or unhealthy(34, 35) are likely to encourage adolescents to follow the same path. Fitzgerald A. *et al*(36) found that peer support for unhealthy eating was significantly associated with higher intake of unhealthy foods. Siblings' impact on children's and adolescents' eating behaviour is also relevant; however, the scarcity of studies leaves uncertainty in this influence(37). Schools' settings and family environments should be models for healthy eating and active lifestyles. Families have an active role in establishing and promoting healthy eating behaviours that will persist throughout life(38). A recent study using data from IAN-AF 2015-2016, showed that parental education and income have a crucial role in the diet quality of their children(39). Despite their own knowledge on nutrition, parents can be pressured to buy out of home foods, especially foods marketed for children(40). Furthermore, an experimental study with Dutch elderly that aimed to analyse food choices between different socioeconomic groups, found that healthiness was the most important aspect for all participants(41). Taste, price, and travel time to the grocery store were also significant but preparation time was not.

2. Food environment

The food environment has been changing over the last 20 years, with an increase in out of home food establishments. An environment where unhealthy and energy-dense foods are more available and easily accessible can be labelled as “obesogenic” and facilitate the proliferation of obesity. Multiple environmental factors can promote the risk of overweight and obesity such as socio-economic deprivation(42, 43), availability of certain types of food outlets(44, 45), land use mix(46), presence of green spaces(47, 48), and walkability by discouraging physical activity and influencing dietary patterns(49-51).

These environments, have been shown to disrupt an individual's ability to make healthy food choices(52). In Porto, Portugal the availability of fast-food restaurants near residences was associated with higher odds of child obesity. The neighbourhood environment can influence the risk of obesity and, in the same study, neighbourhood socio-economic deprivation and pedestrian access to fast food restaurants partially explained the observed obesity hotspots(53). In the US, neighbourhood exposure to fast food establishments augmented consumption, contributing to a poorer diet(54, 55) and promoted an increase in weight and waist circumference among frequent consumers(56). In Porto, a cross sectional study performed with 3rd and 4th grade students, found that school surroundings were associated with children's obesity and the existence of green spaces in these areas might have a positive influence in behaviours that promote a healthy weight(57).

Some authors do not report relevant associations between neighbourhood availability of out of home foods with higher body mass index (BMI) and greater odds of obesity(58-61); others suggest that dietary inequalities seem to have a stronger influence on the purchasing of takeaway food(60). Aspects such as age group, socio-economic status (SES) and culture are important influences that make impossible to differentiate the cause and effect of these eating behaviours, especially within cross-sectional studies. The food environment is complex, with economic and sociocultural variables potentially influencing food consumption and food-related behaviours (62) constituting an important factor when considering the reasons to eat out of home and the causes of obesity, which are complex and multifaceted(16).

3. Individual activity

Patterns of meal consumption and respective sources have been changing, with a decline in home cooked meals(63-65) and preference for out of home foods(64). According to data retrieved from the 2015-2016 Portuguese household budget surveys, the increasing percentage on expenditures on out of home meals was about 6,9% from restaurants and similar establishments, 0,5% from fast food restaurants (delivered at home or takeaway) and 0,6% from canteens and cafeterias; in this report, expenditures in fast food restaurants were distinguished from overall expenditures in restaurants, cafeterias, and similar establishments(66).

Cooking at home has been associated with being female, married, older, having dependents at home and greater time availability(12). The relationship between socio economic status and home cooking is inconsistent(12, 67) but research has shown that this practice is more common among young adults with higher socio economic status, measured by educational and parent educational attainment and occupational status(68-70) and less common among those with lower socio economic status, in terms of household income(71) and education(72) in men and parental educational attainment in adolescents(73). Working patterns can relate to meal sourcing since among employed parents and individuals with longer working hours or volatile schedules, alternatives to home-cooked meals are preferred due to time pressures(74, 75). A study showed that individuals seeking professional success wanted to avoid spending time and effort clearing up after meals, to create time for other activities(76). Ultimately, time constraints and new advances in technology may contribute to an increase in people's consumption of out of home energy-dense foods(77).

4. Socio-economic and demographic differences

Inequalities in diet and overall health at geographical, ethnical and social levels, have greater impact among those in lower socio- economic groups.

Individuals living in deprived areas are more likely to have a higher number of fast-food establishments in their surroundings and tend to consume cheaper fast-food and unhealthy take- away foods comparing with advantaged individuals(78, 79) . A recent report from the National Obesity Observatory of London(80), revealed a strong association between deprivation and existence of fast food establishments, with deprived areas having more fast food outlets per 100000 of the population. These results support those found in Portugal(81), Germany(82), Canada(83) and the USA(84), where it has

been observed that individuals from poor areas have a higher exposure to fast food outlets than those who do not.

Studies with Australian adults showed that individuals from disadvantaged groups frequently consumed less healthy takeaways foods than those from advantaged groups(78, 85). However, instead of considering SES as a unit, differentiating its indicators is more relevant when considering facets of home cooking. Cooking frequency and associated diet quality may differ based on income(86, 87). Time availability, power purchase of healthy ingredients and the existence of healthy food establishments in nearby residences are aspects that can produce different associations between cooking frequency and diet quality based on income(88). In a study that explored the relation between SES and consumption of home-cooked meals vs meals out of home(71), multiple indicators were used which provided a better insight on the relationship between socioeconomic disadvantaged individuals and consumption of main meals from different sources. Higher SES, measured through educational level and household income, was associated with higher consumption of home-cooked meals and meals out and low consumption of take away meals. Among lower SES individuals, whose income was assessed, it was found a higher consumption of ready-meals and eating takeaway meals was associated with both income and educational level. These results suggest that the prejudicial effects of take-away consumption are not equally perceived among individuals of different SES which can emphasize diet-related health inequalities. If we think on education alone, an aspect that reflects health and nutrition literacy, those highly educated probably have greater capacity to solve problems and are more able to overcome issues when cooking meals at home; also, these individuals might be more exposed to cooking skills training and education on nutritional knowledge, health and food literacy which allows for better diet choices.

Poorer socio-economic groups are unlikely to meet recommendations for dietary intake, specifically in terms of adequate fruit and vegetable consumption, and inadequate higher intakes of fat, salt, and sugar(89). A study from Belgium, showed that all groups, particularly adolescents from less-educated households ate less healthy foods products and more unhealthy foods than the more educated(90). These results are consistent with recent studies among adolescents(91-94) and young adults(95).

Individuals from less active occupational categories, are more likely to have an unhealthy diet, with higher consumption of sugar sweetened beverages and lower consumption of fruits and vegetables(90). On the other hand, additional time spent at work also seems to increase take away meal consumption, particularly among mothers

who work full time that have less time to cook, provide family meals and bring their children to food shopping(96). A study in the UK(97) found interactions between number of hours spent at work and gender; males were less likely to eat out of home per week or month than rarely or never compared with females. Among multi-person households without children, individuals that worked more hours were more prone to get takeaway meals weekly or monthly than rarely or never compared with households with children. Additionally, older adults that worked more hours had higher consumptions of red and processed meat.

Literacy is a determinant of dietary patterns and increased food literacy is positively associated with healthier eating practices(98). Health literacy has been suggested as a stronger predictor of health outcomes than income, education, or occupation, causing health inequalities among high income and low-income countries(14, 99). So, it would be relevant to include an assessment of literacy levels when researching out of home consumption to better understand individual's food choices and behaviours.

The concept of food insecurity is related to the limited access to cheap, quality and nutritious food, alongside with limitations in storing, cooking and consuming those foods(14). In deprived areas, where economic and physical constraints to nutritious food are a constant, individuals are more likely to report out of home consumption of unhealthy foods(100); these conclusions may explain the notion that food insecurity may contribute to purchase of out of home foods. Food insecurity would be an interesting variable to add as a measure of individual SES, by measuring individual's notion of food insecurity and their own perception of how it influences their food choices.

Analysis of out of home food consumption by gender has been done in previous research. Findings from the European Prospective Investigation into Cancer and Nutrition (EPIC) study(101), performed in adults, showed that contributions of out of home foods to total energy intake was higher in men than in women, evidence further found in other studies(102-105). Additionally, Powell, L.M. *et al*(106) concluded that males were more likely to have higher energy intakes from restaurants than females and low-income individuals. Being female was associated with a lower frequency of consuming each of the main meal types from out of home sources and a higher frequency of consuming home-cooked meals(71). This could be partially explained by findings stating that gender is the strongest determinant of time spent cooking at home, a responsibility more common among women(67).

Age is also a relevant factor and a negative association between age and eating out of home has been confirmed by multiple studies performed in European countries(101, 105, 107, 108). In a study from the US(106), young people were more likely to consume higher energy from fast food outlets and in China, older adults were less likely to eat foods out of home(109). Among Dutch elderly(41) of higher education levels, healthiness was valued over price unlike less educated participants. Elderly with higher incomes gave preference to a healthy and very tasteful rather than those with a lower income.

5. Food cost

Low-income individuals report that higher energy-dense foods are cheaper and numerous studies infer that healthy foods and beverages are commonly more expensive than the unhealthy ones(110).

Monsivais P. & Drewnowski A. (111) showed that energy-dense foods were least expensive and more resilient to inflation and a further refinement of this research demonstrated an increasing disparity between the price of nutrient-dense foods and less nutrient-dense foods, for a 4-year time period(112). In the period between 2002 and 2012, a study from the UK confirmed this finding, indicating that healthy foods were approximately three times more expensive than unhealthier ones by 100 kcal(113). In Portugal, researchers found a positive association between household income and most healthy food groups analysed, and people with higher incomes had higher consumption of foods commonly associated with the Mediterranean diet(114). Another Portuguese study stated that greater adherence to the Mediterranean diet was associated with an increase in total dietary cost and associated with higher income groups(115). A systematic review and meta-analysis of about thirty studies concluded that healthier diet patterns were on average about \$1.50/d more expensive(116). Furthermore, a cross sectional study that evaluated the impact of food cost on weight gain showed the low price of fast-food meals and snacks were positively associated with increased weight, particularly among overweight and obese individuals(77).

In spite of some studies not finding statistical evidence that energy dense foods are cheaper than foods in general with no changes over long time periods(110, 117), these may not be universally representative, and alternative researches using the same method, during other time periods, locations, and foods, may provide different findings.

The price of healthy foods might be a barrier to adequate food choices among low-income households(118, 119) (45, 38) and it's aggravated by the fact that out of

home food establishments tend to serve energy dense foods in larger portions, creating a low calorie-to-cost ratio(120). In Brazil, the cost of eating out for one week was higher among individuals that ate traditional meals than those that consume snacks such as soft drinks, fried appetizers, and sweets, with the last being highly consumed among lower income individuals(121). Decreasing prices in healthy foods could promote its inclusion in the diet of low-income individuals, as seen in a Brazilian study(122). In Portuguese elderly, increased eating out expenses were related with a lower diet quality and those who ate more outside, purchased more ready-to-eat foods with lower nutritional value(123).

III. Eating out of home: Perspectives and definitions

Eating out of home is not a new concept, but it has not been the same throughout time. Today, this consumption habit, though traditional, is also related to the modernization and transformation of society and it is not the simple act of consuming lunch or dinner out of home. Besides place of consumption, other aspects have been added such as other eating occasions (breakfast, snacks), the place of food acquisition and place of foods preparation. These modifications came in response to consumers' needs to have more places to have meals, excluding the responsibility only from restaurants and services such as take-away meals, home deliveries, street vendors, among others.

To understand the changes in food consumption in each society, it is important to comprehend how individuals satisfy their food needs, in and out of home. Given the complexity of this analysis, studies on eating out are quite heterogeneous, dealing with topics from food cultures to consumer profiles. An important issue limiting comparisons between studies at an international level is the lack of a common definition of the "eating out of home". Although various definitions arise, the most used are:

1. All foods and/or beverages consumed and/or prepared/cooked out of home(124, 125);
2. All foods and/or beverages consumed out of home, regardless of the place of preparation(108, 126, 127).

In the studies within the HECTOR project, for each eating occasion the place of consumption is reported. Locations, other than the home, includes restaurants, friends' houses, work, canteens, cafeterias, bars, fast food establishments, schools, and other places away from home. The HECTOR Consortium(128) stated the core definition of out

of home eating as meals, beverages, snacks consumed out of home. The majority of studies uses this definition; however, if more detailed data are available, eating out can be redefined:

- meals, beverages and snacks eaten out of home prepared by food services.
- meals, beverages, and snacks prepared by food services and consumed in home.

Lachat C. *et al*(129) and Orfanos P. *et al*(126) have called for the need to use standard definitions for foods prepared and/or consumed out of the home to ensure comparability in future studies and to perceive the impact of eating out from all sources. Standard definitions in research might promote the quality of future studies, improving the body of evidence in its entirety. Our study followed the trend of other European studies and used the cored definition of out of home eating.

