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AGRICULTURAL UNIVERSITY OF ATHENS

Dietary habits of primary school children and factors affecting their food choices

PhD dissertation

Department of Food Science and Human Nutrition

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Διαιτητικές συνήθειες μαθητών πρωτοβάθμιας εκπαίδευσης και παράγοντες που επηρεάζουν τις επιλογές τους

Διδακτορική Διατριβή
Εμμανουέλλα Ι. Μαγριπλή

Επιβλέπων Καθηγητής: Αντώνης Ζαμπέλας

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ΤΙΤΛΟΣ: **Διαιτητικές συνήθειες μαθητών πρωτοβάθμιας εκπαίδευσης και παράγοντες που επηρεάζουν τις επιλογές τους**

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Περίληψη

Γενική Επισκόπηση: Η επιδημία της παιδικής παχυσαρκίας αποτελεί παγκόσμια ανησυχία με πιθανές σοβαρές συνέπειες στην υγεία σε εθνική και παγκόσμια κλίμακα. Η επιδημία αυτή πιθανολογείται πως προκαλείται από ιδιαίτερα τροποποιήσιμους παράγοντες, που συμπεριλαμβάνουν φτωχή διατροφική πρόσληψη, έλλειψη σωματικής άσκησης, καθώς και διάφορες μεταβλητές συμπεριφοράς. Ο Παγκόσμιος Οργανισμός Υγείας (ΠΟΥ, 2013), υπολόγισε πως πάνω από 42 εκατομμύρια παιδιά έχουν υπερβάλλον βάρος παγκοσμίως. Συγχρόνως η παιδική παχυσαρκία έχει συσχετιστεί με αυξημένη νοσηρότητα από χρόνια νοσήματα, κατά τη διάρκεια της ζωής, γεγονός που καθιστά την παιδική παχυσαρκία σημαντικό πρόβλημα δημόσιας υγείας.

Επίσης, ενώ στις Ηνωμένες Πολιτείες και στη Βόρεια Ευρώπη ο επιπολασμός της παιδικής παχυσαρκίας φαίνεται να σταθεροποιείται, μελέτες από χώρες της Νότιας Ευρώπης αποδεικνύουν πως το πρόβλημα σε αυτές κλιμακώνεται, με το ποσοστό να φτάνει σε υψηλότερα επίπεδα σε σύγκριση με τις Βόρειες Ευρωπαϊκές χώρες. Η ταχεία αυτή αύξηση του επιπολασμού τις παιδικής παχυσαρκίας στις Μεσογειακές χώρες τις τελευταίες δεκαετίες, έχει δημιουργήσει την ανάγκη να ενταθούν οι έρευνες για την ανάδειξη παραγόντων που συντελούν σε αυτή την αύξηση.

Στόχοι: Δεδομένα από αντιπροσωπευτικό πανελλαδικό δείγμα παιδιών 10-12 ετών και των γονέων ή των κηδεμόνων τους (μελέτη GRECO), χρησιμοποιήθηκαν στη διεξαγωγή της διδακτορικής διατριβής. Πρωταρχικός στόχος της διατριβής ήταν η δημιουργία ενός Διατροφικού Δείκτη (ΔΔ) για τον προσδιορισμό, την έγκυρη πρόβλεψη και κατ' επέκταση την πρόληψη της παιδικής παχυσαρκίας. Δευτερογενείς στόχοι αποτέλεσαν ο εντοπισμός και η αξιολόγηση μεταβλητών, κυρίως συμπεριφοράς, που πιθανόν να επηρεάζουν τη σχέση ΔΔ και του βάρους των παιδιών, καθώς και η διερεύνηση της ετοιμότητας των παιδιών σχολικής ηλικίας, να διαφοροποιήσουν διατροφικές συνήθειες και διατροφικές συμπεριφορές. Τέλος διερευνήθηκε η πιθανή συσχέτιση του καπνίσματος κατά τη διάρκεια της εγκυμοσύνης με το υπερβάλλον

βάρος, με το συνολικό ποσοστό λίπους και την περιφέρεια μέσης, στους μαθητές πρωτοβάθμιας εκπαίδευσης.

Μεθοδολογία: Αντιπροσωπευτικό δείγμα 5000 παιδιών ηλικίας 10-12 ετών, από 10 νομούς, 14 περιφέρειες από τον ευρύτερο Πανελλαδικό χώρο μετά από στρωματοποιημένη δειγματοληψία, προσκλήθηκαν να λάβουν μέρος στην έρευνα GRECO. Ανθρωπομετρικές μετρήσεις διεξήχθησαν στα παιδιά και τους δόθηκαν ερωτηματολόγια να συμπληρώσουν: (1) ημι-ποσοτικοποιημένο ερωτηματολόγιο συχνότητας κατανάλωσης τροφίμων, (2) ερωτηματολόγιο διατροφικών-γευματικών συνηθειών, και (3) ερωτηματολόγιο ετοιμότητα αλλαγής διατροφικών τάσεων και διατροφικής συμπεριφοράς. Όλα τα δεδομένα από τους ενήλικες ήταν αυτοδηλούμενα και συμπεριλάμβαναν βάρος & ύψος, κοινωνικο-οικονομικά στοιχεία, διάφορες συνήθειες, όπως κάπνισμα, καθώς και καταγραφή δεδομένων εγκυμοσύνης και νεογνού (όπως βάρος και μήκος νεογνού) . Για τη δημιουργία ΔΔ a-priory, συμπεριλήφθηκαν 14 τροφές, 6 προστατευτικές και 8 τροφές που συσχετίζονται με υπερβάλλον βάρος και παχυσαρκία, και δόθηκε βαρύτητα στις τροφές που αξιολογήθηκαν σημαντικότερες στην παιδική ηλικία, λόγω ανάπτυξης. Ο ΔΔ χρησιμοποιήθηκε στη διερεύνηση της σχέσης των παραγόντων συμπεριφοράς και του καπνίσματος κατά τη διάρκεια της εγκυμοσύνης, καθώς και στον επιπολασμό της παιδικής παχυσαρκίας. Οι διατροφικές συνήθειες και η ετοιμότητα που δήλωσαν τα παιδιά για αλλαγή διερευνήθηκαν και αξιολογήθηκαν σε σχέση με σε σχέση με (α) την κατηγορία βάρους των παιδιών, (β) το φύλο και (γ) την αυτοεκτίμηση που δηλώνουν τα παιδιά.

Αποτελέσματα: Συγκεντρώθηκαν δεδομένα από 4786 (95%) παιδιά και 2318 (51%) γονείς ή κηδεμόνες. Ο παιδικός ΔΔ είχε τη δυνατότητα/ευαισθησία να προσδιορίζει σωστά τα παιδιά με υπέρβαρο & παχυσαρκία, καθώς τα παιδιά με υπερβάλλον βάρος και παχυσαρκία είχαν χαμηλότερο συνολικό διατροφικό σκορ σε σχέση με τα υγιή σε βάρος παιδιά. Οι παράγοντες παιδικής συμπεριφοράς που είχαν θετική συσχέτιση με τον ΔΔ ήταν οι συνολικές ώρες ύπνου, μελέτης και η συχνότητα οικογενειακών γευμάτων. Στατιστικά σημαντική αρνητική συσχέτιση με τον ΔΔ είχαν οι συνολικές ώρες που τα παιδιά δήλωσαν μπροστά σε κάποια οθόνη, η συχνότητα κατανάλωσης τροφής εκτός σπιτιού και μπροστά σε κάποια οθόνη. Σε πολυπαραγοντική ανάλυση προσαρμοσμένη για ηλικία, φύλο και διατροφικό σκορ, οι πιθανότητες των παιδιών να είναι υπέρβαρα ήταν χαμηλότερες, όταν κοιμούνταν περισσότερες ώρες, διάβαζαν λιγότερες ώρες, είχαν πιο συχνά οικογενειακά γεύματα και κατανάλωναν πιο συχνά γεύματα ημερησίως. Στην πολυπαραγοντική ανάλυση οι ώρες μπροστά σε οθόνη δεν ήταν στατιστικά σημαντική. Στη διερεύνηση της παιδικής ετοιμότητας, μεγαλύτερο ποσοστό παιδιών με υπερβάλλον βάρος ή παχυσαρκία, καθώς και τα κορίτσια, δήλωσαν έτοιμα να αλλάξουν συγκεκριμένες διατροφικές συμπεριφορές. Σε αυτά συμπεριλήφθηκε η ετοιμότητα να αυξήσουν την κατανάλωση υγιεινών σνακ και να αντικαταστήσουν υγρά με υψηλή περιεκτικότητα σε ζάχαρη με αυτά που δεν περιέχουν, αν αυτό τους προσφερθεί. Επίσης, παιδιά με υψηλότερη μέση τιμή ΔΔ σκορ ήταν πιο έτοιμα να αλλάξουν συμπεριφορές, και παιδιά με μεγαλύτερο ποσοστό αυτοεκτίμησης δήλωσαν έτοιμα να μειώσουν μερίδα τροφής και δεν τους απασχολούσε ή άποψη των φίλων τους. Οι πιθανότητες των παιδιών να έχουν υπερβάλλον βάρος και υψηλότερη περιφέρεια μέσης (πάνω από τη διάμεσο) ήταν μεγαλύτερες στα παιδιά που η μητέρα κάπνιζε στην εγκυμοσύνη σε σχέση με τα παιδιά που οι μητέρες που δεν κάπνιζαν. Η σχέση παρέμεινε σημαντική σε όλα τα μοντέλα, που περιλάμβαναν μητρικούς παράγοντες, κατανάλωση καφέ και αλκοόλ, παράγοντες νεογνού, παιδικές συμπεριφορές και διατροφικό σκορ, για το BMI και για την περιφέρεια μέσης. Η συσχέτιση ανάμεσα στο μητρικό κάπνισμα και το ποσοστό λίπους των παιδιών ήταν σημαντική μόνο στην αδρή διερεύνηση.

Συμπεράσματα: Στη διατριβή εντοπίστηκαν διατροφικοί παράγοντες, παράγοντες συμπεριφοράς καθώς και η αυτοεκτίμηση των παιδιών που είναι σημαντικό να αξιολογηθούν ώστε να μειωθεί ή ακόμα και να προληφθεί το φαινόμενο της παιδικής παχυσαρκίας. Επίσης το κάπνισμα κατά τη διάρκεια της εγκυμοσύνης βρέθηκε να αυξάνει τον κίνδυνο για υπερβάλλον βάρος και για κεντρική παχυσαρκία, στα παιδιά σχολικής ηλικίας. Τα παραπάνω ευρήματα υπογραμμίζουν την πολυπαραγοντική φύση που οδηγεί στην επιδημία της παιδικής παχυσαρκίας. Συνίσταται να δοθεί ιδιαίτερη έμφαση στην κατανόηση των παιδικών αναγκών και αντιλήψεων καθώς η παιδική ετοιμότητα μπορεί να αποτελεί τη βάση της πυραμίδας για τη θεραπεία και πολύ περισσότερο για την πρόληψη της παιδικής παχυσαρκίας.

Επιστημονικός τομέας: Επιδημιολογία της Διατροφής

Λέξεις Κλειδιά: Παιδική παχυσαρκία, διατροφικός δείκτης, επιδημιολογία, εμβρυϊκός προγραμματισμός, αυτο-αποτελεσματικότητα, αυτοεκτίμηση

Abstract

Overview: Childhood overweight and obesity epidemic, is of global concern, with potential major national and worldwide health consequences caused by highly modifiable factors, including poor diet, physical inactivity, and various behavioural variables. World Health Organization has estimated childhood overweight to be over 42 million globally (WHO, 2013), making childhood obesity of great concern since it has been associated with an increased susceptibility to chronic diseases later in life.

Furthermore, although the prevalence appears to plateau in the United States and Europe, studies from South European countries demonstrate that the problem is escalating, with higher prevalence in childhood overweight and obesity compared to north European countries. This rapid increase in the prevalence of obesity in Mediterranean countries over the last decades, leads to the necessity to expand research investigations in order to understand the reasons behind this prevalence increase.

