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DEPARTMENT OF NUTRITION AND DIETETICS

POSTGRADUATE PROGRAM "APPLIED NUTRITION AND DIETETICS"

COURSE: CLINICAL NUTRITION

Parental practices and lifestyle correlates of children's overweight and obesity in Europe: The Feel4Diabetes-study

Master's Research Thesis

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Γονικές πρακτικές και τρόπος ζωής των παιδιών σε σχέση με την παιδική παχυσαρκία στην Ευρώπη. Μελέτη Feel4Diabetes

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Περίληψη

Εισαγωγή: Ο επιπολασμός της παιδικής παχυσαρκίας και των σχετιζόμενων επιπλοκών αυξάνονται συνεχώς. Ως αποτέλεσμα, η πρόληψη της παχυσαρκίας είναι υψίστης σημασίας, της οποίας σημαντικό συστατικό είναι ο προσδιορισμός των παραγόντων κινδύνου, ιδιαίτερα των παραγόντων κινδύνου που σχετίζονται με τους γονείς.

Σκοπός: Ο στόχος της παρούσας μελέτης είναι να διερευνήσει τις συσχετίσεις μεταξύ της διαθεσιμότητας, των γονικών πρακτικών, του τρόπου ζωής και της υπερβαρότητας/παχυσαρκίας σε παιδιά που συμμετέχουν στη ευρωπαϊκή μελέτη Feel4Diabetes.

Μεθοδολογία: 12.041 ενήλικες και τα παιδιά τους ηλικίας 5-12 ετών συμπεριλήφθηκαν στη μελέτη (δεδομένα από τη μελέτη Feel4Diabetes). Η ανάλυση λογιστικής παλινδρόμησης χρησιμοποιήθηκε για την αξιολόγηση της πιθανής συσχέτισης μεταξύ του οικογενειακού περιβάλλοντος, των πρακτικών σίτισης και του τρόπου ζωής και της παιδικής υπερβαρότητας και παχυσαρκίας. Επιπλέον, διεξήχθη πολυπαραγοντική ανάλυση προσαρμοσμένη για την φυσική δραστηριότητα, την εκπαίδευση της μητέρας και άλλες μεταβλητές**.**

Αποτελέσματα: Στην προσαρμοσμένη ανάλυση, η διαθεσιμότητα φρούτων και ανθυγιεινών σνακ «σπάνια/ποτέ» [φρούτα: 1,56, 95%CI (1,07-2,28), αλμυρά σνακ:1,21, 95%CI (1,07-1,38); γλυκά: 1,34, 95% CI (1,14 -1,57)] και το να είσαι σωματικά δραστήριος με το παιδί 1,27, 95% CI (1,12-1,44) «σπάνια/ποτέ» συσχετίστηκαν σημαντικά με την υπερβαρότητα και την παχυσαρκία του παιδιού, ενώ στην ίδια συχνότητα, να επιτρέπεται στο παιδί να παρακολουθεί τηλεόραση/DVD 0,81, 95%CI (0,72-0,92) ή να χρησιμοποιεί υπολογιστή/κινητό/tablet 0,77, 95%CI (0,68-0,88)· μαζί με επιβράβευση με παρακολούθηση τηλεόρασης/DVD ή τη χρήση υπολογιστή/κινητού/ tablet [TV/DVD: 0,86, 95%CI (0,74-0,98), υπολογιστής/κινητό/ tablet: 0,77, 95%CI (0,68-0,88)] και η απουσία ψηφιακών συσκευών στο παιδικό δωμάτιο [TV: 0,73, 95%CI (0,66-0,82),·DVD: 0,88, 95%CI (0,77- 0,99), Play station: 0,79, 95%CI (0,68-0,91), Υπολογιστής: 0,84, 95%CI (0,74-0,94), Tablet ή smartphone: 0,82, 95%CI (0,74-0,91)] συσχετίστηκαν αρνητικά με την υπερβαρότητα/παχυσαρκία.

Συμπεράσματα: Το οικογενειακό περιβάλλον και τα ψηφιακά μέσα βρέθηκε να συσχετίζονται σημαντικά με την κατάσταση βάρους των παιδιών στην Ευρώπη. Επειδή το αυξημένο βάρος κατά την παιδική ηλικία είναι ένα ανησυχητικό πρόβλημα δημόσιας υγείας σε όλο τον κόσμο,

στο οποίο οι γονείς μπορεί να έχουν καθοριστικό ρόλο, συνιστάται οι στρατηγικές προώθησης της υγείας και τα προγράμματα παρέμβασης να απευθύνονται στην οικογένεια.

Λέξεις κλειδιά: παιδική παχυσαρκία, παράγοντες κινδύνου, γονικές πρακτικές, τρόπος ζωής, Feel4Diabetes

Abstract

Background: The prevalence of childhood obesity and related complications is escalating. As a result, prevention of obesity is of utmost importance, whose vital component is the identification of childhood obesity risk factors, especially those parents-related.

Objectives: The aim of this study is to investigate associations among home food availability, parenting practices, lifestyle patterns and overweight/obesity in European children participating in the Feel4Diabetes cohort study.

Methods: Data from 12,041 adults and their children aged 5 to 12 years old participating in the Feel4Diabetes cohort were included in this study. Logistic regression analysis was used to assess the possible association between home food environment, child-feeding practices, lifestyle practices and childhood overweight and obesity, adjusting for regular physical activity, maternal education and other variables.

Results: In the adjusted analysis**,** home availability of fruits and unhealthy snacks 'rarely/never' [fruit: OR: 1.56, 95%CI (1.07-2.28); salty snacks: OR: 1.21, 95%CI (1.07-1.38); sweets: OR: 1.34, 95%CI (1.14 -1.57)] and being physically active with my child OR: 1.27, 95%CI (1.12-1.44) 'rarely/never' were significantly associated with child overweight and obesity; whereas at the same frequency, allowing my child to watch TV/DVD 0.81, 95%CI (0.72-0.92) or to use computer/mobile/tablet OR: 0.77, 95%CI (0.68-0.88); along with rewarding by allowing to watch TV/DVD or use computer/mobile/ tablet [TV/DVD: 0.86, 95%CI (0.74-0.98); computer/mobile/ tablet: 0.77, 95%CI (0.68-0.88)] and the absence of digital devices in children's room [TV: OR: 0.73, 95%CI (0.66-0.82); DVD: OR: 0.88, 95%CI (0.77- 0.99); Play station: OR: 0.79, 95%CI (0.68-0.91); Computer: OR: 0.84, 95%CI (0.74-0.94); Tablet or smartphone: OR: 0.82, 95%CI (0.74-0.91)] were negatively associated with overweight/obesity.

Conclusions: The home environment and digital media have been found to be significantly correlated with the weight status of children in Europe. Since childhood overweight and obesity is an alarming public health problem worldwide, to which parents may have a pivotal role, it is recommended that health promotion strategies and intervention programs should be family directed.

Key words: childhood obesity; risk factors; parenting practices; parental lifestyle; Feel4Diabetes

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1. Introduction

1.1 Introduction to childhood obesity and its definition

Obesity has emerged as the largest chronic health problem in the world, which is one of the leading causes of morbidity and mortality, affecting not only adults but also children and adolescents. [1] In fact, this problem seems to be exacerbated after the Pandemic of COVID-19. According to a systematic review, the general quarantine "had a negative impact on the diets and lifestyles of children and adolescents, with a consequent increase in body weight and central fat accumulation". [2]

Presently, the World Health Organization (WHO) defines overweight and obesity as a situation of abnormal or excessive fat accumulation at a degree which endangers the health of the individual.[3]Body mass index (BMI) is commonly used to classify overweight and obesity in adults whereas in children and adolescents the diagnosis of overweight and obesity differs and varies according to their age and gender. The reference BMI thresholds used for categorization of body weight of children and adolescents in the developmental curves of BMI with respect to age (for children and adolescents older than 5 years) or height-weight (for infants and children under 5 years) are listed by gender. [4]

Furthermore, given that the waist circumference is a useful anthropometric indicator for estimating excess central fat, international growth curves for the waist region by gender and age were recently proposed to assess central obesity in children and adolescents aged 6-18 years. [5]

1.2 Epidemiology of childhood obesity

Childhood obesity has been on the rise in recent decades, reaching epidemic proportions worldwide. Regarding the prevalence of overweight and obesity in children and adolescents worldwide, according to a recent report of the World Obesity Federation, the number of children aged between 5- and 19-year-old living with obesity was estimated to be 253 million in 2030 representing almost 1 in 8 (12.91%) of all children and adolescents globally. In Greece specifically, almost 81 thousand (22,76%) children aged 5-9 and almost 143 thousand (16,23%) adolescents aged 10-19 are predicted to be affected by obesity by 2030. [6]

Currently, about one-third of children and adolescents in the United States are classified as either overweight or obese. In fact, the prevalence of overweight or obesity increases with advancing age: from preschool children to adolescents. [7] Meanwhile in Europe, according to the WHO European Childhood Obesity Surveillance Initiative[8], prevalence of overweight is 18% to 52% for boys and 13% to 43% for girls, while of obesity 6 to 28% and 4 to 20% for boys and girls, respectively. In Greece specifically, the prevalence of obesity is 22% for boys and 16% for girls aged 7 years old and 28% for boys and 20% for girls aged 9 years old. These data suggest that more boys than girls are overweight or obese, in most age groups and especially in older ages.

