

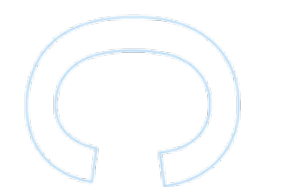
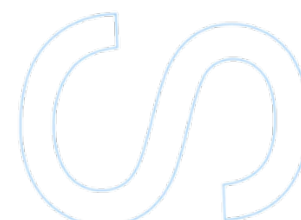
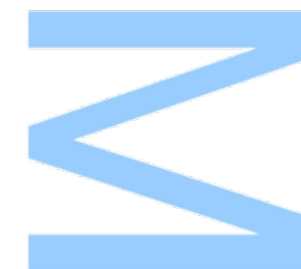
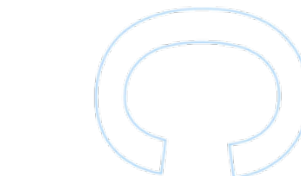
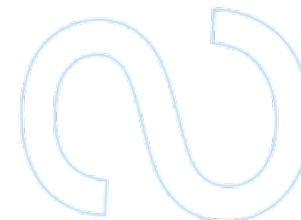
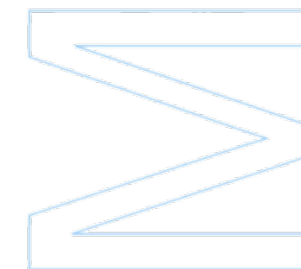
Screen time, food advertising and childhood obesity: an analysis in the Portuguese population.

Marta Vieira da Silva Figueira

Dissertação de Mestrado apresentada à
Faculdade de Ciências da Universidade do Porto
e Faculdade de Ciências da Nutrição e
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Screen time, food advertising and childhood obesity: an analysis in the Portuguese population

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Mestrado em Ciências do Consumo e Nutrição

Departamento de Geociências, Ambiente e Ordenamento do Território

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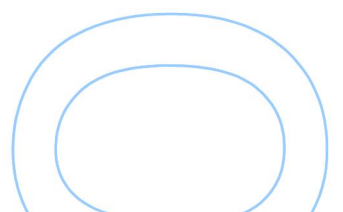
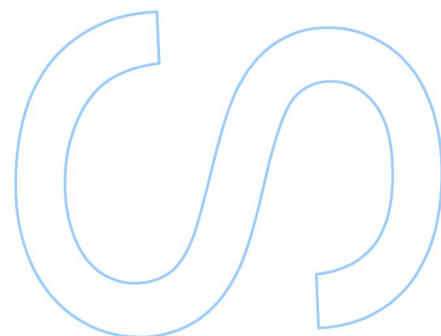
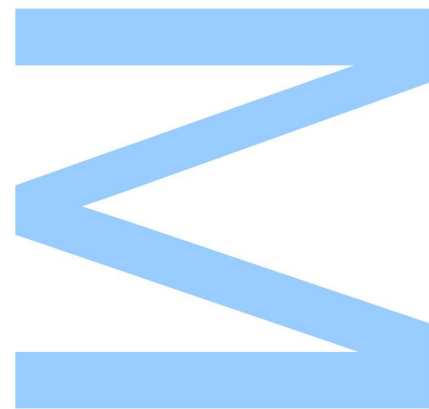
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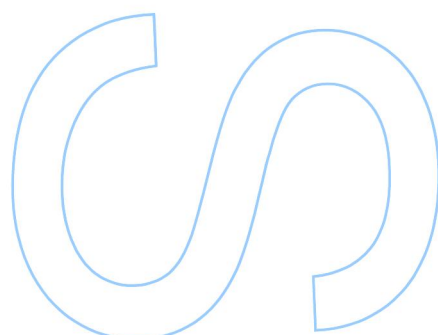
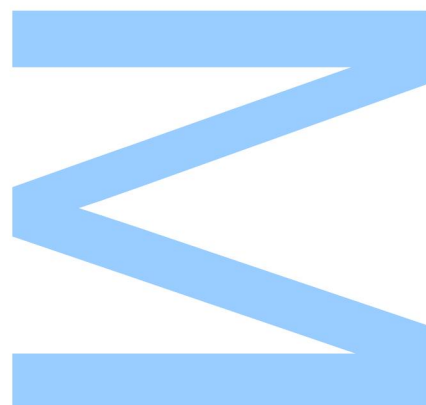
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Esta dissertação tem por base dois manuscritos, nos quais colaborei de forma ativa na revisão da literatura, operacionalização das hipóteses, definição dos objetivos, análise e interpretação dos dados e fui responsável pela redação das suas primeiras versões:

- I. **Changes in screen time from 4 to 7 years of age, dietary patterns and obesity: findings from the Generation XXI birth cohort**
- II. **Monitoring food marketing directed to Portuguese children broadcasted on television**

Declaração de Honra

Eu, Marta Vieira da Silva Figueira, inscrita no Mestrado em Ciências do Consumo e Nutrição da Faculdade de Ciências da Universidade do Porto declaro, nos termos do disposto na alínea a) do artigo 14.º do Código Ético de Conduta Académica da U.Porto, que o conteúdo da presente dissertação reflete as perspetivas, o trabalho de investigação e as minhas interpretações no momento da sua entrega.

Ao entregar esta dissertação, declaro, ainda, que a mesma é resultado do meu próprio trabalho de investigação e contém contributos que não foram utilizados previamente noutros trabalhos apresentados a esta ou outra instituição.

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Figueira da Foz, 29 de Setembro de 2022

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Resumo

Introdução: A exposição das crianças aos ecrãs e à publicidade alimentar afeta os seus comportamentos alimentares, preferências e consumo alimentar, influenciando consequentemente o seu estado nutricional e saúde.

Objetivo: Este trabalho avaliou a exposição das crianças portuguesas aos ecrãs (principalmente à televisão) e associações com o consumo alimentar e obesidade infantil, e a extensão e poder da publicidade alimentar televisiva.

Métodos: Os objetivos foram respondidos através de dois artigos com diferentes metodologias. Para a análise da evolução do tempo de ecrã, padrões alimentares e obesidade infantil, foram utilizados dados do recrutamento e das avaliações aos 4 e aos 7 anos da coorte de nascimento Geração XXI, numa amostra de 4531 crianças. O tempo de ecrã foi avaliado separadamente para dias de semana e de fim de semana, estimando-se posteriormente a média diária. As associações entre alterações no tempo de ecrã entre os 4 e 7 anos, padrões alimentares previamente identificados (*Energy-dense foods*, *Snacking*, e *Healthier*) e o estado nutricional aos 7 anos foram estimadas por *odds ratio* (OR) e respetivos intervalos de confiança a 95% (IC 95%), calculados através de modelos de regressão multinomial ajustados. No segundo objetivo, a análise à publicidade alimentar televisiva foi realizada de acordo com os protocolos de monitorização dos anúncios televisivos, desenvolvidos pela Organização Mundial da Saúde para a região europeia e com o modelo de perfil nutricional determinado pela Direção-Geral da Saúde para as restrições ao marketing alimentar dirigida a crianças. Os anúncios televisivos de 4 canais generalistas portugueses foram recolhidos durante 2 dias de semana e 2 dias de fim de semana, entre as 6:00 e as 22:00 horas no mês de Novembro de 2021.

Resultados: No primeiro artigo verificou-se que dos 4 aos 7 anos de idade 31,5% das crianças diminuíram o seu tempo de ecrã, 21,8% aumentou, 16,5% manteve um tempo de ecrã baixo (≤ 60 min) e 30,2% manteve um tempo de ecrã elevado (61-120 min ou >120 min). A baixa escolaridade materna (OR=2,33; IC 95%, 1,82-2,99) e baixo rendimento familiar mensal (OR=1,72; IC 95%, 1,35-2,11) associaram-se a uma maior probabilidade de aumentar o tempo de ecrã, enquanto ser rapariga estava associado a 35% menor probabilidade de aumentar o tempo de ecrã. Crianças que aumentaram o seu tempo de ecrã ou mantiveram um tempo de ecrã elevado apresentaram maior probabilidade de seguir um padrão alimentar “*Snacking*” aos 7 anos (OR=2,34; IC 95%, 1,64-3,35, e OR=2,65; IC 95%, 1,89-3,72, respetivamente), em comparação com o padrão “*Healthier*”. Não se verificou uma associação significativa entre as alterações do tempo de ecrã e o estado nutricional das crianças aos 7 anos. Adicionalmente, do

segundo artigo concluiu-se que as crianças portuguesas estão potencialmente expostas a um grande número de anúncios a alimentos não saudáveis na televisão. Dos 5272 anúncios transcritos, os alimentos e bebidas foram a 3^a categoria mais publicitada (n=590; 11,2%) e nenhum dos 131 anúncios (22,2%) a alimentos e bebidas dirigidos a um público jovem cumpriu o modelo de perfil nutricional definido pela legislação nacional. Os alimentos mais publicitados a crianças e jovens foram chocolates e produtos de confeitaria (42,0%), bebidas açucaradas (26,7%) e iogurtes (16,0%). A maioria destes anúncios foi transmitida fora do horário de pico das crianças, durante o período da manhã e em noticiários e programas de entretenimento. Por último, as técnicas de persuasão primárias usadas mais frequentemente foram a exclusividade do produto (26,7%), humor (24,4%) e diversão (16,0%)

Conclusão: Os nossos resultados mostram que as crianças em idade pré-escolar estão muito expostas aos ecrãs, a maioria excedendo as recomendações de um máximo de 1h de exposição aos ecrãs por dia, e que existe uma associação positiva entre este comportamento e um consumo alimentar pouco saudável. Adicionalmente, este estudo mostra que apesar das restrições ao *marketing* alimentar, existe ainda uma grande percentagem de anúncios alimentares não saudáveis com conteúdo dirigido a crianças nos canais televisivos portugueses. Intervenções futuras devem procurar limitar o tempo de ecrã das crianças e é necessária uma monitorização contínua da publicidade alimentar para assegurar que as restrições impostas são cumpridas.

Palavras-Chave: *marketing* alimentar; obesidade; televisão; crianças; consumo alimentar.

Abstract

Introduction: Children's exposure to screens and food advertising affects their eating behaviours, preferences, and food consumption, thus influencing their nutritional status and health.

Aim: This study evaluated Portuguese children's exposure to screens (mainly television) and associations with food intake and childhood obesity, as well as the extent and power of television food advertising.

Methods: Objectives were achieved through two papers with different methodologies. To analyse the evolution of screen time, dietary patterns and childhood obesity, data from the baseline and the 4- and 7-years of age assessments from the Generation XXI birth cohort were used, in a sample of 4531 children. Screen time was evaluated separately for weekdays and weekend days, and average daily time was then computed. Associations between changes in screen time between 4 and 7 years, dietary patterns previously identified (Energy-dense foods, Snacking and Healthier) and nutritional status at 7 years were estimated by odds ratios (OR) and respective 95% confidence intervals (95% CI), calculated using adjusted multinomial regression models. In the second objective, the analysis of television food advertising was carried out in accordance with the protocols for monitoring television advertisements, developed by the World Health Organization for the European Region and with the nutrient profile model determined by the Directorate-General for Health for food marketing restrictions aimed at children. Television advertisements from 4 Portuguese generalist channels were collected during 2 weekdays and 2 weekend days, between 6:00 and 22:00 hours in November 2021.

Results: In the first paper, from 4 to 7 years of age, 31.5% of the children reduced their screen time, 21.8% increased it, 16.5% maintained a low screen time (≤ 60 min) and 30.2% maintained a high screen time (61-120 min or > 120 min). Low maternal education (OR=2.33; 95% CI, 1.82-2.99) and low family income (OR=1.72; 95% CI, 1.35-2.11) were associated with higher odds of increasing screen time, while being a girl was associated with 35% lower odds of increasing screen time. Children who increased their screen time or maintained a high screen time were more likely to follow a "Snacking" dietary pattern at 7 years (OR=2.34; 95% CI, 1.64-3.35, and OR=2.65; 95% CI, 1.89-3.72, respectively), compared to the "Healthier" pattern. There was no significant association between screen time changes and children's nutritional status. Furthermore, from the second paper we concluded that Portuguese children are likely exposed to many advertisements for unhealthy foods on television. Of the 5272 transcribed advertisements, food and beverages were the 3rd most advertised category (n=590; 11.2%) and none of the 131 advertisements (22.2%) for food and beverages aimed at a

young audience fulfilled the nutrient profile model defined by national legislation. The most advertised foods and beverages to children and teenagers were chocolates and confectionery products (42.0%), sugary drinks (26.7%) and yogurts (16.0%). Most of these advertisements were broadcasted during children's non-peak time, during the mornings and on News and Entertainment programmes. Finally, the most frequently used primary persuasive techniques were product uniqueness (26.7%), humour (24.4%) and fun (16.0%).

Conclusions: Our results show that preschool-age children are overexposed to screens, majority of them exceeding the recommendations of a maximum of 1h of screen exposure per day, and that there is a positive association between this behavior and unhealthy food consumption. Additionally, this study shows that despite food marketing restrictions, there is still a large percentage of unhealthy food advertisements with children-directed content on Portuguese television. Future interventions should seek to limit children's screen time and continued monitoring of food advertising is needed to ensure that the imposed restrictions are being complied.

Keywords: food marketing; obesity; television; children; food consumption.

Table of contents

Agradecimentos	5
Resumo.....	6
Abstract	8
List of Tables	11
List of Figures.....	12
List of Abbreviations	13
Introduction.....	14
1. Childhood obesity	14
2. Screen time	15
2.1. Sedentary behaviour and screen time	15
2.2. Screen time recommendations for children and prevalence.....	16
2.3. Screen time and health outcomes	16
2.3.1. Screen media exposure and weight gain.....	17
3. Food marketing to children.....	18
3.1. Children's exposure to television food advertising	19
3.2. Impact of food marketing on children's behaviours and health	20
3.3. Restricting and monitoring food marketing to children.....	21
3.3.1. Food marketing restrictions in Portugal.....	22
Objective.....	23
General objective	23
Specific objectives	23
Paper I.....	24
<i>Changes in screen time from 4 to 7 years of age, dietary patterns and obesity: findings from the Generation XXI birth cohort.....</i>	24
Paper II.....	47
<i>Monitoring food marketing directed to Portuguese children broadcasted on television.....</i>	47
Conclusions.....	70
References	72

List of Tables

Paper I – Changes in screen time from 4 to 7 years of age, dietary patterns and obesity: findings from the Generation XXI birth cohort

Table 1 – Family and child’s characteristics of the sample.