Objectives: Using data from the nation wide Greek Childhood Obesity (GRECO) cross sectional study on 10-12 year old children, the primary goal was to derive a food index that may predict childhood overweight and obesity, hence leading to primary prevention. Secondarily, the effect that behavioural factors, including sleep duration, total screen time (average per day) and total study hours, number of meals per day, frequency of having meals while on a screen, frequency of having family meals, and frequency of eating/ordering out, have on the increase of childhood overweight were examined in relation to the FI. Special attention was given on the children's readiness to change behaviors, hence the GRECO study was used to examine school children's willingness to ameliorate eating behaviors in relation to their weight-status and their current eating patterns, as well as to assess potential gender differences Lastly the association between maternal-smoking on children's weight status and on adiposity levels was also assessed.

Methods: A stratified representative sample among 10 Greek regions, of 5000 children and their parents or primary care givers, were invited to enrol in the study. Anthropometric data were measured in children and a 48 question validated Food Frequency Questionnaire (FFQ) was completed. Data on behavioural aspects were also obtained. Data on adults were self reported and included anthropometric, pregnancy and behavioural information. The child derived FI (cd-FI), was created based on obesogenic and protective foods, based on population wide evidence: Mediterranean and National Healthy eating guidelines. A total of 14 foods, were included in the cd-FI, based on a priori knowledge of food items and food patterns for children, with weights given to specific foods, for the first time in an index, considering the populations studied needs, i.e. growth. This was used to assess the effect bahavioral variables and maternal-smoking on the prevalence of child obesity. Eating behaviors and assertiveness to change were assessed based on gender differences and weight status, to assess the possible effect that a child's weight may have on their response.

Results: Data on 4786 (95%) children and 2318 (51%) parents were finally obtained. The cd-FI constructed adequately distinguished overweight and obese children, from their healthy weight peers among a nation wide sample of school-aged children, with overweight and obese children having a lower cd-FI score compared to their normal weight peers. Behavioural analysis showed that total sleep & screen duration, frequency of family meals, frequency of eating out, and frequency of eating while watching TV, when adjusted for age, were associated with cd-FI score, significantly increasing it's predictive ability of childhood overweight and obesity. Furthermore, the likelihood of children being overweight or obese decreased when they slept more, studied less, and had a higher FI score, had more frequent family meals and consumed more meals per day. Although crude total screen time was significantly associated with increased odds of overweight and obesity in children, the effect was nulled in the model that included cd-FI and total study time. When children's willingness to ameliorate eating behaviours was examined, a greater percentage of females and overweight & obese children expressed greater assertiveness to alter various eating behaviours and habits, including increasing healthy snack intake and replacing ssb's with their no sugar counterpart, if this was offered. Also the higher the mean cd-FI score, the more assertive children were to change. Children with high weight perception-self-esteem, addressed via weight-perception, were more likely to reduce portion size and responded that peer opinion did not affect their snack selection.

Maternal-smoking was found to be significantly associated with children's weight status and central adiposity in all models tested, including maternal and child characteristics, coffee and alcohol intake during pregnancy, child behavioural factors and dietary patterns. The association however, was not significant for total body adiposity (%)

Conclusion: Dietary, behavioural and self-esteem factors have been identified in this thesis as factors that need to be addressed in order to decrease or even prevent childhood overweight and obesity. Maternal smoking during pregnancy also increases children's risk of overweight or obesity later in life as well as an increased risk for higher central adiposity suggesting direct effect. These findings underline the multifactorial nature of the childhood obesity epidemic, and suggest that understanding children's needs and perceptions may be the base of the pyramid in order to treat and more so to prevent childhood obesity.

Scientific area: Nutritional Epidemiology

Keywords: Childhood overweight, food-index, epidemiology, early life theory, self-efficacy, self-perception

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List of Papers

I. **Magriplis, E.,** Farajian, P., Risvas, G., Panagiotakos, D., & Zampelas, A. (2015). Newly derived children-based food index. An index that may detect childhood overweight and obesity. *International journal of food sciences and nutrition*, *66*(6), 623-632.

II. **Magriplis, E.,** Farajian, P., Risvas, G., Panagiotakos, D., & Zampelas, A. (2016). Childhood overweight & obesity predicted by specific food pattern, sleep and study duration: Results from the GRECO study (Submitted manuscript in Clinical Nutrition).

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IV. **Magriplis E.,** Farajian P., Panagiotakos DB., Grigoris Risvas, Zampelas A. (2016). Children's food perceptions and assertiveness to change in respect to their weight status and self-esteem. (Under submission).

Abstracts presented in conferences (presented in Appendix 1)

I. **Magriplis, E.,** Farajian, P., Risvas, G., Panagiotakos, D., & Zampelas, A. Newly Derived Children Based Food Index.
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III. **Magriplis, E.,** & Zampelas, A. Title: Butter Or Margarine? A Dietary Patterns Approach Of The Controversy. 9th International Conference of the Cyprus Dietetic & Nutrition Association, 2016

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Abbreviations

ANOVA	Analysis of variance
BMI	Body Mass Index
BMR	Basal Metabolic Rate
BP	Blood pressure
cdFI	Child derived food index
CI	Confidence Intervals
CVD	Cardio vascular disease
DBP	Diastolic blood pressure
EE	Energy Expenditure
EI	Energy Intake
FENS	Federation of European Nutrition Societies
FI	Food Index
FFQ	Food frequency questionnaire
GRECO study	Greek childhood obesity study
IOTF	International Obesity Task Force
PA	Physical Activity
PCA	Principal Component Analysis
OB	Obese
OR	Odds ratio
OW	Overweight
RMR	Resting Metabolic Rate
SBP	Systolic blood pressure
SD	Standard Deviation
SES	Socioeconomic status
SSB	Sugar sweetened beverages
WC	Waist circumference
WHO	World Health Organization
VIF	Variance Inflation Factor

1. Introduction – Thesis overview

1.1 Childhood overweight & obesity: the 20th century epidemic

Childhood overweight and obesity epidemic, is of global concern (Lavie et al, 2009; Barton et al, 2012). It is the first with potential major nationally and worldwide health consequences, not caused by communicable-infectious disease, nor by lack of food or medical care, but by highly modifiable factors, including poor diet, physical inactivity, and various behavioral variables (Stein, 2016). Since in 2013 the number of overweight children was estimated to be over 42 million globally (WHO) and childhood obesity has been associated with an increased susceptibility to chronic diseases later in life (Barton et al, 2012, Berenson et al, 1998, Berenson et al, 2012, Reilly et al., 2003). In Europe the prevalence rates for overweight children in Mediterranean countries were 20–35%, while those in northern areas were considerably lower and reached 10–20% (Lobstein & Frelut, 2003), with over 20 000 obese children in the EU have type 2 diabetes, while over 400 000 have impaired glucose tolerance and the estimated burden of disease indicators among obese children is high (Lobstein & Jackson Leach, 2006).

Research among children represents the new focus in Nutrition and Epidemiology, since the rates of overweight and obesity in this population worldwide, including developed and developing countries, is greatly increasing. Surveys have shown that 31.7% children between 2 and 19 years of age had a BMI above the 85th percentile (using the BMI-for-age growth charts) with 16.9% of these being termed obese (>95th %ile) [Ogden et al 2010]. In 2003-2004, 17.1% of US children and adolescents were overweight with the prevalence increasing significantly among these groups during the 6-year period from 1999 to 2004 (Ogden et al, 2012). Among children 6 to 11 years of age the prevalence was 15.3% in 1999-2000 compared to 11.3% in 1988-1994 (Ogden et al 2002). The prevalence appears to plateau between 1999-2008, according to Ogden et al, since no significant trend over these periods, with boys over the 97%ile being an exception (Ogden et al., 2010). No significant trends were observed between

2005-2006 and 2013-2014 (Ogden et al., 2016). The figure bellow is a graphical depiction of the obesity trend among children from 1999 to 2014.

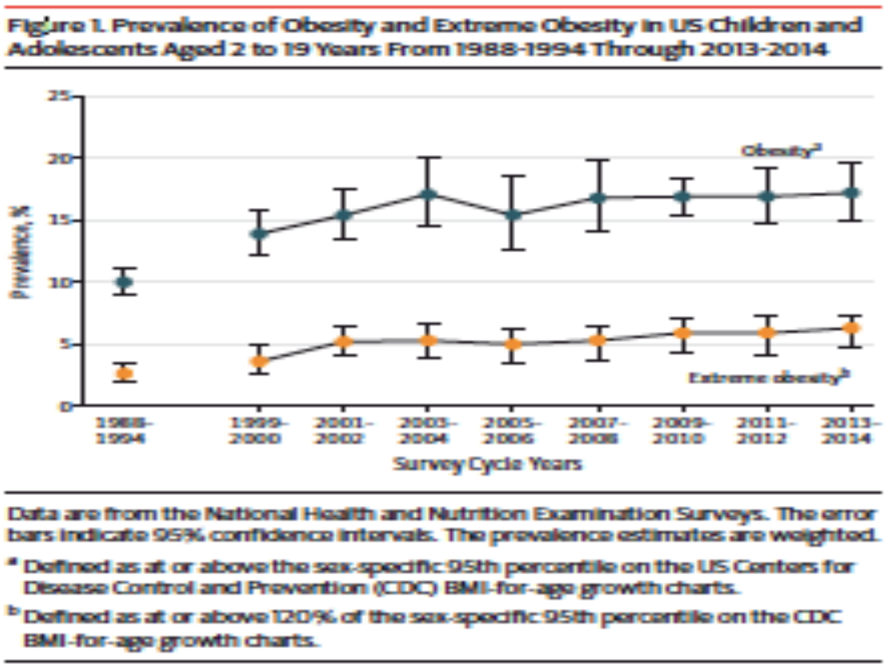

Figure borrowed from: Ogden et al., 2016

Leveling effects in the prevalence of childhood overweight and obesity has been reported in European countries as well (Aeberli et al, 2008, Lioret et al, 2007, Stamatakis et al, 2010), although according to reports from Stamatakis et al., 2010, there appears to be a further increase among children and adolescents of low socioeconomic status (SES). Moreover studies from South European countries demonstrate that the problem is escalating with subsequent adverse health consequences (Padez et al., 2004). This study showed that the prevalence of overweight/obesity in Portuguese children is high when compared to other European countries, following the trend of other socio-cultural similar countries such as Spain, Italy and Greece. This rapid increase in the prevalence of obesity in Mediterranean countries over the last decades, with higher prevalence in childhood overweight and obesity compared to north European countries, leads to the Mediterranean countries childhood obesity paradox, as extensively analyzed by Farajian, P. in his dissertation (Feb. 2014, AUA).

1.2 Childhood Overweight & Obesity in Greece

The Hellenic Medical Association for Obesity conducted a cross-sectional, nationwide epidemiological survey in 2003 to provide estimates of the prevalence of OW, OB, and abdominal obesity in 3,140 children aged 6-12 years and a total of 14,456 Greek adolescents aged 13-19 years (Tzotzas et al, 2008; Tzotzas et al, 2011). Thirty-one percent of children aged 6-12 years were defined as overweight or obese. According to Tambalis et al., (2009) rates of overweight in boys increased with a trend among boys and girls between 1997 and 2007; 0.71 ±0.1% per year, and 0.41 ±0.05% for girls, respectively, with a higher rate see in children from rural areas, and a questionable plateauing effect being observed after 2004. A literature review on regional versus national prevalence of overweight and obesity among Greek children has been recently conducted (Farajian P., 2014. PhD dissertation). From the GRECO study, a nationwide representative study in children in the area of Greece, 30 % of children aged 10-12 years of age were found overweight and approximately 12% were found obese (Farajian et al.,). The prevalence of overweight among school aged children, in a representative sample in Northern Greece, was found in similar ranges (34% overweight and 15% obese) (Cassimos et al., 2011), and slightly lower among children living in a small Greek island (25% overweight and 8% obese) (Sourani et al., 2015). In the latter study, the sample was small. A 10 years meta-analysis conducted, 10% Greek children, 1 to 12 years of age, were obese and 30% were overweight (Kontanidou et al., 2013). Of further interest are latest reports by Tambalis et al., 2013 who found that children living in rural areas although reported higher physical activity levels compared to their urban counterparts, had a higher prevalence of obesity. A higher prevalence of overweight and obesity among children in rural areas was also found by others, but they also had a lower physical activity levels, although no differences were observed in total screen time (Raistenskis et al., 2013).