Moreover, it seems that countries of Southern Europe have a higher rate of overweight and obesity.[8] There are also notable socioeconomic inequalities in childhood obesity: with obesity being more prevalent in low-income populations. [9,10]

1.3 Complications of childhood obesity

Childhood obesity is known to lead to many short-term or long-term health effects. [7] Regarding the short-term effects, obesity can affect both the nutritional status and the development of children and adolescents, increasing the likelihood of developing iron deficiency, iron-deficiency anemia and/or vitamin D deficiency. [11–13] Moreover, obese children and adolescents are at high risk of musculoskeletal and orthopedic complications, (e.g., lower extremity joint pain, fractures, osteoarthritis and musculoskeletal discomfort), respiratory problems (e.g., asthma and sleep apnea), and diseases of the gastrointestinal tract (e.g., NAFLD, gallstones, gastroesophageal reflux disease).

Regarding the long-term effects children and adolescents with obesity are also at an increased risk of dyslipidemia, hypertension, hyperinsulinemia, insulin resistance, prediabetes, and subsequently type II diabetes.[7,14] Furthermore, obesity in childhood and adolescence is a strong predictor for obesity in adulthood and is associated with significant morbidity and mortality, by increasing the risk of cardiovascular diseases in adulthood.[15,16] In fact, according to a meta-analysis[16] of 15 prospective studies, obese children and adolescents were around five times more likely to be obese in adulthood than those who were not obese. Specifically, 55% of obese school children aged (7-11 years) remain obese in adolescence, while 70-80% of obese adolescents (12-18 years old) remain obese and as adults. However, notably 70% of obese adults were not obese as children or adolescents which makes it important to target obesity reduction not solely at obese or overweight children as this may not substantially reduce the overall burden of adult obesity.

Obesity has also an impact on the child's and adolescent's mental health, through 'weight stigma'. Children with obesity can experience weight-related bullying, teasing, poor self-esteem, depressive disorders even more impaired school performance. In turn, these

psychosocial impairments can lead to weight management through unhealthy weight-control, creating a negative feedback loop of stigma and weight gain. [17] This fact is supported by a recent meta-analysis of 22 studies [18] which found strong evidence correlating childhood obesity with depression, especially in girls, with the risk remaining in adulthood.

1.4 Risk factors for childhood obesity

Childhood obesity isn't a single-agent entity but instead the consequence of an interaction among a complex set of factors such as genetic and biological factors, environmental factors, and ecological effects such as child's family, community and school. [7] Below some of the risk factors are listed briefly while the environmental factors especially family are presented in detail influencing children and which could potentially lead to obesity.

Genetic risk factors

As mentioned before, childhood obesity is the consequence of interactions among a complex set of factors, one of which is genetic predisposition. [7] A systematic review and metanalysis of 32 twin studies[19] has shown heritability of obesity to range from 30 to 90% (on average 70%). Several single gene defects and syndromes have been identified, the most common of which are Prader-Willi syndrome and mutations in the melanocortin-4 receptor. However, these account for less than 1% of childhood obesity as polygenetic obesity is the most frequently observed.[7] Genome wide association (GWAs) studies have revealed at least 15 genetic loci (e.g., in or close to ADCY3, FTO, MC4R genes) associated with children's BMI or adiposity, most of them are also associated with adults' BMI. [20] However, there is increasing evidence that the risk of childhood obesity is not only related to specific genetic loci but also gene–environment interactions, such as epigenetic modifications, play likely a major role. For

example, epigenetics has been postulated to represent a bridge between nutrition during early postnatal period and childhood obesity [21,22]

Behavioral risk factors

Lifestyle-related effects that lead to childhood obesity reflect risk factors that focus mainly on diet habits and physical activity. Unbalanced diet leading to increased energy intake, as well as low physical levels activity and / or the increased sedentary time, contribute in reduced energy expenditure and have been identified as the primary causes of weight gain and consequently lead to obesity.[23]

In this context, a recent meta-analysis [24] of 199 studies with 1.634.049 participants aged 5-19 years old provided a clear picture of several behavioral factors that play an important role in the development of childhood obesity. In particularly physical activity and eating breakfast are the first and second most powerful protective factors against overweight and obesity in children and adolescents. On the other hand, inadequate sleep, watching too much TV and drinking sugar-sweetened beverages are associated with increased risk of childhood obesity.

1.5 Parental-related childhood obesity risk factors

The family as part of a child's social environment has an active role in shaping perceptions and knowledge related to food affecting eating habits and food choices, but also adoption behaviors that the child will follow throughout of his life. [25] Most studies examine the impact of the family environment on children's energy balance emphasizing on parental practices, such as feeding restriction or pressuring to consume food, the use of food as a reward or punishment

as well as the role of parents as role models in shaping and maintaining their children's nutritional and weight status. [26]

1.5.1. Association of parental practices with childhood obesity

A recent meta-analysis[27] of 37 studies examined the wide variety of parental behaviors that either promote or prevent certain food consumption behaviors on **children's dietary habits**. Some behaviors, such as parents' own food consumption behavior, and availing certain types of food, have been shown to be strong correlates of child food consumption behavior. In particular, parental intake of fruit and vegetables is positively associated with their children and adolescents' fruit and vegetable consumption, [28] while parents' consuming energy-dense snacks is strongly associated with high consumption of unhealthy foods by children as shown in a cross-sectional study with a multi-ethnic sample of children with middle age 9 years. [29] A consistent positive association of parental modeling with school-aged (6-12 years old) children's vegetable consumption but also with soft drinks consumption is confirmed also by a review. [30]

On the other hand, according to the above meta-analysis, some behaviors such as active (verbal education and encouragement) and restrictive guidance, are effective only in certain contexts; active being more effective in encouraging fruits and vegetables consumption, while restrictive guidance in discouraging unhealthy eating such as SSBs consumption.[27] However, many studies disagree and suggest children exposed to parents' restrictive practices like food restriction are more likely to adopt unhealthy and disordered eating behaviors[31] or consume more unhealthy snacks and less healthy snacks [32].

The same meta-analysis showed that different parenting practices have different effects on children's eating behavior depending on their age, highlighting the use of different practices by

age. For children 6 and younger, rewarding with verbal praise can be more effective in promoting healthy eating and in preventing unhealthy eating, while active guidance (verbal education and encouragement) or education might be more useful in shaping food consumption behaviors with children aged 7 to 11 years old, that are at a more advanced developmental stage. Furthermore, notably, the relationship between restrictive guidance and unhealthy food consumption was more powerful among children 7 and older, as compared to those is younger. [27]

Furthermore, various parenting styles, feeding styles and feeding practices have been associated with **child BMI**. [33] The current literature on parenting practices and their effect on the child's weight suggests that more restraint and less pressure to eat is associated with higher child's weight. [33,34] In particularly, a systematic review of 31 studies with participants aged 4-12 years old showed that feeding practices such as restriction and pressure to eat correlates with child's BMI, especially in cross-sectional studies; restrictive/controlling feeding practices were generally linked to higher child BMI, whereas pressure to eat was associated with lower child BMI. [33] Consistent with these results, a previous systematic review[34] examined the association between two practices related to responsive feeding finding positive associations between nonresponsive feeding and child weight in 24/31 papers. By 'nonresponsive feeding' we mean "a lack of reciprocity between the parent and child", with the caregiver taking excessive control of the feeding situation (forcing/pressuring or restricting food intake), the child completely controlling the feeding situation (indulgent feeding), or the caregiver being completely uninvolved during meals (uninvolved feeding). [35,36]

In disagreement is a recent systematic review of 38 prospective studies examined the association between food parenting practices and children's weight outcomes. The most frequently evaluated practices; restriction, pressure to eat, and monitoring were not consistently

associated with children's weight over time. These findings did not align with the literature on dietary intake, which was discussed above, suggesting that shorter-term influences on dietary intake do not necessarily translate into longer-term associations with children's weight development. [37]

1.5.2. Association of parental lifestyle with childhood obesity

The role of the parents is also important for the sedentary habits of their child. Regarding **sedentary behavior**, the relevant literature states that the role of parents as role models seems to be positively correlated with children's TV-watching, with children spending more time on screen activities when they observe the same behaviors or they watch TV together with their parents. Beyond imitating their parents, even the presence of TV in children's bedroom and the number of TVs in the household were consistently and positively associated with time children spent on TV viewing. [30,38]On the other hand, TV-watching time was negatively related to the existence of family rules on TV viewing. In fact, watching TV in turn was positively related to the consumption of soft drinks and negatively related to the vegetable's consumption, indicating the effect of TV/media/ads on children's food habits [30]

A recent systematic review[39] examined the relationship between the home environment and **child adiposity**. Most consistent relationships were observed for physical aspects of the home media environment. Specifically, twenty-nine studies examined physical aspects of the home media environment, with most studies (21/29) demonstrating positive associations between availability and access to electronic media equipment in the home and measures of child adiposity. This association was observed across children aged 3–12 in both cross-sectional (n = 19) and longitudinal studies (n = 2).

Existing data from the literature on the effect of **parental physical activity** on children's behaviour is not clear. According to a systematic review [38], parental encouragements and

discouragements, parental physical activity, parents being physically active with their child and family recreation showed no association with total physical activity and, in particularly, indeterminate results were found for parental physical activity. In contrast, a more recent systematic review[40] of cross-sectional as well as longitudinal studies, suggests that parental physical activity directly correlates with children's physical activity levels. It was shown that both children and adolescents were more active if their mother was more active while paternal physical activity was also found to have a positive association with physical activity in adolescents.