Table 2 – Associations between family and child characteristics and screen time at 4 years and changes in screen time from 4 to 7 years of age.

Table 3 – Multinomial regression model for the associations between family and child characteristics at 4 years and changes in screen time between 4 and 7 years.

Table 4 – Associations of changes in screen time from 4 to 7 years with dietary patterns at 7 years and children’s BMI at 7 years.

Supplementary Table: Magnitude of the differences between included and excluded participants.

Paper II – Monitoring food marketing directed to Portuguese children broadcasted on television

Table 1 – Percentage of TV food and beverage advertisements, by food category, used in all food and beverage advertisements and those targeted to children and teenagers.

Table 2 – Percentage of TV food and beverage advertisements, according to different factors, used in all food and beverage advertisements and those targeted to children and teenagers.

Table 3 – Secondary persuasive techniques used in all food and beverage advertisements and those targeted to children and teenagers.

Table 4 – Percentage of food and beverage TV advertisements, according to different variables foreseen in the Portuguese Legislation, used in all food and beverage advertisements and those targeted to children and teenagers.

List of Figures

Paper II – Monitoring food marketing directed to Portuguese children broadcasted on television

Figure 1 – Number of food and beverage advertisements, by TV channel, accordingly to the compliance with the nutritional profile outlined by the Portuguese Directorate-General of Health ($p=0.020$).

Figure 2 – Time Slot percentage of all food and beverage advertisements and those targeted to children and teenagers ($p=0.018$).

Figure 3 – Distribution of primary persuasive techniques used in all food and beverage advertisements and those targeted to children and teenagers ($p<0.001$).

List of Abbreviations

AAP	American Academy of Paediatrics
BMI	Body Mass Index
COSI	Childhood Obesity Surveillance Initiative
CPS	Canadian Paediatric Society
DP	Dietary Patterns
DVD	Digital Video Disc
EDF	Energy-dense Foods
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FFQ	Food Frequency Questionnaire
HFSS	High in saturated fats, trans fats, free sugars and/or salt
IAN-AF	National Food, Nutrition and Physical Activity Survey
METs	Metabolic Equivalents
NPM	Nutrient Profile Model
SRBN	Sedentary Behaviour Research Network
SSB	Sugar-sweetened Beverages
SD	Standard Deviation
TV	Television
UNICEF	United Nations International Children's Emergency Fund
US	United States
UK	United Kingdom
WHO	World Health Organization

Introduction

Excessive early screen exposure is associated with adverse health outcomes, especially obesity, which represents a major public health concern (1-3). Both increased exposure to screens and food advertising appears to have a significant effect on children and adolescents' eating behaviours, conditioning their product preferences, requests, and diet, which consequently affects their nutritional status and health (4-7). Previous studies have shown that children snack more on high-density low-nutrient foods in front of television (TV) (4, 5) and are influenced to make unhealthy choices due to their exposure to advertisements for foods high in saturated fats, trans fats, free sugars and/or salt (HFSS) (8, 9), giving rise to weight gain and obesity.

Is it during the preschool period (occurring between the ages of 2 and 6) that children start to develop food preferences and begin to recognize brands (10, 11). Because it represents a period of physical, cognitive, motor, emotional and social development (12) in which children establish health-related lifestyles that may persist into later childhood, adolescence and adulthood, it represents a critical time on children's lives (13). Thereupon, children's exposure to television and other forms of media should be discouraged under the age of 2 and limited to older children, as recommended by several societies (14-16), as well as children's exposure to food advertising on television. Based on this evidence, policy solutions to restrict the marketing of HFSS foods to children have been proposed and should be monitored (17).

1. Childhood obesity

Childhood obesity is a complex and serious public health problem. Joint United Nations International Children's Emergency Fund (UNICEF) / World Health Organization (WHO) / World Bank child malnutrition estimates from 2020 showed that overweight (including obesity) affected 4.4 million children under the age of 5 years in the WHO European Region, representing 7.9% of all children in this age group (18). In Portugal, according to the National Food, Nutrition and Physical Activity Survey 2015-2016 (IAN-AF) data, 7.7% of children under 10 present obesity and 17.3% pre-obesity (19). Additionally, according to the Childhood Obesity Surveillance Initiative (COSI) 2019, around 29.6% of children aged between 6 and 8 years present overweight (including obesity) and 12% present obesity (20).

Children with overweight or obesity are more likely to live with obesity in adulthood and develop associated chronic non-communicable diseases such as diabetes, cardiovascular disease, high blood pressure and respiratory problems, and it

is additionally associated with social exclusion problems, anxiety and depression (21, 22).

As a multifactorial disease, the aetiology of obesity is the set of “genetic, behavioural, environmental, physiological, social and cultural factors that result in energy imbalance and promote excessive fat deposition” (23, 24). Sedentary lifestyles and unhealthy eating behaviours, namely towards foods high in saturated or trans fat, refined sugars and salt, are commonly identified as the main conditioning factors of overweight and obesity (25). Also, heavy marketing of energy-dense foods has been recognized by the WHO and the Food and Agriculture Organization of the United Nations (FAO) as a “probable” cause for the increasing prevalence of childhood overweight and obesity (26). Moreover, the marketing of unhealthy foods is a key component of the so-called obesogenic environments, defined as “the sum of influences that the surroundings, opportunities, or conditions of life have on promoting obesity in individuals or populations” (27-29). In this sense, limiting television viewing and restricting the intake of unhealthy food and beverages - that are commonly being advertised on television - is an important step to prevent childhood obesity.

2. Screen time

2.1. Sedentary behaviour and screen time

The term sedentary behaviour, according to the Sedentary Behaviour Research Network (SRBN) Terminology Consensus Project (30), is described as “any walking behaviour characterized by an energy-expenditure ≤ 1.5 metabolic equivalents (METs), while in a sitting, reclining or lying posture”, not including sleep (which has important health functions) and not to be confused with physical inactivity (i.e., not meeting physical activity guidelines) (30, 31).

According to the same project (30), screen time refers to time spent on screen-based behaviours, which can be performed while being sedentary or physically active. As for sedentary screen time, it is defined as “time spent using a screen-based device (e.g., smartphone, tablet, computer, television), while being sedentary in any context (e.g., school, work, recreational)”. Active screen time, on the other hand, is the “time spent using a screen-based device while not being stationary in any context”, for example, running on a treadmill while watching television (30).

Screen time is often the main contributor to overall sedentary time, and can comprise TV viewing, watching digital video disc (DVDs)/videos, playing video games, recreational computer, smartphone or tablet use (31).

2.2. Screen time recommendations for children and prevalence

Since 2001, the American Academy of Paediatrics (AAP) recommends restricting children's (over 2 years of age) total screen time to no more than 1 to 2 hours per day (15). Other associations have adopted identical guidelines. For example, in 2019 the WHO published Guidelines on physical activity, sedentary behaviour and sleep recommending that, for children 3-4 years, sedentary screen time should be limited to no more than 1 hour; but less is better (14). In Canada, the Canadian Paediatric Society (CPS) has also guidelines according to age, since 2012, for healthy growth and development for children 2-4 years, screen time should be limited to <1 h/day; and for health benefits, children (5-11 years) and youth (12-17 years) should limit recreational screen time to no more than 2 h/day (16). Moreover, all three organizations discourage TV viewing for children under 2 years of age (14-16).

Despite these recommendations, excessive screen time is highly prevalent among children and teenagers and has been increasing over the years (32). In the United States (US), according to the Nielsen 2020 total audience report, children aged 2-11 years were engaged with screens (TV, game console and internet connected device usage) over 3 hours per day (33). Among school-aged children between 8 and 17 years, a comparative analysis of US and United Kingdom (UK) children's screen time has shown that US children spent significantly less time using devices than UK children (146 min/day and 180 min/day respectively, on a non-school day) (34). Results from a cross-sectional study performed in nine European countries among 11-year-old school children, showed a mean of 2.3 hour per day of watching TV and videos in these countries, and children from Belgium, Netherlands and Portugal watched 2.7 hours of TV and videos per day, on average (35). This study has also shown that TV was on, overall, 3.4 days a week during dinnertime and in Portugal this seems to happen most days (5.5 days a week); children from Norway and Sweden, on the other hand, rarely have the TV on during dinnertime (35). According to IAN-AF data in 2015-2016, 37% of children and adolescents between 3 and 14 years spend more than 2 hours per day on weekdays watching television, and this prevalence increases to 71% on weekends (19). Moreover, data from a study on Portuguese children aged 3-4 years from Coimbra, Lisbon and Porto in 2016/2017, showed that children spend an average of 92 min/day on weekdays and 167 min/day on weekends engaged in screen media devices (36).

2.3. Screen time and health outcomes

According to the literature, increased levels of screen time, in both children and adolescents, is associated with multiple adverse outcomes, such as violence and

aggressive behaviour (37), poor school performance (38) and increased risk of obesity (39-41).

Regarding health outcomes, the association with adiposity is the most widely studied (40-42). In a systematic review published in 2012, LeBlanc *et al.* (40) found evidence that increased TV viewing was associated with unfavourable measures of adiposity in the early years (0-4 years), consistent with evidence in older children (5-17 years), that reported a positive association between more daily screen time and an increased risk of becoming overweight or obese (42).

In another systematic review, Gonçalves de Oliveira *et al.* (43) found a significant direct association between sedentary behaviours (represented by screen time over 2 hours/day on weekends) and the development of metabolic syndrome in adolescence. There is also evidence on the positive association between overall screen time and depressive and anxiety symptoms, as well as a lower health-related quality of life (44), decreased self-esteem and pro-social behaviour (40).

2.3.1. Screen media exposure and weight gain

Three mechanisms are thought to explain the relation between screen media exposure and weight gain: reduced energy expenditure and increased energy intake are the most discussed ones, but reduced sleep has also been discussed (45-47).

On the one hand, screen media exposure reduces the time that children are enrolled in more active physical activities that promote energy expenditure, thus displacing time spent being more physically active, as it generally represents a sedentary activity (46). Several studies have manipulated children's TV viewing to determine its impact on physical activity. For example, Ford and colleagues (48) found that reducing TV viewing in 13.7 hours/week increased organized physical activity in 2.5 hours/week and 1 hour/week of playing outside, on school-aged children.

On the other hand, previous studies have shown that children who have a higher screen time also have an increased consumption of high-density foods, rich in fats, free sugars or salt (4, 5, 49), and a decreased consumption of fruits and vegetables (49, 50) – increased caloric intake may be caused by exposure to food advertising (51). Effects of screen time on dietary intake - both foods and nutrients - have been widely studied among children (5, 52) and adolescents (53, 54). A special focus has been given to high-density foods, such as fast-food (4), as well as particular food groups, such as fruits and vegetables (50). Taveras *et al.* found that, among preschool-age children, for each 1-hour increase in TV/video viewing per day, children had 60% greater odds of consuming fast-food 1 or more times per week (OR=1.60; 95% CI, 1.03 - 2.49) (4). Also, in a study in children aged 6-9 years from five European countries, one additional hour of screen

time was associated with lower consumption of fresh fruits (OR=0.91; 95% CI, 0.86 - 0.97) and vegetables (OR=0.89; 95% CI, 0.83 - 0.95) (49). Because foods are consumed in combination and not isolated, dietary patterns (DP) analyses may provide a more comprehensive approach to food consumption and its associations with other outcomes (55). Some studies (56-58) have reported a positive association between screen time and unhealthier DPs. For example, a cross-sectional analysis performed in 1359 French adults showed that TV viewing was positively associated with a 'convenience' DP (characterized by positive coefficients for ready-to-eat products, desserts, candy and croissants and negative coefficients for vegetable, vegetable oil, meat and poultry) in men and a 'alcohol-appetizer' pattern in women (56). Also, the Bibiloni *et al.* study showed that, among adolescents aged 12-17 years living in the Balearic Islands, a 'Western' DP (that included high-fat foods, oils and fats, soft drinks, and other foods) was associated with spending more than 4 hours a day on media screen time. However, little is known about the association between changes in screen time and DP at specific age transitions, such as pre-school to school age.

At last, reduced sleep can cause changes in the appetite-regulating hormones and increase hunger (59, 60). For example, the Sekine *et al.* study showed a strong inverse association between sleeping hours and childhood obesity (60). In comparison with children with 10 or more hours of sleep, the adjusted odds ratio for the prevalence of obesity was 1.49 (95% CI 1.08–2.14) for those with 9–10 hours of sleep, 1.89 (95% CI 1.34–2.73) for those with 8–9 hours of sleep, and 2.87 (95% CI 1.61–5.05) for those with <8 hours of sleep (60). Moreover, sleep timing and chronotype may contribute to obesity by shaping the timing of eating behaviour (61). Although less is known among children, in adults, correlational studies have found associations between adiposity indicators and late-night eating of foods high in fats and carbohydrates (62).

Besides time spent watching TV, parents' cultural attitudes and habits toward media also contribute and influence children's media use (63). Watching TV during meals was associated with a lower intake of vegetables and fruit and a higher intake of soft drinks, pizzas and snack foods (64). Also, having a TV in the child's bedroom was associated to an increased risk being overweight and spent more time watching TV (65).

3. Food marketing to children

Unhealthy food marketing aimed at children and adolescents impacts their eating behaviours, preferences, and nutrition knowledge and is a significant contributor to poor diets and weight-related outcomes (6, 7, 22). The United Nations Convention on the

Rights of Children requires States to recognize the children's best interests and fulfil their right to health, which includes protecting them from harmful marketing messages (66).

Although online advertising has increased rapidly, with marketers using websites, advergames, social media and other platforms to target children (67), television is still one of the leading platforms on marketing foods to children (68).