IV. Eating out of home and dietary adequacy

Eating out of home has been associated with an impaired diet quality, inadequate nutrient and energy intake and poor food consumption(129). Researchers have pinpointed some issues regarding out of home meals such as large portion sizes, availability of energy dense foods, lack of health literacy among consumers and reduced variety of healthy options(129). A recent systematic review concluded that individuals that consumed more foods prepared out of home had higher intakes of energy, saturated or total fat, sugars, and sodium(130). This is concerning and although commonly a problem of high income regions and countries such as Europe, USA and Australia, nowadays it adds up to the burden of malnutrition in low- and middle-income countries including Brazil(131), Chile(132), India(133), Iran(134) and Malaysia(135).

In Portugal, a survey from Nielsen company reported that when Portuguese eat out of home they choose between casual restaurants (63%), fast-food restaurants (58%), cafes (41%) and formal restaurants (33%), following the trend of the European population; also, 15% of them ordered food to eat at home(4). Results from the HECTOR project, with data retrieved from a Portuguese regional study(136), showed that in men 19.8% of total energy intake came from foods eaten out of home whereas in women it represented 14,5% of total energy intake. The lack of information on specific out of home locations in this study was the reason for limiting the overall HECTOR analyses at the two-level of in- home and out of home.

The substitution of home foods for ultra-processed foods, commonly eaten out of home, can be partly explained by their convenience, large availability, marketing strategies and ease of transportation and storage, which allows the consumption at any place (137-139). Consumption of takeaway meals and food purchased outside home (rather than food prepared at home) was found to be negatively associated with diet quality (54, 140). Out of home foods tend to be less healthy and contain high quantities of unhealthy ingredients (fat, salt, and sugar) which might promote weight gain and a variety of negative health outcomes(141-144). Energy and nutrient intake and types of food groups consumed of those who generally eat out may differ from those who eat mostly at home and studies have shown that individuals who mostly eat out have a poor diet quality and increased energy intake.

Foods eaten out of home encompasses different sources, from restaurants and fast-food outlets to institutional settings such as schools, cafeterias, and workplaces. Some studies capture all foods prepared outside of home and others focused on certain types of outlets, such as fast foods, restaurants, or takeaway only. Few distinguish the consumption done at work, for adults, or at schools in children and adolescents.

In a study in Brazilian urban areas(145), individuals aged over 10 years old who consumed meals away from home, had higher mean energy intake, corresponding to 2072 kcal whereas individuals who did not eat away from home consumed about 1802 kcal. Foods that were major contributors to this intake were alcoholic beverages (59 %), baked and deep-fried snacks (54 %), pizza (42 %), soft drinks (40 %), sandwiches (40 %), and sweets and desserts (30 %). A study from 2015 among Brazilian adults(146) concluded that energy intake came mostly from saturated fats and free sugars, with differences in women who also had greater percentage energy from total fat(146). In Chinese adults, eating at restaurants meant an increase of 140kcal in daily energy intake, 6.05g of fat and 547.74 mg of sodium; in company/school canteens, values decreased to 91 kcal per day and 4.3g of fat, compared with days without canteen consumption(109). These results are similar to those found in Korean adults(102), in working-age American adults(147) and middle aged European adults(104). In this multicentre study, a distinction was made between consumption in restaurants and work. In general, Europeans consumed more calories at work than at restaurants with 14% of energy intake from protein, 55% from carbohydrates and 30% from fat. Among “very substantial out-of-home” eaters(104), the increased energy intake was associated with higher fat and protein intakes at restaurants and fat and carbohydrates at work. Among those who ate mostly in restaurants, it was reported lower total carbohydrate intakes and higher total alcohol intakes. The difference in energy intake between “very substantial out-of-home” eaters who ate at restaurants or at restaurants and work and “very

“substantial out-of-home” eaters who only ate at work, was explained by the increased alcohol intake at restaurants.

A cross sectional study from the HECTOR project - Eating Out: Habits, Determinants and Recommendations for Consumers and the European Catering Sector - pointed out sugar, desserts, sweets, savoury bakery products and drinks as the foods generally more consumed out of home(126). Data from this project regarding consumption in Portugal showed that foods that tend to be eaten out were sweet and salty snacks, meat products, butter and animal fat, ice creams, beer and other alcoholic drinks, non-alcoholic beverages, sugar and sugary products and chocolates (128).

Children and adolescents are a critical age group in which out of home eating is a predominant source of energy, and it becomes relevant to evaluate the adequacy of the meals from their out of home food sources and how it can influence the risk of overweight and obesity. A study that aimed to analyse the contribution of school meals to healthy food consumption among public school students in Brazil(148), found that it was associated with a moderate and regular consumption of beans, raw or cooked vegetables, cooked vegetables, and fruits. Furthermore, eating more at school meant consuming less of fried salty snacks and processed meat, sweet biscuits, and sweets. However, this can be different among adolescents, which are more independent and able to purchase foods from schools’ cafeterias and cafes in school surroundings. A study with Norwegian young adolescents(149) showed that students that often used the canteen, bought more snacks and sugar-soft drinks from shops near school.

Unlike home, which is associated with a higher and adequate nutrient intake and lower dietary energy density, meals consumption at European schools are not always associated with better dietary intake(150-152). Nonetheless, in a Portuguese study with preschool children(153), eating at school was associated with higher scores in the dietary adequacy index through a greater consumption of fish, vegetables and fruit and lower intake of total fat and meat, comparing with other locations. Food consumption in restaurants, when compared with school and home, was linked to a lower dietary adequacy given the higher consumption of cakes, salty snacks, soft drinks, and fruit juices. A cross sectional study with children and adolescents, with data retrieved from the UK National Diet and Nutrition Survey Rolling Program(154), showed that the main eating location across all age groups were home (68.8–79.1%), followed by school (7.1–17.0%) and the percentage of meals consumption in leisure places, food outlets, and “on the go” combined was higher among older children. There was a higher percentage of consumption of “core foods” at home and school in all age groups (11–18 years old) than the other locations examined, where a higher percentage of consumption of “noncore foods” was observed, especially in leisure places and “on the go”. Mean contribution to

total energy intake from “noncore foods” increased with age, from 46.8% in 1.5- to 3-year-old children to 55.9% in 11- to 18-year-old- children. Another study in adolescents concluded that home and school environments are associated with a higher consumption of desirable nutrients and lower energy intake(152).

A review by Nago ES. *et al*(155) concluded that eating out frequently is associated with the risk of becoming overweight or obese and weight change, with the last being much higher when eating at fast food outlets rather than in traditional restaurants. In European adults, eating at restaurants was associated with body mass index among men but no evidence in women. This association was not found when individuals ate at work(156). The development of health issues derived from out of home eating seem to be worse in women than men, including increased risk of cardiometabolic disease(157), risk of being overweight and obese and lower levels of biomarkers such as vitamins D, E, C, B6, B12, folate and carotenoids(158). Furthermore, overweight women consume more meals away from home than those with normal weight(146). The raising trend of choosing meals prepared outside the home(159), particularly in young adults(160) can increase the intake in energy and nutrients that are a threat to health(161). Specifically, excessive intake of saturated fat and sodium intakes, are associated with an elevated LDL cholesterol and hypertension which are among the top modifiable risk factors contributing to the burden of disease(162). Along with an escalating rate of obesity, type 2 diabetes has also been prevailing(118, 163).

As eating out trend increases, knowledge of how it affects our dietary choices and nutrient intake should be improved. Identifying priority areas to promote healthy eating out of home is dependent on the profile of out of home eating that is different by country and according to age groups

V. Gaps in the literature

Días-Mendez C. *et al*(164), distinguished four areas of out of home food consumption research: (1) the analysis of food consumption from the perspective of the consumer; (2) studies that analyse the commercial sector; (3) studies that explore the socio-demographic profile of consumers eating main meals outside of the home; (4) and at last, studies in the field of health. Our study fits in this last category, which focus on the analysis of the negative effects of eating out on people's health, and the links between diet adequacy and nutritional variables, such as energy and nutrient intake or food consumption. Data is not consistent, since some authors associate eating out of home with worse diet adequacy, while others do not suggest a causal relationship. Additionally, existent studies are targeted to specific age groups and most of them were performed with adults. Given the growing recognition of school canteens and workplaces as places to promote healthy eating habits and since previous research has shown that eating in canteens can be associated with optimal dietary patterns, studies should analyse dietary intake in these places to perceive the impact on overall health. Furthermore, it is important to comprehend the type of foods and nutrients consumed in restaurants to provide enlightenment on the solutions to improve diet adequacy and consumers awareness on good practices when eating in these establishments.

This is our purpose and to our knowledge, this is the first study performed in Portugal that comprehensively details individual out of home consumption in different age groups of the population - children, adolescents, adults, and elderly - and estimates associations between eating location patterns and dietary intake profile. At an international level, few studies have evaluated this data using national representative samples and including the whole age range of the population.

OBJECTIVE

This thesis aims to understand the dietary profile and adequacy of out of home consumption in the Portuguese population. To evaluate this, it was used data from the National Food, Nutrition and Physical Activity Survey (IAN-AF 2015–2016). The following specific objective was defined:

- Describe and compare eating location patterns regarding energy and macronutrients intake, and food consumption adequacy, within different age groups of the Portuguese population

**Eating location patterns in Portugal: characterization
and effect in the dietary intake profile**

Eating location patterns in Portugal: characterization and effect in the dietary intake profile

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Acknowledgments: The project had institutional support from the General Directorate of Health (DGS), the regional Health Administration Departments, the Central Administration of the Health System (ACSS) and from the European Food Safety Authority (CFT/EFSA/DCM/2012/ 01-C03). The authors gratefully acknowledge these institutions, all persons involved in the different phases of the survey, all researchers and all participants enrolled.

Abstract

Introduction: Eating out of home has been increasing due to social and contextual changes. This phenomenon varies between age groups and eating locations and has been associated with a poor diet adequacy and an increased risk for obesity.

Aim: This study aimed to describe and compare energy, nutrient intake, and food consumption according to eating location patterns, by age groups.

Methods: Data from the National Food, Nutrition and Physical Activity Survey (IAN-AF;2015-2016) was used. Dietary intake was estimated by two non-consecutive days of food diaries (children)/24-hrs recalls (other age groups). Four *a priori* patterns were defined according to eating location: “Home” (at least 80% of meals at home), “Other homes”, “School or Work” and “Restaurants and other Places” (location with the highest prevalence of meals consumption among those eating <80% of meals at home). A healthy eating index was developed to evaluate diet adequacy of each pattern (score range: 9-36).

Results: Most meals were consumed at home (69.1%), or at school in children and adolescents (26.3% and 18.7%, respectively) and at restaurants in adults and elderly (13.9% and 8.3%, respectively). In children and adolescents, “School or Work” pattern was characterized by higher consumption of “fruit, vegetables, and pulses” and “cereals and starchy tubers”. Comparing with other patterns, adults in this pattern consumed more “white meat, fish, and eggs”, “red and processed meat”, “sugar sweetened beverages” and “sweets”. Globally, the “Restaurants and other places pattern” was associated with higher consumption of “salty snacks”, “sugar sweetened beverages” and “red and processed meat”. Particularly adults consumed more “sugar and honey” and less “fruit, vegetables and pulses”. When compared to “Home”, adults in “Restaurants and other places” had higher odds of drinking alcoholic beverages (OR=1.74, 95%CI=1.17, 2.58). Compared to “home”, “School or work” pattern was associated with a better diet adequacy in children ($\beta=0.9$; 95%CI:0.3, 1.5) and adolescents ($\beta=0.2$; 95%CI: -0.4, 0.9) corresponding to higher intakes of fibre, but also sodium. On the contrary, adults in this pattern presented worse diet adequacy ($\beta=-0.3$; 95%CI: -0.6, -0.01), presenting higher energy, free sugars, fibre, saturated fatty acids, and sodium intake. “Restaurants and other places” pattern presented a worse diet adequacy among children ($\beta=-1.0$; 95%CI: -2.0, -0.04), adolescents ($\beta=-2.4$; 95%CI: -3.2, -1.5), and adults ($\beta=-1.3$; 95%CI: -1.6, -1.0), presenting significantly higher intake of energy, fat, trans fatty acids, saturated fatty acids, and sodium intake. The elderly consumed more free sugars and fat out of home.

Conclusions: “School/work” pattern contributes to higher consumption of nutrient-dense foods and “Restaurants/other places” to higher consumption of energy-dense foods, reflecting different nutrient profiles.

Introduction

Since the mid-20th century, the world's food environment shifted due to increased urbanization and market globalization, reflecting the "eating out" increasing trend (1-4). Demographic and socio-economic changes such as longer working hours (5, 6), time pressure among working women (7, 8) and the higher exposure to food outlets (9) contributed to less time spent preparing meals at home and reliance on meals out of home. In the USA, contribution of out of home foods to total energy intake has risen from 18% in 1977–1978 to 32% in 1994–1996(10). In 2016, a survey from Nielsen company reported that about 23% of the Portuguese population did at least one meal out of home and 15% of them ordered food to eat at home. Recent data from the Eurostat (2018) regarding Portuguese families showed that 9,2% of total expenses were spent in out of home meals (11).