Meanwhile, although the effect of parental physical activity on their child's weight has been little studied, data to date show that parents' physical activity levels appear to be related to offspring weight. [41,42] In particular, a study of 1615 children (7.1 ± 0.6 years old) investigated the influence of parental physical activity on their BMI percentiles showed that children of active parents were less likely to be overweight and obese than those whose parents were both or one unactive. [41] Moreover, a Norwegian population-based cohort study, aimed to assess the impact of parental changes in weight and physical activity on offspring weight at adolescence (>13 years old), showed that lifestyle changes in mothers were associated with offspring BMI; reduced weight with lower and reduced physical activity with higher BMI. Father's lifestyle changes, however, did not significantly affect adolescent offspring's weight. [42]

Children's home environment is a key factor for supporting or discouraging healthy eating in children. Specifically, a systematic review of 33 studies[43] examined the components of the home environment associated to children's fruit & vegetables consumption, focusing specifically on primary-school children aged 6–12 years, showed that home food availability and accessibility are positively related to the consumption of fruits and vegetables. **Home food availability** has been found to be positively associated also with soft drink intake in children.[44] Results that are in agreement with a review and a recent metanalysis. [27,30]

Regarding the effect of the home food environment on the child's weight status, the results of a recent systematic review[39] do not lead to clear conclusions. In particularly, greater availability of nutrient dense foods (e.g., fruits and vegetables) were associated with lower BMI z-scores in children aged 10 to 11 years old [45] , while higher availability and access to energy-dense foods (e.g., sugar sweetened beverages and sweets) predicted higher BMI among children [46,47]. But conversely, in one study overweight/obese children had greater access to fruits and vegetables and less access to energy dense foods in the home. [48] However, more studies (8/15) found no relationship between home food availability with child adiposity. [39]

1.6 Research gap

As stated above, childhood obesity has been on the rise in recent decades, reaching epidemic proportions. Consequently, obesity-related complications are being diagnosed with increasing frequency in children and in certain cases can persist in adulthood and lead to life-threatening diseases. As a result, prevention of obesity is of utmost importance therefore identification of childhood obesity risk factors is essential.

To date, a variety of factors such as genetic, socio-demographic, family environment and lifestyle have been associated with its occurrence. Regarding the family environment, both the parenting practices applied by the parents and the lifestyle characteristics that have shaped the children as a result of these practices have at times been associated with childhood obesity.

There is a paucity of data in the literature regarding the influence of parenting practice and childhood obesity. [33,34,37] More specifically, while there are plenty of studies that investigate parenting practices in relation to their children's diet habits, there are only three published systematic reviews [33,34,37] on the relationship between parental feeding practices and their children's weight and subsequently childhood obesity and those with conflicting results. As far

as the parental lifestyle is concerned, bibliographic data are even less and inconsistent. Thus, there is need of further research, to develop awareness of these risk factors and therefore to promote screening, early detection of obesity and treatment in high-risk children.

1.7 Research question

In the interest of preventing childhood obesity as well as developing appropriate prevention programs, risk factors of child overweight and obesity need to be better understood. The aim of this cross-sectional study is to investigate associations among home food availability, parenting practices, lifestyle patterns and overweight/obesity in European children participating in the Feel4Diabetes cohort study.

2. Methodology

2.1. Study Design

The Feel4Diabetes-study was a large school- and community- based intervention with a cluster-randomized design, aimed to prevent diabetes mellitus type 2 in families across Europe by promoting a healthy lifestyle and managing obesity and obesity-related metabolic risk-factors (National Clinical Trial number, NCT 02393872). Families (primary-school children, their parents, and grand-parents) were recruited from two low/middle –income countries (Bulgaria, Hungary), two low socio-economic areas in high – income countries (Belgium, Finland) and two countries under austerity measures (Greece, Spain). [49]

The study was conducted between 2015 and 2019 and reached 30,309 families. The study consisted of two major components, the "all families" component, which was delivered at schools, home and the local municipalities, and the "high-risk families" component delivered by trained health professionals, in families at increased risk of diabetes mellitus type 2. The present study is a cross-sectional analysis of baseline data of all families (parents-children's dyads) participating in the Feel4Diabetes- Study.

2.2. Ethnics and consent

The Feel4Diabetes-study adhered to the Declaration of Helsinki and the conventions of the Council of Europe concerning human rights and biomedicine. Ethical clearance was obtained in all participating countries, prior to the initiation of the intervention, from the relevant ethical committees and local authorities. More specifically, in Greece ethical clearance was obtained from the Bioethics Committee of Harokopio University and the Greek Ministry of Education. All parents and caregivers gave signed consent before enrolling in the study.

2.3. Study Sample

The sample of the study consisted of families from "vulnerable" social groups from six European countries. In Bulgaria and Hungary, the two low/middle income countries, all areas within the selected provinces were considered "vulnerable" and eligible to participate in the study. In Belgium, Finland, Greece and Spain, the municipalities, school districts or other equivalent units were grouped in tertiles according to socio-economic indices and "vulnerable" areas were randomly selected only from the lowest tertile.

Children attending the first three grades of primary school and their parents and grandparents were recruited into the study. In total, 12, 041 families (parent-dyads) were enrolled at baseline, and data was assessed for 12, 041 children (age range 5–12 years old).

2.4. Measurements

A series of anthropometric indices were conducted. Furthermore, children's and adults' behavioral indices on drinking, eating, physical activity, sedentary behaviors as well information or data on home food availability, parenting practices and digital devices in children's rooms were collected using self-administered questionnaires (Appendix 1). Sociodemographic information (children's age, gender, maternal education) was collected via self-administered questionnaires completed by parents.

Children's physical activity

Physical activity in children was measured qualitatively by the following question: 'On how many days during the last week was your child physically active for a total of ≥ 1 hour daily?' Possible responses were none, one day, two days, three days, four days or five days. Data was recoded to two categories < 3 days and ≥ 3 days/week, where regular physical activity was considered to be ≥ 3 days/week.

Home food availability

Home food availability of specific foods was evaluated by questioning respondents 'On a weekly basis, how often are the following foods: fruits, fruit juice, soft drinks (regular and diet), sweets (e.g., biscuits, ice-cream, cake, pastries) and salty snacks (chips and savory pastries) available at your home?' (Appendix 1). Five possible response options were available:

'always', 'often', 'sometimes', 'rarely' or 'never' which were recoded to two categories 'always/often' and 'rarely/never'.

Parenting Practices

Parenting practices were evaluated by questioning respondents 'On a weekly basis, how often do you do … the followings?' and particular practices were mentioned e.g., 'Consume fresh fruits with your child?'. All nine questions are reported in Appendix 1. Five possible response options were available: 'very often', 'often', 'sometimes', 'rarely' or 'never' which were recoded to two categories 'very often/often' and 'rarely/never'.

Digital devices in children's room

The presence of the digital devices TV, DVD player, game consoles (e.g., play station), computer, tablet or smartphone in children's room was evaluated by the question 'Are the following devices available in your child's room?'. Respondents ticked either 'Yes' or 'No' (Appendix 1).

Maternal Education level

Maternal educational level was evaluated by a question that measured the number of years of completed education: ≤ 6 years, 7-9 years, 10-12 years, 3-14 years, 15-16 years and > 16 years. Response groups were recoded to two groups ≤ 12 years and > 12 years of completed education.

2.4.1. Anthropometric measurements

During the study, anthropometric indices of the children and the adult family members were taken. All measurements were conducted by trained research assistants, using standardized protocols and calibrated equipment.

Height: Height was measured twice in every session by the same research assistant, using a portable stadiometer (SECA 213, SECA 214, SECA 217 and SECA 225). A third measurement was taken if the measurements varied by 1cm. Volunteers were asked to remove their shoes, heavy clothing and hair accessories that could lead to false measurements. Then they were asked to stand in a natural position firmly on the stadiometer with their head positioned correctly so that the Frankfort horizontal plane is parallel to the ground.

Weight: Weight was measured twice in every session, by a trained examiner. A third measurement was conducted if the first two differed for more than 100gr. Measurements were conducted by using an accredited digital weight scale (either SECA 813 or SECA 877). Participants were asked to remove shoes, any heavy objects such as belts or keys, and heavy clothing. They were asked to stand in the center of the scale with their weight evenly distributed on both legs. The indication was recorded and rounded to the nearest tenth of a kilogram. BMI was then calculated by weight (kg)/ height^2 (m^2) and classified to normal, overweight and obese groups, applying the International Obesity Task Force (IOTF) sex-age specific cut-off points. Children who had a BMI below the "18.5" line were categorized as underweight, those who had values between the "25" and the "30" line were overweight, and those whose BMI exceeded the 30th line were obese. [4] For analytical purposes overweight and obese categories were combined to one group as overweight/obese.

2.5. Statistical Analysis

For the statistical analysis of the Feel4Diabetes data, SPSS version 27 (SPSS: Statistical package for social sciences, SPSS Inc., Chicago, IL, USA) was used and the statistical significance level was set at $p \leq 0.05$. Continuous variables were assessed for normality applying the Kolmogorov-Smirnov test and the histogram. Normally-distributed variables were expressed as means and standard deviations and in frequencies (n) and percentages, otherwise. Group differences were assessed using Pearson's X^2 test or Kruskal-Wallis non-parametric test. The logistic regression model was used to explore associations between the home food environment, child-feeding practices, and lifestyle practices (as the independent variables) and children's overweight/obesity (dependent). For each independent variable a separate regression analysis was performed and measures of associations were estimated by computing crude odds ratio (OR) with 95% confidence intervals (CI). Furthermore, multivariate analysis was conducted adjusting for children's age, sex, regular physical activity, maternal education and country of residence.