Hence, regulating children's exposure to unhealthy food marketing on television and other forms of media and implementing policies and restrictions is mandatory.

3.1. Children's exposure to television food advertising

Television continues to be a major source of food advertisements to children and teenagers, especially younger children (69). As major targets of food marketing, children are massively exposed to it through a variety of media, including TV (68, 70). In Russia and China, according to studies conducted in both countries, food and beverages were the most frequently advertised products on television, counting nearly 20% and 25.5% of all advertisements, respectively (71, 72). Moreover, in a collaboration study among 13 research groups in Australia, Asia, Western Europe and North and South America, it was found that in each country food products were among the top 3 advertised products, contributing between 11% (Brazil, n=454) and 29% (Greece, n=1816; and Italy, n=732) of total advertisements (73).

Marketing is defined as an activity used to facilitate and promote the purchase of a product or service, and advertising is one type of marketing activity (74). Food marketing includes but is not limited to advertising. It covers a wide range of techniques such as branding, sponsorship, promotional activities, and product placement in order to add value to a food product and persuade the consumer to purchase it (17, 75, 76).

Children's understanding of TV advertising largely depends on their age. Preschool children have the ability to distinguish advertising from programming; around the age of 8, children perceive the intention of persuasion and after the age of 11-12 they can build a critical thinking about advertising and its intention (76). Besides recognizing familiar packages in the stores and familiar characters on food products (which happens around 2-3 years of age), pre-schoolers are also able to recall brand names from seeing them in advertised television or featured in product packages, especially if associated with colours, pictures, or characters. Hence, most of children's food requests are for branded products (10). Teens, on the other hand, are likely to experiment numerous brands – being that brand loyalty is highest for carbonated soft drinks and fast-food restaurants (77).

Children and teenagers are marketers preferred target, not only because they are extremely vulnerable to marketing strategies, but also because of their spending

power, their purchasing influence, and as future adult consumers (74). Also, marketers use a range of strategies, from branded spokes characters to promotions or premium offers, to build awareness and develop brand loyalty among youth, which is intended to be sustained into adulthood (69)

Results from Kelly *et al.* (2010) collaborative study among 13 research groups showed that high-density foods represented 53% to 57% of the advertisements and the rate of advertising of unhealthy food and beverage products was highest during children's peak viewing hours. Also, most advertisements using persuasive marketing techniques were from unhealthy food and beverage products: in all countries 12% of food advertisements contained premium offers and 23% contained promotional characters (73).

3.2. Impact of food marketing on children's behaviours and health

Research recognizes that unhealthy food and beverage marketing has a negative impact on children's eating behaviours, during or after exposure to food advertisements and other forms of marketing. Food marketing influences children's dietary preferences (particularly for branded foods), purchase requests, beliefs, consumption, and dietary intake, particularly for children and adolescents (70, 78, 79). This raises concern as advertised foods are usually the opposite of a balanced and healthy diet. Sugary breakfast cereals, savoury snacks, cakes and sweets, soft drinks and fast-food are among the most often advertised food products, whereas vegetables and fruits are significantly underrepresented (80).

Crespo *et al.* found that girls who watched 5 or more hours of TV daily had an extra energy intake of about 175 kcal, compared to those watching 1h or less/day - most likely due to a higher consumption of energy dense and low in nutrients foods (81). For preschool-aged children, Longacre and colleagues (82) found that exposure to advertising for sugary breakfast cereals was associated with higher consumption of those products.

Additionally, there is increasing evidence that children with obesity or overweight are more responsive to food advertising (7). Exposure to television advertising is associated with adiposity in both children aged 2-11 years and teenagers between 12 and 18 years (69). Also among teenagers aged 12-18 years, Chou *et al.* (83) found that greater exposure to fast-food advertising was statistically associated with higher body mass index (BMI). Furthermore, Powell and colleagues (84) examined the impact of exposure to food and beverage advertising on consumption and obesity outcomes. The results showed that children's exposure to cereal advertising was associated with both higher percent trunk and body fatness; fast-food advertising was significantly associated

with higher percent trunk fatness; and exposure to sugar-sweetened beverages (SSB) advertising was marginally significantly associated with percent body and trunk fatness.

3.3. Restricting and monitoring food marketing to children

Television advertising has been the subject of great debate and concern around the globe, as several countries have reported a high number of advertisements for unhealthy foods aimed at children and teenagers (80). Hence, television advertising is also the most widely regulated technique to advertise food and beverages to children, both at statutory and self-regulatory levels. A study by Corinna Hawkes (85) showed that from 73 countries, 85% have regulations on television advertising that specifically refer to children; 63% have statutory guidelines (usually in the national laws that control advertising) and 70% have self-regulatory guidelines (ethical guidelines, that is, the advertising should not be abusive or misleading).

Restricting the marketing of HFSS foods to children is a key recommendation in order to protect children from the impact of food marketing, as a means to improve dietary habits and reduce obesity rates (17). Over a decade ago, the WHO called for global action to reduce the impact of HFSS food marketing with the publication of the WHO's 2010 set of recommendations on the marketing of foods and non-alcoholic beverages to children, developed to guide efforts by Member States in designing new and/or strengthening existing policies on food marketing communications to children. (86). A recent systematic review on the effect of policies to restrict the marketing of foods and non-alcoholic beverages to which children are exposed found that restrictions may result in reduced purchases of unhealthy foods by or on behalf of children and that policies can effectively limit food marketing to children (79). The implementation of legislation in this area involves a prior definition of a monitoring system. In 2016, the WHO published a proposed protocol to provide the basis for monitoring and quantifying the extent and nature of children's exposure to the marketing of foods HFSS, via TV and the Internet (87). In brief, the protocol states the background, rationale and methods of data collection and analysis to assess both exposure and power of marketing to children, combining the best attributes of previous studies and research. Depending on a country's needs and research capabilities, the protocol and accompanying coding templates can be used for either TV or the Internet or both and includes a minimal and expanded version for the sampling, coding, and data entry.

According to 2018 Progress Report on Monitoring Policy Implementation, the majority (54%) of the WHO European Region have made progress to limit marketing of HFSS foods to children, either through mandatory or voluntary measures. Of these, 43% specified that the measures applied to television (88). United Kingdom was the first

European country to introduce regulations targeting HFSS food marketing to children, back in 2007, banning this type of advertising from children's channels and on programmes of appeal for children under 16 years of age (89). Guidelines vary between countries but, in general, advertisements should not give the impression that sweets, soft drinks and snacks can replace a regular meal; advertisements should not encourage excessive consumption; advertisements should encourage healthy diets and discourage unhealthy diets; misleading food advertisements regarding its nutritional value and other properties should be prohibit and good dental hygiene among children should be promoted (85).

3.3.1. Food marketing restrictions in Portugal

In Portugal, there are statutory and self-regulatory guidelines as well as specific restrictions on advertising to children (90-92). Since April 2019, the Law nº30/2019 is in effect, which applies restrictions to HFSS food advertising aimed at children under 16 years of age (92). According to this law, food marketing of HFSS to children is prohibited in traditional TV and on-demand audio-visual programmes and radio service, as well as TV and radio programmes targeted to children, and according to viewing audiences: when over 25% of the audience is under 16 years. Food advertising of HFSS foods must abstain from:

- encourage excessive consumption;
- create a sense of urgency or need for the consumption of the advertised product;
- transmit the idea of easy access to products, minimizing their cost;
- relate the consumption of the products to potential health benefits;
- use characters, figures, personalities, among others, that are aimed at children and promoting these foods as healthy, omitting harmful effects of such product, among other variables.

Accordingly, the Directorate-General for Health identified the values that should be taken into account in the identification of high energy value, salt, sugar, saturated fatty acids and trans fatty acids, published through the Dispatch nº7450-A/2019 (93). The nutritional profile model defined by the Directorate-General for Health was inspired by the WHO nutrient profile model (94), to which some changes were introduced in order to align the limits for some nutrients with the values defined by European Union (EU) legislation, as well as the limits imposed by Law nº30/2019.

Continued monitoring of food advertising in Portugal, in particular the compliance with the Law nº30/2019, in all venues, is essential to ensure that evidence is available to inform and guarantee that policies are adequately evaluated.

Objective

General objective

This research aims to study children's exposure to screens (mainly in the form of television) and associations with food intake and childhood obesity, as well as the extent and power of television food advertising.

Specific objectives

Specific objectives were defined and are divided into the two papers composing the dissertation:

Paper I

"Changes in screen time from 4 to 7 years of age, dietary patterns and obesity: findings from the Generation XXI birth cohort":

- To analyse changes in screen time from 4 to 7 years of age, and associated factors;
- To describe the association between screen time changes and dietary patterns;
- To describe the association between screen time changes and childhood obesity.

Paper II

"Monitoring food marketing directed to Portuguese children broadcasted on television"

- To evaluate the extent (reach and frequency) and power (creative content and design) of food advertising aimed at children broadcasted on Portuguese television.

Paper I

Changes in screen time from 4 to 7 years of age, dietary patterns and obesity: findings from the Generation XXI birth cohort.

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ABSTRACT

Introduction: Increased exposure to screens has been linked with unhealthy eating behaviours and obesity, but screen time changes from pre-school to school age and its association with dietary patterns and obesity have not been studied.

Aims: To analyse changes of screen time from 4 to 7 years of age and associated factors, and the relation with dietary patterns and obesity.

Methodology: The analysis included 4 531 children evaluated at 4 and 7 years of age, as part of the population-based birth cohort Generation XXI (Porto, Portugal). Screen time (television and electronic games) was assessed for weekdays and weekend and average daily time was estimated. Associations between covariates and screen time changes, and between screen time changes and three dietary patterns (DP) previously identified at 7 years (Energy-dense foods, Snacking, and Healthier DP) were estimated by odds ratios and confidence intervals (95% CI), using adjusted multinomial regression models.

Results: At 4 years of age, 27.9% of children were exposed to screens more than 120min/day. From 4 to 7 years, 31.5% of the children decreased their screen time, 21.8% increased, 16.5% maintained low (≤ 60 min) and 30.2% maintained high (either 61-120 min or >120 min) screen time. After adjustment, lower maternal education (OR=2.33; 95% CI, 1.82-2.99) and lower family income (OR=1.72; 95% CI, 1.35-2.11) were associated with higher odds of increasing screen time, while being a girl was associated with 35% decreased odds of increasing screen time. Children that increased and those that maintained high (vs. low) screen time, showed greater odds of presenting a Snacking DP at 7 years (OR=2.34; 95% CI, 1.64-3.35, and OR=2.65; 95% CI, 1.89-3.72, respectively), in comparison to those with a Healthier DP. No statistically significant differences were found regarding changes in screen time and child's BMI.

Conclusions: Children increasing screen exposure from pre-school to school age were more frequently from lower socioeconomic strata and presented unhealthier dietary patterns at 7 years.

Introduction

Early childhood high screen exposure can negatively impact children's and adolescents' health (1, 2), having been linked to a higher prevalence of violence and aggression (3), learning problems and poor school performance (4, 5), and obesity (6, 7). The relation between screen media exposure and weight gain has been well documented both in children and adolescents (8). Three mechanisms are thought to explain the effects of screen time on obesity. Firstly, this type of sedentary behaviour reduces the time that children are enrolled in more active physical activities that promote energy expenditure (9); secondly, it promotes food consumption, namely larger portions of food, an increased consumption of high-density foods, rich in fat, free sugars or salt (10-12) and a decreased consumption of fruits and vegetables (13), as a result of food marketing and advertising (14); and finally, shorter sleep duration has also been linked to screen media exposure, excessive energy consumption and obesity (8). Sleep deprivation can cause changes in the appetite-regulating hormones and increase hunger (15) and behavioural hypotheses such as "less sleep – more time to eat" have been discussed (16).

The American Academy of Paediatrics (AAP) recommends that the total media time should be limited to no more than 2 hours of quality programming per day (2) and the Canadian Paediatric Society (CPS) and World Health Organization (WHO) both recommend that screen-related sedentary behaviours should not exceed the maximum of 1 hour per day, for children aged 2 to 4 years (17, 18). However, evidence shows that many children do not meet these recommendations, easily exceeding the maximum screen time recommended (19-23). According to the Portuguese National Food, Nutrition and Physical Activity Survey in 2015-2016, 37% of children and adolescents between 3 and 14 years spend more than 2 hours per day on weekdays watching television (TV), and this prevalence increases to 71% on weekends (24). Moreover, data from 3–4-year-old Portuguese children, showed that children spend an average of 92 min/day on weekdays and 167 min/day on weekends using screen media devices (25).

Although several studies have studied prevalence of high screen time at different ages and the association with obesity, to our knowledge, few examined a child's changes of screen time, specifically from a preschool to a school-age (26, 27). Previous cross-sectional studies have reported a positive association between screen time and unhealthier dietary patterns (DP), mostly in adolescents and adults (28-30), but also in children (31). However, there is no information on the association between changes in screen time during childhood and dietary patterns. As habits and routines are easily created and established at early ages, an overexposure to screens increases the likelihood of overuse later in life (32), and the establishment of eating habits and food

choices in childhood may also persist into adulthood (33, 34). Thereby, understanding how screen time patterns evolve as well as their impact on children's dietary patterns can provide important data on the early behavioural antecedents of obesity (26). Therefore, the aim of this study was to analyse changes in screen time (TV and electronic games) from preschool to school age (from 4 to 7 years of age) and associated factors, and its association with dietary patterns and obesity at 7 years.

Material and Methods

Study design, Ethics and Participants

The present study was conducted within Generation XXI, a population-based birth cohort of new-borns and their mothers, recruited between April 2005 and August 2006, at each of the five level III maternity units in the Porto Metropolitan Area (35, 36). Of the invited mothers, 91% agreed to participate, resulting in a total sample of 8647 children and 8495 mothers evaluated at baseline. The whole cohort was invited to attend follow-up re-evaluations at ages 4, 7, 10 and 13 years.

The project Generation XXI was conducted according to the principles of the Declaration of Helsinki, and all procedures were approved by the Portuguese Authority of Data Protection and the Ethical Committee of the São João Hospital. At baseline and follow-up evaluations parents or legal tutors of each participant signed an informed consent form.