Food environment, age group, region, and socioeconomic indicators such as education, income and occupation are important factors when considering out of home consumption (9). This phenomenon is commonly associated with special occasions, with meals from take away and fast-food restaurants and families point out different reasons to eat in these places such as their convenience, cost effectiveness, variety, and the provision of "family time" (12). Health concerns are less considered when thinking of a place to eat. Previous studies have focused on the relation of at home and out of home consumption or considered eating out within restaurants and fast-food establishments. However, the public catering sector, namely, work (13) and/or school canteens have gained relevance in out of home consumption since individuals spent more than half of their waking hours working or learning (14).

Researchers have pinpointed some issues regarding out of home meals namely large portion sizes, higher energy densities, lack of health literacy among consumers and reduced variety of healthy options (14). In Europe, out of home meals are part of their dietary habits and have been linked to the development of overweight and obesity (15-17). Energy and nutrients intake and types of food groups consumed of those who generally eat out may differ from those who eat mostly at home. Studies have shown that individuals who mostly eat out have a poor diet quality and increased energy intake, as a result of consuming more low-nutrient and energy-dense foods and in larger portions. In a European multicentre study carried out in adults, among "very substantial out-of-home" eaters (18), the increased energy intake was associated with higher fat and protein intakes at restaurants and fat at work. Among those who ate mostly in restaurants, it was reported lower total carbohydrates intake and higher total alcohol intake. A cross sectional study from the HECTOR project pointed out sugar, desserts,

sweets, savoury bakery products and drinks as the foods generally more consumed out of home (3). Also, higher out of home consumption was more common among men, younger participants, and those highly educated; “substantial out-of-home eaters” had similar food intakes at home and out of home, unlike “non-substantial out-of-home eaters” that consumed higher amounts of the foods previously referred (12).

Among children, meals at European schools are not always associated with better dietary intake, unlike home which is associated with a higher and adequate nutrient intake and lower dietary energy density (19, 20). Nonetheless, in a Portuguese study with preschool children (21), eating at school was associated with higher scores in the dietary adequacy index through a greater consumption of fibre, fish, vegetables and fruit and lower intake of total fat and meat comparing with other eating locations. Yet, consumption in restaurants, when compared with school and home, was linked to a lower dietary adequacy index score given the higher consumption of cakes, salty snacks, soft drinks, and fruit juices. Similarly, among British children and adolescents there was a higher energy intake derived from “core foods” at home and school and higher contribution of “non-core foods” to the daily energy intake from leisure places and food outlets (22). Another study in adolescents concluded that, home and school environments are associated with a higher consumption of desirable nutrients and lower energy intake (23).

As eating out trend increases, knowledge of how it affects our dietary choices and nutrient intake should be improved. Identifying priority areas to promote healthy eating out of home is dependent on the profile of out of home eating that is different by country and according to age groups. Few studies have evaluated data using national representative samples and including the whole range of the population. Thus, the present study aims to describe and compare energy, nutrient intake, and food consumption according to eating location patterns, by age groups using data from the Portuguese National Food, Nutrition and Physical Activity Survey (IAN-AF 2015-2016).

Methods

Participants

The protocol and methodology from the IAN-AF 2015–2016 have been previously published (24, 25). This survey collected nationwide and regional data on food consumption and its relation to health determinants, from participants aged between 3 months and 84 years old. The study population was represented by a probabilistic sample obtained from the National Health registry, through multistage sampling: firstly,

by the stratification of the seven statistical geographic units; secondly, by randomly selecting Primary Health Care Units in each region; and finally, individuals were randomly selected from each Health Care Unit according to sex and age. The sample of 6553 subjects were submitted to one face-to-face interview but only 5811 participants completed two dietary assessments 8 to 15 days apart. In the present analysis, participants from 3 to 84 years old were included (n=5005).

Data collection

Dietary assessment

To capture season effects and daily variations on food consumption, data was collected from October 2015 to September 2016. In children under the age of 10, dietary intake was assessed with two non-consecutive one-day food diaries which were filled by parents or caregivers, followed by an interview to add details on the food description and quantification. For the remaining participants, dietary intake was evaluated through two non-consecutive 24h recalls. For subjects aged from 10 to 14 years old, it was mandatory to have the presence of one parent or caregiver during the assessment. Most of the procedures were adapted from the European Food Safety Authority (EFSA) Guidance, taking in account the EU Menu methodology (26). “eAT 24” software, that included the classification system FoodEx2(27), was used to collect all dietary data and to describe food, recipes and supplements consumed during meals, including information on time, and eating location. The initial food list was based on the Portuguese food composition table (28), and it was expanded to a total of 2479 food items and 117 supplements. Also, a total of 1696 recipes that reflect the Portuguese cuisine were included (24, 25). Food portion size was quantified through a food picture book (29), as well as predefined household measures, weight or volume methods, and standard unit methods. A list of default mean portions was also available for participants who did not know how to estimate a food item. All food groups considered in this study are specified elsewhere (25). Water was excluded from the non-alcoholic beverages for the purpose of this analysis.

Definition of eating location patterns

Four a priori patterns were defined according to eating location, following a similar methodology of a previous study of the research group (21). “Home”, at least 80% of meals at home; “Other homes”, less than 80% of meals at home and the remaining ones

mainly at other family/friends home; “School/Work” less than 80% of meals at home and the remaining ones mainly at school or work, including canteens; “Restaurants and other places”, less than 80% of meals at home and the remaining ones mainly at restaurants, bars, coffee shops, pastry or snack bars, or travelling, at outdoors or other public places.

Among the elderly, the eating location patterns “Home”, and “Other Homes” were concatenated, as well as “School/Work” and “Restaurants/other places”, due to low frequency of patterns “Other Homes” and “School/Work” (4.8% and 2.5%, respectively).

Healthy Eating Index (HEI)

To evaluate the dietary adequacy of each eating location pattern, a healthy eating index (HEI) was developed based on dietary recommendations proposed by the World Health Organization (30), considering data from foods groups and not nutrient content, as previously used with Portuguese children (31). This index included nine food groups: 1. “fruit, vegetables, and pulses”; 2. “dairy” (milk, yogurt, and cheese); 3. “cereals, cereal products, and starchy tubers” (rice, pasta, potatoes, bread and other grains); 4. “white meat, fish and eggs”; 5. “Red meat and processed meat”; 6. “Salty snacks” (chips, snacks, pizzas and commercial burgers); 7. “Sweets” (cakes, candies, sweet pastry, chocolate, biscuits and ice cream, breakfast cereals and cereals bars); 8. “Sugar and Honey”; 9. “Sugar-sweetened beverages” (Soft drinks and nectars).

Quartiles of consumption were calculated for each food group, by age, and a score ranging from 1 to 4 was assigned. For the first four groups, considered “healthy foods”, the lowest quartile of consumption was assigned a score of 1, intermediate quartiles were given the scores 2 and 3, and the highest quartile was given a score of 4. The remaining groups (from 5 to 9) were scored in the reverse direction with the highest quartile of consumption receiving the lowest score. The final score of the HEI ranges between 9–36, with higher scores representing healthier diets composition.

Other variables

As part of the survey, participants were asked about demographic and socioeconomic characteristics, health-related data, and lifestyle behavioural characteristics. In the present study, the following demographic and socioeconomic characteristics were used: sex, age group, degree of urbanization (predominantly urban, mostly urban, predominantly rural) and education level (low: none/primary/preparatory education; middle: middle/secondary/post-secondary education; high: tertiary education). Children and adolescents’ education level was classified according to parents’ highest education level.

Statistical analysis

The distribution of meals (%) by eating location (“Home”, “Other family/friends’ home”, “School/Work”, “Restaurants”, “Other places”) was estimated for the total sample and according to sex, age group, degree of urbanization and education level. The mean contribution of meals to the total energy intake (%) by eating location was also calculated. The distribution of eating location patterns (“Home”, “Other Homes”, “School or Work”, “Restaurants and other places”) was analysed by socioeconomic variables and HEI.

Mean daily intake of energy (in kcal), nutrients (as % of total energy intake (TEI) or in weight (grams/ milligrams)) and food groups (in grams) was estimated by eating location patterns, stratified by age group. Interactions between eating location patterns and age groups were calculated to each nutrient and food group and the analysis was stratified by age group anytime a significant interaction was found. For both nutrients and food groups, differences between patterns and within age groups were tested using the ANOVA method.

To estimate the association between mean daily intake of energy, nutrients, and food groups, with the eating location patterns, and considering sociodemographic variables, linear regression coefficients (β) and the respective 95% confidence intervals (95%CI) were assessed. A model was constructed adjusting for sex, degree of urbanization and education level.

The association between the consumption of alcoholic beverages in adults and elderly and eating location patterns, stratified by age group, were evaluated through odds ratios (OR) and the respective 95%CI, from logistic regression models. Two models were fitted: crude model (Model 1) and a second model (Model 2) adjusted for sex and education level. These models were used for all alcoholic beverages and by type of alcoholic beverage.

The R software version 3.4.1 for Windows was used for the statistical analysis and all estimates were weighted to the distribution of the Portuguese population. A significance level of 5% was considered.

Ethics

The IAN-AF 2015-2016 was developed under the guidelines present in the Declaration of Helsinki and the national legislation. All personal information was kept in the necessary confidentiality. Procedures were approved by the National Commission for Data Protection, the Ethic Committee of the Institute of Public Health of the University of Porto, and the Ethic Committee of each Regional Health Administration. Participants or legal caregivers (for children and adolescents aged less than 18 years old) signed a written informed consent, and for adolescents aged 10–17 years old, both caregivers

and participants signed the written informed consent. Participants identifiable information was treated separately and introduced in an exclusive database. All researchers signed a declaration of confidentiality and good practices.

Results

Percentage of meals according to eating location

Table 1 shows that “Home” was the eating location where participants consumed more meals (69.1%) and that most contributed to total energy intake (70.3%). “School/work” and “Restaurants” were the second and third places where participants had most of their meals (12.6% and 11.9%, respectively, corresponding to 11.7% kcal and 10.9% kcal of total energy intake).

Both females and males did most of their meals at “Home” (71.8% and 66.3%), followed by “School/work” (12.9% and 12.3%) and “Restaurants” (9.0% and 14.8%). This was similar for children and adolescents but not for adults and elderly which second most frequent eating location was “Restaurants” (Table 1).

In predominantly urban and mostly urban areas, “School/work” was the most common place to eat out of home; but in predominantly rural areas, this was observed for “Restaurants” (12.2%) (Table 1).

The percentage of meals consumed at “Home” was higher among individuals with a lower level of education. Individuals with middle and with high education level consumed most of their out of home meals at “School/work” (14.5% and 15.4%, respectively), followed by Restaurants (12.5% and 13.9% respectively), a higher proportion when compared to those with lower levels of education (6.9% at “School/work” and 9.2% at restaurants) (Table 1).

Table 1. Distribution of meals of the Portuguese population (3-84 years old), according to eating location, by sociodemographic characteristics, the IAN-AF 2015-2016.

	n	<i>Meals distribution</i>				
		<i>Home, % (95%CI)</i>	<i>Other family/ friends' home, % (95%CI)</i>	<i>School/work, % (95%CI)</i>	<i>Restaurants, % (95%CI)</i>	<i>Other places, % (95%CI)</i>
Total	5005	69.1 (67.8, 70.4)	4.8 (4.3, 5.3)	12.6 (11.7, 13.5)	11.9 (11.2, 12.6)	1.7 (1.4, 2.0)
Sex						
Female	2613	71.8 (70.2, 73.4)	4.7 (4.0, 5.4)	12.9 (11.7, 14.1)	9.0 (8.2, 9.8)	1.6 (1.3, 1.9)
Male	2392	66.3 (64.7, 67.9)	4.8 (4.0, 5.6)	12.3 (11.2, 13.4)	14.8 (13.7, 15.9)	1.8 (1.4, 2.2)
Age group						
Children (3-9 years)	521	55.3 (51.8, 58.8)	10.8 (8.2, 13.4)	26.3 (22.8, 29.8)	4.6 (2.8, 6.4)	3.0 (2.2, 3.8)
Adolescents (10-17 years)	632	63.9 (61.4, 66.4)	7.5 (5.6, 9.4)	18.7 (16.0, 21.4)	6.7 (5.3, 8.1)	3.3 (2.4, 4.2)
Adults (18-64 years)	3102	66.1 (64.7, 67.5)	4.5 (3.9, 5.1)	13.6 (12.5, 14.7)	13.9 (13.1, 14.7)	1.8 (1.5, 2.1)
Elderly (65-84 years)	750	87.4 (85.3, 89.5)	2.5 (1.5, 3.5)	1.2 (0.5, 1.9)	8.3 (6.9, 9.7)	0.6 (0.4, 0.8)
Degree of urbanization						
Predominantly urban	3650	68.8 (67.2, 70.4)	4.7 (4.1, 5.3)	12.7 (11.7, 13.7)	12.1 (11.3, 12.9)	1.7 (1.4, 2.0)
Mostly urban	863	70.0 (67.6, 72.4)	5.0 (4.2, 5.8)	13.4 (11.2, 15.6)	10.3 (8.8, 11.8)	1.4 (1.0, 1.8)
Predominantly rural	492	69.8 (67.0, 72.6)	5.2 (3.8, 6.6)	9.9 (8.0, 11.8)	12.2 (9.7, 14.7)	2.9 (1.7, 4.1)
Education level ^(a)						
Low	1497	79.5 (77.4, 81.6)	3.2 (2.4, 4.0)	6.9 (5.8, 8.0)	9.2 (8.1, 10.3)	1.3 (0.8, 1.8)
Middle	2201	66.3 (64.7, 67.9)	4.9 (4.2, 5.6)	14.5 (13.3, 15.7)	12.5 (11.4, 13.6)	1.7 (1.4, 2.0)
High	1291	62.2 (60.0, 64.4)	6.3 (5.3, 7.3)	15.4 (13.7, 17.1)	13.9 (12.4, 15.4)	2.3 (1.9, 2.7)

^(a) for participants with <18 years old, it was considered the highest parents' education level.
CI – Confidence Interval.