The reasons behind the high prevalence of overweight and obesity in Greece along with the discrepancies among activity level and weight status remain to be understood and formulate the reasoning behind the current thesis.

1.3 Factors affecting body weight regulation

Based on the previous findings, other factors, such as dietary patterns, behavior factors and beliefs or otherwise self–efficacy and esteem, should also be considered for the understanding and prevention of the child obesity epidemic. Studies on childhood obesity have shown that diet and physical inactivity are the most important factors, exceeding the effect of genetic susceptibility (Berckey et al., 2000; Berckey et al., 2003; Lavie at el., 2009; Barton, 2012). Research has also shown that parental weight is an important risk factor for the overweight and obesity increase in children, in many areas, including Europe and Asia (Keane et al., 2012, Manios et al., 2007, Jiang et al., 2006). In Greece it has been reported that the adjusted odds for being overweight among preschool aged children with one obese parent were 91% greater compared to those with no obese parent, while the likelihood for being overweight was 2.38 times greater for children with two obese parents (Manios et al., 2007). Family – food environment is therefore a main determinant to consider, from early childhood, with the specific factor encompassing many variables that will be investigated in this dissertation. These include dietary patterns, extrapolated from dietary habits, eating behaviors and self-efficacy/beliefs, as well as behavioral patterns that are seen in everyday life.

1.3.1 Dietary intake and Childhood obesity

Since World War II, changes have been seen in the portion sizes and food availability and quality has highly changed (Stein, 2016). Malnutrition, a term that was characterized to date by lack of food, now contains a second definition. Malnutrition is also the excessive food intake and poor dietary habits. Dietary habits characterized by high energy dense and nutrient poor food consumption, low intake of fruits and vegetables, whole grains, high intake of processed food, saturated and trans fats, refined carbohydrates and sodium.

The focus in nutritional epidemiology was for long directed towards the effect of specific dietary macro- and micro-nutrients, or single dietary components, on humans health and weight status. Dietary habits and diet in general have been studied in two ways: by studying specific food items and through dietary patterns. Although the understanding of the impact of individual components may be important, it has been criticized as a «reductionist approach» and limitations have been proposed (Willett, 1998). Dietary patterns have been derived theoretically and empirically. The latter consist of patterns statistically derived 'a posteriori' from collected food consumption data based on correlations in intakes of the various dietary components (Waijers et al., 2007). Theoretically defined dietary patterns, however, are created 'a priori' based on current nutrition knowledge. They consist of nutritional variables, generally foods and/or nutrients considered to be important to health that are quantified and summed to provide an overall measure of dietary quality. These involve a series of food items that are or are not consumed with scores being applied accordingly, hence the term Food Index (FI). Dietary patterns- indexes differ in their composition, and the many choices in the creation of a score. Yet these issues are of essential importance to assess the usefulness and validity of a specific index, and of diet quality scores in general, as a tool for dietary assessment, hence these factors were considered during the development of the child-derived Food Index (cd-FI).

1.4 Food Index Overview – Brief literature review

A food index, as mentioned earlier, is a tool created in order to precisely measure dietary patterns and quality, by addressing human diet as a whole (Lazarou et al., 2011). This allows the assessment of the interaction between food items and nutrients, depending on the foods dietary patterns that are used to construct a Food index contain. Such FI's have been constructed mostly for adults with a total of over twenty different indexes formulated (Waijers et al, 2006), four of which are the most dominant, and 11 are widely accepted, based on which other indixes were created. Food indexes differ in components used, including food groups and/or nutrients and scores adopted, and therefore a high heterogeneity among these patterns is seen (Lazarou et al., 2011, Wirt et al., 2009, Knoops et al., 2006). The basic components present in all FI's are fruits and vegetables, either combined or separated. All other food groups vary based on the year the research was done, the established guidelines and the objectives of the study. The construction of a food index has taken three major approaches (Kant 1996): i. Based on food groups and/or foods (i.e. Healthy Food Index: HFI); ii. Based on specific nutrients (Healthy Eating Index (HEI), and Diet Quality Index (DQI)); iii. A combination of both. Moreover, most food index scores are based on adherence on national dietary guidelines or the Mediterranean pattern (Waijers et al, 2007) and contain a minimum of 3 components and a maximum of 10 (Knoops et al 2006). The Recommended Food Score (RFS) is an exception where a 23 food item score consumed within a week, or a 17 item consumed 1-3 times monthly. The scoring methods also differ, with most scoring the data based on specified dietary guidelines (met/not met), using cut-offs, medians, or specific recommendations. Indices that have a small scoring scale appear to be less sensitive in the evaluation of indexes and fail to capture extremes and intrinsic characteristics of food behaviors and eating patterns (Wirt et al., 2009). Lower diet quality scores have been found to be consistently associated with higher rates of all cause mortality, and for some specific disease rates in adults, even when adjustments are done (Wirt et al., 2009).

1.4.1 Food-Index for children

To date limited data have been selected on children and not many food indexes have been created specifically for this population group. Few indexes have been designed specifically for children (Kleisser et al 2009; Lazarou, 2011; Kranz et al., 2008; Lazarou et al., 2009; Kranz et al., 2006; Sera-Majem et al., 2004; Feskanich et al, 2004; Manios et al 2010; Golley et al., 2011), the majority of which were developed to measure diet quality and adherence to national guidelines. Kranz et al, (2008) found an association between diet quality and prevalence of obesity in preschoolers using the Revised Diet Quality Index, and Golley et al (2011) studied the dietary quality of Australian children aged 4-16 yo, modifying the DGI for Australian Adults for children and based on the Australian Guide to Healthy Eating (AGHE provides age-specific recommendations for children from the age of 4 years on consumption of 5 core food groups). The KIDMED score that has been created and is being used for Children in the Mediterranean area is simple in use and follows general rules of healthy Mediterranean eating, with some Western influences (cereal, potatoes, rice) and scores positively for each, all cereal is grouped together (processed and whole wheat). It does not set cut-off levels to obtain more sensitive results (Sera-Majem et al., 2004), as the previous indexes mentioned, it was constructed to measure diet quality and not overweight or obesity. Feskanich et al, (2004) modified the Healthy Eating Index (HEI) and adapted it for children and adolescents aged 9 to 14 years of age. They found no correlation between YHEI (Youth HEI) and Energy intake, but a strong correlation with time spent in inactive pursuits. In adults however, HEI was strongly correlated with total Energy. The authors suggested that children's food score might benefit from the inclusion of unhealthful foods and concluded that more research is needed to determine the dietary elements that are most related to health in diverse populations of youth (Fescanich et al, 2004). The previous results however were based on dietary patterns that were developed to assess the healthfulness of their eating habits in comparison to specific dietary guidelines, and therefore were not specific to child obesity. According to the literature review, only three (3) indexes have been created for school aged children (Manios et al., 2010; Lazarou et al., 2011, Sera-Majem et al., 2004), two (2) of which have been derived (Lazarou et al., 2011; Manios et al., 2015) with the main objective to detect risk for childhood overweight and obesity, one of which was designed for primary school children with relevant cut-offs applied (Manios et al., 2015). Lazarou et al., (2011) developed indexes to examine the associations with overweight and obesity in children and found an inverse association with BMI, although the index contained 3 sub-indexes, including dietary patterns, behavioral patterns and beliefs, and dietary practices. The latter makes the Food-index complex for a usual dietary assessment. In conclusion, Not many indices have been developed for children and the ones that have been developed are in adherence to specific national dietary guidelines. The relationship between children's weight status and dietary patterns remain inconsistent (Togo et al., 2001) and an index based on a priory knowledge on obesogenic and non foods was warranted.

Table 1 consists the list of foods in summary that were used in the cd-FI derivation and Table 2 depicts the score used for the food index score derivation. More information on methodology and scoring can be viewed in the published paper (Magriplis et al., 2015).

Table 1: Food Items included in the Food Index separated in two categories

Positive - Protective	Negative - Harmful
Fruit	Cheese
Vegetables	Red meat
Whole grains	Processed food (processed meat, chips)
Legumes	Sugared Sweet Beverages
Nuts	Sweets
Fish	Fast food (pizza, souvlaki, french fries hamburger)
Milk	
Yogurt	

Table 2: Food Index scoring system

Score Food group*	4	3	2	1
Whole grains (x 1.5)**	≥4	≥3,<4	≥2,<3	<2
• 1 food portion = 1 slice of bread = 30 gr; ½ cup cooked pasta or rice; 30 gr ready to eat cereal; ½ pita bread; 2 whole wheat rusks o potatoes were not included				
Vegetables (x 1.5)**	≥4	≥3,<4	≥2,<3	<2
• 1 portion = 1 cup of raw salad; ½ cup cooked vegetables; 1 medium vegetable o Potatoes and vegetable juice not included o Cooked vegetable Mediterranean dishes were considered as ½ portion				
Fruit^ (x 1.5)**	≥3	≥2,<3	≥1,<2	<1
• 1 portion = 1 medium fruit or 2 small (ie clementines) o fruit juice was not included				
Milk (x 1.5)**	≥2	≥1,<2	>0, <1	0
• 1 portion = 1 glass of milk = 250 ml				
Yogurt	≥2	≥1,<2	>0, <1	0
• 1 portion = 200 gr				
Fish	≥2	≥1,<2	>0, <1	0
• a fish portion = approx. 90 gr when cooked				
Nuts	≥3	≥2,<3	≥1, <2	<1
• A portion = 30 gr of nuts or about 2 tablespoons (tbs); Or 1 tbs tahini or peanut butter				
Legumes	≥2	≥1,<2	>0, <1	0
• A portion = 1 cup cooked legumes				
Red meat	<1	≥1,<2	≥2,<3	≥3
• A portion of red meat = 70 grams cooked				
Processed food	<1	≥1,<2	≥2,<3	≥3
• A portion of processed meat = 70 grams • A portion of chips = 30 gr				
Cheese	≤1	>1-≤2	>2, <3	≥3
• A cheese portion = 40 gr				
Fast-food	0	>0-≤1	>1, ≤2	>2
• A portion of pizza = 1 slice • A portion of souvlaki or hamburger = 1 regular size • A portion of fries = 1 cup				
Sugar sweet beverages (ssb's)	<1	≥1, <2	≥2, <3	≥3
• A portion of soda = 330 ml; Of fruit drink= 250 ml				
Sweets	<1	≥1, <2	≥2, <3	≥3
• A dessert portion = 2 cookies/a slice of cake/60 gr chocolate/1 bowl of rice-pudding or				

	cream/ 1tbs merenda (chocolate spread)

***Whole grains, fruit, vegetables, milk, yogurt and cheese are designated in servings per day. Nuts, legumes, fish, fast-food, redmeat, processed food, ssb's and sweets are designated in servings per week.**
^618 missing values for wgrains (total n=3817); 1 missing for fruit (n=4434); 6 missing for milk (n=4429); 114 missing for yogurt (n=4321); 25 missing in fish group (n=4410); 40 missing in nuts (n=4395); 233 missing in legumes (n=4202); 46 missing in redmeat group (n=4389); 178 missing in cheese group (n=4257); 0 missings for sweets, ssb's fastfood and processed food (n=4435).
****weights of 1.5 were given to whole grains, vegetables, fruits, milk and legumes**

1.5 Behavioral factors: Behavioral aspects to child overweight & obesity

A combination of positive health behaviors, including physical activity, not smoking and Mediterranean diet, was associated with significant lower weight gain and lower waist circumference in adults (May et al., 2012), where the combined effect of various lifestyle factors and individual dietary factors on a person's weight and WC were evaluated. A systematic review on longitudinal studies performed in adults, found a consistent relationship of self-reported sedentary behavior with weight gain from childhood to adolescence (Thorp et al., 2011) although food Intake was not considered by the authors.

In children studies have found few significant associations between BMI z-score and family food environment, including breakfast eating patterns, food consumption while watching TV, parental provision of energy dense foods and child consumption of energy-dense food at home and away from home (MacFarlane et al, 2009). Studies have found an association between eating while watching TV and weight status even when PA was adjusted for (Rey-López et al., 2012).