Of the 8647 children evaluated at baseline, 7459 were re-evaluated at the age of 4 and 6889 at the age of 7. After exclusion of children with incomplete information on screen time, at either 4 or 7 years, a subsample of 4966 subjects was considered eligible for the present study. From these, we excluded subjects with incomplete information on variables of interest: dietary patterns at 7 years ($n=119$), children's body mass index (BMI) ($n=46$ and $n=13$ at 4 and 7 years, respectively), maternal educational level ($n=22$), children's sedentary activities at 7 years ($n=19$), income ($n=74$), children's participation in sports ($n=17$ and $n=16$ at 4 and 7 years, respectively), children's active playtime at 7 years ($n=26$), mother's parity ($n=81$), and children's sleep duration at 4 years ($n=2$). A total of 4 531 children were used in final analysis.

Data collection

Data, at both 4 and 7 years of age, were collected using structured and standardized questionnaires answered by the main caregivers (usually mothers), by trained interviewers in face-to-face interviews.

The amount of time, in hours: minutes, spent watching television (or playing video games) was evaluated using an open question, separately for weekdays and weekend

days. The average daily time was computed and recoded into minutes per day and participants were classified into three categories: ≤ 60 minutes, 61-120 minutes and > 120 minutes. Screen time changes from 4 to 7 years of age were assessed through a computed variable with four categories: maintaining a low screen time (≤ 60 minutes), maintaining a high screen time (maintaining in the category 61-120 minutes or in the category > 120 minutes), decreasing screen time (changing to a category of lower duration) or increasing screen time (changing to a category of higher duration).

Dietary intake of the child's diet over the previous 6 months was evaluated through a 35 and 38-item qualitative food frequency questionnaire (FFQ), at 4 and 7 years of age, respectively (37). Caregivers were queried about how many times, on average, children had consumed each food item, using nine frequency options: '4 or more times per day'; '2-3 times per day'; '1 time per day'; '5-6 times per week'; '2-4 times per week'; '1 time per week'; '1-3 times per month'; 'less than once a month'; 'never'. Items were then combined in eleven food groups: (i) dairy (milk, yoghurts and cheese); (ii) meat and meat products (red and white meat, ham, sausages, pepperoni, smoked ham, bacon); (iii) fish; (iv) eggs; (v) vegetables (raw or cooked and vegetable soup); (vi) fruit; (vii) cereal (rice, potatoes, pasta, cereal flakes, bread) (viii) salty snacks (fast-food, salted snacks, patties); (ix) sweets and pastry (ice-cream, chocolate, lollipops, gums, candies, cakes, pastry, cookies and biscuits); (x) sugar-sweetened beverages (SSB); and (xi) fat spread (butter and margarine).

Three DP were previously identified in 4-year-old children, through latent class analysis and its definition was based on a framework, described elsewhere (38). Briefly, the DP definition included four conceptual levels: maternal socio-economic position at 12 years, maternal socio-economic and demographic characteristics at child's delivery, family characteristics at child's 4 years and maternal characteristics and behaviours at child's 4 years, as well as children's dietary intake evaluated by the FFQ. The three DP identified were: "Energy-dense foods" (EDF) characterized by higher consumption of EDF, "Snacking" characterized by a low consumption of foods consumed at main meals and intermediate in snacks, and "Healthier" characterized by a higher consumption of healthy foods, and lower in unhealthy ones (38).

Children's anthropometric measurements were performed according to standard procedures by experienced examiners, in both evaluations. Weight was measured using a digital scale to the nearest 0.1 kg, in underwear and without shoes, and body height was measured using a fixed stadiometer to the nearest 0.1 cm, without shoes, from the top of the head to the bottom of the feet.

Children's BMI was calculated and then converted into age- and sex-specific standard deviation (SD) scores (BMI Z-scores), according to the WHO growth charts

(39). As the prevalence of underweight was very low at both 4 and 7 years (0.5% corresponding to 24 and 23 individuals, respectively), the “underweight” BMI Z-score category was merged with the “normal weight” category. Thus, BMI Z-score categories were defined with the following cut-off points at 4 years: normal weight/underweight, $\leq +1$ SD; at risk of overweight, $+1 < \text{SD} \leq +2$; overweight, $+2 < \text{SD} \leq +3$; and obese, $> +3$ SD; at 7 years cut points were: normal weight/underweight, $\leq +1$ SD; overweight, $+1 < \text{SD} \leq +2$; and obese, $> +2$ SD.

Children’s sex and maternal characteristics were retrieved from baseline. Mother’s characteristics analysed included mother’s parity (categorized as 1st pregnancy, 2nd pregnancy and 3rd or further pregnancy), age, education level (≤ 9 , 10-12 or > 12 completed years of formal schooling), and monthly available income in euros (≤ 1000 , 1001-1500 and > 1500). Maternal pre-conception BMI was computed using self-reported weight before pregnancy (reported at study baseline), and height (measured, derived from clinical records or self-reported), and classified according to the WHO BMI cut-offs: underweight and normal weight ($\text{BMI} < 25 \text{ kg/m}^2$), overweight ($\text{BMI} 25\text{-}30 \text{ kg/m}^2$) and obesity ($\text{BMI} > 30 \text{ kg/m}^2$) (40).

Family structure and number of siblings living with the child were assessed at the 4-year-follow-up evaluation. Children’s participation in sports, dichotomized as yes or no, and children’s sleep duration (calculated as the difference between the hour that the child goes to sleep and the hour the child wakes up), categorized as less than or ≥ 10 h per night, were also obtained at the 4-year follow-up evaluation. Other covariates were obtained in 7-year-follow-up evaluation: children’s active playtime (average daily time spent playing, running, riding a bike...), classified in ≤ 60 min/day or > 60 min/day.

Statistical analyses

The characteristics of participants were presented as mean and standard deviation (SD) for continuous variables, and as absolute (n) and relative frequencies (%) for categorical variables. Proportions were compared using the Chi-square test and means through analysis of variance (ANOVA).

Associations between family and child characteristics and changes in screen time between 4 and 7 years were estimated by crude and adjusted odds ratio and 95% confidence intervals, using multinomial logistic regression models. The models were adjusted for different variables, according to the outcome. When the outcome was changes in screen time, the reference category was ‘Maintained low’ and the model included child’s sex, mother’s parity, child’s participation in sports, maternal age, and household income. Due to high correlation between mother’s education and household income, the model including mother’s education was not adjusted for income, and vice

versa. For models with dietary patterns as the outcome (Healthier DP as reference), adjustments were made for maternal education and children's active playtime; and for outcome nutritional status, the reference category was normal weight/underweight, and adjustments were maternal education, children's sex, and children's active playtime.

Statistical analyses were performed using the IBM®SPSS® Statistics software (IBM Corp. Released 2020. IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp), and the significance level was fixed at 0.05.

Results

Family and child characteristics are described in Table 1. Just over half the children were male (51.2%), and the majority corresponded to the mother's first pregnancy (58.6%). Mothers' mean age (SD) was 29.79 years (5.20) at baseline, 41.3% had up to 9 years of education and 67.7% presented normal weight/underweight before conception. At 4 years of age, most children did not have siblings (45.8%) and lived with both parents (88.9%). Regarding the household income, 46.4% earned >1500 euros per month, while a quarter of the sample (25.2%) earned less than 1000 euros per month.

At 4 years of age, 68.2% of the children included in the analysis were exposed to screens more than 1 hour per day, and 27.9% were exposed more than 120 min/day (Table 2). Associations between family and child characteristics and screen time at 4 years showed that screen time over 120 min/day was more frequent among boys ($p<0.001$), children with obesity ($p<0.001$), those not practicing sports ($p<0.001$) and sleeping less than 10h/night ($p=0.015$). Children with screen time over 120min/day had younger mothers, and excessive screen time was also more frequent among those with lower maternal education ($p<0.001$), lower household income ($p<0.001$) and no siblings living with the child ($p=0.046$). As for maternal pre-conception BMI and family structure no differences were found.

Between 4 to 7 years, 16.5% of children maintained a low screen time (≤ 60 min), 30.2% maintained a high screen time (maintaining in the category 61-120 minutes or in the category >120 minutes), 21.8% increased their screen time, and 31.5% decreased it (Table 2). The proportion of children maintaining low screen time (≤ 60 min) was higher among girls ($p<0.001$), normal weight children ($p<0.002$), those doing sports ($p<0.001$) and sleeping ≥ 10 h/night at 4 years ($p=0.011$), and among children whose mothers had higher education and higher household income at 4 years ($p<0.001$).

Table 3 summarizes the crude and adjusted associations between family and child characteristics and changes in screen time between 4 and 7 years. After adjustment for all variables in the table and using the category 'Maintained low' as the reference in the outcome variable, we found that boys were more likely to change their screen time,

either increasing (OR=1.53; 95%CI 1.26-1.86) or decreasing (OR=1.39; 95% CI 1.16-1.67) and were also more likely to maintain high screen time (OR=1.60; 95%CI 1.33-1.67). Children who did not practice sports showed 73% greater odds of decreasing their screen time (OR=1.73; 95% CI 1.41-2.12) and 33% greater odds of maintaining high screen time (OR=1.33; 95% CI 1.08-1.64). Regarding the maternal age, for each additional 5 years of mothers' age, children were 13% less likely to maintain a high screen time (OR=0.87; 95% CI 0.79-0.97). The lower the mother's education (≤ 9 years: OR=2.33; 95% CI 1.82-2.99) and the family income (≤ 1000 €/month: OR=1.72; 95% CI 1.35-2.11), the greater the odds for children to increase their screen time.

Considering the association between changes in screen time and dietary patterns at 7 years (Table 4), children that increased or maintained a high screen time between 4 and 7 years of age were more likely to present an Energy Dense-foods or a Snacking dietary pattern. After adjustment for maternal education and children's active playtime, and when compared to maintaining low screen time, all the other three categories (maintained high, increased and decrease) were associated with increased odds of following an Energy Dense-foods or a Snacking dietary pattern, but associations were stronger for those maintaining high or increasing screen time between 4 and 7 years. Children who maintained a high screen time showed 142% greater odds of following an Energy Dense-foods DP (OR=2.42; 95% CI 1.98-2.95) and 165% great odds of having a Snacking DP (OR=2.65; 95% CI 1.89-3.72). Association for the category of increased screen time were 2.13 (95% CI 1.73-2.64) and 2.34 (95% CI 1.64-3.35), respectively. Regarding the associations between changes in screen time between 4 and 7 years and child's BMI at 7 years (Table 4), although no statistically significant differences were found ($p=0.192$), we found a lower prevalence of overweight and obesity among those who maintained a low screen time.

Discussion

In our sample, about 28% of 4-year-old children spent more than 2h per day watching television or playing video games, thus exceeding the AAP guidelines. However, if considering the CPS and WHO guidelines of less than 60 min per day, over two thirds did not adhere to screen time recommendations. Additionally, the study findings show that children increasing or maintaining a high screen time from 4 to 7 years of age were more frequently from a lower socioeconomic strata and were more likely to follow unhealthier dietary patterns at 7 years.

This study focused on the changes of screen time between preschool to school age, as it represents a critical time on children's lives and future health (41). From 4 to 7 years of age, just about one third of the children decreased their screen time, a smaller

proportion maintained low, and half of the sample maintained high (30%) or increased (22%) screen time exposure. Roberts and Foehr (27) examined how media exposure vary with age and found that media exposure begins early, increases until children begin school (around 6-7 years), drops off briefly and increases again around the age of 11-12. The decrease of screen time from preschool to school age in some of the children is more likely to be due to the demands of school and school-related activities, as well as the school television-free environment, which translates in less time available for the media (27). However, in Certain and Kahn longitudinal study (26), television viewing levelled off instead of declining (26), from 3 to 7 years of age, attributed to the continuing environmental influences and the development of child preferences or habits. Screen time appears to maintain a role in children's daily lives, suggesting that higher screen time in early childhood is associated with higher screen time at school age (41).

Consistent with previous work (42, 43), our results show that lower maternal educational level and lower household income were associated with greater odds of increasing screen time. Also, a systematic review by Gebremariam *et al.* (44) reported an inverse relation between socioeconomic position and the presence of a TV in the children's bedroom, parental modelling for TV viewing, parental co-viewing and also having meals in front of the TV, highlighting the impact of parental behaviours, attitudes, and beliefs on children's screen time habits. For example, Rek *et al.* (45) showed that role modelling is crucial in developing children's media habits. Both parent's own media habits and their opinion and beliefs on children's appropriate daily screen time, as well as their formal education, seems to significantly impact parents' behaviour in terms of education and therefore affect children's media exposure.

Of the child factors assessed, male sex was associated with higher odds of increasing screen time or maintaining a high screen time exposure. This sex difference, boys more likely to have higher screen time, is consistent with previous studies (43, 46-48). This can be partly explained by two factors: on the one hand, parent-child interactions might differ according to the child's sex (43); on the other hand, girls may take part in more activities, such as homework and extracurricular cultural activities, besides screen behaviours (48).

Surprisingly, children who did not practice sports showed greater odds of reducing their screen time. In fact, several studies in children have demonstrated a small, but significant inverse association between screen time and physical activity (6, 49). Likewise, another study has shown that screen time during childhood is not a significant predictor of physical activity (50). One explanation for our findings may be that children who had a higher screen time at 4 years, decreased it when they entered school age because they were enrolled in other activities that not included practicing sports.

Furthermore, we aimed to study the associations between screen time and dietary patterns. Our results suggest that children that increased their screen time or maintained a high screen time, from preschool to school age, were more likely to present unhealthier dietary patterns – either Snacking or Energy-dense foods. Similar results among children and adolescents suggest that TV viewing is associated with unhealthier dietary patterns, frequently characterized by a high consumption of sweets, salted snacks and soft drinks, after adjusting for covariates of interest (29-31, 51). Also, some studies show that a Mediterranean DP was found to be inversely associated with screen time, both among 4-year-old children (52) and adolescents aged 12-17 years (29). Potentially, screens exposure interferes in satiety and hunger signs, leading to an overconsumption of low-nutrient high-energy foods due to the less pronounced regulation of food consumption when eating while doing other things, such as watching television or playing videogames (53, 54).