Eating location patterns

Sociodemographic characterization

Table 2 shows that most participants were allocated into the “Home” eating location pattern (36.8%) followed by “School or Work” (31.1%), “Restaurants and other places” (24.4%) and “Other homes” (7.7%). Females were mostly classified in the “Home” pattern (42.1%), followed by “School or Work”, unlike males who were evenly distributed between the “Home” (31.2%) and “Restaurants and other places” (31.3%) patterns. Children, adolescents, and adults were predominantly classified into “School or Work” pattern (54.4%, 44.7% and 35.0% respectively) and older adults in the “Home” pattern (72.2%).

Among the out of home patterns, in predominantly urban and mostly urban areas, the “School or work” pattern was more frequent whereas in predominantly rural areas the most common was “Restaurants and other places” (**Table 2**).

Individuals of high education level were more frequently classified into “School or Work” pattern, and those with low education were mainly classified in the “Home” pattern, followed by “Restaurants and other places”.

Dietary intake profile

Supplementary tables S1 and S2 show that interactions between eating location patterns and age groups were significant for all food groups, energy, and nutrients, except for “fruit, vegetables and pulses”. So, the results were presented by age categories. Considering crude comparison of food groups consumption according to eating location patterns, globally children and adolescents in the “School or work” pattern consumed more “fruit, vegetables and pulses” and “cereals and starchy tubers” and those in the “Restaurants and other places” pattern consumed more “salty snacks” and “sugar sweetened beverages” (**Table S1**). Adults in the “School or work” pattern consumed significantly more “fruit, vegetables and pulses”, and in “Restaurants and other places” pattern and “Other homes” pattern consumed significantly more “red and processed meat”, “salty snacks”, and “sugar sweetened beverages”. Globally, adults eat also more” sweets” out of home. A significant lower HEI score, representing worse dietary adequacy, was observed in “Restaurants and other places” pattern in children, adolescents, and adults. The elderly had higher consumption of “red and processed meat” and “sugar and honey” in the “School or work & Restaurants and other places” pattern and lower HEI score. (**Table S1**).

Table 2. Distribution of individuals according to eating location patterns by sociodemographic characteristics, weighted for the Portuguese population distribution, the IAN-AF 2015-2016.

	n	<i>Eating location patterns^(a)</i>			
		<i>“Home” % (95%CI)</i>	<i>“Other homes” % (95%CI)</i>	<i>“School or work” % (95%CI)</i>	<i>“Restaurants and other places” % (95%CI)</i>
Total	5005	36.8 (34.5, 39.1)	7.7 (6.6, 8.8)	31.1 (28.6, 33.6)	24.4 (22.1, 26.7)
Sex					
Female	2613	42.1 (38.9, 45.3)	7.7 (6.2, 9.2)	32.3 (29.2, 35.4)	17.9 (15.4, 20.4)
Male	2392	31.2 (27.9, 34.5)	7.7 (6.0, 9.4)	29.8 (26.7, 32.9)	31.3 (28.3, 34.2)
Age group					
Children (3-9 years)	521	18.0 (12.7, 23.4)	18.5 (13.3, 23.7)	54.4 (46.7, 62.1)	9.0 (3.6, 14.4)
Adolescents (10-17 years)	632	26.2 (21.2, 31.1)	12.8 (9.0, 16.7)	44.7 (37.0, 52.3)	16.3 (11.8, 20.9)
Adults (18-64 years)	3102	30.4 (27.7, 33.1)	6.9 (5.6, 8.2)	35.0 (32.0, 37.9)	27.8 (25.3, 30.2)
Elderly (65-84 years)	750	72.2 (66.8, 77.6)	4.8 (2.6, 7.1)	2.5 (0.8, 4.2)	20.4 (15.5, 25.4)
Degree of urbanization					
Predominantly urban	3650	36.9 (34.2, 39.7)	7.5 (6.2, 8.8)	31.5 (28.5, 34.5)	24.1 (21.7, 26.6)
Mostly urban	863	37.7 (33.6, 41.8)	8.5 (5.9, 11.2)	33.1 (28.8, 37.4)	20.7 (16.8, 24.6)
Predominant rural	492	33.7 (24.2, 43.3)	8.5 (4.9, 12.1)	24.6 (18.8, 30.4)	33.2 (24.9, 41.4)
Education level^(b)					
Low	1497	56.5 (52.3, 60.6)	6.3 (4.2, 8.3)	16.2 (13.4, 18.9)	21.1 (17.5, 24.7)
Middle	2201	30.8 (27.4, 34.2)	8.1 (6.3, 9.9)	35.6 (31.9, 39.3)	25.4 (22.7, 28.1)
High	1291	23.8 (19.9, 27.7)	8.7 (6.4, 11.0)	40.8 (36.6, 45.0)	26.7 (22.4, 30.9)

CI – Confidence Interval.

^(a) “Home”: at least 80% of meals at home; “Other homes”: less than 80% of meals at home and the remaining ones mainly at other family/friends home; “School or work”: less than 80% of meals at home and the remaining ones mainly at school or work, including canteens; “Restaurants and other places”: less than 80% of meals at home and the remaining ones mainly at restaurants, bars, coffee shops, pastry, or snack bars, or travelling, at outdoors or other public places

^(b) for participants with <18 years old, it was considered the highest parents’ education level

Table 3A and 3B illustrate the model fitted to estimate the association between food group consumption and HEI score and eating location patterns. “Home” was considered the reference class in children, adolescents, and adults. For the elderly, comparisons were made between “Home & Other homes” and “School or work & Restaurants and other places”.

Children and adolescents showed a positive association between “School or Work” pattern and “fruit, vegetables, and pulses” (Children: $\beta = 37.6$; 95%CI = 5.4, 69.8; Adolescents: $\beta = 39.7$; 95%CI = 9.3, 70.0) and “cereals and starchy tubers” consumption (Children: $\beta = 42.2$; 95%CI = 21.9, 62.5; Adolescents: $\beta = 39.9$; 95%CI = 15.0, 64.7). Adolescents had a negative association for “sugar sweetened beverages” consumption ($\beta = -59.7$; 95%CI = -105.4, -14.1). In this pattern, adults presented a positive association regarding the consumption of “white meat, fish, and eggs” ($\beta = 14.9$ 95%CI = 7.1, 22.8), “red and processed meat” ($\beta = 9.5$ 95%CI = 2.6, 16.3), “sugar sweetened beverages” ($\beta = 21.1$ 95%CI = 3.8, 38.4), and “sweets” ($\beta = 10.9$; 95%CI = 4.5, 17.4) (**Table 3A**).

In the “Restaurants and other places pattern”, among children and adolescents, a negative association was found for “dairy” consumption (Children: $\beta = -123.8$; 95%CI = -203.5, -44.1; Adolescents: $\beta = -49.8$; 95%CI = -99.5, -0.03) and a positive association for “salty snacks” (Children: $\beta = 18.6$; 95%CI = 3.0, 34.3; Adolescents: $\beta = 28.8$; 95%CI = 12.2, 45.4) and “sugar sweetened beverages” consumption (Children: $\beta = 113.6$; 95%CI = 51.8, 175.4; Adolescents: $\beta = 130.5$; 95%CI = 69.3, 191.7) (**Table 3A**). Also, adolescents had higher mean daily intakes of “red and processed meat” ($\beta = 21.1$; 95%CI = 2.8, 39.4) and “sweets” ($\beta = 24.1$; 95%CI = 4.3, 43.9) (**Table 3A**). Adults presented a positive association for the consumption of “red and processed meat” ($\beta = 17.2$; 95%CI = 9.8, 24.6), “salty snacks” ($\beta = 13.6$; 95%CI = 8.2, 19.1), “sugar sweetened beverages” ($\beta = 76.6$; 95%CI = 57.9, 95.3), “sugar and honey” ($\beta = 1.6$; 95%CI = 0.7, 2.5) and “sweets” ($\beta = 12.6$; 95%CI = 5.6, 19.5). Furthermore, they presented a negative association with “fruit, vegetables and pulses” ($\beta = -33.1$; 95%CI = -52.7, -13.4) and “dairy” consumption ($\beta = -42.0$; 95%CI = -59.7, -24.3) (**Table 3B**). All age groups mentioned had a negative association between this pattern and HEI score.

In the “Other Homes” pattern, adults presented a positive association for the consumption of “red and processed meat” ($\beta = 21.2$; 95%CI = 9.5, 32.9), “salty snacks” ($\beta = 11.5$; 95%CI = 2.8, 20.1), “sugar sweetened beverages” ($\beta = 49.6$; 95%CI = 20.1, 79.1) and “sweets” ($\beta = 19.0$; 95%CI = 8.1, 30.0) (**Table 3B**). Adolescents presented a negative association for “white meat, fish, and eggs” consumption ($\beta = -21.9$; 95%CI = -41.7, -2.1) and a positive for “sugar and honey” consumption ($\beta = 1.5$; 95%CI = 0.2, 2.9) (**Table 3A**).

Table 3A. Adjusted association of mean daily intakes of food groups and Healthy Eating Index (HEI) score with eating location patterns in children and adolescents, weighted for the Portuguese population distribution, the IAN-AF 2015-2016.

	Children (3-9 years)				Adolescents (10-17 years)			
	“Home”	“Other Homes” β (95%CI)	“School or work” β (95%CI)	“Restaurants and other places” β (95%CI)	“Home”	“Other Homes” β (95%CI)”	“School or work” β (95%CI)	“Restaurants and other places” β (95%CI)
Fruit, vegetables, and pulses (g),	ref	-25.6 (-65.9, 14.6)	37.6 (5.4, 69.8)	0.8 (-52.1, 53.6)	ref	12.1 (-30.1, 54.3)	39.7 (9.3, 70.0)	-32.8 (-73.5, 7.8)
Cereals and starchy tubers (g)	ref	8.0 (-17.3, 33.3)	42.2 (21.9, 62.5)	18.7 (-14.6, 51.9)	ref	16.0 (-18.5, 50.6)	39.9 (15.0, 64.7)	-18.8 (-52.0, 14.5)
Dairy (g)	ref	-82.0 (-142.6, -21.3)	-44.1 (-92.7, 4.5)	-123.8 (-203.5, -44.1)	ref	-18.9 (-70.5, 32.8)	13.5 (-23.6, 50.6)	-49.8 (-99.5, -0.03)
White meat, fish, and eggs (g)	ref	2.1 (-12.0, 16.0)	5.1 (-6.1, 16.3)	-7.0 (-25.3, 11.3)	ref	-21.9 (-41.7, -2.1)	-9.3 (-23.5, 5.0)	-18.2 (-37.3, 0.9)
Red and processed meat (g)	ref	3.0 (-9.3, 15.3)	6.3 (-3.6, 16.2)	5.7 (-10.4, 21.9)	ref	14.2 (-4.9, 33.2)	5.8 (-7.9, 19.5)	21.1(2.8, 39.4)
Salty Snacks (g)	ref	0.3 (-11.6, 12.2)	-8.8 (-18.3, 0.8)	18.6 (3.0, 34.3)	ref	3.2 (-14.1, 20.4)	-2.4 (-14.8, 10.0)	28.8 (12.2, 45.4)
SSB (g)	ref	41.0 (-6.1, 88.1)	-37.2 (-74.9, 0.5)	113.6 (51.8, 175.4)	ref	55.3 (-8.3, 118.8)	-59.7 (-105.4, -14.1)	130.5 (69.3, 191.7)
Sugar and Honey (g)	ref	-0.2(-1.1, 0.7)	-0.6 (-1.4, 0.05)	-1.0 (-2.1, 0.2)	ref	1.5 (0.2, 2.9)	-0.2 (-1.2, 0.8)	0.004 (-1.3, 1.3)
Sweets (g)	ref	7.7 (-11.1, 26.4)	-1.7 (-16.7, 13.3)	24.0 (-0.6, 48.7)	ref	2.6 (-17.9, 23.2)	9.3 (-5.4, 24.1)	24.1 (4.3, 43.9)
Healthy Eating Index	ref	-0.5 (-1.2, 0.3)	0.9 (0.3, 1.5)	-1.0 (-2.0, -0.04)	ref	-1.3 (-2.2, -0.4)	0.2 (-0.4, 0.9)	-2.4 (-3.2, -1.5)

Models adjusted for sex, degree of urbanization and education level
CI – Confidence Interval; SSB – sugar sweetened beverages.