3. Results

3.1. Descriptive characteristics

Overall, 12,041 children participated in this multicenter study, about half were male (49.4%; 5,942/12,041) and children's ages ranged from 5-12 years old. With respect to weight status, 25.5% (3,068/12,041) were overweight/obese [45.89% (1,408/3,068) boys versus (vs) 54.11% (1,660/3,068) girls; $P < 0.001$) with 85.5% of children (9,756/12,041) exercising

regularly at least three days weekly [50.4% (4,916/9,756) boys vs 49.6% (4,839/9,756) girls; P < 0.001]. Population characteristics by country of residence are presented in ***Table 1***.

Table 1: Population characteristics by country of residence

CHILDREN	COUNTRY						
N=12, 041	**Belgium (n= 1787)**	**Finland (n= 1504)**	**Greece (n= 2283)**	**Hungary (n= 1828)**	**Bulgaria (n= 2972)**	**Spain (n=1667)**	
Characteristics	**% (n)**	**%(n)**	**%(n)**	**%(n)**	**%(n)**	**%(n)**	**P[a]**
Boy	49.92% (891/1785)	50.27% (756/1504)	47.83% (1092/2283)	47.76% (873/1828)	48.79% (1450/2972)	52.79% (880/1667)	
Girl	50.08% (894/1785)	49.73% (748/1504)	52.17% (1191/2283)	52.24% (955/1828)	51.21% (1522/2972)	47.21% (787/1667)	0.024
Age (Mean ± SD) years	7.96 ± 0.92	8.69 ± 0.94	7.79 ± 0.88	8.68 ± 1.02	8.31 ± 0.91	7.90 ± 0.95	**P<0.001**
Normo-weight	85.79% (1527/1780)	78.33% (1175/1500)	63.54% (1450/2282)	73.56% (1344/1827)	74.97% (2226/2969)	74.07% (1234/1666)	
Overweight/obese	14.21% (253/1780)	21.67% (325/1500)	36.46% (832/2282)	26.44% (483/1827)	25.03% (743/2969)	25.93% (432/1666)	**P<0.001**
< 3 days/week	20.44% (359/1756)	4.82% (72/1494)	17.48% (388/2220)	7.48% (132/1764)	18.46% (531/2876)	13.70% (179/1307)	
≥3 days/week	79.56% (1397/1756)	95.18% (1422/1494)	82.52% (1832/2220)	92.52% (1632/1764)	81.54% (2345/2876)	86.30% (1128/1307)	**P<0.001**
≤ 12 years	21.94% (373/1700)	9.42% (139/1475)	44.34% (971/2190)	51.13% (903/1766)	26.60% (755/2838)	4.89% (61/1247)	
> 12 years	78.06% (1327/1700)	90.58% (1336/1475)	55.66% (1219/2190)	48.87% (863/1766)	73.40% (2083/2838)	95.11% (1186/1247)	**P<0.001**

In bold text statistically significant P-values at 5%

[a] P-value estimated by Chi Square test; [b]Kruskal-Wallis Test

Comparisons for within group differences as assessed by the z- test with the Bonferroni adjustment, showed no differences.

In ***Table 1***, country differences were observed in childhood overweight/obesity with the highest prevalence in Greece at 36.5% and the lowest in Belgium 14.2% ($P < 0.001$), predominating in girls; Greece: 38% vs Belgium 17.2% ($P < 0.001$) (data not shown).

3.2. Associations between home availability, parental practices and devices in children's room with childhood overweight/obesity

Differences between the home environment, digital devices in children's room and children's BMI category are displayed in ***Table 2***.

Table 2: Differences in home availability, parenting practices, and devices in children's room per BMI category for the total sample of European children

		Normal	Overweight/Obese	
	Frequency	**%(n)**	**%(n)**	**P[a]**
Home Availability				
Fruits	Always/Often	75.09% (8054/10,726)	24.91% (2672/10,726)	**0.003**
	Rarely/Never	63.97% (87/136)	36.03% (49/136)	
Vegetables	Always/Often	75.28% (7969/10,586)	24.72% (2617/10,586)	**0.020**
	Rarely/Never	66.67% (92/552)	33.33% (460/552)	
Sweets	Always/Often	77.20% (5314/6883)	22.80% (1569/6883)	**P<0.001**
	Rarely/Never	71.20% (727/1021)	28.80% (294/1021)	
Salty snacks	Always/Often	78.25% (2856/3650)	21.75% (794/3650)	**P<0.001**
	Rarely/Never	73.19% (2757/3764)	26.81% (1010/3764)	
Parenting practices				
Consume fresh fruit with child	Very Often/Often	75.43% (5214/6912)	24.57% (1698/6912)	0.065
	Rarely/Never	72.99% (916/1255)	27.01% (339/1255)	
Be physically active with child	Very Often/Often	77.54% (3653/4711)	22.46% (1058/4711)	**P<0.001**
	Rarely/Never	70.27% (1510/2149)	29.73% (639/2149)	

		Normal	Overweight/Obese	
	Frequency	**%(n)**	**%(n)**	**P[a]**
Watch TV together with your child	Very Often/Often	73.16% (3211/4389)	26.84% (1178/4389)	**0.041**
	Rarely/Never	75.56% (1552/2054)	24.44% (502/2054)	
Allow child to eat sweets/ salty snacks whenever he/she asks for	Very Often/Often	74.67% (1775/2377)	25.33% (602/2377)	0.613
	Rarely/Never	75.23% (3350/4453)	24.77% (1103/4453)	
Allow your child to watch TV or DVD when he/she wants	Very Often/Often	72.95% (2451/3360)	27.05% (909/3360)	**0.033**
	Rarely/Never	75.20% (2647/3520)	24.80% (873/3520)	
Allow your child to use the computer, mobile or tablet	Very Often/Often	72.18% (2146/2973)	27.82% (827/2973)	**0.001**
	Rarely/Never	75.66% (3351/4429)	24.34% (1078/4429)	
Reward your child by allowing him/her to watch TV/DVD or use the computer, mobile or tablet	Very Often/Often	71.35% (949/1330)	28.65% (381/1330)	**0.016**
	Rarely/Never	74.52% (5338/7163)	25.48% (1825/7163)	
Reward your child with sweets, salty snacks (e.g., potato chips) or fast food	Very Often/Often	74.86% (521/696)	25.14% (175/696)	0.705
	Rarely/Never	74.20% (6193/8346)	25.80% (2153/8346)	
Reward your child by being physically active together or by taking him/her to the playground or park	Very Often/Often	73.60% (3161/4295)	26.40% (1134/4295)	0.819
	Rarely/Never	73.85% (1878/2543)	26.15% (665/2543)	
Digital devices in child's room				
TV	Yes	70.60% (3314/4694)	29.40% (1380/4694)	**P<0.001**
	No	77.61% (5152/6638)	22.39% (1486/6638)	
DVD player	Yes	70.94% (1118/1576)	29.06% (458/1576)	**P<0.001**
	No	75.66% (6844/9046)	24.34% (2202/9046)	
Game console (e.g., play station)	Yes	70.08% (827/1180)	29.92% (353/1180)	**P<0.001**
	No	75.53% (7098/9398)	24.47% (2300/9398)	
Computer	Yes	70.55% (1655/2346)	29.45% (691/2346)	**P<0.001**
	No	76.07% (6455/8486)	23.93% (2031/8486)	
Tablet or smartphone	Yes	71.76% (3179/4430)	28.24% (1251/4430)	**P<0.001**
	No	76.85% (5078/6608)	23.15% (1530/6608)	

In bold text statistically significant P-values at 5%

[a]P-value derived by Chi Square test

Table 2 shows that there were significant differences between home availability, parenting practices, and presence of digital devices in children's room among the normo-weight and overweight/obese groups. It seems that the availability of fruit and vegetables 'always/often' was higher in the normo-weight group than in the overweight/obese. The same trend was observed for the availability of sweets and salty snacks at a frequency of 'rarely/never', being physically active 'very often/often' along with permissive parenting practices such as watching TV and 'allowing and rewarding' by permitting the use of computer, DVD, mobile and tablet. Associations between the home environment, digital devices and overweight/obesity using the logistic regression model are presented in ***Table 3***.