In our study there was no significant association between screen time and obesity, although higher screen time was more frequent among children with obesity, consistent with previous studies. For example, Sorrie *et al.* (19) reported that preschool children who are engaged in screen activities (watching television or playing games) more than 2 hours per day were more likely to be overweight or obese, compared to those who spent less than 2 hours. However, in our study, when analysing changes in screen time, although not statistically significant, a greater prevalence of obesity among those who reduced screen time was found. This tendency may be explained by reducing screen time as an intervention strategy for weight control. A randomized controlled trial showed that reducing children's screen time have resulted in less BMI gain, showing a potential causal relationship between screen media viewing and weight gain, and suggesting that reducing children's screen time may be a promising intervention approach to prevent childhood obesity (55).

The current study is not without limitations. Firstly, no information about the context of screen use (parenting style and media use, media in the child's bedroom, number of screens) or a direct measure of advertisement were available, which would have been important covariates to include in the analysis. Another limitation is that we did not address the content of children's viewing, only the average daily time, and therefore it is not possible to distinguish between educational versus entertainment television. Also, both children's dietary intake and screen time were reported by their caregivers, thus the possibility of misreporting cannot be discarded. Diet was assessed through a FFQ, thus estimation of dietary intake using frequency and not quantity could be argued as a limitation (56). The data we analysed in the present paper was collected about ten years ago, and therefore, ST patterns might have changed, namely, there may

have been an increase in the use of tablets and mobile devices among children aged 5 and younger, since 2014 (57). Finally, consistent with population-based studies, our study is affected by losses of follow-up and exclusions due to missing data. Nevertheless, we compared the characteristics of the included and excluded participants, and for mother's age, mother's parity, mother's educational level and household income the magnitude of the differences was small, according to the Cohens' D and the Cramer's V effect size.

Strengths of our study include being the first one, to our knowledge, to evaluate changes of screen time from preschool to school age and its predictors using a longitudinal design, in Portuguese children. Because screen time patterns are modifiable behaviours and preschool is a critical time on children's lives, interventions to prevent the poor outcomes associated with screens overexposure should be considered at an early age. Another strong aspect of our study is the use of dietary patterns to assess the associations between screen time and food consumption, instead of looking at isolated food groups, which allows us to examine children's overall diet. Dietary patterns used in this study were identified using latent class analysis which is an appropriate methodology for categorical variables common in data from FFQ (58, 59). Moreover, the use of *a posteriori* DPs is an important strength as they consider the different effects and interactions among food components (56). This study is part of Generation XXI, a population-based cohort with a large sample size, conducted by experienced researchers with procedures in place to warrant the quality of the data assessment, thus reducing the risk of bias, and supporting the validity of the results.

Conclusions

The results of our study suggest that preschool children are highly exposed to screens, and there is a positive association between this behaviour and an unhealthier food consumption. Also, screen exposure seems to persist into childhood, and lower parental education level, lower household income and male child sex increase the likelihood of maintaining high or increasing screen time from pre-school to school age.

Our findings may be of interest to policy makers, researchers, and public health professionals, and may provide useful insights for the design of intervention programmes addressing childhood screen time patterns. Given that children who are overexposed to screens tend to remain so in the future, and that this behaviour is associated with several poor health outcomes, including overweight and obesity, future interventions should promote awareness among parents and caregivers.

Future research should examine the effect of TV content and food advertising to which children are exposed, as well as parental influences and the family TV environment.

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Table 1: Family and child's characteristics of the sample.

	n (%)
Child characteristics at birth	
Child's sex	
Female	2 210 (48.8)
Male	2 321 (51.2)
Mother's parity	
First pregnancy	2 654 (58.6)
Second pregnancy	1 513 (33.4)
Third or further pregnancy	364 (8.0)
Maternal characteristics	
Age, mean (SD)	29.79 (5.20)
Pre-conception BMI	
Normalweight or underweight	1 697 (67.7)
Overweight	579 (23.1)
Obesity	232 (9.3)
Missings	2 023
Education	
≤9 years	1 871 (41.3)
10-12 years	1 295 (28.6)
>12 years	1 365 (30.1)
Family and house characteristics (at 4 years)	
Household income (euros/month)	
≤1000	1 143 (25.2)
1001 – 1500	1 284 (28.3)
>1500	2 104 (46.4)
Family structure	
Both parents	4 030 (88.9)
Single parent	465 (10.3)
Other family structure	36 (0.8)
Number of siblings	
None	2 075 (45.8)
1	1 948 (43.0)
2 or more	508 (11.2)

SD, standard deviation

Table 2: Associations between family and child characteristics and screen time at 4 years and changes in screen time from 4 to 7 years of age.

	Screen Time at 4 years			p-value	Changes in Screen Time from 4 to 7 years				p-value
	≤60 min	61-120 min	>120 min		Maintained low	Maintained high	Decreased	Increased	
Total	1 442 (31.8)	1 826 (40.3)	1 263 (27.9)		749 (16.5)	1 367 (30.2)	1 426 (31.5)	989 (21.8)	
Child characteristics									
Child's sex									
Female	772 (34.9)	865 (39.1)	573 (25.9)	<0.001	428 (19.4)	623 (28.2)	695 (31.4)	464 (21.0)	<0.001
Male	670 (28.9)	961 (41.4)	690 (29.7)		321 (13.8)	744 (32.1)	731 (31.5)	525 (22.6)	
Child's BMI									
Normalweight/underweight	1 006 (32.3)	1 271 (40.8)	841 (27.0)	<0.001	540 (17.3)	938 (30.1)	969 (31.1)	671 (21.5)	0.002
Risk of overweight	317 (32.7)	383 (39.5)	269 (27.8)		156 (16.1)	272 (28.1)	309 (31.9)	232 (23.9)	
Overweight	89 (28.2)	136 (43.0)	91 (28.8)		36 (11.4)	119 (37.7)	93 (29.4)	68 (21.5)	
Obesity	30 (23.4)	36 (28.1)	62 (48.4)		17 (13.3)	38 (29.7)	55 (43.0)	18 (14.1)	
Participation in sports									
Yes	1 082 (34.6)	1 275 (40.7)	774 (24.7)	<0.001	575 (18.4)	944 (30.2)	907 (29.0)	705 (22.5)	<0.001
No	360 (25.7)	551 (39.4)	489 (34.9)		174 (12.4)	423 (30.2)	519 (37.1)	284 (20.3)	
Sleep duration									
<10h/night	439 (29.4)	604 (40.4)	451 (30.2)	0.015	217 (14.5)	491 (32.9)	468 (31.3)	318 (21.3)	0.011
≥ 10h/night	1 003 (33.0)	1 222 (40.2)	812 (26.7)		532 (17.5)	876 (28.8)	958 (31.5)	671 (22.1)	
Family and parents' characteristics									
Maternal age (years), mean (SD)	30.27 (5.01)	29.85 (5.08)	29.15 (5.50)	<0.001	30.40 (4.72)	29.46 (5.11)	29.65 (5.39)	29.99 (5.33)	<0.001
Mother's pre-conception BMI									
Normalweight/underweight	541 (31.8)	680 (40.1)	476 (28.0)	0.552	280 (16.5)	498 (29.3)	539 (31.8)	380 (22.4)	0.767
Overweight	175 (30.2)	223 (38.5)	181 (31.3)		84 (14.5)	177 (30.6)	182 (31.4)	136 (23.5)	
Obesity	78 (33.6)	85 (36.6)	69 (29.7)		34 (14.7)	74 (31.9)	66 (28.4)	58 (25.0)	

Missings: 2 023

Mother's education									
≤ 9 years	551 (29.4)	708 (37.8)	612 (32.7)	<0.001	240 (12.8)	587 (31.4)	586 (31.3)	458 (24.5)	<0.001
10-12 years	389 (30.0)	523 (40.4)	383 (29.6)		204 (15.8)	382 (29.5)	427 (33.0)	282 (21.8)	
>12 years	502 (36.8)	595 (43.6)	268 (19.6)		305 (22.3)	398 (29.2)	413 (30.3)	249 (18.2)	
Household income (euros/month)									
≤ 1000	359 (31.4)	402 (35.2)	382 (33.4)	<0.001	158 (13.8)	336 (29.4)	364 (31.8)	285 (24.9)	<0.001
1001 – 1500	356 (27.7)	535 (41.7)	393 (30.6)		172 (13.4)	413 (32.2)	414 (32.2)	285 (22.2)	
> 1500	727 (34.6)	889 (42.3)	488 (23.2)		419 (19.9)	618 (29.4)	648 (30.8)	419 (19.9)	
Family structure									
Both parents	1 267 (31.4)	1 652 (41.0)	1 111 (27.6)	0.114	663 (16.5)	1 225 (30.4)	1 279 (31.7)	863 (21.4)	0.438
Single parent	163 (35.1)	162 (34.8)	140 (30.1)		81 (17.4)	134 (28.8)	135 (29.0)	115 (24.7)	
Other family structure	12 (33.3)	12 (33.3)	12 (33.3)		5 (13.9)	8 (22.2)	12 (33.3)	11 (30.6)	
Number of siblings									
None	618 (29.8)	844 (40.7)	613 (29.5)	0.046	312 (15.0)	649 (31.3)	660 (31.8)	454 (21.9)	0.185
1	660 (33.9)	779 (40.0)	509 (26.1)		353 (18.1)	573 (29.4)	608 (31.2)	414 (21.3)	
2 or more	164 (32.3)	203 (40.0)	141 (27.8)		84 (16.5)	145 (28.5)	158 (31.1)	121(23.8)	

Proportions were compared using the Chi-square test and means through analysis of variance (ANOVA).

Table 3: Multinomial regression model for the associations between family and child characteristics at 4 years and changes in screen time between 4 and 7 years.

	Maintained high	Decreased	Increased	Maintained high	Decreased	Increased
	Crude OR (95% CI) *			Adjusted OR (95% CI) *		
Child's Sex						
Female	1	1	1	1	1	1
Male	1.59 (1.33-1.91)	1.40 (1.17-1.68)	1.51 (1.25-1.83)	1.60 (1.33-1.92)	1.39 (1.16-1.67)	1.53 (1.26-1.86)
Mother's parity						
First pregnancy	1	1	1	1	1	1
Second pregnancy	1.01 (0.83-1.22)	0.95 (0.79-1.15)	0.96 (0.78-1.18)	1.02 (0.69-1.50)	1.21 (0.83-1.76)	1.13 (0.76-1.67)
Third or further pregnancy	0.98 (0.69-1.40)	1.21 (0.86-1.70)	1.36 (0.95-1.95)	1.04 (0.84-1.29)	0.96 (0.78-1.18)	0.87 (0.69-1.09)
Child's participation in sports						
No	1.48 (1.21-1.82)	1.89 (1.55-2.31)	1.33 (1.07-1.66)	1.33 (1.08-1.64)	1.73 (1.41-2.12)	1.15 (0.92-1.44)
Yes	1	1	1	1	1	1
Maternal age (per 5 years)	0.84 (0.78-0.91)	0.87 (0.80-0.95)	0.93 (0.84-1.02)	0.87 (0.79-0.97)	0.90 (0.82-1.00)	1.00 (0.90-1.12)
Mother's education (years)						
≤ 9	1.87 (1.52-2.32)	1.80 (1.46-2.23)	2.34 (1.86-2.94)	1.67 (1.33-2.11) ^a	1.55 (1.23-1.95) ^a	2.33 (1.82-2.99) ^a
10-12	1.43 (1.14-1.80)	1.55 (1.24-1.93)	1.69 (1.32-2.16)	1.28 (1.02-1.62) ^a	1.38 (1.09-1.74) ^a	1.67 (1.29-2.15) ^a
>12	1	1	1	1	1	1
Household income (euros/month)						
≤ 1000	1.44 (1.15-1.81)	1.49 (1.19-1.86)	1.80 (1.42-2.29)	1.28 (1.01-1.62) ^b	1.28 (1.01-1.62) ^b	1.72 (1.35-2.21) ^b
1001 – 1500	1.63 (1.31-2.02)	1.56 (1.25-1.93)	1.66 (1.31-2.09)	1.50 (1.20-1.87) ^b	1.41 (1.13-1.76) ^b	1.62 (1.27-2.05) ^b
> 1500	1	1	1	1	1	1

* The reference category of the outcome is "Maintained low". Adjusted models included all variables in the table

^a Adjusted for all variables in the table, except household income. ^b Adjusted for all variables in the table, except mother's education.

Table 4: Associations of changes in screen time from 4 to 7 years with dietary patterns at 7 years and children's BMI at 7 years.

	Dietary patterns at 7 years				Dietary patterns at 7 years			
	Energy-dense foods	Snacking	Healthier		Energy-dense foods	Snacking	Energy-dense foods	Snacking
	n (%)				p-value	Crude OR (95% CI)		Adjusted OR (95% CI) *
Changes in screen time								
Maintained low	260 (34.7)	54 (7.2)	435 (58.1)	<0.001	1	1	1	1
Maintained high	734 (53.7)	165 (12.1)	468 (34.2)		2.62 (2.16-3.18)	2.84 (2.03-3.97)	2.42 (1.98-2.95)	2.65 (1.89-3.72)
Decreased	716 (50.2)	135 (9.5)	575 (40.3)		2.08 (1.72-2.52)	1.89 (1.35-2.65)	1.90 (1.56-2.31)	1.74 (1.23-2.44)
Increased	520 (52.6)	115 (11.6)	354 (35.8)		2.46 (2.00-3.01)	2.62 (1.84-3.72)	2.13 (1.73-2.64)	2.34 (1.64-3.35)
Children's BMI at 7 years								
	Children's BMI at 7 years				Children's BMI at 7 years			
	Normalweight/ Underweight	Overweight	Obesity		Overweight	Obesity	Overweight	Obesity
	n (%)				p-value	Crude OR (95% CI)		Adjusted OR (95% CI) ^a
Changes in screen time								
Maintained low	503 (67.2)	155 (20.7)	91 (12.1)	0.192	1	1	1	1
Maintained high	856 (62,6)	309 (22.6)	202 (14.8)		1.17 (0.94-1.46)	1.13 (0.99-1.71)	1.18 (0.94-1.48)	1.22 (0.93-1.60)
Decreased	938 (65.8)	279 (19.6)	209 (14.7)		0.96 (0.77-1.21)	1.23 (0.94-1.61)	0.97 (0.77-1.21)	1.14 (0.87-1.50)
Increased	630 (63.7)	222 (22.4)	137 (13.9)		1.14 (0.90-1.45)	1.20 (0.90-1.61)	1.14 (0.90-1.45)	1.11 (0.82-1.48)

P-value is calculated using the Chi-square test.