Table 3B. Adjusted association of mean daily intakes (and 95% confidence Interval) of food groups and Healthy Eating Index (HEI) score with eating location patterns in adults and elderly, weighted for the Portuguese population distribution, the IAN-AF 2015-2016.

	Adults (18-64 years)				Elderly (65-84 years)	
	<i>“Home”</i>	<i>“Other Homes”</i> β (95%CI)	<i>“School or work”</i> β (95%CI)	<i>“Restaurants and other places”</i> β (95%CI)	<i>“Home & Other homes”</i> β (95%CI)	<i>“School or work & Restaurants and other places”</i> β (95%CI)
<i>Fruit, vegetables, and pulses (g)</i>	ref	-12.3 (-43.3, 18.7)	13.4 (-4.8, 31.6)	-33.1 (-52.7, -13.4)	ref	-29.4 (-65.9, 7.0)
<i>Cereals and starchy tubers(g)</i>	ref	18.5 (-2.4, 39.4)	-1.2 (-13.4, 11.1)	-2.1 (-15.3, 11.1)	ref	-17.8 (-43.0, 7.3)
<i>Dairy (g)</i>	ref	-15.9 (-43.9, 12.1)	-2.6 (-19.0, 13.8)	-42.0 (-59.7, -24.3)	ref	-14.2 (-44.2,15.7)
<i>White meat, fish, and eggs (g)</i>	ref	-3.4 (-16.8, 10.0)	14.9 (7.1, 22.8)	4.1 (-4.4, 12.6)	ref	1.6 (-10.6, 13.9)
<i>Red and processed meat (g)</i>	ref	21.2(9.5, 32.9)	9.5 (2.6,16.3)	17.2 (9.8, 24.6)	ref	17.3 (6.3, 28.2)
<i>Salty Snacks (g)</i>	ref	11.5 (2.8, 20.1)	3.1 (-2.0, 8.2)	13.6 (8.2, 19.1)	ref	5.3 (0.5, 10.1)
<i>SSB (g)</i>	ref	49.6 (20.1, 79.1)	21.1 (3.8, 38.4)	76.6 (57.9, 95.3)	ref	22.8 (5.9, 39.8)
<i>Sugar and Honey (g)</i>	ref	0.2 (-1.1, 1.7)	0.6 (-0.3, 1.4)	1.6 (0.7, 2.5)	ref	2.6 (1.1, 4.2)
<i>Sweets (g)</i>	ref	19.0 (8.1, 30.0)	10.9 (4.5, 17.4)	12.6 (5.6, 19.5)	ref	-0.6 (-11.4, 10.2)
<i>Healthy Eating Index</i>	ref	-0.9 (-1.3, -0.4)	-0.3 (-0.6, -0.01)	-1.3 (-1.6, -1.0)	ref	-0.8 (-1.3, -0.3)

Models adjusted for sex, degree of urbanization and education level
CI – Confidence Interval; SSB – sugar sweetened beverages.

In the “School or work & Restaurants and other places” pattern, elderly had a positive association for the consumption of “red and processed meat” ($\beta = 17.3$; 95%CI = 6.3, 28.2), “salty snacks” ($\beta = 5.3$; 95%CI = 0.3, 10.1), “sugar sweetened beverages” ($\beta = 22.8$; 95%CI = 5.9, 39.8) and “sugar and honey” ($\beta = 2.6$; 95%CI = 1.1, 4.2). Also, they presented a negative association with the HEI score ($\beta = -0.8$; 95%CI = -1.3, -0.3) (**Table 3B**).

Regarding the HEI score, children presented a positive association for the “School or Work” pattern ($\beta = 0.9$; 95%CI = 0.3, 1.5) and a negative association with “Restaurants and other places” ($\beta = -1.0$; 95%CI = -2.0, -0.04), as well as the adolescents regarding this pattern ($\beta = -2.4$; 95%CI = -3.2, -1.5). Adolescents showed a negative association regarding the HEI in the “Other Homes” pattern ($\beta = -1.3$; 95%CI = -2.2, -0.4) (**Table 3A**). Adults presented a negative association between HEI score and all out of home eating location patterns (**Table 3B**).

Table 4 displays the association between alcoholic beverages consumption and eating location patterns in adults and elderly. In adults there was a significant and positive association between “Restaurants and other places” pattern and the consumption of all alcoholic beverages and the different types of alcoholic beverages (All alcoholic beverages - Model 2: OR=1.74, 95%CI = 1.17,2.58; Wine - Model 2: OR=1.42, 95%CI = 1.05,1.91; Beer - Model 2: OR=3.02, 95%CI = 2.00,4.57). Beer distinguished from the other alcoholic beverages since it was observed a significant and positive association between beer consumption and “School or work” pattern in adults (OR=1.52, 95%CI = 1.04,2.29), and with the “School or work & Restaurants and other places” pattern in the elderly (OR=2.23, 95%CI = 1.17,4.23); after adjustment, the association among the elderly lost its significance.

Regarding crude comparison of nutrient and energy intake according to eating location patterns, overall children, and adolescents in the “School or work” pattern consumed more fibre and those in the “Restaurants and other places” pattern consumed more saturated fatty acids and children had a significantly higher intake of sodium and fat. Children in the “Home” and “Other Homes” pattern had higher intakes of free sugars (**Table S2**). Adults in the “School or work” pattern consumed more fibre and those in the “Other Homes” and “Restaurants and other places” pattern had lower intakes of protein and higher intakes of energy and free sugars. In the “Restaurants and other places” pattern, they consumed fewer total carbohydrates and more saturated fatty acids and sodium (**Table S2**). Elderly did not present any significant differences in the mean daily intake of macronutrients among the patterns analysed.

Table 4. Association between consuming alcoholic beverages and eating location patterns in adults and elderly, weighted for the Portuguese population distribution, the IAN-AF 2015-2016).

	Consumption frequency (%)	Model 1* OR (95%CI)	Model 2† OR (95%CI)
Adults (18-64 years)			
All alcoholic Beverages			
Home	68.3	ref	ref
Other homes	78.6	1.57 (0.93, 2.65)	1.45 (0.85, 2.48)
School or work	72.4	1.08 (0.81, 1.44)	1.05 (0.77, 1.41)
Restaurants and other places	82.5	2.1 (1.47, 2.98)	1.74 (1.17, 2.58)
Wine			
Home	54.1	ref	ref
Other homes	73.2	1.59 (0.99, 2.56)	1.52 (0.93, 2.48)
School or work	67.7	1.07 (0.82, 1.41)	1.08 (0.81, 1.44)
Restaurants and other places	74.4	1.58 (1.21, 2.07)	1.42 (1.05, 1.91)
Beer			
Home	10.6	ref	ref
Other homes	18.7	1.65 (0.91, 2.99)	1.45 (0.77, 2.71)
School or work	12.9	1.59 (1.04, 2.43)	1.52 (1.01, 2.29)
Restaurants and other places	29.4	3.99 (2.67, 5.97)	3.02 (2.00, 4.57)
Other alcoholic beverages			
Home	10.0	ref	ref
Other homes	12.9	0.82 (0.39, 1.75)	0.78 (0.37, 1.65)
School or work	13.1	1.23 (0.67, 2.26)	1.19 (0.65, 2.16)
Restaurants and other places	19.7	2.07 (1.32, 3.22)	1.80 (1.13, 2.86)
Elderly (65-84 years)			
All alcoholic Beverages			
Home & Other homes	70.8	ref	ref
School or work & Restaurants and other places	80.3	1.31 (0.61, 2.80)	0.83 (0.38, 1.81)
Wine			
Home & Other homes	68.7	ref	ref
School or work & Restaurants and other places	77.0	1.23 (0.60, 2.52)	0.81 (0.39, 1.68)
Beer			
Home & Other homes	9.4	ref	ref
School or work & Restaurants and other places	20.2	2.23 (1.17, 4.23)	1.55 (0.78, 3.08)
Other alcoholic beverages			
Home & Other homes	8.7	ref	ref
School or work & Restaurants and other places	15.2	1.47 (0.68, 3.15)	1.10 (0.48, 2.52)

* Model 1: Crude Model.

† Model 2: Model adjusted for sex, degree of urbanization and education level

CI – Confidence Interval

Tables 5A and 5B shows the adjusted associations between energy and nutrients mean daily intake and eating location patterns, for children and adolescents and adults and elderly, respectively. “Home” was considered the reference class in children, adolescents, and adults. For elderly, comparisons were made between “Home & Other homes” and “School or work & Restaurants and other places”.

Children and adolescents had higher intakes of fibre and sodium in the “School or work” pattern. In this pattern children had lower intakes of free sugars ($\beta = -2.6$; 95%CI = -3.9, -1.3) and adolescents had higher intakes of energy ($\beta = 142$; 95%CI = 35, 250) and lower protein intakes ($\beta = -1.0$; 95%CI = -1.7, -0.3) (**Table 5A**). Adults had higher energy ($\beta = 161$; 95%CI = 105, 217), free sugars ($\beta = 0.8$; 95%CI = 0.3, 1.3), fibre ($\beta = 1.0$; 95%CI = 0.3, 1.6), saturated fatty acids ($\beta = 0.3$; 95%CI = 0.1, 0.6) and sodium intake ($\beta = 343$; 95%CI = 231, 454) within this pattern.

Energy and sodium intake was higher in the “Restaurants and other places” pattern among children, adolescents, and adults and they consumed significantly less protein (Children: $\beta = -1.8$; 95%CI = -2.9, -0.7; Adolescents: $\beta = -1.3$; 95%CI = -2.3, -0.3; Adults: $\beta = -0.5$; 95%CI = -0.9, -0.1, respectively). Total carbohydrates contributed less to total energy intake in adults ($\beta = -1.8$; 95%CI = -2.6, -1.0) and both adolescents and adults had a positive association regarding free sugars intake (Adolescents: $\beta = 2.4$; 95%CI = 0.8, 4.0; Adults: $\beta = 1.6$; 95%CI = 1.0, 2.1, respectively). Intake of fat, trans fatty acids and saturated fatty acids was higher among all age groups, except for trans fatty acids in adolescents (**Table 5A/5B**).

In the “Other Homes” pattern, there were no significant associations on energy and nutrients intake in children. Adolescents and adults consumed significantly less protein ($\beta = -1.5$; 95%CI = -2.5, -0.5; $\beta = -0.7$; 95%CI = -1.3, -0.02, respectively), and adolescents consumed more fat ($\beta = 1.7$; 95%CI = 0.1, 3.2) and saturated fatty acids ($\beta = 0.9$; 95%CI = 0.1, 1.6). Adults had higher energy ($\beta = 240$; 95%CI = 144, 335) and free sugars intake ($\beta = 1.5$; 95%CI = 0.6, 2.4) (**Table 5B**).

The elderly presented significantly higher free sugars ($\beta = 1.6$; 95%CI = 0.7, 2.4) and fat intake ($\beta = 0.3$; 95%CI = 1.0, 1.5) out of home.

Table 5A. Adjusted association of mean daily intakes of energy and nutrients with eating location patterns in children and adolescents, weighted for the Portuguese population distribution, the IAN-AF 2015-2016.