Table 3: Associations between children's BMI category vs home availability, parenting and digital devices in children's room from the crude and adjusted regression analysis

Total sample (N= 12, 041)		Overweight/Obese				
		Model 1		Model 2		Model 3
		Unadjusted		Adjusted for Children's age, sex, regular exercise and maternal education		Adjusted for Children's age, sex, regular exercise, maternal education and country
	β	OR (95%CI); P-value	β	OR (95%CI); P-value*	β	OR (95%CI); P-value*
Home food availability						
Fruit						
Often/always		ref				
Rarely/never	0.53	1.70(1.19, 2.42); P = **0.003**	0.37	1.46(1.00, 2.11); P_{adj} = **0.049**	0.45	1.56(1.07, 2.28); P_{adj} **= 0.020**
Vegetables						
Often/always		ref				
Rarely/never	0.42	1.52(1.07, 2.17); P = **0.021**	0.27	1.30(0.89, 1.91); P_{adj} = 0.174	0.19	1.21(0.82, 1.79); P_{adj} = 0.324
Sweets						
Often/always		ref				
Rarely/never	0.31	1.37(1.18, 1.59) ; P < **0.001**	0.34	1.40(1.21, 1.63); P_{adj} < **0.001**	0.29	1.34(1.14, 1.57); P_{adj} < **0.001**
Salty snacks						
Often/always		ref				

Total sample (N= 12, 041)		Overweight/Obese				
		Model 1		Model 2		Model 3
		Unadjusted		Adjusted for Children's age, sex, regular exercise and maternal education		Adjusted for Children's age, sex, regular exercise, maternal education and country
	β	OR (95%CI); P-value	β	OR (95%CI); P-value*	β	OR (95%CI); P-value*
Rarely/never	0.28	1.32(1.18, 1.47); P < **0.001**	0.37	1.44(1.29, 1.61); P_{adj} < **0.001**	0.19	1.21(1.07, 1.38); P_{adj} = **0.003**
Parenting Practices						
Consume fruit with child						
Very often/often						
Rarely/never	0.13	1.14(0.99, 1.30); P = 0.066	0.12	1.13(0.98, 1.30); P_{adj} = 0.082	0.12	1.13(0.98, 1.30); P_{adj} = 0.100
Be physically active with child						
Very often/often		ref				
Rarely/never	0.38	1.46(1.30, 1.64); P < **0.001**	0.35	1.41(1.25, 1.59); P_{adj} < **0.001**	0.24	1.27(1.12, 1.44); P_{adj} < **0.001**
Watch TV together with child						
Very often/often		ref				
Rarely/never	-0.13	0.88(0.78, 0.99); P = **0.041**	-0.10	0.90(0.80, 1.02); P_{adj} = 0.112	-0.12	0.89(0.78, 1.01); P_{adj} = 0.062
Allow child to eat sweets/salty snacks whenever wants						
Very often/often		ref				

Total sample (N= 12, 041)		Overweight/Obese				
		Model 1		Model 2		Model 3
		Unadjusted		Adjusted for Children's age, sex, regular exercise and maternal education		Adjusted for Children's age, sex, regular exercise, maternal education and country
	β	OR (95%CI); P-value	β	OR (95%CI); P-value*	β	OR (95%CI); P-value*
Rarely/never	-0.03	0.97(0.87, 1.09); P = 0.613	0.06	1.07(0.94, 1.21); P_{adj} = 0.301	0.12	1.12(0.98, 1.28); P_{adj} = 0.085
Allow child to watch TV or DVD whenever wants						
Very often/often		ref				
Rarely/never	-0.12	0.89(0.80, 0.99); P **= 0.033**	-0.06	0.94(0.84, 1.06); P_{adj} = 0.312	-0.21	0.81(0.72, 0.92); P_{adj} = **0.001**
Allow child to use computer/mobile/tablet whenever wants						
Very often/often		ref				
Rarely/never	-0.18	0.83(0.75, 0.93); P= **0.001**	-0.11	0.90(0.80, 1.00); P_{adj} =0.063	-0.26	0.77(0.68, 0.88); P_{adj} < **0.001**
Reward your child by allowing to watch TV/DVD, use computer/mobile/or tablet						
Very often/often		ref				
Rarely/never	-0.16	0.85(0.75, 0.97); P= **0.016**	-0.12	0.89(0.78, 1.02); P_{adj} = 0.100	-0.16	0.86(0.74, 0.98); P_{adj} = **0.029**
Reward child with sweets, salty snacks (e.g., potatoes chips) or fast food						
Very often/often		ref				

Total sample (N= 12, 041)		Overweight/Obese				
		Model 1		Model 2		Model 3
		Unadjusted		Adjusted for Children's age, sex, regular exercise and maternal education		Adjusted for Children's age, sex, regular exercise, maternal education and country
	β	OR (95%CI); P-value	β	OR (95%CI); P-value*	β	OR (95%CI); P-value*
Rarely/never	0.03	1.03(0.87, 1.24); P= 0.705	0.20	1.22(1.00, 1.48); P_{adj} = **0.043**	0.12	1.13(0.93, 1.37); P_{adj} = 0.233
Reward child by being physically active together						
Very often/often		ref				
Rarely/never	-0.01	0.99(0.88, 1.10); P = 0.819	-0.03	0.97(0.86, 1.09); P_{adj} = 0.634	0.07	1.07(0.95, 1.21); P_{adj} = 0.276
Digital devices in child's room						
TV						
Yes		ref				
No	-0.37	0.69(0.64, 0.75); P < **0.001**	-0.31	0.74(0.67, 0.81); P_{adj} < **0.001**	-0.31	0.73(0.66, 0.82); P_{adj} < **0.001**
DVD						
Yes		ref				
No	-0.24	0.78(0.70, 0.88); P < **0.001**	-0.17	0.84(0.74, 0.95); P_{adj} = **0.007**	-0.13	0.88(0.77, 0.99); P_{adj} = **0.042**
Play station						
Yes		ref				
No	-0.28	0.76(0.66, 0.87); P < **0.001**	-0.23	0.79(0.68, 0.91); P_{adj} < **0.001**	-0.24	0.79(0.68, 0.91); P_{adj} < **0.001**

Total sample (N= 12, 041)		Overweight/Obese				
		Model 1		Model 2		Model 3
		Unadjusted		Adjusted for Children's age, sex, regular exercise and maternal education		Adjusted for Children's age, sex, regular exercise, maternal education and country
	β	OR (95%CI); P-value	β	OR (95%CI); P-value*	β	OR (95%CI); P-value*
Computer						
Yes		ref				
No	-0.28	0.75(0.68, 0.83); P < **0.001**	-0.21	0.81(0.73, 0.91); P_{adj} < **0.001**	-0.18	0.84(0.74, 0.94); P_{adj} = **0.003**
Tablet or Smartphone						
Yes		ref				
No	-0.27	0.77(0.70, 0.83); P < **0.001**	-0.20	0.81(0.74, 0.89); P_{adj} < **0.001**	-0.20	0.82(0.74, 0.91); P_{adj} < **0.001**

In bold text statistically significant P-values < 0.05
Total sample N= 12, 041
* ref: Reference group
Dependent BMI category (0= normo-weight vs 1= overweight/obese)
Model 1 Unadjusted logistic regression
Model 2 Adjusting for age, sex, physical activity and mother's educational level
Model 3 Adjusting for age, sex, physical activity, mother's educational level and country

In the crude regression analysis, home availability of fruit, vegetables, sweets, salty snacks at a frequency of rarely/never as compared to always/often were positively associated with overweight/obesity in children. In fact, home availability of fruits and vegetables 'rarely/never' were associated with 70% and 52% increased odds of children being overweight/obese as compared to those when these foods were available 'always/often' [(fruit: OR: 1.70, 95%CI: 1.19-2.42, P = 0.003); (vegetables: OR: 1.52, 95%CI: 1.07-2.17, P = 0.021)]. Similarly, home availability of salty snacks and sweets 'rarely/never' were associated with 32-37% increased odds of overweight/obesity [(salty snacks: OR: 1.32, 95%CI; 1.18-1.47, P < 0.001; sweets: OR: 1.37, 95%CI: 1.18-1.59, P < 0.001). Parenting practices such as being physically active with the child 'rarely/never' was associated with 46% increased odds of overweight/obesity as compared to 'very often/often' (OR: 1.46, 95%CI: 1.30-1.64, P < 0.001). In contrast, parents watching TV with the child and allowing the child to watch TV/DVD whenever he/she wants 'rarely/never' including rewarding and children's watching TV/DVD or computer/mobile/tablet use at a frequency of ' rarely/never' were inversely associated with overweight/obesity than 'very often/often'[(watching TV with child: OR: 0.88, 95%CI: 0.78-0.99, P= 0.041); allow child to watch TV/DVD: OR: 0.89, 95%CI: 0.80-0.99, P= 0.033); (allow child to use computer/mobile/tablet: OR: 0.83, (95%CI: 0.75-0.93, P= 0.001); (reward by allowing to watch TV/DVD or use computer/mobile/ tablet; OR: 0.85, 95%CI: 0.75-0.97, P = 0.016). As for the presence of digital devices in the child's room, parents' responding 'no' was associated with 22-31% decreased odds of children's overweight/obesity [TV: OR:0.69, 95%CI: 0.64-0.75, P < 0.001; DVD: OR: 0.78, 95%CI:0.70-0.88, P < 0.001; Play station; OR:0.76, 95%CI: 0.66-0.87, P < 0.001; Computer: OR:0.75, 95%CI: 0.68-0.83, P < 0.001; Tablet or smartphone: OR:0.77, 95%CI: 0.70-0.83, P < 0.001)]. After adjusting for children' age, sex, regular exercise, maternal educational level, and country, statistical significance remained for all variables except for home availability of vegetables and 'watch TV together with my child'. It appears that for all variables regular exercise (one hour at

least 3 days/week) and mother's educational level ≥ 12 years were associated with decreased odds of children's overweight/obesity (data not shown).

4. Discussion

The present study aimed to investigate associations among home food availability, parenting practices, lifestyle patterns and childhood overweight/obesity. The results underlined four principal findings. First, after adjusting for children's age, sex, physical activity, mother's educational level and country, home availability of fruits and unhealthy snacking (sweets and salty snacks) 'rarely/never' as compared to 'always/often' were associated with childhood overweight/obesity. Secondly, parents being physically active with their child 'rarely/never' as compared to 'always/often' were associated with overweight/obesity. Thirdly, allowing and rewarding by TV/DVD watching, computer/mobile and tablet use 'rarely/never' than 'very often/often' were inversely associated with overweight/obesity. Finally, the absence of these digital devices in the child's room, were also inversely associated with overweight/obesity, that is protective.