* The reference category is: Healthier; adjusted for maternal education and children's active playtime.

^a The reference category is: Normalweight/underweight; adjusted for maternal education, children's sex and children's active playtime.

Supplementary Table: Magnitude of the differences between included and excluded participants.

	Included		Excluded		
	Mean	SD	Mean	SD	Effect Size
Mother's age	29.79	5.2	28.22	6.47	0.267*
	n	%	n	%	Effect Size
Mother's parity					
First pregnancy	2654	58.6	2182	55.2	0.084 ^a
Second pregnancy	1513	33.4	1252	31.6	
Third or further pregnancy	364	8	522	13.2	
Mother's education (years)					
≤ 9	1871	41.3	2357	58.1	0.182 ^a
10-12	1295	28.6	1005	24.8	
>12	1365	30.1	698	17.2	
Household income (euros/month)					
≤ 1000	1411	34.9	1613	47.6	0.135 ^a
1001 – 1500	1201	29.7	904	26.7	
> 1500	1436	34.5	872	25.7	

* Calculated using Cohen's D

^a Calculated using Cramer's V

Paper II

Monitoring food marketing directed to Portuguese children broadcasted on television.

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ABSTRACT

Introduction: Children are massively exposed to food marketing through television and other forms of media, which promotes unhealthy eating behaviours and is considered a significant risk factor for obesity. As consequence, food marketing restrictions are being implemented worldwide.

Aims: To assess the extent and power of food advertisements aimed at children, broadcasted on Portuguese television.

Methodology: Television data was recorded for 2 weekdays and 2 weekend days between 6:00 and 22:00 during November 2021 from four generalist and free access Portuguese television channels. Data was analysed according to the World Health Organization television protocol to assess food and beverage marketing aimed at children and according to the Portuguese Legislation on food marketing restrictions to children. Channel, hour of transmission and type of product and power of food and beverage advertisements persuasive techniques were analysed. Advertised products were analysed according to the Portuguese Nutrient Profile Model.

Results: Overall, 5272 advertisements were transcribed, and food and beverage were the third most heavily advertised category (n=590, 11.2 %). Among food and beverage advertisements considered to be aimed at children and adolescents (n=131, 22.2%), chocolate and bakery products were the most advertised food category (42.0%), followed by soft drinks (26.7%) and yoghurts (16.0%), and none met the nutritional profile outlined by the national legislation. More unhealthy food advertisements targeting youth were shown in children's non-peak time and morning, and during news/commentary and entertainment programmes. The most frequent primary persuasive techniques were product uniqueness (26.7%), humour (24.4%) and fun (16.0%). Most advertisements showed a low use of promotional characters, health claims and disclaimers, and a high use of brand logos, product image and premium offers.

Conclusions: Portuguese children and adolescents are potentially exposed to large numbers of unhealthy food advertisements on television, despite marketing regulation and restriction policies. Continuous monitoring is essential to evaluate the effectiveness of food marketing restrictions in Portugal.

Keywords: Food advertising, food marketing, television, children, childhood obesity.

Introduction

In recent decades, childhood obesity has increased dramatically, posing a threat to children's and adolescents' health (1). Children with overweight and obesity are more likely to live with obesity in adulthood and to develop chronic non-communicable diseases such as diabetes, cardiovascular disease, high blood pressure and respiratory problems, and is additionally associated with social exclusion problems, anxiety, and depression (2). Globally, in 2016, 40 million children under the age of 5 years and over 330 million children and adolescents between 5 and 19 years were overweight or obese (3). In Portugal, according to the Childhood Obesity Surveillance Initiative (COSI) 2019, around 29.7% of children aged between 6 and 8 present overweight and 11.9% present obesity (4).

Food marketing is a key characteristic of the food environment - heavy marketing of energy-dense foods and fast-food outlets were recently pointed out by World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO) as a "probable" cause for the increasing prevalence of childhood overweight and obesity (5). Research recognizes that exposure to unhealthy food and beverages advertising increases children's dietary intake and has a negative impact on children's preferences for energy dense foods (6). A 2009 review commissioned by the WHO on the extent, nature, and effects of food promotion to children found that food marketing impacts nutrition knowledge, food preferences and consumption patterns (7). Moreover, children are easy targets to marketing strategies and are the main influencers of the family food purchase (particularly towards advertised products) (6, 8). The fact that most advertised products are unhealthy ones - sugary breakfast cereals, savoury snacks, cakes and sweets, soft drinks, and fast-food (commonly referred to as the "Big-Five") - and vegetables and fruits, on the other hand, are significantly underrepresented (7) raises great concern.

A key recommendation to protect children from the marketing of high energy content, salt, sugar, saturated and trans fatty acids (HFSS) foods is the implementation of mandatory policies to restrict food marketing to which children are exposed (9). In Portugal, since April 2019 the Law n°30/2019 has been implemented, which applies restrictions to HFSS food advertising aimed at children under 16 years of age (10). Accordingly, the Directorate-General for Health identified, in accordance with the WHO recommendations for the definition of the nutritional profile of these foods (11), the values that should be considered in the identification of HFSS foods, published through the Dispatch n°7450-A/2019 (12). The implementation of legislation in this area involves a prior definition of a monitoring system. Thereupon, since 2016, the WHO has proposed a protocol to provide the basis for monitoring and quantifying the extent and nature of

children's exposure to the marketing of HFSS foods, via television (TV) and the Internet (13).

According to the National Food, Nutrition and Physical Activity Survey (IAN-AF) in 2015-2016, 37% of Portuguese children and adolescents between 3 and 14 years spend more than 2 hours per day on weekdays watching television, and this prevalence increases to 71% on weekends (14). Hence, although the constantly growth of digital marketing is a big concern and young people are ever more engaged in the internet and social media platforms (15), more traditional media, such as TV, should still be considered as a major source of food marketing exposure to children.

It is, therefore, essential to continuously monitor the compliance with Law n°30/2019 on food marketing restrictions in Portugal, through the analysis of food advertising aimed at children. Thus, the main aim of this study was to assess the exposure variables and power variables of food advertisements aimed at children, broadcasted on Portuguese TV channels. Exposure is defined as “the reach and frequency of the marketing message”, whereas the power is “the creative content, design, and execution of the marketing message” (9).

Material and Methods

Television sampling

The present study was conducted according to the WHO television study protocol to assess food and beverage marketing aimed at children (13). The analysis followed an adapted version of this protocol, adjusted to the Portuguese legislation (10, 12).

Television transmission was recorded from four generalist and free access Portuguese channels (RTP1, RTP2, SIC and TVI) between 06:00 and 22:00 hours on two weekdays (Tuesday and Friday) and two weekend days (Saturday and Sunday) in November 2021, avoiding national holidays, major sporting competitions, special events or other festive seasons. Children's channels were excluded from the analysis, since previous studies have shown that there are no advertisements on food products in these channels (16). After the video acquisition, the material was stored and scanned for advertisements.

Commercial coding

Recorded television data were analysed according to the WHO proposed tool and coding templates (13), adapted to the Portuguese legislation. Opening and closing credits, closed captioned acknowledgments, brief sponsorship announcements and content promotions that appear later in the same programme were not considered advertisements.

Details of the TV advertisements were grouped into 2 categories: the exposure variables (quantity, frequency, and reach of marketing communications for unhealthy foods to children) and the power variables (prevalence of specific marketing techniques used) – only assessed for food and beverage advertisements.

Exposure variables

All advertisements broadcasted by the selected TV channels were coded. Coding categories included the country, channel, date, day of the week, programme name, programme category (e.g., comedy, drama, movie; etc.), programme start time, time slot of the advertisement, whether the programme occurs during peak or non-peak children's viewing time, whether the programme occurs between or within the programme (i.e., during the programmes breaks), and advertised product type (e.g., food and beverages, clothes/shoes, education, entertainment; etc.). Five additional categories of advertised product type were added to adapt to country-specific trends in advertising, namely: Supermarkets and Food Delivery; Lottery; Real Estate Agencies; Mobility/Medical Equipment's and Gadgets (including smartphones, watches...).

Peak children's viewing times are defined as the period of time in which the number of children watching television is greater than 25% of the maximum child-audience are likely to be watching (13). Due to the lack of this data, the time slot between 5:00 p.m. and 8:00 p.m. was considered as peak viewing time for children, according to previous studies (17, 18); other viewing times were designated as 'non-peak'.

For food and beverage advertisements additional coding variables were accessed, namely the food-product brand name, detailed description of the food product, nutrient profile food-category code (e.g., chocolate, beverages, cheese, etc.), nutritional information (including total fat, saturated fat, total sugars, added sugars, non-sugar sweeteners, salt, energy and fiber) and whether the marketing is permitted according to the Portuguese Nutrient Profile Model (NPM) outlined by the Portuguese Directorate-General of Health (12).

Power Variables

Power of persuasive techniques were only assessed for food and beverage advertisements. Coding variables were subdivided into 6 categories:

1. Increased advertisement engagement, visual and auditory appeal: including primary persuasive appeal (e.g., quantity, convenience, taste, health/nutrition, energy, price, etc.) and dynamic audio-visual components;
2. Increased brand engagement and brand synergy: including brand equity characters, licensed characters, cartoon characters and celebrity endorsers;

3. Increased awareness of the brand and website: including website address provided and links to social media platforms;
4. Consumption norms, brand, and product imagery: including brand logo, images of the product or packaging, child or child-like character and premium offers;
5. Health-related imagery or messaging: including health claims (e.g., low fat/fat free, sugar free, organic, etc.), physical activity depicted and disclaimers (e.g., part of a balanced/healthy diet, enjoy in moderation, etc.);
6. Targeting content - primary target (children, children and teenagers, teenagers, teenagers and adults, adults, the elderly, and the whole family). The following criteria were considered in the identification of food advertisements aimed at children and teenagers: presence of cartoons, animations or children and informal language aimed at a young public.

Also, additional variables in accordance with Portuguese legislation (10) were assessed:

- a) if the advertising creates a sense of urgency or need to consume the product;
- b) if the advertising conveys the idea of facilitating its acquisition, minimizing its costs;
- c) if the advertising conveys the idea of benefit in its exclusive or exaggerated consumption, compromising the appreciation of a varied and balanced diet and healthy lifestyle;
- d) if the advertising associates the consumption of the product with the acquisition of status, social success, special skills, popularity, success or intelligence;
- e) if the advertising communicates characteristics of high energy content, salt, sugar, saturated and trans fatty acids food and beverages as health benefits, omitting harmful effects of these high levels.

Food and Beverage Products Coding

When more than one food product appeared on the advertisement, only the most dominant product (appearing for most of the commercial's time) was considered. When more than one product receives equal attention, all the products were considered - in such cases if one of the products was not in accordance with the Portuguese NPM, the advertisements food content was then considered as not permitted.

To obtain the nutritional information (including total fat, saturated fat, total sugars, added sugars, non-sugar sweeteners, salt, energy and fiber) required to correctly classify advertised products, company websites (Continente®, Auchan® and

ElCorteInglês®) were accessed, as well as the ingredients labels on product packaging on December 2021.

Statistical Analyses

Statistical analyses were performed using the IBM®SPSS® Statistics software (IBM Corp. Released 2020. IBM SPSS Statistics for Windows, Version 27.0. Armonk, NY: IBM Corp), and the significance level was fixed at 0.05, after coding the data in the WHO television coding templates. Descriptive analyses were presented as means ($\pm$ SD) for continuous variables and as frequency distributions (%) for categorical variables. Proportions were compared using the Qui-square test.

Results

Overall Marketing Extent

During the recording days on the four generalist and free-access Portuguese channels, we obtained 256 hours of TV broadcasting, with a total of 5272 advertisements transcribed. Overall, the top five advertised products on Portuguese television were retailing and mail order, including catalogues (n=646, 12.2%), supermarkets and food delivery (n=633, 12%), food and beverages (n=590, 11.2 %), channel promotions (n=552, 10.5%) and pharmaceuticals (n=437, 8.3%).

As for food and beverages advertisements, proportions of advertisements ranged across TV channels from 4.6% (n=27) on RTP1 to 40.3% (n=238) on SIC and 55.1% (n=325) on TVI. There was no advertising for food and beverages on RTP2.

Food and Beverage Marketing Exposure

Across all TV channels most food and beverage advertisements targeted all ages/family (44.6%), followed by adults (25.9%) and 131 of which targeted children and teenagers (22.2%).

Among all food and beverage advertisements, 78.3% did not meet the nutritional profile outlined by the Portuguese Directorate-General of Health (12). Prevalence of food and beverage advertisements according to the compliance with the nutritional profile outlined by the Portuguese Directorate-General of Health, by TV channel is described in Figure 1.

Prevalence of food and beverage advertisements, according to food category, are described in Table 1. Ready-made convenience foods (mainly pizzas and hamburgers from fast-food companies) were the most advertised category (25.9%), followed by chocolate and bakery products (23.6%), others - including coffee and teas – (9.5%) and soft drinks (9.3%). No advertisement on fruit, vegetables or legumes were

registered and only a small percentage of meat/fish/eggs advertisements was found. Regarding the food and beverage advertisements targeting children and teenagers, chocolate and bakery products were the most advertised food category (42%), followed by soft drinks (26.7%) and yoghurts and fermented milks (16%) - none of the food and beverage advertisements met the nutritional profile outlined by the Portuguese Directorate-General of Health (12).