While other studies have shown a weak association between PA and TV viewing in children and adolescence (7-18 yo) (Jackson et al., 2009). It has therefore been recommended that PA should be analyzed as a mediator variable, viewing PA as a consequence rather than a cause for obesity, since children who are overweight or obese tend to be less active and not vice versa. Furthermore, due to the difficulty in assessing PA levels, physical inactivity has been recommended as a more precise covariate in understanding child overweight and obesity epidemic. In order to measure physical inactivity, proxy measures are used, including total TV viewing hours and total screen time, since it has been shown that Energy Expenditure (EE) during TV viewing is only 18% higher than Resting Metabolic Rate (RMR) in adults (Jackson et al, 2009). Another variable has been lately recommended by members of the GRECO study (Farajian and Magriplis), to further address inactivity level, based on children's responsibilities, and that includes total study hours. Results to the latter are reported in published papers in the general discussion section.

1.5.1 Physical inactivity: TV viewing versus screen time

Total TV- viewing

A review in school aged children showed that TV watching was the most common measure of sedentary behavior, and that watching TV more than 2 hours per day was associated with unfavorable body composition, decreased fitness, and lower scores for self-esteem (Trembley et al, 2011). Evidence suggests that TV exposure is related to Energy intake (EI) rather than PA (Marsh et al, 2014, Epstein et al., 2008), with researchers linking TV-viewing, and/or eating while watching TV, with ‘unhealthy’ dietary habits, including snacking on high fat – high sugar foods, having high calorie-low nutrient dense meals, having low fruit and vegetable consumption, and drinking more sodas (Campbell et al 2006, Utter et al, 2006, Dubois et al, 2008). Pearson et al., (2011), through a systematic review reported that sedentary behavior in children, usually termed via total screen time or TV viewing, appears to be “clearly” associated with elements of a less healthy diet (less fruits and vegetables, higher fast-food and energy dense food intake, and higher total E intake) while Lipsky et al., (2012) found an inverse relationship between TV-viewing and F&V intake, and a positive relation with candies, fast-food, and skipping breakfast. The combination of TV use appears to lead to unhealthy dietary habits, that further increase or mediate the risk of overweight & OB, with poor nutritional status and low self esteem needed to be considered. Children having dinner while watching TV more frequently, had a higher bmi z-score longitudinally, while more frequent fast food consumption at home was associated with higher odds of OW (MacFarlane et al, 2009). Borghese et al., 2015 found that overweight and obese children watched more TV per day compared to their normal weight peer. They also found that obese children consumed fruits and fast foods more frequently while watching TV than normal weight or overweight children. The overall higher F&V intake while watching TV by obese children may be due to their overall higher Energy intake, although this should be accounted for as a probable mediator factor. Dubois et al., 2007 found an association between a child’s BMI and the frequency of eating while watching TV, especially for snacks and dinner, while more or less than 3 hours of TV viewing per day was not associated to BMI status (Dubois et al., 2007). Sisson et al, 2012, assessed TV-viewing time and composite measures of dietary quality, via the HEI (Healthy Eating Index-2005) and found that the lower the TV-viewing time the higher the total HEI score. The authors adjusted for BMI and total Energy consumption among other factors, therefore the association between total FI score, TV-viewing and BMI was not assessed. There appears to be many discrepancies among findings and furthermore the effect that a trend towards less TV viewing and more screen time in respect to gaming and computer use should be considered (Falbe et al., 2013). Therefore, total screen time is referred to.

Total Screen time

Studies have shown a high screen-based behavior among children and adolescents (2-4 hours per day) (Salmon et al, 2011). It has been suggested that increased screen time may lead to an increase in body weight, due to (1) a decrease in Energy expenditure through sedentary behavior, (2) an increase in Energy intake, through an increase in snacking of advertised foods that are high in sugar and fats. Review of longitudinal studies failed to show an association between total screen time and BMI in adolescents (Chinapaw et al, 2011) while other studies found an association between increased sedentary time and adiposity, and consistent evidence that sedentary behavior increases with age in school aged children, by approximately 30 min extra daily per year (Tanaka et al, 2014). These studies however, did not account for BMI distribution. Grontved et al, 2014, prospectively assessed the association between TV viewing, computer use, and total screen time with risk factors for CVD in young adulthood. They found a positive correlation between TV and computer use with adipocity, BP, triglycerides and metabolic syndrome in young adulthood. Furthermore individuals who increased their total screen time for more than 2 hours per day had significantly higher BMI, insulin, and metabolic syndrome, from adolescence to young adulthood, compared to those who kept it stable or decreased it. Martinez-Gomez et al, 2009, found that sedentary behavior and in particular screen time was associated with BP in children, independent of body composition. TV-viewing and screen time but not computer use were positively associated with systolic and diastolic BP following adjustments, independent of body composition (Martinez-Gomez et al., 2009).

In general, higher TV and screen time duration has been associated with higher E, sugar, salt and fat intake, a greater soda consumption and lower fruit and vegetables intake. Mitchell et al, 2013, through a longitudinal study, observed increases at the BMI percentiles over time with increased screen time in adolescents with BMI percentiles at the upper tail of the BMI distribution. Although they adjusted for gender, race, physical activity, maternal education and hours of sleep, food intake was not assessed and therefore may have been confounded by food intake and potentially total food score if the diet was viewed as a whole. Others reported that screen based sedentary behaviors, including TV/DVD viewing and computer/games use were positively associated with higher soft drink and unhealthy snack intake, and inversely associated with vegetable intake (Gebremariem et al., 2013).

All of the above, among other healthy and potentially protective & unhealthy, potentially obesogenic foods, have been included in the child derived FI created during the course of this PhD thesis in order to differentiate between the effects of screen time on children's weight status.

1.5.2 Sleep duration

Short sleep duration has been linked to increased risk childhood obesity by 58% to 89% (Capuccio et al., 2008, Chen et al., 2008) and to unhealthy food patterns including high fat & sugars and low fruit & vegetable intake (Nedeltcheva et al., Kjeldsen et al., 2014; Golley et al., 2013). Olds et al 2011, examined sleep behavior to physical activity, weight status and screen time. The found that those that children that slept late and woke up late had a higher screen time and lower moderate to vigorous PA compared to children that slept early and woke up early, in spite of similar sleep duration. Also they were more likely to be overweight or obese.

Nuutinien et al (2014) found that computer use and TV viewing predicted shorter sleep duration and later bedtimes.

In relation to diet, Hart et al., 2013 found that children that increased sleep duration reported lower food intake, while Kjeldsen et al., 2014 reported that sleep duration was negatively associated with Energy Density of the diet, added sugars and ssb's after adjusting for screen time and PA, suggesting that short sleep duration may be associated with poor-obesity promoting diet in children (Kjeldesn et al., 2014).

Although meta-analyses have found a negative relationship between sleep and child BMI (Cappucio et al., 2008, Chen et al., 2008), Bagley et al., 2013, found that not all children exposed to poor sleep are at equal risk for higher BMI (Bagley et al., 2013), and Bayon et al., related screen to sleep suggesting that use of multimedia disrupts sleep efficiency/duration (Bayon et al., 2014). The above indicate that although screen, sleep, eating patterns and eating behaviors are related to childhood OW & OB problem, an interrelation of these factors, as shown in this study, need to be further investigated. Studies may need to account for potential interaction or mediating effects.

Golley et al., 2013, further assessed sleep time/hours in accordance to energy intake, diet quality (using Dietary Guideline Index for Children and Adolescence), and BMI z-score. Study adjusted for sleep duration and physical activity. They found that children that went to bed late and woke up late had a higher BMI z-score and lower diet quality compared to children going to bed early and waking up early. Also those that went to bed late consumed more energy dense, nutrient-poor foods, while those going to bed early ate more fruits and vegetables. Energy intake was associated with sleep duration but not sleep timing behavior. These findings were accounted for in the second paper of this PhD thesis.

1.5.3 Eating & Behavioral perceptions based on school & environmental settings

As noted earlier, over the past 30 years childhood obesity has quadrupled in children 6-11 years old, from 6.5% in 1976 to 18.8% in 2004 (Ogden et al., 2009 –National Health and Nutrition

Examination Surveys). Many researchers have investigated a series of questions pertaining to eating behavior and there is evidence supporting the theory that certain such behaviors may precede overweight in some children (Birch et al., 1998, Fischer et al., 2003, Pearson et al., 2009). The work of Albert Stunkard in the field of obesity research and children's mood and other anxiety factors, are well documented (Allison KC et al., 2016). Evidence also suggests that dietary habits acquired in childhood persist through to adulthood (Kelder et al., 1994), therefore understanding children's eating attitudes and behavior is important in terms of children's health. Attitudes are developed at home via early experience with food and eating with several studies showing that a child's eating behaviour is strongly influenced by the family environment (Scaglioni et al., 2009, Briefel et al., 2009, Brown et al., 2004), with Hill, 2002 reporting that the choice of less-healthy foods is not just because of their taste, but an act of parental defiance and peer solidarity. As revealed by Albert Stunkard via psychological research studies, a complex interplay of innate, learned and environmental factors which shapes children's eating patterns may be the basis for the epidemic.

It has been shown via a systematic review, that home availability of fruit and vegetable and intake, were positively associated (Pearson et al., 2009). Kral et al. 2015 & Fischer et al., 2013, found that environments that offer larger portions of palatable foods affect all children's intake irrespective of their weight status or how reinforcing they find food to be. Some studies have linked childhood obesity with poorer quality of life, stress and low self-esteem rated by body dissatisfaction (Cartwright et al., 2003, Brown et al., 2004). Scaglioni et al., 2008 via a literature review, reported that parents create environments for children that may foster the development of healthy eating behaviors and weight, or environments that may promote overweight and various aspects of disordered eating.

In relation to school environment it has been estimated that forty-one percent of elementary schoolchildren bring lunch to school on any given day and forty-five percent bring snacks (Farris et al., 2015, Hubbard et al., 2014). Surprisingly, little is known about the foods and beverages they bring. Hubbard et al., 2014 sought to characterize foods and beverages brought from home to school by elementary schoolchildren and compare the quality of packed lunches with National School Lunch Program standards and packed snacks with Child and Adult Care Food Program requirements. They found that twenty-seven percent of lunches met at least three of five National School Lunch Program standards, whereas only 4% of snacks met two of four Child and Adult Care Food Program standards, with vegetables being only 3% and ssb's 35%. Farris et al. (2015), reported similar results, with sixth graders having significant large amount of ssb's and deserts in packed lunches among. Kenney et al (2014) further added that on days when children brought their own after-school snack, they consumed more salty and sugary foods and nearly twice as many calories than on days when they consumed only program-provided snacks. Other researchers also found a positive association between high fat and energy dense foods and childhood obesity when these were offered more often at the school setting (Fox et al., 2009, Briefel et al., 2009), with authors recommending limiting these choices. Beets et al., (2014) examined the choices children make when provided with disparate snack options in out-of-school-time programs among 5 to 10 year old children and found that sliced fruit was selected more than whole fruit across all conditions but was seldom selected when served simultaneously with sugar-sweetened, with flavored salty, snacks or other unflavored grain snacks, whereas others also reported that the majority of the empty calories consumed by children were at home (Briefel et al., 2009), with SSB intake being higher during weekend compared to weekdays among adolescents, whereas the frequency of FV intake was low (Bjelland et al., 2011), while Energy density was highest for consumption at locations away from home and school (Briefel et al., 2009,). Differences in adolescents' perceived availability of both SSB and FV on the basis of parental education were found, whereas the differences in intake were significant only for SSB (Bjelland et al., 2011).

Cartwright et al., 2003, reported that not only palatability and hunger but greater stress In school children (mean age 11.8 years) was associated with higher fatty food intake, less F&V intake and a reduced likelihood of daily breakfast consumption, independently of gender and SES.

Therefore limiting food options at school may not be adequate in combating the childhood obesity epidemic.