In more detail, in the adjusted analysis, home availability of fruits 'rarely/never' was positively associated with childhood overweight/obesity. Thus, suggesting that home availability of fruits 'always/often' is a protective practice against childhood overweight/obesity. According to the existing literature[27,30,43], home availability of fruits and vegetables leads to increased consumption by children. Additionally, it is well known that adequate consumption of foods with high nutritional value but few calories, such as the consumption of fruits and vegetables, is a protective factor against childhood obesity. [24,50] Thus, a possible explanation for the above finding is that home availability of fruit and vegetables leads to children's fruits and vegetables consumption which in turn protects them against overweight/obesity. Similarly, a previous study agrees that greater availability of nutrient dense foods

(e.g., fruits and vegetables) were associated with lower BMI z-scores in children. [45] However in the present study in the adjusted analysis no correlations were found for vegetables. This may be due to the fact that according to prior studies[51], Greek children are known to have low intake of vegetables which could account for no significant result in our analysis.

Moreover, the present study indicated that even low home availability of sweets and salty snacks was associated with childhood overweight/obesity. We know that high availability of unhealthy snacks leads to overconsumption by children[27,52] and the frequent consumption of calories dense foods, such as sugary drinks, sweet and savory snacks are associated with a higher risk of being overweight and obese in both children and adolescents. [24] This finding is very likely to be subject to bias resulting from parents' excessive desire to overestimate that they are pursuing practices that benefit their children, even if this is not entirely accurate, giving socially acceptable answers. Another possible explanation is that parents who participated in this study may have changed their feeding practices in reaction to their child's weight. There is some limited evidence that parents, and in particular mothers, adopt specific restrictive feeding strategies in response to their concerns about their child's weight. In particularly, if a child had already developed excessive body weight, the parents impose limitations on their child's diet. [53,54] We should also take into account that in the present study we examined only the family environment so that children may not consume unhealthy snacks at home but outside of the home. For example, children may purchase and consume unhealthy sweets and snacks at school without the parents being aware. In fact, according to COSI study[8] evaluated the school environment in 19 countries in Europe, including Greece, in relation to the possibility of buying healthy products (e.g., milk and fresh fruit) and unhealthy foods (e.g., cold drinks containing sugar, sweet snacks and salty snacks), showed that schools in Ireland, Malta, Norway, Portugal and Slovenia all had medium to high nutritional environment scores, while 97% of Albanian schools had low scores.

Also, the largest percentage of schools in Greece was rated with an average score. Thus, it is feasible that the availability of unhealthy snacks at schools can promote intake in children.

Furthermore, the present study indicated that children were more likely to be overweight/obese when being less frequently physically active with their parents. To date the effect of parental practices related to children's physical activity on their children's weight status has been little studied. In fact, there is limited evidence that parents' physical activity levels [41,42] and caregiver support of physical activity[55] appear to be related to offspring weight, particularly associated with lower BMI z-scores. However, there isn't evidence about the association between collaborative social control (active together) and the children's weight status. So, our study is important in adding new data to the existing literature. A recent longitudinal study examined the effect of six parental practices to BMI z-scores showed no significant interaction effects between collaborative social control and children's BMI z-scores. [55]

Another main finding of the present study is that allowing and rewarding by TV/DVD watching, computer/mobile and tablet use at a frequency of 'rarely/never' were inversely associated with childhood overweight/obesity. Contradictory to our findings [39]; some studies similar to the present study show fewer caregivers limits[56–58] are associated with increased BMI in children while other studies show the opposite result[59,60] or no correlation[61,62].

Last but not least, the present study suggests that the presence of digital devices in the child's room is positively associated with overweight/obesity. Similarly, a recent systematic review[39] of twenty-nine studies showed a consistent association between home media environment and childhood obesity; greater availability and access to electronic media devices in the home, and specifically in the child's bedroom, were associated with higher risk of adiposity. This is perhaps unsurprising as greater

availability of media in the home has been shown to be associated with weight-related energy balance behaviours; increased sedentary behaviour, decreased activity levels and increased snacking. [63]

To the best of our knowledge, this is the first study that examines parental practices and lifestyle according to childhood obesity in 6 different countries of Europe. This study has both strengths and limitations. Study's main strengths are the large study sample and methodology design. Specifically, our sample includes a large and socioeconomically diverse population of primary-school-aged children and their families from six European countries. Also, among the strengths of the present study is the fact that the standardized protocols and procedures followed across all centers and the objectively collected data (i.e., anthropometric indices) ensure more objective, reliable and valid assessment, allowing for greater generalizability of study results. On the other hand, some limitations of this study must be considered. Most of the collected data is self-reported and thus prone to recall bias and social desirability. Additionally, because the current study is cross-sectional, we are unable to determine causality. For example, we cannot conclude if the home availability of nutrient dense food was protective against overweight/obesity or in response to their children's weight status parents may avail this kind of food. Despite the limitations mentioned above, the reported findings deserve further attention for the development of effective strategies to fight childhood obesity.

For future research, we recommend to include and other children's caregivers such as grandmother or/and grandfather because today grandparents are not occasional visitors, but it seems that they also play an important role in children's upbringing and therefore in their eating habits and lifestyle behaviors related to childhood obesity. In fact, a recent meta-analysis[64] of 14 studies, examined the relationship between grandparental child care and childhood obesity, showed that children receiving care from grandparents have 30% increased risk of being overweight or obesity. A possible explanation is that grandparents urge their grandchildren to eat larger meals and provide them both delicious and unhealthy food (e.g., sweets and fried food) as an expression of love, which also points

to a Greek study [65] ; obese children compared to non-obese counterparts reported that the preparation of their food was done by their grandmothers.

Another factor that could be taken into account along with parental feeding practices is parenting styles (neglectful, permissive, authoritarian, and authoritative). These parenting characteristics appear to play a role in children's eating behavior and weight status. In fact, there is extensive data in the literature regarding the influence of parenting style on child's body weight. [33,66–68] The current literature argues that authoritative appear to be the most protective parenting style and is associated with a healthy child's BMI [33,66–68], whereas a permissive style with increased BMI. [33,66,68] Additionally, parenting styles influence childhood obesity also as a mediator. Specifically, a recent cross-sectional study showed that parental feeding styles moderate the relationship between food parenting practices and children's eating behavior specifically preferences for fruits, vegetables, or high fat/sugar foods. [69] So, if feeding style does alter the effectiveness of food parenting practices on children's eating behavior and/or weight outcomes, obesity prevention programs may need to consider the feeding style that the food parenting practice is occurring in.

The field would also benefit from additional longitudinal studies examining the long-term impacts of food parenting practices and parental lifestyle as well as the bidirectional relationships between parental practices and child's eating behaviors and weight status over time.

5. Conclusion

The home environment and digital media have been found to be significantly correlated with the weight status of children in Europe. Parents being physically active with their child 'rarely/never' as compared to 'always/often' including home availability of fruits and vegetables and unhealthy

snacking ‘rarely/never’ were associated with overweight/obesity. However, allowing and rewarding by TV/DVD watching, computer/mobile and tablet use ‘rarely/never’ than ‘very often/often’ as well as the absence of these digital devices in the child’s room, were inversely associated with overweight/obesity, that is protective. Since childhood overweight and obesity is an alarming public health problem worldwide, to which parents may have a pivotal role, it is recommended that health promotion strategies and intervention programs should be family directed.

6. References

1. Frühbeck G, Toplak H, Woodward E, Yumuk V, Maislos M, Oppert JM. Obesity: The gateway to ill health - An EASO position statement on a rising public health, clinical and scientific challenge in Europe. *Obes Facts*. 2013;6(2):117-120. doi:10.1159/000350627

2. Karatzi K, Poulia KA, Papakonstantinou E, Zampelas A. The impact of nutritional and lifestyle changes on body weight, body composition and cardiometabolic risk factors in children and adolescents during the pandemic of covid-19: A systematic review. *Children*. 2021;8(12). doi:10.3390/children8121130

3. WHO. Obesity and Overweight. Accessed April 26, 2022. https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight

4. Cole TJ, Lobstein T. Extended international (IOTF) body mass index cut-offs for thinness, overweight and obesity. *Pediatr Obes*. 2012;7(4):284-294. doi:10.1111/j.2047-6310.2012.00064.x

5. Xi B, Zong X, Kelishadi R, et al. International Waist Circumference Percentile Cutoffs for Central Obesity in Children and Adolescents Aged 6 to 18 Years. J Clin Endocrinol Metab. 2020;105(4): e1569-e1583. doi:10.1210/clinem/dgz195

6. WOF (World Obesity Federation). *Compiled by Tim Lobstein, Hannah Brinsden and Margot Neveux, with Input and Review from Acknowledgments*.; 2022. Accessed March 15, 2022. https://www.worldobesity.org/resources/resource-library/world-obesity-atlas-2022

7. Kumar S, Kelly AS. Review of Childhood Obesity: From Epidemiology, Etiology, and Comorbidities to Clinical Assessment and Treatment. Mayo Clin Proc. 2017;92(2):251-265. doi: 10.1016/j.mayocp.2016.09.017

8. WHO. *WHO European Childhood Obesity Surveillance Initiative: Overweight and Obesity among 6-9-Year-Old Children*.; 2018. http://www.euro.who.int/pubrequest

9. Eagle TF, Sheetz A, Gurm R, et al. Understanding childhood obesity in America: linkages between household income, community resources, and children's behaviors. Am Heart J. 2012;163(5):836-843. doi: 10.1016/j.ahj.2012.02.025