	Children (3-9 years)				Adolescents (10-17 years)			
	<i>“Home”</i>	<i>“Other Homes”</i> β (95%CI)	<i>“School or work”</i> β (95%CI)	<i>“Restaurants and other places”</i> β (95%CI)	<i>“Home”</i>	<i>“Other Homes”</i> β (95%CI)	<i>“School or work”</i> β (95%CI)	<i>“Restaurants and other places”</i> β (95%CI)
Energy (kcal)	ref	7 (-111, 126)	44 (-51, 139)	163 (7, 318)	ref	140 (-9, 289)	142 (35, 250)	249 (105, 393)
Protein (%TEI)	ref	-0.4 (-1.3, 0.4)	0.3 (-0.4, 0.9)	-1.8 (-2.9, -0.7)	ref	-1.5 (-2.5, -0.5)	-1.0 (-1.7, -0.3)	-1.3 (-2.3, -0.3)
Total carbohydrates (%TEI)	ref	0.4 (-1.2, 1.9)	0.5 (-0.8, 1.7)	-0.1(-2.2, 1.9)	ref	-0.2 (-1.9, 1.5)	1.0 (-0.2, 2.2)	-1.1 (-2.8, 0.6)
Free sugars (%TEI)	ref	0.5 (-1.1, 2.1)	-2.6 (-3.9, -1.3)	0.8 (-1.3, 2.9)	ref	0.8 (-0.9, 2.4)	-0.8 (-2.0, 0.4)	2.4 (0.8, 4.0)
Fibre (g)	ref	-0.8 (-2.2, 0.6)	1.8 (0.7, 2.9)	1.5 (-0.4, 3.3)	ref	1.0 (-0.5, 2.5)	2.5 (1.4, 3.5)	0.7 (-0.8, 2.1)
Fat (%TEI)	ref	0.2 (-1.3, 1.6)	-0.9 (-2.1, 0.3)	2.0 (0.1, 3.9)	ref	1.7 (0.1, 3.2)	-0.1 (-1.2, 1.0)	2.4 (1.0, 3.9)
Saturated fatty acids (%TEI)	ref	0.5 (-0.2, 1.2)	-0.3 (-0.9, 0.2)	1.2 (0.3, 2.0)	ref	0.9 (0.1, 1.6)	0.3 (-0.3, 0.8)	1.3 (0.6, 2.0)
Trans fatty acids (%TEI)	ref	0.1 (-0.1, 0.2)	-0.1 (-0.1, 0.03)	0.2 (0.003, 0.3)	ref	-0.01 (-0.1, 0.08)	-0.05 (-0.1, 0.01)	0.08 (-0.01, 0.16)
Sodium (mg)	ref	-7 (-221, 207)	190 (19, 362)	350 (69, 631)	ref	347 (75, 619)	361 (165, 556)	410 (148, 672)

Models adjusted for sex, degree of urbanization and education level
TEI – total energy intake; CI – Confidence Interval.

Table 5B. Adjusted association (and 95% confidence Interval) of mean daily intakes of energy and nutrients with eating location patterns in adults and elderly, weighted for the Portuguese population distribution, the IAN-AF 2015-2016.

	Adults (18-64 years)				Elderly (65-84 years)	
	<i>“Home”</i>	<i>“Other Homes” β (95%CI)</i>	<i>“School or work” β (95%CI)</i>	<i>“Restaurants and other places” β (95%CI)</i>	<i>“Home & Other homes” β (95%CI)</i>	<i>“School or work & Restaurants and other places” β (95%CI)</i>
Energy (kcal)	ref	240 (144, 335)	161 (105, 217)	220 (159, 280)	ref	23 (-70, 116)
Protein (%TEI)	ref	-0.7 (-1.3, -0.02)	0.2 (-0.2, 0.6)	-0.5 (-0.9, -0.1)	ref	0.6 (-0.001, 1.3)
Total carbohydrates (%TEI)	ref	-0.7 (-1.9, 0.6)	-0.7 (-1.4, 0.03)	-1.8 (-2.6, -1.0)	ref	-0.3 (-0.9, 1.4)
Free sugars (%TEI)	ref	1.5 (0.6, 2.4)	0.8 (0.3, 1.3)	1.6 (1.0, 2.1)	ref	1.6 (0.7, 2.4)
Fibre (g)	ref	0.5 (-0.6, 1.6)	1.0 (0.3, 1.6)	-0.3 (-1.0, 0.4)	ref	-0.8 (-2.0, 0.4)
Fat (%TEI),	ref	0.6 (-0.4, 1.6)	0.4 (-0.2, 1.0)	0.9 (0.3, 1.5)	ref	0.3 (1.0, 1.5)
Saturated fatty acids (%TEI)	ref	0.4 (-0.1, 0.8)	0.3 (0.1, 0.6)	0.7 (0.4, 2.0)	ref	0.3 (-0.2, 0.9)
Trans fatty acids (%TEI)	ref	0.003 (-0.04, 0.05)	0.008 (-0.02, 0.03)	0.03 (0.003, 0.06)	ref	0.03 (-0.01, 0.07)
Sodium (mg)	ref	385 (194, 576)	343 (231, 454)	401 (280, 521)	ref	112 (-79, 302)

Models adjusted for sex, degree of urbanization and education level
TEI – total energy intake; CI – Confidence Interval

Discussion

This is the first study in Portugal examining out of home consumption on a national level and one of the few studies involving a whole range of age groups. Our analysis showed that most meals in the Portuguese population were made at home, and only about 30% of total energy intake came from foods eaten out of home. In a large study with European adults (18), contribution from meals made out of home to total energy intake was different by country and gender, varying in men from 12% in Poland to 29% in Sweden and in women from 11% in Italy to 31% in Sweden. Another study performed in a nationally representative sample of Belgium (32) where 35,2% of the population were considered “substantial out of home” eaters, showed that 23,5% of daily energy consumed were from foods eaten out of home. Data from the Brazilian Nationwide Dietary Survey conducted in 2008–9, revealed a smaller contribution from out of home foods on the percentage of total energy intake, with 18% corresponding to an average of 337kcal (33).

Overall, being classified with out of home eating patterns was more frequent in younger, male, and highly educated participants, as previously concluded by Naska *A et al.* in adults from a European multicentre study with data collected from 1996 to 2004(34).

Using the information of the four eating location patterns defined *a priori*, it was possible to observe that children, adolescents, and adults were mostly classified in the “School or work” eating location pattern and the elderly in the “Restaurants and other places” pattern. A study with data retrieved from the UK National Diet and Nutrition Survey 2008-2014, found similar results in children from 1.5 to 18 years old whose main eating location out of home was school, corresponding to 7.1–17.0% of eating occasions (22). In adults, the most frequent eating location after home was work with the exception for individuals aged 65 and over; in this age group, food outlets were more relevant when eating out of home (35).

As concluded in a systematic review by Lachat C. *et al.* (14) and confirmed in this analysis, an age gradient in energy contribution from meals eaten out of home is observed, with a peak during childhood. In the present study, the percentage of meals performed out of home was 45%, 36%, 34% and 13% in children, adolescents, adults, and elderly. Older people may be less prone to eat out of home since they did not develop this habit in young age (4), and when younger they did not have the food availability that exists today (36); also, they tend to have less disposable income (37).

Less educated individuals consumed more meals at home, and when out of home, did it more in restaurants than at school or work. In an UK study, children from low socio-economic status (SES) were more likely to eat unhealthy take away meals at

home (36). In adults, despite higher SES being associated with eating out more frequently, those of lower SES consumed unhealthy take away meals more frequently (38). Individuals with higher SES, estimated through income, probably have more money to spend on out of home meals; those of higher educational level probably eat out more at work, as seen in individuals of higher educational level in our sample which were mainly classified into the “School or work” pattern.

Additionally, regarding the degree of urbanization and eating location patterns, the main difference was that in urban areas individuals were mainly classified in the “School or Work” pattern and in rural areas into “Restaurants and other places” pattern. Probably these results could be explained by age and education differences since urban areas are commonly populated by younger and higher educated individuals, unlike predominantly rural areas which are mainly occupied by the elderly. About 30% of the Portuguese population that live in rural areas are over 65 years and about 9% over 80 years old or more (39); simultaneously there is a lower frequency of working individuals among the elderly.

“Restaurants and other places” pattern was associated with lower HEI scores among all age groups, characterized by an unhealthier dietary profile with higher consumption of “salty snacks”, “sugar sweetened beverages” among all age groups, of “red and processed meat” and “sweets” in adolescents and adults and of “sugar and honey” in adults. These foods, commonly high in fat, sugars, and sodium, contributed to the positive associations between this pattern and the higher intake of total energy, fat, saturated fatty acids, trans fatty acids, sodium, and free sugars. In adults, higher mean intakes of fat and saturated fatty acids, and of trans fatty acids, are results similar to those found in a study with middle aged adults from Europe (34). In Portuguese preschool children (21), data on food consumption at restaurants was similar to our study. Irish children, aged 5-12 years old, had higher percentage of energy from fat out of home, comparing with home, that was above the national recommendation for fat intake (40). This pattern was positively associated with the consumption of sweets and sugar sweetened beverages, foods previously documented as most eaten out of home (34). Our results regarding alcoholic beverages support previous findings that alcohol intake is higher out of home (3, 41). Specifically, in our study, the odds of consuming beer were two to three times higher in this pattern and one to two times in “School or work” pattern. This phenomenon has been detailed for the Portuguese population by Bento A. *et al.* (42) that described, with food balance sheet data a reversal of availability regarding alcoholic beverages since 1988, with beer becoming the most available, over wine. Also, in the IAN-AF 2015-2016(43), although wine is the most common alcoholic beverage in adults, among consumers beer is consumed in higher quantities. Unhealthy

diet choices made out of home, especially in restaurants, can be explained in several ways. Celebrating special occasions, where taste or pleasure of eating surpasses the concept of healthy eating; making unusual diet choices; and, ultimately eating in higher quantities if included in big social gatherings (44).

Compared to “Home”, “School or work” pattern was characterized by a higher consumption of “fruit, vegetables and pulses” and “cereals and starchy tubers”. Similar results have already been reported in Portuguese pre-school children (21) and in studies with children and adolescents in the UK (22). This consumption was reflected on the positive association between this pattern and higher fibre and sodium intake among children and adolescents. Particularly in children and adolescents, the higher sodium intake could be derived from soup and breads, foods that contributed to a higher sodium intake among the Portuguese population (21, 43, 45). These data suggest that it is more feasible for children to have a healthier diet at school than at home, a result further confirmed by the positive association between this pattern and the HEI score in children, but not in adolescents. The school food environment maybe more protective of children than adolescents, probably because of public policies such as School Scheme which distributes fruits and vegetables in preschools and 1st cycle students (46) but not after that education level. Besides, Portuguese adolescents have access to foods in school cafeterias and vending machines that may not agree with the legislation regarding healthy food supply. A national study showed that most establishments did not comply with this legislation, not following the recommended proportion of foods to be promoted versus foods to be limited (3:1) (47). Also, healthy foods are more expensive, a factor that weighs more than the nutritional value of foods in the moment of purchase (48). Adolescents are more independent and are free to choose from a wider range of foods outside of school and, subsequently, are more vulnerable to the food environment which may influence dietary behaviours through differences in availability and access to foods (49-51). The sale of unhealthy foods outside school, such as ultra-processed foods, has been documented in previous studies (52, 53), suggesting that an unhealthy school neighbourhood may contribute to poorer dietary choices. As seen in other studies and in our sample, we can conclude that the school food environment and its impact on dietary choices may be different for younger than older children (22, 54).

In adults, the higher consumption of “sugar sweetened beverages” and “sweets” “probably explains the higher free sugars intake. In the UK, non-milk extrinsic sugars, also known as free sugars, were consumed more at work than at home, a trend that remained from young adults (19-23 years old) to older adults (50-64 years old) (35). Tea and coffee have been previously documented as foods most out of home among European adults, contributing both in quantity and energy, on account of the added sugar

(3). The higher consumption of “white meat, fish, and eggs”, “red and processed meat” and “sweets” possibly contributed to the association between higher intake of saturated fatty acids and this pattern. Other studies consistently show that eating at work contributes to higher energy intakes through higher fat and carbohydrates intake (18, 55). Consumption at work vs at home can vary by gender as seen in a Norwegian study (56) in working adults with differences in the added sugars, meat and meat products and sugar sweetened beverages consumption, higher in men. However, both groups had similar and higher intakes of carbohydrates and fibre at work. Eating at work might include foods from various sources (canteen, vending machine, foods brought from home) and eating at staff canteens should be promoted since this practice has been associated with compliance of recommended food habits, such as eating vegetables more than once daily (57). In our study, higher fibre intake was associated with “School or work” pattern probably due to higher mean daily intake of fruit, vegetables, and pulses; however, we did not distinguish the sources of consumption at work so cannot infer that this consumption came from workplace canteens.

Adolescents and adults in the “Other Homes” pattern presented significantly lower HEI scores. Adolescents had higher fat and saturated fatty acids intake and adults’ higher free sugars intake, and both had lower protein and higher sodium intake. Accordingly, a study with Irish children aged 5-12 years showed worse dietary profile in other homes (40). Data on social facilitation, that is, eating more in the presence of others would be an important factor to consider in adolescents given the effects of peer pressure on their food choices (58). Peer influence has been shown to contribute to higher consumption of fast food in adolescents of poor neighbourhoods (51) and of snacks high in solid fats and added sugars at friend’s homes (59). Information regarding consumption in other homes among adults is scarce, and some authors choose to aggregate data in a single category such as “home” (55).

Study strengths and limitations

One main strength of this study is the fact that the data was obtained from a representative sample of the Portuguese population and used a harmonized methodology of dietary assessment standardized to Europe, proposed by the EFSA (26). Representativeness was assured by comparing participants with the distribution of the population living in Portugal, according to data from the National Statistics Institute. As already previously detailed (24), after weighting, the final sample of the IAN-AF presented an even distribution to the population living in Portugal, and the largest difference did not exceed three percentage points in relation to the distribution of the age

group of the very elderly (75–84 years). Despite non-participants being older and less educated, common in dietary surveys, these differences were not significant considering the main areas of interest of this survey (diet, physical activity, and nutritional status). Additionally, even though the participation rate was low, results were similar to other dietary surveys.