1.6 Childhood overweight and prenatal factors

It is recently accepted that basic lifestyle habits during early childhood, and even sooner, may play a significant role in the wellbeing of these as adults. Based on the Early Life Theory, a great number of chronic diseases that occur later in life start from in utero fetal development (Barker et al. 1994), due to fetal adaptation in structure, physiology and metabolism (Bakker et al., 2011). Investigators have reported links between prenatal characteristics and child overweight and obesity risk including maternal nutrition, maternal smoking during pregnancy, maternal weight status prior to pregnancy, weight gain during pregnancy. These are some of the factors that may exert influence on the child's weight status with an early tendency towards overweight, perpetuated with age (Salsberry et al., 2005, Strauss et al., 1997). There is increasing evidence that child health and weight-status may be «programmed» from in utero life, with maternal smoking, one of the most modifiable factors linked to children's BMI status, blood pressure (BP) and cardiovascular disease (Law et al. 1996, Bakker et al., 2011) as well. In relation to blood pressure, researchers have found a higher mean systolic blood pressure (SBP) in young children whose mother smoked during pregnancy, compared to non-smokers (Law et al. 1996, Lawlor et al. 2004) but others have not confirmed these findings (Bergel et al. 2000).

Furthermore, observational studies from 1990's reported a possible association between maternal smoking and children's BMI status later in life, with a high BMI prevalence found in children among mothers who smoked (Riedel et al., 2014). Researchers have found higher BMI and adiposity levels in children whose mothers smoked during pregnancy (Salsberry et al. 2005, Florath et al., 2014, Li et al. 2015). Researchers have also found a significant higher mean BMI among offspring's of mothers who smoked during pregnancy (Al Mamun et al., 2006, Wang et al., 2013) reporting a direct effect; observations strengthened by a meta-analyses reporting higher effect estimates on childhood obesity for maternal smoking when compared to paternal smoking (Riedel et al., 2014). The GENESIS study, however found that 3- to 5-year old children born from mothers who were both active and passive smokers during pregnancy were 1.79 times more likely of being overweight compared to children born from nonsmoking mothers and children with rapid weight gain in infancy was 1.9 times more likely to be overweight (Manios et al, 2010). Findings supported by others as well, leading to the notion of residual confounding. Another study in children 9-13 years indicated certain perinatal factors (maternal pre-pregnancy obesity, maternal smoking at pregnancy, rapid infant weight gain and late introduction of solid foods at weaning) and parental characteristics as important risk factors for adolescence overweight and obesity, (Birbilis et al, 2013).

Considering that maternal smoking is one of the most modifiable factors, research that accounts for most of the covariates found to be mediating and or moderating, partly or completely, the effect of maternal smoking on childhood overweight and obesity, should be accounted for in a well conducted study and analysis. The study along with the findings can be viewed in paper III.

1.7 Remaining gaps in knowledge

Based on the above gaps remain in the ideal dietary structure, food knowledge and use :

Depending on inclusion or exclusion of specific foods, food indices can be generated to reflect a dietary pattern that is healthy, unhealthy, or a combination of both (Waijers et al 2007). Furthermore at present there is no gold standard for food intake pattern analysis with more refined scoring methods allow both protective dietary patterns and unfavorable intakes to be identified. It remains debatable whether cut-off boundaries, dichotomous values or continuous variables allow for a better evaluation of food intake and/or of possible associations with positive or negative outcomes.

The next question referred to is the association of child behavioral factors and perceptions to these obesogenic dietary patterns. Do they increase or decrease the association? Furthermore factors that adjust for sedentary behavior as clearly as possible should be used, including all such behaviors that children are prone to.

Another aspect that should be referred to are prenatal exposures. Since childhood overweight and obesity outcome has been termed multifactorial, are all these factors associated with the increased risk, or does residual confounding and mediation affect the results.

Further questions that may be asked is how are school aged children affected by the above factors and what beliefs have they developed concerning eating patterns and altering their eating habits? Starting at the baseline, children's perceptions and willingness to change based on their weight status should be assessed. These are basic questions that can make a big difference once assessed, on developing public health interventions to combat or prevent the obesity epidemic. All of the above have been the scope of this PhD thesis, with a detailed methodology followed in order to account for all potential factors that may disturb the results.

2. Scope of the current PhD thesis

The aims of the current PhD dissertation was the examination of Greek school children and preadolescents dietary intakes & patterns, along with factors that influence their selections & preferences, in a nationally representative sample from the GRECO (Greek Childhood Obesity) study

Specific aims by paper in support to PhD thesis:

1st Aim: To derive a validated food index with a simple scoring system, able to capture risk of overweight and/or obesity in school aged children, based on a-priory knowledge of potential obesogenic food factors, USDA data and the Mediterranean Food Pyramid guidelines.

2nd Aim: To examine the association of known obesogenic behavioral factors, including sleep, screen and study hours, with a validated child derived dietary pattern. Secondary to assess how these factors are related to children's weight status when addressed together.

3rd Aim: To examine the effect of maternal-smoking on school children's weight status, as defined by the International Obesity Task Force (IOTF) BMI cutoffs, central adiposity, defined by waist circumference (wc), and total adiposity, measured with bio-impedance analysis (BIA). Secondarily, the potential association of maternal-smoking with children's blood pressure (BP) was investigated.

4th Aim: To investigate the extent by which school aged children in the area of Greece are ready to change eating behaviors, based on gender, weight status and weight perception.

3. Presentation of papers

PAPER I

Magriplis, E., Farajian, P., Risvas, G., Panagiotakos, D., & Zampelas, A. (2015). Newly derived children-based food index. An index that may detect childhood overweight and obesity. *International journal of food sciences and nutrition*, *66*(6), 623-632.

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RESEARCH ARTICLE

Newly derived children-based food index. An index that may detect childhood overweight and obesity

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Abstract

A food index (FI) based on *a priory* knowledge was developed to assess the role of diet on overweight (OW) and obesity (OB) in school-aged children. This included «positive» and «negative» foods based on research evidence and food guidelines, with scores set accordingly. Statistical tests were used to strengthen the sensitivity of the index. The FI was validated using data from the GRECO study. The score ranged from 17 to 53.5 (mean 34.8 ± 5.01) and was inversely associated with body mass index (BMI) (-0.057 ± 0.02; 95% CI -0.098, -0.017) and waist circumference (WC) (-0.08 ± 0.03, 95% CI: -0.137, -0.022). Associations remained significant upon adjusting for age, gender and physical-inactivity ($p = 0.02$ ad 0.013, respectively). When stratified by gender, the association between FI and WC was not significant for boys ($p = 0.08$). The association with BMI remained significant for females and males ($p = 0.047$ and 0.037, respectively). The derived FI seems a valuable tool in detecting OW in children.

Keywords

Children, dietary habits, epidemic, food, obesogenic factors

History

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Introduction

Childhood obesity (OB) rate, nowadays termed an ''epidemic'', is rising in the United States and in Europe, regardless of all the population food guidelines and measures that are taken to combat this phenomenon (O'Connor et al., 2006). This is of Global concern (Barton, 2012; Lavie et al., 2009) since in 2013 the number of overweight (OW) children was estimated to be over 42 million globally (WHO) and childhood OB has been associated with an increased susceptibility to chronic diseases later in life (Barton, 2012; Berenson et al., 2012). The latter stresses the need to identify obesogenic factors early on, as underlined by other researchers as well (Barton, 2012).

To date there is much speculation regarding the reasons for the OW epidemic among children worldwide, however the specifics remain inconclusive. Studies on childhood OB have shown that diet and physical inactivity are the most important factors, exceeding the effect of genetic susceptibility (Barton, 2012; Berkey et al., 2000, 2003; Lavie et al., 2009). Many food items have been investigated, such as sweets, sugar-sweetened beverages (ssb's) and junk food, with inconclusive results but it is now widely accepted that food items interact and no one food alone can be investigated without being confounded by the diet as a whole. This has lead researchers to the search of an index that will accurately measure and assess food intake in relation to specific guidelines with end result overweight/obesity (OW/OB) and chronic disease status.

Most indexes present to date ''fit'' their populations' food habits are based on adherence on national dietary guidelines or the Mediterranean pattern (Waijers et al., 2007) and assess dietary intake based on a score created that can possibly explain the relationship of OW and OB with morbidity and mortality. In adults, lower diet quality scores have been found to be consistently associated with higher rates of all-cause mortality, and specific morbidity rates, associations that remain even when confounders are considered (Wirt & Collins, 2009), but to date limited data have been selected on children. Furthermore, data selected on this population are from food indexes that have been adapted for children, not created for them (Feskanich et al., 2004; Golley et al., 2011; Kleiser et al., 2009a; Kranz et al., 2006, 2008; Lazarou et al., 2009).

Few indexes have been designed specifically for children (Feskanich et al., 2004; Golley et al., 2011; Kleiser et al., 2009b; Kranz et al., 2006, 2008; Lazarou et al., 2009, 2011; Manios et al., 2010; Serra-Majem et al., 2004), and according to our literature review, only three (3) indexes have been created for school aged children (Lazarou et al., 2011; Manios et al., 2010; Serra-Majem et al., 2004), only two (2) have been derived (Lazarou et al., 2011; Manios et al., 2015) with the main objective to detect risk for childhood OW and OB. These indexes, however, are either too complex (Lazarou et al., 2011) to be performed (many variables need to be determined, and nutrient calculation is required), or too simplified (Serra-Majem et al., 2004) using a very small scoring system increasing the risk for false results since small dietary variations cannot be detected.

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The Revised Healthy Lifestyle Diet Index (R-HLD) has considered many of the above aspects, it includes two non-dietary components, including sedentary life (total time for TV watching and playing computer games) and total Moderate to Vigorous Physical Activity (MVPA) (Manios et al., 2015). Estimates of physical activity, however, can be very difficult to perform, if not actually measured by devices, increasing the risk of bias and confounding. Also, it does not distinguish between certain food items (i.e. red and processed meat) in light of new evidence, showing that red and processed meat may have different mechanism of action on health and disease (Micha et al., 2010). In our view, although these factors should not be neglected, a pure food index (FI) created for school-aged children that will detect OW–OB risk is of primary aim, with the latter factors investigated separately and in combination with the FI in order to obtain clear results.

The goal of this study was to derive a FI with a simple scoring system, able to capture risk of OW and/or OB in school aged children, based on *a priory* knowledge of potential obesogenic food factors, USDA data and the Mediterranean Food Pyramid guidelines.

Hypothesis

A FI designed for children aged 9–13 years old, based on *a priori* knowledge and food recommendations-dietary guidelines, will assess dietary habits that potentially increase risk of OW and OB, in order to accurately determine food habits that need change in order to combat increasing rates of childhood OB.

Methods

FI derivation-rational

A total of 14 foods (11 food items and three specified food groups) were selected based on *a priori* knowledge to be included in the FI (Table 1) for children aged 9–13 years of age, based on *a priori* knowledge of food items and food patterns. Factors accounted for included research data on specific food and food patterns, age and gender. These foods were categorized as positive- non-obesogenic or negative-obesogenic foods, based on *a priori* knowledge of food items and food patterns. Foods that belong in the same food group, i.e. vegetables & fruit; meat, legumes and nuts (meat & alternatives) were separated based on their bodily effects, upon findings.

Specifically in this index positive-non-obesogenic foods include: fruit, vegetables, whole grains, fish, nuts, legumes/pulses, milk and yogurt; negative-obesogenic foods include: cheese, red meat, sugared sweet beverages (ssb's), processed food, fast food and sweets.

Table 1. List of positive-non-obesogenic and negative-possibly obesogenic foods that are included in the FI.

Positive non-obesogenic food	Negative possibly obesogenic food
Fruit	Cheese
Vegetables	Red meat
Whole grains	Processed food[a]
Legumes	Sugared sweet beverages[b]
Nuts	Sweets[c]
Fish	Fast food[d]
Milk	
Yogurt	

[a]Including processed meat, and chips.
[b]Including regular soda, fruit drinks, nectars.
[c]Including puddings and creams, biscuit-cereal bars, cakes/croissant, cookies, jam-marmelade, chocolate and chocolate waffers, chocolate spread and icecream.
[d]Including pizza, souvlaki, hamburger and french fries.