10. WHO. *Taking Action on Childhood Obesity*.; 2018.

11. Fiamenghi VI, Mello ED de. Vitamin D deficiency in children and adolescents with obesity: a meta-analysis. *J Pediatr (Rio J)*. 2021;97(3):273-279. doi: 10.1016/j.jped.2020.08.006

12. Pereira-Santos M, Costa PR, Assis AM, Santos CA, Santos DB. Obesity and vitamin D deficiency: a systematic review and meta-analysis. Obes Rev. 2015;16(4):341-349. doi:10.1111/obr.12239

13. Zhao L, Zhang X, Shen Y, Fang X, Wang Y, Wang F. Obesity and iron deficiency: a quantitative meta-analysis. Obes Rev. 2015;16(12):1081-1093. doi:10.1111/obr.12323

14. CDC (Center for Disease Control and Prevention). About Overweight and Obesity. Published 2021. Accessed May 1, 2022. https://www.cdc.gov/obesity/basics/consequences.html

15. Umer A, Kelley GA, Cottrell LE, Giacobbi P Jr, Innes KE, Lilly CL. Childhood obesity and adult cardiovascular disease risk factors: a systematic review with meta-analysis. BMC Public Health. 2017;17(1):683. Published 2017 Aug 29. doi:10.1186/s12889-017-4691-z

16. Simmonds M, Llewellyn A, Owen CG, Woolacott N. Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. Obes Rev. 2016;17(2):95-107. doi:10.1111/obr.12334

17. Haqq AM, Kebbe M, Tan Q, Manco M, Salas XR. Complexity and Stigma of Pediatric Obesity. Child Obes. 2021;17(4):229-240. doi:10.1089/chi.2021.0003

18. Sutaria S, Devakumar D, Yasuda SS, Das S, Saxena S. Is obesity associated with depression in children? Systematic review and meta-analysis. Arch Dis Child. 2019;104(1):64-74. doi:10.1136/archdischild-2017-314608

19. Min J, Chiu DT, Wang Y. Variation in the heritability of body mass index based on diverse twin studies: a systematic review. Obes Rev. 2013;14(11):871-882. doi:10.1111/obr.12065

20. Felix JF, Bradfield JP, Monnereau C, et al. Genome-wide association analysis identifies three new susceptibility loci for childhood body mass index. Hum Mol Genet. 2016;25(2):389-403. doi:10.1093/hmg/ddv472

21. Alfano R, Robinson O, Handakas E, Nawrot TS, Vineis P, Plusquin M. Perspectives and challenges of epigenetic determinants of childhood obesity: A systematic review. Obes Rev. 2022;23 Suppl 1: e13389. doi:10.1111/obr.13389

22. Marousez L, Lesage J, Eberlé D. Epigenetics: Linking early postnatal nutrition to obesity programming? *Nutrients*. 2019;11(12). doi:10.3390/nu11122966

23. Hill JO, Wyatt HR, Peters JC. Energy balance and obesity. *Circulation*. 2012;126(1):126-132. doi:10.1161/CIRCULATIONAHA.111.087213

24. Poorolajal J, Sahraei F, Mohamdadi Y, Doosti-Irani A, Moradi L. Behavioral factors influencing childhood obesity: a systematic review and meta-analysis. Obes Res Clin Pract. 2020;14(2):109-118. doi: 10.1016/j.orcp.2020.03.002

25. Scaglioni S, de Cosmi V, Ciappolino V, Parazzini F, Brambilla P, Agostoni C. Factors influencing children's eating behaviours. *Nutrients*. 2018;10(6). doi:10.3390/nu10060706

26. Gerards SMPL, Kremers SPJ. The Role of Food Parenting Skills and the Home Food Environment in Children's Weight Gain and Obesity. *Curr Obes Rep*. 2015;4(1):30-36. doi:10.1007/s13679-015-0139-x

27. Yee AZ, Lwin MO, Ho SS. The influence of parental practices on child promotive and preventive food consumption behaviors: a systematic review and meta-analysis. Int J Behav Nutr Phys Act. 2017;14(1):47. Published 2017 Apr 11. doi:10.1186/s12966-017-0501-3

28. Pearson N, Biddle SJH, Gorely T. Family correlates of fruit and vegetable consumption in children and adolescents: A systematic review. *Public Health Nutr*. 2009;12(2):267-283. doi:10.1017/S1368980008002589

29. van Grieken A, Wang L, van de Gaar VM, Jansen W, Raat H. Associations between family and home-related factors and child's snack consumption in a multi-ethnic population. *J Public Health (Oxf)*. 2019;41(3):430-438. doi:10.1093/pubmed/fdy124

30. Moschonis G, Tsoutsoulopoulou K, Efstathopoulou E, et al. Conceptual framework of a simplified multi-dimensional model presenting the environmental and personal determinants of cardiometabolic risk behaviors in childhood. Expert Rev Cardiovasc Ther. 2015;13(6):673-692. doi:10.1586/14779072.2015.1039992

31. Loth KA, MacLehose RF, Fulkerson JA, Crow S, Neumark-Sztainer D. Are food restriction and pressure-to-eat parenting practices associated with adolescent disordered eating behaviors? Int J Eat Disord. 2014;47(3):310-314. doi:10.1002/eat.22189

32. Boots SB, Tiggemann M, Corsini N, Mattiske J. Managing young children's snack food intake. The role of parenting style and feeding strategies. *Appetite*. 2015; 92:94-101. doi: 10.1016/j.appet.2015.05.012

33. Shloim N, Edelson LR, Martin N, Hetherington MM. Parenting styles, feeding styles, feeding practices, and weight status in 4–12-year-old children: A systematic review of the literature. *Front Psychol*. 2015;6(DEC). doi:10.3389/fpsyg.2015.01849

34. Hurley KM, Cross MB, Hughes SO. A systematic review of responsive feeding and child obesity in high-income countries. J Nutr. 2011;141(3):495-501. doi:10.3945/jn.110.130047

35. Black MM, Aboud FE. Responsive feeding is embedded in a theoretical framework of responsive parenting. J Nutr. 2011;141(3):490-494. doi:10.3945/jn.110.129973

36. Black, M.M. and Hurley, K.M. (2010). Infant Nutrition. In The Wiley-Blackwell Handbook of Infant Development (eds J.G. Bremner and T.D. Wachs). https://doi.org/10.1002/9781444327588.ch2

37. Beckers D, Karssen LT, Vink JM, Burk WJ, Larsen JK. Food parenting practices and children's weight outcomes: A systematic review of prospective studies. *Appetite*. 2021;158. doi: 10.1016/j.appet.2020.105010

38. De Craemer M, De Decker E, De Bourdeaudhuij I, et al. Correlates of energy balance-related behaviours in preschool children: a systematic review. Obes Rev. 2012;13 Suppl 1:13-28. doi:10.1111/j.1467-789X.2011. 00941.x

39. Kininmonth AR, Smith AD, Llewellyn CH, Dye L, Lawton CL, Fildes A. The relationship between the home environment and child adiposity: a systematic review. *Int J Behav Nutr Phys Act.* 2021;18(1). doi:10.1186/s12966-020-01073-9

40. Lu C, Stolk RP, Sauer PJJ, et al. Factors of physical activity among Chinese children and adolescents: A systematic review. *Int J Behav Nutr Phys Act.* 2017;14(1). doi:10.1186/s12966-017-0486-y

41. Erkelenz, Nanette & Kobel, Susanne & Kettner, Sarah & Drenowatz, Clemens & Steinacker, Jürgen. (2014). Parental Activity as Influence on Children's BMI Percentiles and Physical Activity. J Sports Sci Med. 13. 645-50.

42. Naess M, Sund ER, Holmen TL, Kvaløy K. Implications of parental lifestyle changes and education level on adolescent offspring weight: A population-based cohort study - The HUNT Study, Norway. *BMJ Open*. 2018;8(8). doi:10.1136/bmjopen-2018-023406

43. Ong JX, Ullah S, Magarey A, Miller J, Leslie E. Relationship between the home environment and fruit and vegetable consumption in children aged 6-12 years: a systematic review. Public Health Nutr. 2017;20(3):464-480. doi:10.1017/S1368980016002883

44. Verloigne M, Van Lippevelde W, Maes L, Brug J, De Bourdeaudhuij I. Family- and school-based correlates of energy balance-related behaviours in 10-12-year-old children: a systematic review within the ENERGY (EuropeaN Energy balance Research to prevent excessive weight Gain among Youth) project. Public Health Nutr. 2012;15(8):1380-1395. doi:10.1017/S1368980011003168

45. Humenikova L, Gates GE. Social and physical environmental factors and child overweight in a sample of American and Czech school-aged children: a pilot study. J Nutr Educ Behav. 2008;40(4):251-257. doi: 10.1016/j.jneb.2007.06.008

46. Chen JL, Esquivel JH, Guo J, Chesla CA, Tang S. Risk factors for obesity in preschool-aged children in China. Int Nurs Rev. 2018;65(2):217-224. doi:10.1111/inr.12371

47. Cassimos D, Sidiropoulos H, Batzios S, Balodima V, Christoforidis A. Sociodemographic and dietary risk factors for excess weight in a Greek pediatric population living in Kavala, Northern Greece. Nutr Clin Pract. 2011;26(2):186-191. doi:10.1177/0884533611399772

48. López-Barrón, Rita & Jimenez-Cruz, Arturo & Bacardi-Gascon, Montserrat. (2015). Modifiable Environmental Obesity Risk Factors among elementary school children in a Mexico-US Border City. Nutricion hospitalaria: organo oficial de la Sociedad Espanola de Nutricion Parenteral y Enteral. 2015;31(5):2047-2053. doi:10.3305/nh.2015.31.5.8669