Characteristics of food and beverage advertisements according to different factors are described in Table 2. When comparing all food advertisements and those targeting children and teenagers, according to different factors, the differences were statistically significant for programme category ($p<0.001$), peak/non-peak time ($p=0.023$) and time slot ($p=0.002$). As for day of the week and if the advertisement occurred within or between programme, no differences were found ($p=0.072$ and $p=0.602$, respectively).

Most of the food and beverage advertisements, as well as those targeting children and teenagers, occurred during News/Commentary programmes (42.4% and 42.0%, respectively) and Entertainment/Variety shows (34.6% and 35.9%, respectively) – only about 7% of the advertisements targeting youth occurred during children's shows. Just over half of all food and beverage advertisements (52.7%) occurred during the weekdays and about a third of all advertisements ($n=173$, 29.4%) occurred during children's peak viewing time. As for the food and beverage advertisements directed at youth, the majority (54.2%) occurred during weekend days and only 21.4% on children's peak viewing time. Most of the advertisements occurred within the programmes. Most of the food and beverage advertisements occurred in the afternoon period ($n=202$, 34.2%), and most of the advertisements targeting children and teenagers occurred during the morning period ($n=56$, 42.7%).

Regarding advertisements time slots, most of the advertisements occurred between 2pm-3pm (9%) and 7pm-8pm (9%) and most of the advertisements targeting children and teenagers between 8am-9am (11%) and 9am-10am (11%) (Figure 2).

Marketing Persuasive Techniques

Among primary persuasive techniques, the "other" category was the most frequently used in all food and beverage advertisements ($n=180$, 30.5%). This category was stood out when the advertisements focused on sustainability matters and environmental protection, vegetable protein choices and fair-trade labels. "Enjoyment/satisfaction" ($n=81$, 13.7%) and "general superiority" ($n=57$, 9.7%) were the second and third most used primary persuasive techniques. Considering food and beverage advertisements targeted to a young public, "Unique" was the most used

primary persuasive technique (n=35, 26.7%) followed by “Humour” (n=32, 24.4%) and “Fun” and “other” (n=21, 16.0%) (Figure 3).

Regarding secondary persuasive techniques, “image of the product/packaging” was the most often used marketing technique (n=586, 99.3%) and the “brand logo” was the second most used technique in all food and beverage advertisements, being displayed on screen in 89.2% (n=526) of the advertisements. Dynamic audio-visual components and brand equity characters were displayed on screen on 34.9% (n=206) and 9% (n=53) of all food and beverage advertisements, respectively. As for licensed and cartoon characters, these were absent in the totality of the advertisements. Regarding celebrity endorsers only 15 advertisements had the presence of an entertainment celebrity (2.5%) and 9 advertisements a sports person (1.5%). Only 5% of the advertisements presented health claims, such as “sugar free”, “no added sugars/less sugar” and “low calorie/light” and only 9 advertisements (1.5%) used the “part of a balanced/complete/nutritious breakfast or meal” disclaimer (Table 3).

Regarding the advertisements targeting children and teenagers, “image of the product/packaging” was displayed in all advertisements and the “brand logo” in 96.9% (n=127) of the advertisements, being those two the most used marketing techniques. The website address was present in 13.0% (n=17) of the advertisements and no links to social media platforms were displayed. Dynamic audio-visual components and brand equity characters were displayed on screen on 42.7% (n=56) and 25.2% (n=29) of food and beverage advertisements targeting youth, respectively. No health claims or disclaimers were presented in any of the food and beverage advertisements targeting youth, neither physical activity was depicted. Also, licensed characters, cartoon characters and celebrity endorsers were absent (Table 3).

Marketing techniques were more often used in advertisements aimed at children and teenagers, and differences were statistically significant for dynamic audio-visual components ($p=0.033$), brand equity characters ($p<0.001$), brand logos ($p=0.001$) and child character ($p<0.001$).

Additional variables in accordance with Portuguese legislation

Regarding the additional variables in accordance with the Portuguese legislation, 9.5% (n=56) of all beverage and food products advertisements created a sense of urgency or need to consume the product and about 6% of the advertisements associated the consumption of the product with the acquisition of status, social success, special skills, popularity, success, or intelligence. About 10% of the advertisements conveyed the idea of facilitating its acquisition, minimizing its costs, mostly when it refers to the possibility of home delivery (*Uber eats*® and *Glovo*®), free delivery and discounts (Table

4). Regarding the advertisements targeting children and teenagers, 26.7% (n=35) associated the consumption of the product with the acquisition of status, social success, special skills, popularity, success, or intelligence and only 7.6% of the advertisements created a sense of urgency or need to consume the product (Table 4).

Discussion

Present findings indicate that Portuguese children might be largely exposed to food and beverage advertisements on television, which are mainly classified as unhealthy. In our sample, consistent with past research (17, 19-24), food and beverage were among the top 3 advertised products, accounting for 11.2% of total advertisements. In general, the percentage of food advertisements found in this study was lower than results from past studies, that ranged from 12.8% in the United Kingdom (19) to 25% in both Australia and China (17, 22) and similar to the results obtained from a study conducted in Portugal in 2020 (10.4%) (16).

The most frequently advertised products, overall, were ready-made and convenience foods, chocolate and bakery products, others, and soft drinks. Yet, when analysing the most frequently advertised products to children and teenagers, chocolate and bakery products comprised the most advertised food category, followed by soft drinks and yoghurts and fermented milks. A possible explanation for this difference is that an older audience (adults and families) are more likely to buy these ready-made and convenience foods, whereas a young public more often choose food like chocolates and soft drinks, which are more easily accessible. In Russia, Kontsevaya *et al.* (23) found beverages, chocolate and confectionery and ready-made and convenience foods to be among the most advertised products overall. Also, in the study conducted by Kelly and colleagues (20), fast-food restaurant meals and chocolate and confectionery were the two most advertised products, across the 11 countries considered. Our study also found that there were no food advertisements that promoted fruits or vegetables, similar to a previous study in China (17).

Of the total advertisements analysed about one fifth were considered to be aimed at children and teens, a higher prevalence than the one found in the study conducted in Portugal in the previous year (18.6%) (16). However, 44.6% of the food and beverage advertisements were considered to be aimed at families, which means that these advertisements could also be directed at children and adolescents and therefore also aim to influence their dietary habits. Our research also provides some insight into the fragilities of the Portuguese Law nº30/2019 on food marketing restrictions that are worth further discussion. According to the WHO framework for implementing the set of recommendations on the marketing of foods and non-alcoholic beverages to children,

defining child-directed advertising as TV advertising during programmes with an audience of (in the case of Portugal) at least 25% children under the age of 16 does not cover programmes for both children and adults or other programmes popular among children but not made especially for them, such as sporting events or family shows (9). Future restrictions should encompass these ambiguity issues regarding the concept of “marketing to children” and cover mixed audiences’ programmes.

Despite Portuguese marketing regulation, none of the food advertisements aimed at children and adolescents met the NPM defined by the Directorate-General of Health (10,12). Consistent with these results, Kontsevaya and colleagues (23) and Cossenza-Quintana and colleagues (25) recently showed that 64.2% and 85% of the food advertisements should not be permitted to be advertised to children according to the WHO NPM, respectively.

Non-peak children’s viewing time and the morning and afternoon time slots (rather than meals time – lunch and dinner) were the periods during which food advertisements for children appeared most frequently. Contrary to our results, previous research in the United Kingdom and Australia showed a significantly higher percentage of food advertisements during children’s peak viewing times, compared to non-peak times (19, 22). Also, more food advertisements targeting youth were shown during weekend days, compared to weekdays. According to the IAN-AF results (14), television use among children and adolescents was higher during the weekend days. Nonetheless, considering that there were no significant differences on the amount of non-permitted food advertisements transmitted throughout the day, policies and regulations should be focused on restriction of food advertisements regardless of peak hours.

In this paper we also aimed to analyse the marketing strategies associated to the advertised products. Because all the food advertisements aimed at children were for foods that did not meet the NPM, we were unable to make a comparative analysis regarding marketing persuasive techniques of unhealthy vs healthy food products. Nevertheless, in the current study, product ‘uniqueness’, humour and fun were the most frequently used primary persuasive techniques in advertisements considered to be aimed at children. In 2014, Jenkin *et al.* (26) performed a systematic review and found that the main persuasive techniques used by food advertisements targeted to a young public (among 38 studies) were premium offers, promotional characters, nutrition or/and health-related claims, taste, and fun. In fact, regarding secondary persuasive techniques, in our study, premium offers were displayed on screen in 27.5% of the advertisements targeting children and brand equity characters were present in 25.2% of the advertisements. Similarly, Kelly *et al* found that, across 11 countries considered in their study, 12% of food advertisements contained premiums and 23% contained promotional

characters (20). The use of these techniques varied between countries but was used more often in advertisements for noncore food products. Moreover, evidence confirms that persuasive marketing techniques, such as premium offers and promotional characters influence children's preferences and purchasing requests (6). Besides these marketing techniques', our results showed, overall, a high use of dynamic audio-visual components, brand logos and the image of the product. These marketing strategies influence the 'power' of marketing communications, i.e., the creative content, design, and execution of the marketing message (9).

Evidence shows that exposure to food advertising increases dietary intake in all children, but the increase is higher in overweight and obese children (6). Additionally, children's food preferences and purchase requests are massively influenced by TV food advertising (27), particularly their preference for energy-dense foods during or shortly after exposure to advertisements (28). Thus, restricting unhealthy food marketing may be an effective strategy to reduce childhood obesity rates.

One of the main strengths of this study was the application of the WHO protocol and templates, which highly impacts the methodological quality of the study and allows the comparability with other countries. The large sample size of the advertisements (n=5272) and recorded hours (n=256), as well as the wide set of variables assessed are additional strengths. In addition, for advertisements with multiple products, all products were coded, and nutrition information was collected, excluding the possibility of potentially ignoring the presence of additional unhealthy products.

Our study is not without limitations: firstly, our concept of peak viewing time might not be accurate enough since it is based on previous studies and not in the yearly television audience data for this age group, as we did not have access to that data. Moreover, we did not measure actual children's exposure to food advertising, hence the fact that this study does not necessarily allows us to assess whether or not the Portuguese Law nº30 is being violated. Other monitoring approaches would be necessary to conduct that research, such as survey data on audience size and characteristics, surveys of children's use of TV and other forms of media and also surveys to assess exposure to marketing (9). Second, we did not register the advertisements' duration, which would be an important aspect as some authors remark that it can impact child's food choices. Third, we did not measure product placement in children's movies, which is an important aspect of food marketing on television and has been shown to have a significant effect on children's snack and drinks consumption (29). Another important limitation of our study is the researcher's subjectivity in the evaluation of some of the variables under study. Finally, more extensive research is needed to

assess the impact of these food and beverage advertisements on children's health outcomes, specifically childhood obesity.

Conclusions

Our findings suggest that, despite marketing regulation and restriction policies currently in place in Portugal, there is still a high percentage of food advertisements with potentially child-directed content on television and children and adolescents are likely exposed to large numbers of unhealthy food advertisements on television.

Continuous monitoring is essential to ensure compliance with the policies in place, as well as to support the development or update of these policies. Also, more research is needed in this area, to evaluate policy impact, particularly on children's exposure to marketing and on the effect of marketing on children's attitudes, beliefs, and preferences and on their actual food consumption, dietary patterns, and health.

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Table 1 - Percentage of TV food and beverage advertisements, by food category, used in all food and beverage advertisements and those targeted to children and teenagers.

Food Category	All food and beverage advertisements	Advertisements targeted to children and teenagers
Chocolate, bakery products, energy bars, sweet spreads, and toppings	139 (23.6%)	55 (42.0%)
Ready-made and convenience foods and composite dishes	153 (25.9%)	4 (3.1%)
Bread, bread products and crisp breads	1 (0.2%)	---
Meat, fish, and eggs	11 (1.9%)	---
Processed meat, poultry, fish and similar	1 (0.2%)	---
Cakes and other pastries	21 (3.6%)	5 (3.8%)
Other	56 (9.5%)	---
Snacks	1 (0.2%)	---
Milk	29 (4.9%)	---
Soft drinks	55 (9.3%)	35 (26.7%)
Ice-cream	16 (2.7%)	---
Breakfast cereal	20 (3.4%)	11 (8.4%)
Yoghurts, fermented milks and similar	48 (8.1%)	21 (16.0%)
Cheese and analogs	39 (6.6%)	---
Total	590	131

Table 2 – Percentage of TV food and beverage advertisements, according to different factors, used in all food and beverage advertisements and those targeted to children and teenagers.

	All food and beverage advertisements	Advertisements targeted to children and teenagers	p-value
Advertisement permitted according to the Portuguese NP			
Yes	128 (21.7%)	---	-
No	462 (78.3%)	131 (100%)	
Programme category			
News/Commentary	250 (42.4%)	55 (42.0%)	<0.001
Entertainment/Variety show	204 (34.6%)	47 (35.9%)	
Talk show	78 (13.2%)	12 (9.2%)	
Children's show	12 (2.0%)	9 (6.9%)	
Soap opera	30 (5.1%)	4 (3.1%)	
Drama	6 (1.0%)	1 (0.8%)	
Other	10 (1.7%)	3 (2.1%)	
Children's peak viewing time			
Peak viewing time (5pm-20pm)	173 (29.3%)	28 (21.4%)	0.023
Non-peak	417 (70.7%)	103 (78.6%)	
Timeslot			
Morning	168 (18.5%)	56 (42.7%)	0.002
Lunch time (12h-14h)	82 (13.9%)	15 (11.5%)	
Afternoon	202 (34.2%)	34 (26.0%)	
Dinner time (19h-21h)	96 (16.3%)	17 (13.0%)	
Night	42 (7.1%)	9 (6.9%)	
Day of the week			
Weekday	311 (52.7%)	60 (45.8%)	0.072
Weekend day	279 (47.3%)	71 (54.2%)	
If the advertisement occurred within or between the programmes			
Within	394 (66.8%)	85 (64.9%)	0.602
Between	196 (33.2%)	46 (35.1%)	

P-value was calculated using the Chi-square test.