Reasoning for protective and negative foods

Dietary guidelines stress the need to consume whole-wheat grains (USDA), due to their high fiber contents, and latest evidence suggest that these may be associated with lower weight gain (Mozaffarian et al., 2011). All food organizations recommend that grains and cereals should be whole wheat, non-processed and an Acceptable Intake (AI) of 14 g of fiber per 1000 kcal in children and adolescence aged 4–18 years is recommended. A daily vegetables and fruit consumption is also underlined. These were entered separately in the FI as it has been recommended (Waijers et al., 2007), due to their different carbohydrate composition, fiber and nutrient content. Dietary guidelines also stress the need for dairy intake due to the children's high needs for calcium, phosphorus and magnesium; minerals that support growth. Milk, yogurt and cheese however, were analyzed separately due to their composition differences, with the latter being incorporated in negative foods due to its high saturated fat and sodium content. Furthermore, research has shown a potential beneficial effect of yogurt on health and weight status (Mozaffarian et al., 2011). Evidence has also emphasized the need for vegetable protein intake for health, in adults and children, mainly from legumes and nuts (Matthews et al., 2011; Moreno et al., 2013; Rossi et al., 2013; Turati et al., 2014). Epidemiologic studies and clinical trials suggest that regular nut intake may help in weight loss and is unlikely to contribute to OB despite their high energy density (Ros, 2010). An inverse relationship has also been found between peanut consumers and OW/OB in children compared to non-peanut consumers (Moreno et al., 2013). In 2011, Canada recommended that nuts, legumes and tofu should replace meat as often as possible (Santé et Services sociaux Québec, 2015). In their 2010 recommendations, USA recommended that fish and seafood should replace meat and poultry whenever possible with an intake of at least two portions of fish per week being supported (AGHE, UK 2011, France 2004).

For the negative foods of the FI, emphasis on recent OW–OB studies, and fat and sodium was given. It has been recommended that children should decrease saturated fat intake to <8% of total daily energy intake (FAO/WHO/UNU, 2004) or to <10% (FAO/WHO/UNU, 2004; Nordic Council of Ministers, 2013) as well as a reduction in sodium. The former recommendation limits red meat, and both suggest a lower processed meat and cheese consumption. Research has shown that children with a high Mediterranean diet score can have a high Na intake, with cheese being a major contributor (Magriplis et al., 2011). Processed food (including processed meat and chips/crisps) were grouped together due to their high sodium and preservative content.

A reduction of total simple sugars intake is also recommended. Institution of Medicine (IoM, 2005) recommended minimizing simple sugars to <25% of a total of 45–65% of total carbohydrates, for children between 4 and 18 years of age. NNR 2012 advises a reduction of simple sugars to <10% of carbohydrates (45–65% in total) for any child over 2 years old and WHO to <10% of total energy intake for all ages. In order to comply with the above recommendations a score on sugar intake from dessert items is warranted, irrespective of the food's caloric value. The goal of the FI is not to remove all sugar content (addressed by the 4–1 score, compared to 0–1), since this would be unnatural, but to minimize ''empty calories'' (i.e. jam and marmalade) and energy dense foods, low nutrients content foods (i.e. cookies, cake and chocolate). Sweets encompass sugared solid items, including cake, cookies, sweet pastries like croissant, marmalade, honey, chocolate bar and chocolate spread, and ice-cream. Ready to eat

(RTE) cereals have been investigated for their potential obesogenic role due to their sugar content, but to date remain controversial. Many studies, however, have found a negative correlation of RTE cereals and body weight in children (de la Hunty et al., 2013; Kosti et al., 2008). Furthermore, whole wheat (ww) RTE cereals were therefore included in positive foods, due on their fiber composition and high nutrient supply through fortification. Potatoes and refined grains were not included since their effects on body weight are either not linked or highly controversial.

This FI separates ssb's from sweets, due to evidence that these may play a key role in the etiology of OW and OB during childhood, and evidence supporting that liquids have less impact on satiety compared to solid foods (Dennison, 1996; Nissinen et al., 2009; O'Connor et al., 2006). In order to derive measurable and comparable results, a specific definition for ssb's defined as any liquid containing >25% of its calories as simple sugars (Mariner & Annas, 2013) was used in the creation of this FI, including all regular soft drinks, fruit drinks and fruit nectars.

The «Fast-food» category (including souvlaki, hamburger, pizza and fries) included energy dense but nutrient poor foods, high in saturated and trans fatty acids. Fast food intake has been associated with an increase in body weight and waist circumference (WC) OB in children (Nago et al., 2014; Shang et al., 2014). A link was also found with type 2 diabetes in adult women when consuming $\geq$2 fast-food meals per week (Krishnan et al., 2010).

Scoring system

A weighting system of 1 or 1.5 was used for positive foods in order to increase the sensitivity of the index in detecting internal variation in dietary habits and to underline the increased requirements of some foods in school-aged children, due to growth, as earlier stressed. To date, in all child-based indices, all individual variables are given the same weight therefore equally contributing to the score. It has been suggested that it is not plausible for all index components to have the same health impact (Waijers et al., 2007) and furthermore, the same obesogenic or non-obesogenic effect.

More specifically a score of 1–4 was given to protective foods, based on their intake, with 4 given for consuming the maximum recommended intake and 1 if consumption was at the lowest recommended level (Table 2). Intake was specified in total servings per day, with a serving being food dependent (i.e. raw versus boiled vegetables, RTE versus cooked cereal, portion of cheese, meat, milk, etc.) and is depicted in Table 2.

Higher weights (score 1–4 multiplied by 1.5, hence 1.5–6) were then given to whole grains, fruits, vegetables and milk based on data of there increased requirements in school-aged children due to growth, as per the recommendations made by the American Academy of Pediatrics (National Heart, Lung and Blood Institute, 2011) for OB and cardiovascular disease prevention.

For negative-harmful foods the opposite was performed; 4 was given to those consuming the lowest level and 1 to children consuming the highest levels of these food. With regards to fast-food, where no intake is suggested a score of 4 was assigned to no intake and 1 if these foods were consumed more than twice a week. For sweets and ssb's, the highest score was assigned for a limited intake of less than one portion per week and the lowest score for a frequency of more than three per week.

Table 2 provides a detailed summary of the scoring system for each food separately. The total FI score was obtained by summing the scores assigned to each individual index component. Theoretically based on the total foods in the FI and considering the weights given to four of these, the total FI a child can achieve will range from 16 (minimum value possible) to 64 (maximum value). Higher FI values indicate healthier dietary intake and support the hypothesis of lower probability for OW and OB in school-aged children. Median values were also considered further in the analysis.

FI validation

The derived FI was validated based on a large cross-sectional study that included Greek children aged 10–12 years old (GRECO study). Complete usual dietary intake was assessed using a 48-item self-administered picture aid FFQ (FFQ can be seen in Supplementary material) through public schools. All participants were asked about their usual frequency of food consumption on average over the last year with response categories ranging from never, 1–2 times per month, once a week, twice a week, 3–6 times a week, to everyday. Visuals were used to help children to understand and address portion sizes. Specifics on the type of food consumed were also asked for, including whole wheat grains and cereals. Total frequency intake was converted to servings per day and these were used to calculate the total FI score per child. Data from 4832 children leaving in the Greek municipality (semiurban and urban areas), aged 10–12 years were collected. Anthropometrics gathered included measurements by trained personnel, on body weight to the nearest 100 g (Tanita TBF 300), body-standing height without shoes (Leicester height measure) to the nearest 0.1 cm and WC to the nearest 0.1 cm (Seca, non elastic tape, Germany). Percentage of body fat (%BF) and fat mass (kg) were estimated by the foot-to-foot impedence method (Tanita TBF 300). Body mass index (BMI) was calculated by dividing weight (kg) by standing weight squared (m^2). Detailed information on sampling and measurements has been already published (Farajian et al., 2011, 2013). After data inspection, a total of 452 children were excluded; 117 children had all data missing; 95 children had left unanswered over 20% of the FFQ ($\geq$10 questions) and 240 individuals had reported implausible energy intake (<600 kcal/day or >6000 kcal/day). A total of 4439 individuals remained and were included in the FI validation.

Basal Metabolic Rate (BMR) was calculated based on Schofield's equation (Schofield, 1985).

Physical inactivity

The FFQ contained questions on television (TV) and computer possession in the bedroom, as well as total time spent (a) watching TV, (b) playing video games, (c) surfing on the Internet and (d) studying. The total sedentary hours were derived and added in order to adjust for physical inactivity as a proxy measure of physical activity.

BMI category derivation

Children's BMI cut-offs were defined based on International Obesity Taskforce (IOTF) standards (IV) (Cole & Lobstein, 2012). According to the authors, these new cut-offs are easy to derive and can be expressed as BMI centiles, allowing them to be compared with other BMI references. Children were separated in five categories based on their age and gender specific BMI; underweight, normal weight, OW, obese and morbidly obese, as per IOTF definitions (Table 3). Age and gender were considered since a child's BMI changes with age, and growth patterns differ between genders (Cole & Lobstein, 2012). They were finally grouped into three categories for the final statistical tests based on the frequency and percentages observed (1: under- and normal-weight; 2: overweight; 3: obese and morbidly obese children) (Table 3).

Table 2. Food index scoring system.

Score Food group[a]	4	3	2	1
Whole grains (×1.5)[b]	≥4	≥3, <4	≥2, <3	<2
• 1 food portion = 1 slice of bread = 30 g; ½ cup cooked pasta or rice; 30 g ready to eat cereal; ½ pita bread; 2 whole wheat rusks ◦ potatoes were not included				
Vegetables (×1.5)[b]	≥4	≥3, <4	≥2, <3	<2
• 1 portion = 1 cup of raw salad; ½ cup cooked vegetables; 1 medium vegetable ◦ Potatoes and vegetable juice not included ◦ Cooked vegetable Mediterranean dishes were considered as ½ portion				
Fruit[c] (×1.5)[b]	≥3	≥2,<3	≥1,<2	<1
• 1 portion = 1 medium fruit or 2 small (ie clementines) ◦ fruit juice was not included				
Milk (×1.5)[b]	≥2	≥1, <2	>0, <1	0
• 1 portion = 1 glass of milk = 250 ml				
Yogurt	≥2	≥1, <2	>0, <1	0
• 1 portion = 200 g				
Fish	≥2	≥1, <2	>0, <1	0
• A fish portion = approx. 90 g when cooked				
Nuts	≥3	≥2, <3	≥1, <2	<1
• A portion = 30 g of nuts or about 2 tablespoons (tbs); or 1 tbs tahini or peanut butter				
Legumes	≥2	≥1, <2	>0, <1	0
• A portion = 1 cup cooked legumes				
Red meat	<1	≥1, <2	≥2, <3	≥3
• A portion of red meat = 70 g cooked				
Processed food	<1	≥1, <2	≥2, <3	≥3
• A portion of processed meat = 70 g • A portion of chips = 30 g				
Cheese	≤1	>1–≤2	>2, <3	≥3
• A cheese portion = 40 g				
Fast-food	0	>0–≤1	>1, ≤2	>2
• A portion of pizza = 1 slice • A portion of souvlaki or hamburger = 1 regular size • A portion of fries = 1 cup				
Sugar sweet beverages (ssb's)	<1	≥1, <2	≥2, <3	≥3
• A portion of soda = 330 ml; of fruit drink = 250 ml				
Sweets	<1	≥1, <2	≥2, <3	≥3
• A dessert portion = 2 cookies/a slice of cake/60 gr chocolate/1 bowl of rice-pudding or cream/1tbs merenda (chocolate spread)				

[a]Whole grains, fruit, vegetables, milk, yogurt and cheese are designated in servings per day. Nuts, legumes, fish, fast-food, redmeat, processed food, ssb's and sweets are designated in servings per week.
[b]Weights of 1.5 were given to whole grains, vegetables, fruits, milk and legumes.
[c]618 missing values for wgrains (total $n = 3817$); one missing for fruit ($n = 4434$); six missing for milk ($n = 4429$); 114 missing for yogurt ($n = 4321$); 25 missing in fish group ($n = 4410$); 40 missing in nuts ($n = 4395$); 233 missing in legumes ($n = 4202$); 46 missing in redmeat group ($n = 4389$); 178 missing in cheese group ($n = 4257$); zero missings for sweets, ssb's fastfood and processed food ($n = 4435$).

Table 3. Children's weight categorization based on adult's BMI according to IOTF standards and BMI categories used in FI validation.