49. Manios Y, Androutsos O, Lambrinou CP, et al. A school- and community-based intervention to promote healthy lifestyle and prevent type 2 diabetes in vulnerable families across Europe: Design and implementation of the Feel4Diabetes-study. *Public Health Nutr*. 2018;21(17):3281-3290. doi:10.1017/S1368980018002136

50. Schlesinger S, Neuenschwander M, Schwedhelm C, et al. Food Groups and Risk of Overweight, Obesity, and Weight Gain: A Systematic Review and Dose-Response Meta-Analysis of Prospective Studies. *Adv Nutr.* 2019;10(2):205-218. doi:10.1093/advances/nmy092

51. Farajian P, Risvas G, Karasouli K, et al. Very high childhood obesity prevalence and low adherence rates to the Mediterranean diet in Greek children: The GRECO study. *Atherosclerosis*. 2011;217(2):525-530. doi: 10.1016/j.atherosclerosis.2011.04.003

52. Blaine RE, Kachurak A, Davison KK, Klabunde R, Fisher JO. Food parenting and child snacking: A systematic review. *Int J Behav Nutr Phys Act*. 2017;14(1). doi:10.1186/s12966-017-0593-9

53. Webber L, Hill C, Cooke L, Carnell S, Wardle J. Associations between child weight and maternal feeding styles are mediated by maternal perceptions and concerns. Eur J Clin Nutr. 2010;64(3):259-265. doi:10.1038/ejcn.2009.146

54. Liszewska N, Scholz U, Radtke T, Horodyska K, Luszczynska A. Bi-directional associations between parental feeding practices and children's body mass in parent-child dyads. *Appetite*. 2018; 129:192-197. doi: 10.1016/j.appet.2018.07.011

55. Liszewska N, Scholz U, Radtke T, Horodyska K, Liszewski M, Luszczynska A. Association between children's physical activity and parental practices enhancing children's physical activity: The moderating effects of children's BMI z-score. *Front Psychol*. 2018;8(JAN). doi:10.3389/fpsyg.2017.02359

56. Kim HS, Park YH, Park HB, Kim SH. Estimation of Effects of Factors Related to Preschooler Body Mass Index Using Quantile Regression Model. *Asian Nurs Res*. 2014;8(4):293-299. doi: 10.1016/j.anr.2014.07.005

57. Tiberio SS, Kerr DCR, Capaldi DM, Pears KC, Kim HK, Nowicka P. Parental monitoring of children's media consumption the long-term influences on body mass index in children. *JAMA Pediatr*. 2014;168(5):414-421. doi:10.1001/jamapediatrics.2013.5483

58. Mihrshahi S, Drayton BA, Bauman AE, Hardy LL. Associations between childhood overweight, obesity, abdominal obesity and obesogenic behaviors and practices in Australian homes. *BMC Public Health*. 2017;18(1):44. doi:10.1186/s12889-017-4595-y

59. Sleddens EFC, Gubbels JS, Kremers SPJ, van der Plas E, Thijs C. Bidirectional associations between activity-related parenting practices, and child physical activity, sedentary screen-based behavior and body mass index: A longitudinal analysis. *Int J Behav Nutr Phys Act.* 2017;14(1). doi:10.1186/s12966-017-0544-5

60. Gubbels JS, Kremers SPJ, Stafleu A, et al. Association between parenting practices and children's dietary intake, activity behavior and development of body mass index: The KOALA Birth Cohort Study. *Int J Behav Nutr Phys Act.* 2011;8. doi:10.1186/1479-5868-8-18

61. Lin YC, Fung XCC, Tsai MC, Strong C, Hsieh YP, Lin CY. Insufficient Physical Activity and Overweight: Does Caregiver Screen-Viewing Matter? *Child Fam Stud*. 2019;28(1):286-297. doi:10.1007/s10826-018-1247-5

62. Taylor A, Wilson C, Slater A, Mohr P. Parent- and child-reported parenting. Associations with child weight-related outcomes. *Appetite*. 2011;57(3):700-706. doi: 10.1016/j.appet.2011.08.014

63. Pearson N, Biddle SJH, Griffiths P, Johnston JP, Haycraft E. Clustering and correlates of screen-time and eating behaviours among young children. *BMC Public Health*. 2018;18(1). doi:10.1186/s12889-018-5698-9

64. An R, Xiang X, Xu N, Shen J. Influence of Grandparental Child Care on Childhood Obesity: A Systematic Review and Meta-Analysis. *Child Obes.* 2020;16(3):141-153. doi:10.1089/chi.2019.0246

65. Hassapidou M, Papadopoulou SK, Frossinis A, Kaklamanos I, Tzotzas T. Sociodemographic, ethnic and dietary factors associated with childhood obesity in Thessaloniki, Northern Greece. Hormones (Athens). 2009;8(1):53-59. doi:10.14310/horm.2002.1222

66. Vollmer RL, Mobley AR. Parenting styles, feeding styles, and their influence on child obesogenic behaviors and body weight. A review. *Appetite*. 2013; 71:232-241. doi: 10.1016/j.appet.2013.08.015

67. Sokol RL, Qin B, Poti JM. Parenting styles and body mass index: a systematic review of prospective studies among children. *Obes Rev.* 2017;18(3):281-292. doi:10.1111/obr.12497

68. Sleddens EFC, Gerards SMPL, Thijs C, de Vries NK, Kremers SPJ. General parenting, childhood overweight and obesity-inducing behaviors: A review. *Int J Pediatr Obes.* 2011;6(2-2). doi:10.3109/17477166.2011.566339

69. Vollmer RL. Parental feeding style changes the relationships between children's food preferences and food parenting practices: The case for comprehensive food parenting interventions by pediatric healthcare professionals. *J Spec Pediatr Nurs.* 2019;24(1). doi:10.1111/jspn.12230

7. Appendix 1

Feel4Diabetes Study Questionnaires (All Families)

Physical Activity was assessed by question below:

With the term "physical activity" we are referring to any kind of physical activity (in leisure time, for transportation, during work), such as cycling with friends, participating in team sports, dancing, farming, that increases your heart rate or make you sweat a bit.

YOU$_a$

On how many days during the last week were <u>you</u> physically active for a total of at least <u>30 minutes</u> per day?

WEEKDAYS$_1$

❑$_1$ None
❑$_2$ 1 day
❑$_3$ 2 days
❑$_4$ 3 days
❑$_5$ 4 days

❑$_6$ 5 days

WEEKENDDAYS$_2$

❑$_1$ None
❑$_2$ 1 day (Saturday or Sunday)
❑$_3$ 2 days (Saturday and Sunday)

YOUR CHILD$_b$

On how many days during the last week was <u>your child</u> physically active for a total of at least <u>1 hour</u> per day?

WEEKDAYS$_1$

❑$_1$ None
❑$_2$ 1 day
❑$_3$ 2 days
❑$_4$ 3 days
❑$_5$ 4 days

❑$_6$ 5 days

WEEKENDDAYS$_2$

❑$_1$ None
❑$_2$ 1 day (Saturday or Sunday)
❑$_3$ 2 days (Saturday and Sunday)

Home food availability was assessed question below:

On a weekly basis, how often the following foods are available at your home?

	Always	Often	Sometimes	Rarely	Never
1. Fruits	❑1	❑2	❑3	❑4	❑5
2. Fruit juices, freshly-squeezed or prepacked without sugar	❑1	❑2	❑3	❑4	❑5
3. Fruit juices, prepacked, containing sugar	❑1	❑2	❑3	❑4	❑5
4. Soft drinks containing sugar	❑1	❑2	❑3	❑4	❑5
5. Soft drinks without sugar	❑1	❑2	❑3	❑4	❑5
6. Vegetables	❑1	❑2	❑3	❑4	❑5
7. Sweets, biscuits, ice cream, cakes, pastries	❑1	❑2	❑3	❑4	❑5
8. Salty snacks (e.g., chips, savory pastries)	❑1	❑2	❑3	❑4	❑5

Parenting child-feeding practices were evaluated by question below:

On a weekly basis, how often do you do the following?

	Very often	Often	Sometimes	Rarely	Never
1. Consume fresh fruits with your child	❑1	❑2	❑3	❑4	❑5
2. Be physically active with your child	❑1	❑2	❑3	❑4	❑5
3. Watch TV together with your child	❑1	❑2	❑3	❑4	❑5
4. Allow your child to eat sweets and/or salty snacks whenever he/she asks for	❑1	❑2	❑3	❑4	❑5
5. Allow your child to watch TV or DVD when he/she wants	❑1	❑2	❑3	❑4	❑5
6. Allow your child to use the computer, mobile or tablet when he or she wants	❑1	❑2	❑3	❑4	❑5
7. Reward your child by allowing him/her to watch TV/DVD or use the computer, mobile or tablet	❑1	❑2	❑3	❑4	❑5
8. Reward your child with sweets, salty snacks (e.g., potato chips) or fast food	❑1	❑2	❑3	❑4	❑5
9. Reward your child by being physically active together with him/her or by taking him/her to the playground or to the park	❑1	❑2	❑3	❑4	❑5

Availability of digital devices in the child's room was evaluated by question below.

Are the following devices available in your child's room?

		Yes	No
1	TV	❑1	❑2
2	DVD player	❑1	❑2
3	Game consoles i.e., Play Station	❑1	❑2
4	Computer	❑1	❑2
5	Tablet or smartphone	❑1	❑2