Table 3 – Secondary persuasive techniques used in all food and beverage advertisements and those targeted to children and teenagers.

Secondary persuasive techniques	All food and beverage advertisements	Advertisements targeted to children and teenagers	p-value
Dynamic audio-visual components			
Absent	384 (65.1%)	75 (57,3%)	0.033
Displayed on screen	206 (34.9%)	56 (42.7%)	
Brand equity characters			
Absent	537 (91%)	98 (74.8%)	<0.001
Displayed on screen	53 (9.0%)	29 (25.2%)	
Licensed characters			
Absent	590 (100%)	131 (100%)	---
Cartoon characters			
Absent	590 (100%)	131 (100%)	---
Celebrity endorsers			
Absent	566 (95.9%)	131 (100%)	-
Entertainment celebrity	15 (2.5%)	---	
Sports person	9 (1.5%)	---	
Website address			
Absent	498 (84.4%)	114 (87.0%)	0.349
Displayed on screen	92 (15.6%)	17 (13.0%)	
Links to social media platforms			
Absent	574 (97.3%)	131 (100%)	-
Present	16 (2.7%)	---	
Brand logos			
Absent	64 (10.8%)	4 (3.1%)	0.001
Displayed on screen	526 (89.2%)	127 (96.9%)	
Image of product/packaging			
Absent	4 (0.7%)	---	-
Displayed on screen	586 (99.3%)	131 (100%)	
Child character			
Absent	536 (90.8%)	94 (71.8%)	<0.001
Present	54 (9.2%)	37 (28.2%)	

Premium offers			
Absent	519 (88.0%)	95 (72.5%)	<0.001
Present	71 (12.0%)	36 (27.5%)	
Health claims			
None	561 (95.1%)	131 (100%)	
Other	8 (1.4%)	---	
Sugar free	7 (1.2%)	---	
No added sugars/less sugar	10 (1.7%)	---	-
Low calorie/light	3 (0.5%)	---	
Whole grain/Whole wheat	1 (0.2%)	---	
Physical activity			
None depicted	573 (97.1%)	131 (100%)	-
Depicted	17 (2.9%)	---	
Disclaimers			
None	581 (98,3%)	131 (100%)	
Part of a balanced/complete/nutritious breakfast or meal	9 (1.5%)	---	-

P-value was calculated using the Chi-square test.

Table 4 – Percentage of food and beverage TV advertisements, according to different variables foreseen in the Portuguese Legislation, used in all food and beverage advertisements and those targeted to children and teenagers.

	All food and beverage advertisements	Advertisements targeted to children and teenagers	p-value
Urgence in consumption			
Yes	56 (9.5%)	10 (7.6%)	0.411
No	534 (90.5%)	121 (92.4%)	
Facilitation			
Yes	56 (9.5%)	---	-
No	534 (90.5%)	131 (100%)	
Status			
Yes	36 (6.1%)	35 (26.7%)	<0.001
No	554 (93.9%)	96 (73.3%)	

P-value was calculated using the Chi-square test.

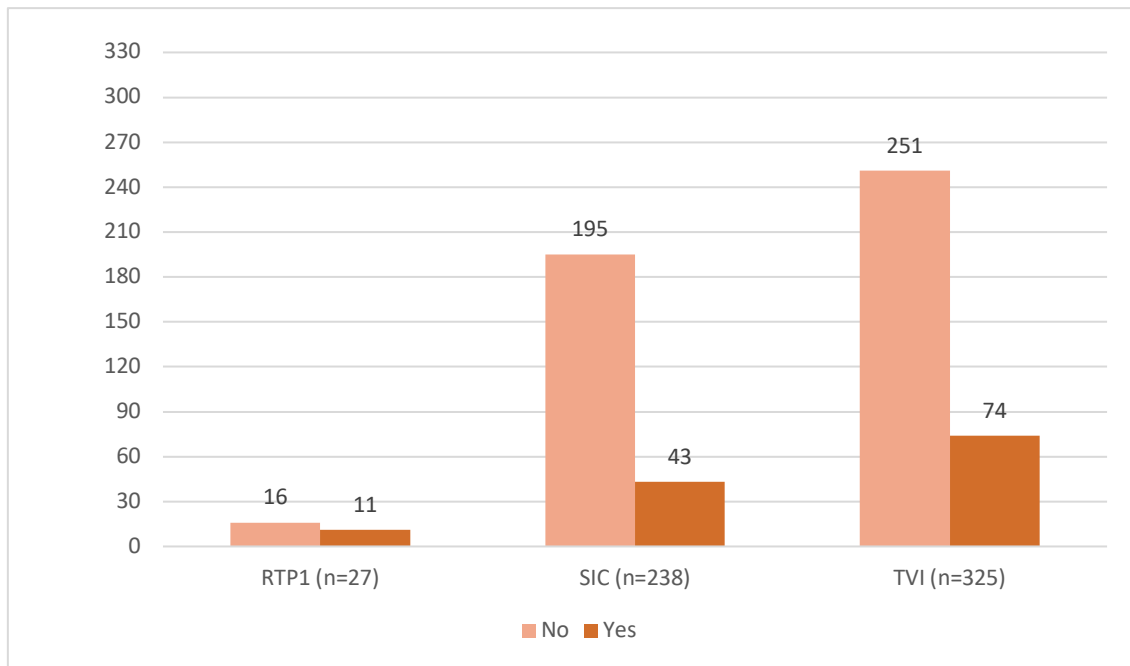


Figure 1- Number of food and beverage advertisements, by TV channel, accordingly to the compliance with the nutritional profile outlined by the Portuguese Directorate-General of Health (p=0.020).

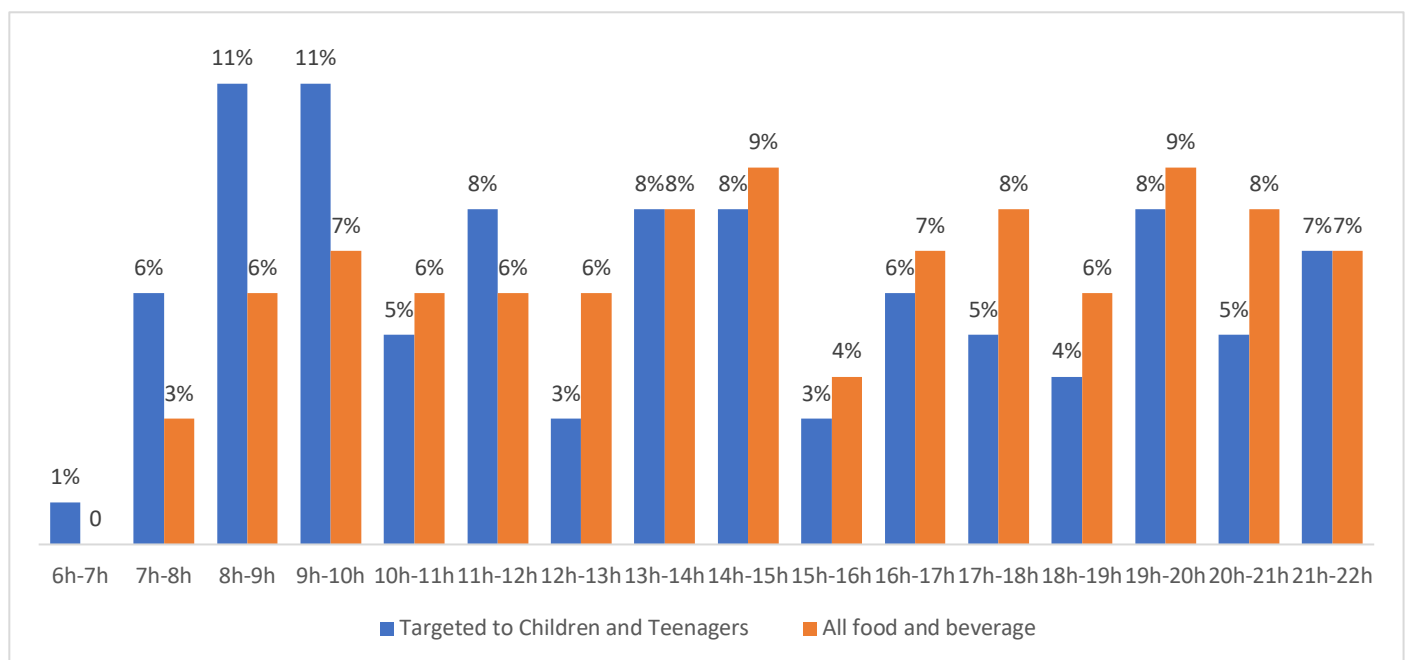


Figure 2 – Time Slot percentage of all food and beverage advertisements and those targeted to children and teenagers (p=0.018).

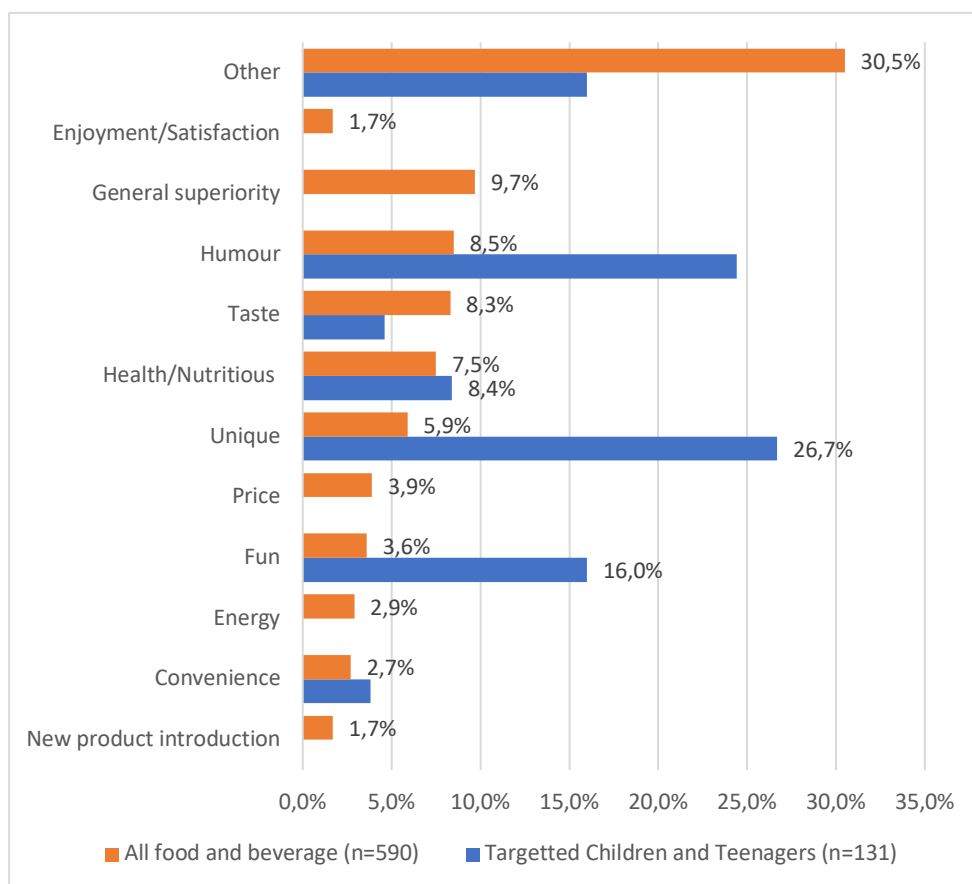


Figure 3 - Distribution of primary persuasive techniques used in all food and beverage advertisements and those targeted to children and teenagers ($p < 0.001$).

Conclusions

The present dissertation provides insight on the children's exposure to screens and food advertising, through television, in Portugal. This study also aimed to assess the associations between children's exposure to screens, food intake and childhood obesity.

Our results showed that Portuguese children are overexposed to screens (mainly in the form of television) and are likely exposed to a high percentage of unhealthy food advertisements on television. Results from the first paper suggest that over 68% of our preschool children sample exceeded the CPS and WHO recommendations of less than 60 minutes of screens per day, and there is a positive association between this behaviour and an unhealthier dietary pattern. Also, screen exposure seems to persist from 4 to 7 years of age, and we have identified lower parental education level, lower household income and male child sex as predictors of maintaining high or increasing screen time from pre-school to school age. Moreover, the second paper emphasizes the need to continuously monitor food advertising in Portugal in all venues. Additionally, adaptations to the Portuguese legislation on food marketing restrictions to children might be considered, particularly regarding the restriction of unhealthy food advertisements regardless of children's peak viewing hours and the inclusion of mixed audiences' programmes on these restrictions.

Our research highlights the importance of limiting children's screen time, to improve dietary habits and reduce childhood obesity rates - interventions to promote awareness among parents, caregivers and professors should be considered. These findings may be of interest to policy makers, researchers, and public health professionals, as they provide important insights for future research, both for the design of intervention programmes addressing childhood screen time patterns and for the development, update and better monitoring of policies to protect children from unhealthy food advertising, to ensure full compliance of the imposed restrictions in Portugal. Within the scope of Consumer's Sciences and Nutrition, this work provides knowledge about some of the current determinants of food consumption, namely the time spent in front of a TV (as well as other forms of media) and the impact of food advertising to children and promotes critical thinking about the new challenges of food consumption.

Notwithstanding, more research is needed in the area. Future studies should examine, not only the amount of time children spent in front of the TV, but also the effect of TV content and food advertising to which they are exposed, as well as parental influences and the family TV environment, on the children's own exposure to screens. Regarding the monitoring of food marketing restrictions, these methodologies should be replicated periodically and further venues such as digital marketing, internet, and

influencers, as well as other marketing strategies should be covered. Moreover, future research is needed on the effects of public policies in the protection of children from the harmful effects of food marketing.

It is undoubtedly crucial to implement measures that promote healthier food choices among children and teenagers. Reducing children's screen time, regulating food and beverage advertisement transmitted on TV and ban unhealthy ones are important steps in preventing childhood obesity and protecting children.

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