Children's classification	Respective adult BMI	BMI category	GRECO frequency	Total %	% Boys	% Girls	*p* Value
Normal weight	18.5–<25		2327	54.87	53.97	55.72	$p = 0.572$
Underweight	<18.5	1	148	3.49	2.96	4.00	
Overweight	25–<30	2	1260	29.71	30.18	29.26	
Obese	30–<35		447	10.54	11.24	9.88	
Morbidly obese	>35	3	59	1.39	1.65	1.15	
Total	n/a		4241	100	100	100	

Statistical analysis

Data presentation

Descriptive statistics, including frequencies, mean, median, standard deviation (±SD) and range (minimum–maximum values) were calculated for continuous variables and to describe the distribution of the FI. Categorical variables (such as gender, age-group, BMI categories, inactivity level) were summarized as relative frequencies (%).

Probable gender differences were assessed using *t*-test, whereas differences in age and in BMI categories were assessed using ANOVA, with Bonferroni correction in order to reduce type

1 error (reject the null hypothesis Ho when it is true), a possible error seen with Student's *t*-test when analyzing more than two variables.

Scatter plots were constructed for each variable of interest separately to assess linear association with total food score and detect common outliers or any other discrepancies in data.

Food index (FI)

Cronbach-alpha (α) was performed in order to test the interrelation of each variable used in the FI model constructed and in total. Most acceptable values were considered as $\alpha = 0.7–0.95$ (Tavakol & Dennick, 2011). In order to strengthen the results from Cronbach-α and to confirm the constructive validity of the index, *Factor analysis* was done. An Eigen value >1 was considered informative.

Via *Variance Inflation Factor (VIF)*, the extent to which pairs of variables provide independent information for purposes of predicting the dependent variable (FI total), given the presence of other variables in the model, was tested. The main aspect was to avoid collinearity. As a rule of thumb, a variable whose VIF values are greater than 10 merit further investigation; tolerance (1/VIF) level less than 0.1 is comparable to VIF+ >10. A high value may mean that the variable could be considered as a linear combination of other independent variables and should be removed. *Bootstrap* in 100 replications from the data set was also performed to assess results from random sampling.

In order to assess whether the FI can adequately detect children at risk for OW or OB, random sampling without replacement was performed, splitting the GRECO data randomly into two (2) new data sets 75–25%. An OB equation derived from the first data set (75% sample; 3326 random observations) was then applied to the 2nd data set (25% sample):

$$\left[\text{probability of being obese} = \frac{\exp(b0 + b1 * \text{score})}{1 + \exp(b0 + b1 * \text{score})}\right]$$

The strength of the index was assessed by examining the association of the probability of being OW/OB, as derived from the first sample, with the total FI score achieved by the children from the second sample (25% sample).

Data analysis

Multiple linear regression analysis was performed to test the contribution of each individual food included in the FI on the total score *via* the coefficient of variation (R^2). This is a quantitative measure of the weight each food quartile has on the total FI score alone and when adjusted for the other variables. The coefficient of variation (R^2) was determined and was reported as a test of how well the model accounts for the outcome. To overcome the limitation that the coefficient of variation has (increases as the number of variables increase), the adjusted R^2 were also calculated and reported. A positive adjusted R^2 indicates that the gain in adding the variable is greater than the charge.

FI scores were depicted in total for each child and then stratified by gender and age, to detect any differences. Total score and median values were compared. Linear regression was used to assess the relationship between total FI score and BMI (continuous) measure, as well as the association between FI and WC. Crude and adjusted measures were investigated, considering age, gender and physical inactivity in the model. The median value of the total FI was assigned as the cut-off point in the analysis to discriminate among the children's weight status. Specifically, the total food score was dichotomized above and below the median (Q3 & Q4 versus Q1 & Q2), to investigate the upper two quartiles and its association with OW and OB (BMI) compared to the lower two. Logistic regression analysis was used to evaluate potential associations between the median FI score and categorical BMI status assuming linear association. This was firstly seen in unadjusted (crude) format and then probable confounders were assessed by a stepwise approach via multivariable logistic regression. In each step the Likelihood Ratio Test (LRT; Chi square model) was used.

Confounding

Confounders, including age, gender, physical inactivity and potentially energy intake were included in a step-wise approach. Physical inactivity was used as a proxy of sedentary activity and was derived by summing the average time spent watching TV and/or other ''screen time'' including video games and computer plus the total number of study hours over the week. Statistical analysis was conducted using Stata Version 12.0 (StataCorp., 2011). Differences of $p < 0.05$ were considered to be significant.

Results

Total FI score in the GRECO population ranged from 17 (min value) to 53.5.(max value). The overall mean was 34.5 ($\pm$5.01) and the median score was 34.81, therefore a normal distribution was assumed (Table 4). The mean FI score and the mean inactivity hours, between genders were not statistically different (ANOVA; $p = 0.138$ and 0.290, respectively), whereas a difference was found in the gender's mean BMI ($p = 0.034$), WC ($p<0.001$) and in total Energy intake ($p < 0.001$). Table 1 summarizes the food that have been used to create the FI, whereas Table 2 depicts the scoring system derived as explained earlier in methods section. In Table 5, the unique variance contribution of each independent food variable to the FI listed and the common variance contributions for all independent variables to the equation were derived. Vegetables and legumes had the highest individual contributions ($R^2 = 0.179$ and 0.232, respectively). A 0.989 (or 98.9%) total coefficient variation was obtained in the FI model meaning that the variables in the model can explain 98.9% of the total score obtained.

No collinearity was observed among explanatory variables (age, BMI, gender and inactivity). The VIF and tolerance (1/VIF) ranged from 1.02 to 3.31, with the latter being the tolerance level for WC (data not shown). Independency was therefore assumed among the variables.

Children's weight classification and its relation to adult's BMI levels as per IOTF standards are given in Table 3. About 58% were depicted as under- and normal-weight (3.49% and 54.87%, respectively), approximately 30% of the children were found OW and 12% were noted as obese, with no evident statistical difference in mean BMI distribution between males and females ($p = 0.572$). The final BMI categories developed and used for the analysis are also depicted in this table. Children were classified into three groups based on their age: 1 if $\leq$10, 2 if around 11 years old and 3 if $\geq$12. Approximately 30% of the total children were in category 1 (28% boys and 32% girls), 49% children in 2 (49.6% boys and 48.9% girls) and 21% in category 3 (22.8% boys and 19.2% girls). A statistically significant difference was observed between age groups and gender ($p < 0.001$). A statistical significant difference was also found when assessing BMI categories between boys and girls ($p = 0.03$), with approximately 57% of boys versus 60% of girls being under- or normal-weight; 30% boys versus 29% girls being OW; and 13 % boys versus 11% girls being OB. A borderline difference between BMI categories and age groups ($p = 0.047$) was also found (data not shown).

A statistically significant effect was derived between total food score and child's BMI (-0.057 ± 0.02, 95% CI: -0.098, -0.017), and their WC (-0.08 ± 0.03, 95% CI: -0.137, -0.022), in a crude

Table 4. Informative variable identification with statistical description.

Variables of interest	Frequency[a]	Mean	Median	SD	Min	Max	p Value
BMI	4241	20.25	19.66	3.74	12.47	38.16	
BMI_girls	*2177*	*20.13*	*19.54*	*3.68*	*12.86*	*36.05*	0.034
BMI_boys	*2064*	*20.37*	*19.77*	*3.80*	*12.47*	*38.16*	
Total FI score[b]	4435	34.81	34.5	5.01	17	53.5	
Females	*2271*	*34.70*	*34.5*	*4.91*	*17*	*50.5*	*0.138*
Males	*2164*	*34.93*	*35*	*5.11*	*17.5*	*53.5*	
Physical inactivity[c]	4422	10.03	9.5	4.32	0	34.5	
Females	2266	10.09	9.5	4.18	0.5	34.5	0.290
Males	2156	9.96	9	4.46	0	30	
Energy[d]	4435	1990.6	1746.1	1008.3	602.6	5966.6	
Females	*2271*	*1837.4*	*1610.3*	*911.6*	*603*	*5883.4*	***<0.001***
Males	*2164*	*2151.4*	*1900.9*	*1077.8*	*602.6*	*5966.6*	
Waist circumference[e]	4246	68.56	67	9.59	40	109	
Females	*2176*	*67.42*	*66*	*9.14*	*40*	*108*	***<0.001***
Males	*2070*	*69.76*	*68*	*9.91*	*44*	*109*	

Statistically significant results are shown in bold and italicized.
[a]Number of observations.
[b]Total food index score for all children and by gender.
[c]Physical inactivity a sum of total screen and study hours per day for all children and stratified by gender.
[d]Total energy intake for all children and stratified by gender.
[e]Waist circumference in centimeters (cm) for all children and stratified by gender.

Table 5. Contribution of individual predictive variable on total food index.

Variables[a]	Unique R^2	Combined R^2	Adj. R^2	Total R^2
Vegetable	0.179			0.989
Legumes	0.119	0.265	0.264	
Fish	0.1008	0.310	0.309	
Fruit	0.2332	0.438	0.437	
Yogurt	0.052	0.450	0.450	
Whole grain	0.144	0.507	0.506	
Milk	0.119	0.556	0.555	
Nuts	0.074	0.568	0.567	
Fast food	0.046	0.638	0.638	
Processed food	0.102	0.771	0.770	
Red meat	0.0261	0.845	0.845	
Cheese	0.0003	0.908	0.908	
Sweets	0.027	0.932	0.931	
SSB's	0.067	0.989	0.989	

[a]All variables defined based on score derivation.

analysis (Table 6). When stratified by gender, the association remained significant for both genders for BMI (boys: -0.058 ± 0.03, 95% CI: -0.012, -0.001; girls: -0.06 ± 0.04, 95% CI: -0.016, -0.004) but only for girls in the case of WC (boys: -0.075 ± 0.04, 95% CI: -0.158, 0.008; girls: -0.098 ± 0.01, 95% CI: -0.177, -0.019). With every unit increase in the FI score the children were -0.057 times less likely to be OW or OB and 0.08 less likely to have a high WC. When adjusted for confounders (gender, age and inactivity), the strength of the association remained significant in both the cases.

In Table 7, the data depicted reveal that as the BMI category increases the total FI score is lower than the median FI score (-0.069 ± 0.03, 95% CI: -0.121, -0.018; $p = 0.007$). The model including gender, age and inactivity provides significant results, however when total energy intake is entered BMI categories have no significant association with the dichotomized FI score (-0.046 ± 0.03, 95% CI: -0.098, 0.007; $p = 0.089$).

Sensitivity analysis that tested the probability of children being OW/OB with the total FI score showed that as the FI total increases in the 25% randomly selected GRECO sample, the probability of OW/OB decreases significantly ($p < 0.001$), as depicted in Figure 1.

Discussion

The FI score adequately distinguished OW and obese children, from normal and under-weight. With every unit increase in the FI score the children were -0.057 times less likely to be OW or obese and 0.08 times less likely to have a larger WC, whereas the higher the BMI category the higher the likelihood of children having a FI score below the median. The association remained significant upon adjusting for age, gender and total inactivity.

Composing an index remains a complex matter with a large degree of subjectivity. In order to avoid creating «yet another index» but to expand on the ones already created, data from previous scores derived along with current knowledge on childhood OW/OB and obesogenic factors were used to derive a more sensitive index. Feskanich et al. (2004) suggested and used an index that contained «harmful» foods along with those recommended by organizations. The current FI index expanded upon the researchers work and further distinguished foods based on recent evidence in order to create an index that may detect OW/OB in children. The FI was derived specifically for school aged children, and designed to primarily detect OW and OB in this age group based on *a priori* knowledge. All known food items that have been shown to add to health, prevent weight increase and those that may increase weight were added. Also potential high-risk foods, not yet proven but speculated to lead to weight increase were added in order to test the interrelatedness of these food items. For example, a large prospective study in the US women found that weight gain was inversely associated with fruit, vegetable, whole grain, nut and yogurt intake (Mozaffarian et al., 2011). This is in accordance with evidence suggesting that an index that includes all components associated with the outcome, separated even if these belong in the same food group, in order to account for interaction between dietary components, as long as they are not interrelated (no collinearity), has a higher diagnostic accuracy compared to indexes that contains only some of the components (Kourlaba & Panagiotakos, 2009; Waijers et al., 2007). No collinearity was present in our results and a good Cronbach-alpha (value of 0.7) was derived with this FI.