Regarding the dietary assessment methods, the electronic platform (eAT24) to collect dietary intake, the conversion of nutrients at ingredient level, the food classification system FoodEx2 and the use of five methods to estimate food portions, are also considered strengths of the present study. The use of two non-consecutive 24 h recalls dietary assessment allowed to consider the intraindividual variation and the estimation of usual intake. An additional strength of this study is the inclusion of food and beverages and not only nutrients, as well as the use of an index to characterize dietary adequacy. The HEI is one example of a theoretically defined dietary pattern a priori, based on current nutritional guidelines or recommendations and it comprises food groups and nutrients (60). It is useful to measure overall diet adequacy and it is a comprehensive and complementary approach to study single food and cumulative and interactive effects of nutrients and foods (31, 60). However, indexes for overall diet adequacy involve multiple arbitrary choices related to what variables (foods and/or nutrients) to be included, cut-off values and scoring; there is not a defined methodology to construct them and therefore, they vary between authors, studies and countries given the different nutritional guidelines (60).

Comparisons with other studies might be hardened by the diversity of methodological approaches – evaluation of the whole food service sector or a particular element (take away restaurants, fast food restaurants); analysis of a full day or specific meals; different data collection methods or age groups; and different definitions of eating out. Describing food consumption according to eating location patterns and not just outside/inside home provides a better comprehension of out of home food consumption. Most research regarding eating out practices considered foods prepared out of home irrespective of where the items were consumed and methods to define eating out are not homogeneous, with some studies capturing all foods eaten out of home, others from specific food outlets such as fast food or full-service restaurants, but few made the distinction between eating at food outlets vs. worksites. In our study, the eating location patterns defined a priori, did not consider food that has been prepared out and consumed at home, or food that has been prepared at home and consumed out. Although the adoption of the HECTOR Consortium (61) core definition of “eating out” as to include “meals, beverages, snacks consumed out of home was done in an multicentre European study (that included Portugal) (18), this can mask the real prevalence of eating out. As it

is the place of preparation that determines the composition of the food and not the place of consumption, the assessment of the source and/or preparation of the food instead of the place consumption, would be an advantage. A further strength of this study is the inclusion of a whole range of age groups, especially in children and adolescents which is relevant since many of the existent studies were performed with adults, and it is important to understand this type of consumption in younger individuals.

Conclusions

In the present study, eating location patterns apart from “Home”, were strongly associated with higher energy intakes and specifically “Restaurants and other places”, with worse dietary adequacy. Simultaneously, there was an association between meals away from home and more total energy, sodium, and fat intake. One important finding is that among children, it is possible to have a better diet adequacy within the school environment than at home, which demystifies the premise that eating out has necessarily a negative impact on the diet adequacy.

Given that children and adolescents do most of their out of home meals at school, food and nutrition policies regarding these groups should consider the role of the school food environment and its surroundings (62). Among adults, and as confirmed by our results, there is a growing acknowledgment that the workplace setting could have a significant impact on health given the contribution of meals to overall diet (63). Promoting healthy diets in the workplace can benefit individuals, employers and society since diet-related burdens such as obesity are related to increased sickness absence and absenteeism in employees (64-67), injuries at work and compensation claims (64).

Regarding out of home food consumption, school or work canteens and restaurants seem to be important places to consider when developing nutrition policies and health promoting strategies, specially targeting younger age groups, higher-educated individuals, and males.

The knowledge produced by IAN-AF 2015-2016 and the present analysis give light on the issues regarding out of home food consumption in Portugal, contributing to the current scientific evidence in different age groups, and ultimately providing inputs for policy makers and caterers to continue an efficient planning and execution of effective public health policies.

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Supplementary material

Table S1. Mean daily intake of food groups and respective Healthy Eating Index (HEI) score, according to eating location patterns by age groups, weighted for the Portuguese population distribution, the IAN-AF 2015-2016).

<i>mean (SE)</i>	<i>Fruit, vegetables, and pulses (g)</i>	<i>Cereals and starchy tubers(g)</i>	<i>Dairy (g)</i>	<i>White meat, fish, and eggs (g)</i>	<i>Red and processed meat (g)</i>	<i>Salty Snacks (g)</i>	<i>SSB (g)</i>	<i>Sugar and Honey (g)</i>	<i>Sweets (g)</i>	<i>Healthy Eating Index</i>
Children (3-9 years)										
<i>Home</i>	224 (18.7)	202 (18.1)	438 (32.9)	73.4 (6.8)	51.4 (5.8)	12.6 (2.9)	138 (22.4)	2.4 (0.66)	82.6 (7.9)	18 (0.42)
<i>Other homes</i>	242 (20.5)	215 (10.3)	387 (23.4)	71.6 (4.8)	49.6 (4.4)	20.9 (9.1)	175 (28.0)	1.9 (0.61)	99.8 (10.0)	17.9 (0.43)
<i>School or work</i>	314 (12.1)	256 (7.3)	385 (15.4)	78.3 (3.7)	56.3 (3.4)	13.1 (2.4)	105 (10.1)	1.2 (0.32)	91.3 (5.2)	19.2 (0.19)
<i>Restaurants and other places</i>	272 (45.7)	231 (28.2)	286 (56.3)	58.1 (7.1)	57 (7.3)	64.6 (19.3)	248 (66.1)	0.7 (0.41)	102.6 (11.3)	16.8 (0.53)
p-value	0.011	0.022	0.073	0.131	0.655	0.015	0.042	0.166	0.451	<0.001
Adolescents (10-17 years)										
<i>Home</i>	226 (13.8)	322 (15.6)	328 (20.4)	105.3 (9.1)	85.5 (8.1)	39.9 (7.9)	262 (24.9)	2.1 (0.57)	110 (8.8)	21.4 (0.3)
<i>Other homes</i>	259 (35.7)	298 (20.1)	292 (21.3)	83.2 (11.1)	93.6 (8.1)	34.7 (7.6)	305 (59.0)	2.8 (0.73)	93.8 (7.9)	20.3 (0.46)
<i>School or work</i>	283 (14.4)	349 (13.0)	346 (17.3)	91.7 (5.4)	90.1 (6.6)	33.9 (7.3)	211 (20.0)	2 (0.32)	112.6 (7.5)	22 (0.3)
<i>Restaurants and other places</i>	198 (17.8)	274 (12.0)	239 (24.2)	75.1 (7.8)	102.4 (14.7)	66.2 (9.3)	382 (39.0)	2 (0.61)	131.7 (13)	18.6 (0.53)
p-value	0.019	0.005	0.003	0.106	0.649	0.037	0.01	0.782	0.138	<0.001
Adults (18-64 years)										
<i>Home</i>	350 (10.6)	295 (8.0)	225 (10.2)	105.9 (4.2)	73.2 (3.8)	20.9 (3.5)	75 (7.9)	6.5 (0.43)	63.1 (3.3)	21.2 (0.15)
<i>Other homes</i>	351 (21.1)	320 (17.0)	213 (14.7)	107.1 (7.5)	97 (8.5)	40.3 (9.3)	167 (37.9)	6.5 (0.98)	79.6 (7.2)	20.4 (0.29)
<i>School or work</i>	384 (10.1)	294 (5.7)	244 (8.4)	119 (3.9)	85.3 (3.7)	23.7 (2.5)	110 (9.8)	7.4 (0.57)	80.0 (3.7)	21.0 (0.14)
<i>Restaurants and other places</i>	334 (11.1)	309 (9.2)	199 (6.8)	112.8 (4.7)	100.3 (3.9)	33.5 (3.2)	171 (11.1)	8.0 (0.41)	79.9 (4.6)	20.0 (0.15)
p-value	0.009	0.248	0.005	0.116	<0.001	0.030	<0.001	0.117	0.012	<0.001
Elderly (65-84 years)										
<i>Home & Other homes</i>	411 (11.8)	291 (11.2)	232 (15.1)	93.8 (5.0)	47.1 (3.5)	9.1 (2.0)	28.0 (5.3)	7.1 (0.63)	47.4 (3.8)	18.9 (0.19)
<i>School or work & Restaurants and other places</i>	400 (25.2)	268 (13.4)	202 (18.6)	94.1 (8.7)	70.9 (7.8)	11.2 (3.2)	44.0 (11.4)	9.6 (0.81)	45.8 (4.9)	17.8 (0.4)
p-value	0.657	0.160	0.210	0.977	0.010	0.582	0.244	0.017	0.813	0.013
p-value for interaction with age group	0.233	0.025	0.001	<0.001	<0.001	<0.001	<0.001	0.003	0.006	<0.001

SE- standard error; SSB – sugar sweetened beverages

Table S2. Mean daily intake and the respective standard error (SE) of energy and nutrients, according to participants eating location patterns by age groups, weighted for the Portuguese population distribution, the IAN-AF 2015-2016.

<i>mean (SE)</i>	<i>Energy (kcal)</i>	<i>Protein (%TEI)</i>	<i>Total carbohydrat es (%TEI)</i>	<i>Free sugars (%TEI)</i>	<i>Fibre (g)</i>	<i>Fat (%TEI)</i>	<i>Saturated fatty acids (%TEI)</i>	<i>Trans fatty acids (%TEI)</i>	<i>Sodium (mg)</i>
Children (3-9 years)									
<i>Home</i>	1539 (82)	17.8 (0.6)	50.3 (1.3)	13.0 (0.8)	12.0 (0.7)	30.1 (1.0)	10.6 (0.4)	0.5 (0.1)	2100 (140.0)
<i>Other homes</i>	1639 (57)	17.1 (0.6)	51.3 (0.6)	13.3 (0.7)	12.7 (0.7)	29.8 (0.8)	11.0 (0.4)	0.7 (0.1)	2265 (86.0)
<i>School or work</i>	1689 (30)	17.6 (0.2)	51.4 (0.4)	10.4(0.3)	15.8 (0.3)	28.8 (0.5)	10.1 (0.2)	0.5 (0.03)	2472 (54.0)
<i>Restaurants and other places</i>	1868 (118)	15.5 (0.7)	49.2 (0.9)	12.5(0.9)	15.7 (1.3)	33.3 (0.9)	12.0 (0.5)	0.7(0.1)	2862 (221.0)
p-value	0.077	0.118	0.313	0.002	<0.001	0.015	0.006	0.092	0.007
Adolescents (10-17 years)									
<i>Home</i>	2024 (67)	18.3 (0.4)	50.9 (0.7)	12.5 (0.9)	15.6 (0.6)	29.0 (0.5)	10.0 (0.3)	0.5 (0.04)	2836 (93.0)
<i>Other homes</i>	1965 (84)	17.2 (0.6)	48.7 (1.2)	12.1 (1.2)	15.5 (0.9)	32.3 (1.1)	11.5 (0.5)	0.5 (0.04)	2992 (193.0)
<i>School or work</i>	2122 (59)	17.3 (0.3)	51.2 (0.5)	11.0 (0.6)	18.2 (0.6)	29.6 (0.4)	10.7 (0.3)	0.5 (0.02)	3221 (110.0)
<i>Restaurants and other places</i>	2148 (71)	17.1 (0.6)	48.7 (0.9)	14.1 (0.9)	16.2 (0.9)	32.3 (0.7)	12.0 (0.4)	0.6 (0.1)	3118 (134.0)
p-value	0.308	0.608	0.055	0.078	0.007	0.003	0.002	0.033	0.102
Adults (18-64 years)									
<i>Home</i>	1780 (34)	18.4 (0.2)	46.8 (0.5)	7.4 (0.2)	17.4 (0.3)	29.7 (0.4)	9.3 (0.2)	0.4 (0.02)	2952 (66.0)
<i>Other homes</i>	2059 (86)	18.3 (0.6)	46.1 (0.9)	8.9 (0.8)	18.5 (0.8)	30.0 (0.7)	9.7 (0.3)	0.4 (0.03)	3360 (126.0)
<i>School or work</i>	1973 (26)	18.8 (0.2)	46.2 (0.4)	8.4 (0.3)	19.0 (0.3)	30.3 (0.3)	9.7 (0.1)	0.4 (0.01)	3373 (68.0)
<i>Restaurants and other places</i>	2109 (44)	18.3 (0.2)	44.3 (0.4)	8.7 (0.3)	17.9 (0.4)	30.4 (0.4)	10.0 (0.2)	0.4 (0.01)	3509 (83.0)
p-value	<0.001	<0.001	<0.001	0.023	0.016	0.540	0.003	0.019	<0.001
Elderly (65-84 years)									
<i>Home & Other homes</i>	1649 (28)	17.2 (0.3)	47.5 (0.7)	5.6 (0.3)	18.3 (0.5)	28.0 (0.5)	8.5 (0.2)	0.3 (0.01)	2752 (61.0)
<i>School or work & Restaurants and other places</i>	1671 (55)	17.7 (0.4)	45.5 (1.3)	7.0 (0.6)	17.6 (0.7)	28.3 (0.8)	8.8 (0.3)	0.3 (0.02)	2894 (125.0)
p-value	0.708	0.280	0.169	0.063	0.440	0.700	0.380	0.981	0.322
p-value for interaction with age group	<0.001	<0.001	<0.001	0.025	0.020	<0.001	<0.001	0.027	<0.001

SE- standard error; TEI – total energy intake

GENERAL DISCUSSION

In this thesis, and by using individual intake data from a national dietary survey, including a representative sample of the Portuguese population, a detailed description of eating location patterns was performed. We examined energy and nutrients intake, food consumption and explored eating location patterns association with diet adequacy, using a cross sectional approach. We further analysed these associations within different age groups – children, adolescents, adults, and elderly – providing an overall picture of out of home food consumption in Portugal.

Overall, results suggest that eating out of home seems to be associated with worse diet adequacy, with some exceptions among age groups and patterns, and an overall decrease in individuals' meals frequency out of home as they got older. Differences in the types of foods consumed out of home might depend on the motifs to eat in those places. Eating at canteens in schools or workplaces can be a part of an individual's daily life, a necessity, since they spend most of their time learning or working. However, eating at restaurants might be related with the celebration of special occasions, where taste or pleasure of eating surpasses the concept of healthy eating. Unusual dietary choices and eating in higher amounts are common when included in big social gatherings [62]. Additionally, larger portion sizes, greater availability of energy-dense foods, beverages and desserts, healthy food options scarcity and lack of nutrition information about foods content, might also contribute to more total calories eaten out of home [14, 63]. Among children and adolescents, the worse diet adequacy in restaurants could be related with the fact that parents might have lenient practices towards food consumed out of home, compared to home(165). Understanding the differences in food parenting styles between environments could help to perceive the implications in their children's diet choices(166).

From a social perspective, children are less responsible of their diet choices, a responsibility that falls to their parents or educators. Families' food environment plays an important role in shaping young individuals' behaviours and attitudes towards food choices in the early years of life. As children grow and become adolescents, the freedom to choose from a wider range of foods and their social relationships change, being more exposed to the food environment surrounding them and being susceptible to peers and family members. In this stage, school become an important place to promote healthy eating habits, more than just a place to have meals. Adults face other types of daily constraints such as longer working hours, time scarcity to eat and to prepare food, the presence of dependents at home and pressure from family members or colleagues to eat and make diet choices in a certain manner. Among the elderly, the better dietary adequacy can be explained by the lower consumption of processed foods(167) and spending less on out of home meals(168).

An overall improved diet adequacy was observed in children that mostly ate at school. This did not happen in adolescents, and this might be because the school food environment maybe more protective of children since current public school policies implemented in Portugal are targeted to 1st cycle students(169) but not after that educational level. Adolescents have access to a wider range of unhealthy foods in their school surroundings and to foods in school cafeterias and vending machines that may not agree with the legislation regarding healthy food supply. Also, adolescents generally choose foods that are more available or easily accessible(170, 171). Healthy-eating education seems to be an insignificant aspect in the secondary school curriculum(172). Besides food accessibility, it is important to include healthy eating education as part of school's initiatives, targeting adolescents and their families.

The workplace might not be as protective as the school environment in terms of food availability and promotion of healthy eating habits. Eating at work has been described as an “ambiguous area”(104) since it might include foods from various sources: canteen, vending machine or foods brought from home. Identifying barriers and facilitators of healthy eating at work might help human resources departments and occupational health professionals that work to improve employees mental and physical health. Mazzola J. *et al*(173) depicted as barriers to healthier nutrition behaviours heavy workload, temptations to indulge, scarcity of healthy food options and social influences; the most common facilitators were healthy planning and the availability of healthy food options. Promoting healthy diets in the workplace can benefit individuals, employers and society since diet-related burdens such as obesity are related to increased sickness absence and absenteeism in employees(174-177), injuries at work and compensation claims(174).

Income, occupation, and health literacy may also be associated with individual's diets adequacy when eating out of home. A recent study, with data from IAN-AF 2015-2016, showed that a higher income was associated with greater consumption of food groups commonly included in the Mediterranean diet, especially for fruits and vegetables, except for legumes. Non-Mediterranean foods consumption did not follow a clear income gradient and varied with education level and age(114). In a study in the UK, adults of lower socio-economic status, estimated through lower educational attainment and household income, consumed take away meals more frequently (71). Low income individuals might see the higher price of healthy foods as a barrier(178) unlike those of higher income who probably have more disposable income to spare on out of meals. In the USA, home-cooked dinners were strongly associated with higher diet adequacy with no extra self-reported cost proving that interventions to improve home-cooked meals should be promoted (179). Cooking at home might be an effective strategy to reduce

energy-dense foods consumption and improve diet adequacy within the budget. Moreover, since time constraints have been appointed as barriers to home cooking(71), cooking classes should teach efficient cooking approaches and time-saving skills.

Unlike education, occupation measures the current socio-economic status of an individual and can relate to their income (ability to purchase material resources), social standing (access to certain privileges), social networks and work exposures(180, 181). Adults of higher occupation class are more likely to eat out at least once per week and variances in out of home consumption using occupation class can be explained by the cost of the meal and cultural differences in leisure activities(182). To infer how the nutritional quality and quantity of food purchased varies across SES, it would be useful to include the financial cost and nutritional information on the purchased products and the places where food was purchased(79); this would help to determine if the association between SES and higher energy contribution from eating out is due to higher frequency of meals (ability to purchase OH meals) or worse energy density (differentiate what is healthy and what is not)(129). Besides the analysis of the education level and given that poor health literacy is associated with an unhealthy lifestyle and poor diet(183), nutritional literacy would be an interesting aspect to assess in studies regarding out of home food consumption, regarding for example, nutrition facts labels knowledge and consumer's interpretation(14).

Currently, there is a discussion over the possible paths for out of home food consumption interventions. Lachat C. *et al*(184) proposed five different strategies to engage European caterers in the supply of health-promoting products. First to increase the offer on seasonal and or local products/traditional dishes; second to educate caterers on healthy menus; third to promote nutritional literacy among consumers; fourth, to improve marketing strategies regarding healthy options, in and out of home; and finally, to include catering strategies in governmental policies.

Adapting restaurants menus to have healthier food options could be done by increasing the number of fruits and vegetables options, especially in main dishes and desserts, and providing healthy options at a lower price. Other factors that could improve healthier food choices out of home are the flexibility and adequacy of foods portion sizes, healthier cooking methods and marketing strategies towards healthier foods(125, 185). Menu changes can be challenged by profitability, customer demand, regulation, and corporate social responsibility, and thus become obstacles to the commercial sector to maintain revenue and remain competitive. The European Union legislation does not extend the obligation of nutrition labelling in menu items prepared and served in food outlets, despite the increase in foods eaten outside home and strong consumer support for this kind of actions.

Menu labelling is necessary in these interventions since most consumers underestimate the energy content of out of home foods (186), which are associated with increased energy intake(129, 187). A study with university students(188) acknowledged the importance of improving and changing menu labelling by including ingredients lists as a method to allow informed choices on healthy foods. Moreover, it was suggested a numerical scale or traffic light system to enable gradation of foods healthiness. The information required when eating out can vary according to consumer and setting (189, 190). Health messages, such as energy or other key nutrients information in fast food restaurants, seem to be more effective since food-based decisions in those locations are taken under time pressure and require high cognitive load which rely on simple processing strategies, such as an energy restriction. At home, decisions can be made calmly and consciously and thus a complex ingredient list can be better perceived(191, 192). Consumers seem to trust more in restaurants that provide clear information.

Considering the work environment, a good example of a positive intervention is currently implemented in Brazil. These guidelines state that food establishments or contractors of meals supply must offer only unprocessed or minimally processed foods and homemade dishes(121). Ultra-processed foods cannot be sold directly, promoted or advertised and processed foods should be limited. This is the type of initiative that promotes healthy eating out habits and should be considered when considering out of home consumption in employed individuals.

In Portugal, within the last decade, the National Program for the Promotion of Healthy Eating (PNPAS) has developed multiple and intersectoral actions within the context of the modification of the food environments(193), particularly in public spaces such as schools and workplaces. In schools, specific policies were promoted regarding menus, school meals guidelines for school buffets and the establishment of School Scheme, with distribution of milk and fruit in primary schools and pre-schools. In the workplace setting, guidelines for the food supply in restaurants were created under the FOOD Program (Fighting Obesity through Offer and Demand) and in 2015, data from this project showed that Portuguese's restaurants had a growing recognition of the importance of preparing healthy meals.

Study strengths and limitations

This work has several strengths and limitations that require discussion.

The present study was strengthened by the inclusion of individual intake data retrieved from a representative sample of the Portuguese population and by the use of a standardized methodology of dietary assessment proposed by the EFSA(194). The

use of two non-consecutive 24h-recalls for dietary assessment considered the intra-individual variation of usual intake. Moreover, the possibility of using five methods to estimate food portions (as previously described) may increase the precision of our estimates.

Previous studies on out of home consumption have focused on specific age groups, mostly in adults. A further strength of our analysis is the inclusion of an all range of age groups, especially children and adolescents, which out of home consumption has been understudied.

An additional strength of this study is the inclusion of an index to characterize dietary adequacy, which is a comprehensive and complementary approach to study single food and cumulative and interactive effects of nutrients and foods(195, 196). However, there are limitations to its comparability with other studies since there is not a defined methodology among authors (variables to be included, cut-off values and scoring(195). An over-reporting of healthier foods and/or under-reporting of less healthy foods might have produced a social desirability bias. If this is true, our associations could be underestimated and might be even stronger. Additionally, by using large food groups and not distinguish specific foods, we could have masked the estimation of other associations. For example, the category of “Sweets” included a range of products that contain ingredients from other categories as well, such as cakes, pastry, ice cream and cereals bars.

The diversity of methodological approaches used among studies accentuates the difficulty in comparing results. Our study described food consumption according to eating location patterns and other authors choose to evaluate all foods eaten out of home or from specific food outlets such as fast food or full-service restaurants; our approach provides a better comprehension of out of home food consumption and makes the distinction between eating at food outlets vs. worksite.

The definition of eating location patterns did not consider food that has been prepared out and consumed at home, or food that has been prepared at home and consumed out. The adoption of the HECTOR Consortium(128) core definition of “eating out” as to include “meals, beverages, snacks consumed out of home, as done in an multicentre European study (that included Portugal)(104), does not allow to perceive the real prevalence of eating out. Since the place of preparation determines the composition of the food and not the place of consumption, this assessment instead of the place consumption, would be an advantage.

CONCLUSIONS

Recently, the WHO expressed their concerns regarding the increasing popularity of out of home food consumption, claiming that “action is needed to improve countries’ capacities to collect quality data, share resources and adopt best practices”(197). Accordingly, these interventions should make feasible the availability of healthier options, the establishment of adequate portion sizes, the regulation of the digital environment and ultimately improve population health. “Our current level of understanding is inadequate to develop relevant policies. WHO/Europe will continue to facilitate this dialogue among Member States and other stakeholders to advance the agenda in this area,” added Dr Wickramasinghe.

This analysis explored out of home consumption in different age groups of the Portuguese population and supported previous conclusions that this consumption varies according to age and location. “Home” was the prevailing pattern, more frequent among women, elderly, and individuals of low education. “School or work” was the most common out of home pattern among children, adolescents, adults and those of higher education.

In children, the school pattern was associated with a better adequacy than at home, with less intake of free sugars and higher consumption of fruits, vegetables, and pulses and consequently, of fibre. However, in restaurants, the food and nutritional profile was less adequate, through greater consumption of energy-dense foods such as salty snacks and sugar sweetened beverages and higher energy, fat, and sodium intake. Adolescents showed a pattern in transition to worse food choices outside the home, in other homes or restaurants, with subsequent worse diet adequacy. As for adults, all eating out contexts were associated with a less adequate diet and higher consumption of sugar sweetened beverages, sweets, salty snacks, and sugar. Also, they had a higher probability of drinking alcoholic beverages in restaurants. The elderly, as said above, ate most of their meals at home. Outside the home environment, they had a worse diet adequacy and consumed more red meat, sugar, salty snacks, and sugar sweetened beverages.

Identifying the contributions of home cooked meals and different out of home meal types to individuals’ overall diet adequacy, provided additional insights that can help guide public health policies and interventions encouraging healthier dietary patterns. Future studies should work on developing a standardized terminology regarding the definition of eating out to enable adequate and clearer comparisons between studies as well as the inclusion of questions on meal sourcing. Moreover, it is important to address the different aspects of socio-economic status – education, income, and occupation – to explore potential associations with meal patterns. Regular surveys

on this matter are important to identify secular trends in meal sourcing and consumption, to adapt public health initiatives to prevailing eating patterns.

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