The role of ssb's on childhood OW and OB was investigated in a total FI aspect, due to the controversial results (Malik et al., 2006) and potential publication bias (Forshee et al., 2008) when

Table 6. Crude and adjusted linear regression between total FI score and BMI, and between total FI score and WC.

		Coefficient (±SE)	*p* Value	95% CI
Crude linear regression[a]				
		BMI		
Total FI[c]		−0.057 [0.02]	**0.005**	−0.098, −0.017
By Gender[e]	Males	−0.058	0.05	−0.012, −0.001
	Females	−0.06 [0.04]	**0.037**	−0.116, −0.004
		Waist circumference		
Total FI		−0.08 [0.03]	**0.007**	−0.137, −0.022
By Gender	Males	−0.075 [0.04]	**0.077**	−0.158, 0.008
	Females	−0.098 [0.01]	**0.014**	−0.177, −0.019
Adjusted linear regression[b]				
		BMI		
Total FI		−0.057 [0.02]	**0.005**	−0.098, −0.017
Gender		−0.058 (0.02)	**0.004**	−0.099, −0.018
Age		−0.049 (0.02)	**0.017**	−0.090, −0.009
Inactivity[d]		−0.048 (0.02)	**0.020**	−0.089, −0.008
		Waist circumference		
Total FI		−0.08 [0.03]	**0.007**	−0.137, −0.022
Gender		−0.09 [0.03]	**0.003**	−0.143, −0.029
Age		−0.075 [0.29]	**0.010**	−0.132, −0.018
Inactivity		−0.072 [0.013]	**0.013**	−0.130, −0.015

Statistical significant results are shown in bold.
[a]Crude values are stratified by gender.
[b]Linear regression in a stepwise approach, adjusting in a stepwise approach.
[c]Total food Index score.
[d]Physical inactivity a sum of total screen and study hours per day for all children and stratified by gender.
[e]Regression stratified by gender.

Table 7. Acquired results between BMI categories and total FI median score: crude and adjusted data from logistic & multivariable logistic regression.

BMI[a]	Coefficient	SE	*p* Value	95% CI	Unique chi square	Model chi square[c]
Total FI[b]	−0.069	0.03	0.007	−0.121 to −0.0187	0.0073	–
Gender	−0.071	0.03	0.007	−0.122 to −0.020		0.016
Age[d]	−0.076	0.03	0.004	−0.127 to −0.025		<0.001
Inactivity[e]	−0.076	0.03	0.004	−0.127 to −0.024		<0.001
Total energy	−0.046	0.03	0.089	−0.098 to −0.007		<0.001

[a]BMI in three categories.
[b]Based on median value (above and below 34.5); first row depicts crude data. Rows below depicts the effect of each confounder in a stepwise approach.
[c]LRT tests for each factor shown as Chi square value.
[d]Age as a categorical variable (in three categories).
[e]Inactivity in quartile.

studied individually. Results obtained support the hypothesis that when ssb's are consumed in association with a low FI score, the probability for OW/OB in school-aged children increases. This is supported by researchers (Collison et al., 2010) that have reported poor dietary choices in individuals aged 10–19 years with a high intake of sugared sweetened carbonated beverages.

To further decrease subjectivity, a sensitivity analysis, *via* splitting the data into two new data sets (75–25%) *via* random sampling was performed upon FI validation by the GRECO study. This strengthened the power of the index to detect OW/OB children since the probability equation derived from the first data set was used to find the probability of OB in the second data set (25% random sample). The FI score was significantly lower among those OW/OB compared to normal or underweight children.

The index was kept simple, by including food items only, in order to be used easily as a tool by trained health care professionals. To date only five other researchers, to our knowledge have addressed school aged children (Feskanich et al., 2004; Lazarou et al., 2011; Manios et al., 2015; Serra-Majem et al., 2004) and only two have derived scores with primary objective to assess OW and OB (Lazarou et al., 2009; Manios et al., 2015).

A scale of 1–4 was used with a weighting system in order to increase its discriminating power. It is reported that indices that have a small scoring scale appear to be less sensitive in their evaluation of dietary intake and fail to capture extremes and intrinsic characteristics of food behaviors and eating patterns (Wirt & Collins, 2009; Waijers et al., 2007), whereas indices with a larger scoring system are more sensitive in detecting small

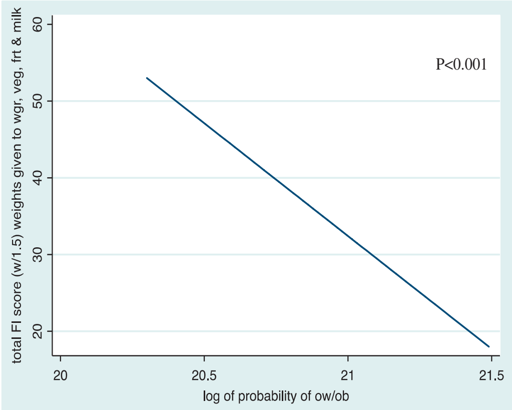

Figure 1. The log probability of children being overweight/obese versus the total weighted FI score.

changes in eating habits, and may allow the score to better discriminate individual intake unfolding internal variability (Waijers et al., 2007).

Results of the present study indicate that as the FI score increases, the probability of a child being OW/OB decreases. In all child-based indices all individual variables are given the same weight, therefore contribute equally to the score. Since this is the first time to our knowledge, that weights are given to food items, and since the exact ''health'' impact is difficult to ascribe, the weights given may be underestimated, hence further under-estimating the probability of a child being OW/OB. Research specifically testing the risk ratio (RR) of the individual index components on OB may be warranted in order to determine more specifically the exact differences in weights of each individual component in the index.

When inactivity, age and gender were controlled for the association increased, and remained statistically significant, in support to other research findings (Feskanich et al., 2004; Lazarou et al., 2011; Manios et al., 2015; Serra-Majem et al., 2004). When energy intake was controlled for, the association between BMI and FI seized to be significant. This is in discordance with Golley et al. (2011), although the FI (DGI-CA) used was not specifically derived to assess OW/OB. It has been suggested that energy may be a mediator in the causal pathway (Mozaffarian et al., 2011), and should therefore not be adjusted for. It should also be underlined that children's energy needs are related to their growth and activity level, a difficult variable to measure, and may therefore lead to misclassification if controlled for. This is strengthened by the fact that Feskanich et al. (2004), found no relationship between energy intake and BMI in children, results opposite to the ones observed in adults. No upper cut-off levels were therefore used for protective foods when deriving this FI, unlike Manios et al. (2015). Total FI score remained statistically significant even when inactivity was accounted for as reported by other authors in the same population (Feskanich et al., 2004). Physical activity is hard to measure accurately, if not actually monitored in a strict fashion, therefore a proxy measure of inactivity, including average total screen time and study hours per week, was used. This has been accepted and used by many other researchers to increase the precision of the model used in the analysis and decrease residual confounding (Berkey et al., 2003; Feskanich et al., 2004). Furthermore, research designed specifically to assess the effect of inactivity on BMI on school aged children have found a significant increase in BMI for boys and girls, aged 9–14 years, with increased screen time and caloric intake in a year period (Berkey et al., 2000, 2003).

It has been speculated that too much fiber may decrease iron availability, with iron deficiency (ID) being a concern in children (Manios et al., 2015), when all grain products consumed are whole wheat. Under normal conditions, it is difficult to exceed the recommended AI for fiber in children (14 g per 100 kcal intake), considering that one slice of whole wheat bread contains approximately 2 g of fiber, and children are recommended to consume between 4 and 6 portions of grains and cereals. Fruits and vegetables also provide fiber but this is within a range of 1–2 g of fiber per serving, maximum, whereas pulses and nuts are not consumed daily. It is evident that in order to meet the recommended AI for fiber, most servings, if not all should be whole wheat.

Although, APA recommends that all children over 2 years old should consume low fat dairy products, the distinction has not been made in this FI, since cheese, a high fat dairy product, was added to the «harmful foods». Furthermore, two cohort studies in young children (Scharf et al., 2013) and adolescents (Berkey et al., 2005) showed that children or adolescents consuming low fat milk had a similar increase in body weight as those consuming full fat. Refined grains were omitted since they are counterbalanced with whole grains. Alcohol was not accounted for due to the age of the population studied. Total fat content and other macronutrients were not separately assessed since the food as a whole, and how these interrelate, and not specific macronutrients, was investigated. This further simplifies the providing an easy tool for use to health care professionals.

Measurements were performed by trained personnel and substantial equipment, decreasing reporting bias, which can decrease the size and reliability of the evidence. Under-reporting of total food intake by children with weight problems or those who were weight concerned, is always a problem. This was accounted for in the analyses where implausible data (>6000 kcal, or <600) were excluded.

Limitations

Behavioral factors, which have also been greatly studied, have been associated with childhood OW and OB, and have been used in other food indexes (Feskanich et al., 2004; Lazarou et al., 2011; Manios et al., 2015) were not accounted for in this FI, since the major difficulty is assessing the food interrelationship and how this may affect children weight status and adiposity. Based on the results of food intake on body weight the effects that behavioral factors exert, can be determined by adding these to the basic model.

The GRECO study is a large cross-sectional study, it does not provide longitudinal data to evaluate whether normal weight children with low FI become OW over time. Also reverse causality and random errors in measurement of self-reported are types of bias that may affect cross-sectional studies in general since not all confounders can be fully excluded. In this case however, this seems unlikely, since it is unlikely that OW and obese individuals had a lower FI than normal weight individuals due to reverse causality or random error, since due to their weight status and their age they would be prone to eat and/or report healthier food choices, leading the results towards null. An underestimation of true association (bias) would result, meaning that the FI created may be even stronger in detecting child ow/ob if these probable errors are further accounted for. Furthermore, cross-sectional studies, developed reliably with a large sample size, as in the case of GRECO study, that minimize bias and adjust for confounders can show substantial results.

The FFQ used to assess children's dietary habits and intakes in general had a total of 48 questions, with some sub-questions. This may have been overwhelming for a child, therefore leading to reporting bias. However, the FFQ was based on seasonal variability and any discrepancies viewed were either tailored back to the child by a trained professional or were cleaned from the data prior to analysis (i.e. implausible energy intake >6000 kcal). The age group studied affects the results derived since food/nutrient recommendations differ based on their growth and overall needs. Although, food portions and not portion sizes have been used, care must be taken when using this index since it has been specifically been derived for school aged children.

Conclusion

The application of food indexes in children is limited and those that have been applied have mostly aimed on assessing diet quality. It is this population that sets the basis for many weight and health related problems later in life, therefore it is the childhood population that researchers should focus on in a greater degree, considering the world-spread OW problem in children, if the goal is to achieve primary prevention. A diet score, therefore, that will potentially assess OW/OB in children was warranted. Unlike most previous studies this FI was created to specifically detect OW and OB, and not healthy eating habits, with the scoring method being based on age and gender recommendations when these were available and were not population driven. Hence, generalizability of the index would be possible as well as comparison of results. The FI created as tested, shows promising results in detecting this epidemic. More research is warranted on the «weights» that foods should be given in order to further increase the sensitivity of the index.

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Supplementary material available online
Supplementary File S1

PAPER II

Magriplis, E., Farajian, P., Risvas, G., Panagiotakos, D., & Zampelas, A. (2016). Childhood overweight & obesity predicted by specific food pattern, sleep and study duration: Results from the GRECO study (Submitted manuscript in the International Journal of Public Health).

Title Page

Childhood overweight & obesity predicted by specific food pattern, sleep and study duration: Results from the GRECO study

Running Title: Food Index, eating behavior, sleep & childhood overweight

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"Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Heraclitus II. Investing in knowledge society through the European Social Fund.

Abstract
Objectives To assess the effect of dietary and behavioral factors on childhood overweight (ow) and obesity (ob) epidemic and assess the predictive ability of a child derived Food Index (cdFI) of children's weight status, when total sleep, study and screen time are addressed.

Methods Study included Greek school-aged children (n=4308) from the GRECO study, a cross-sectional survey. Participants self-reported behavioral habits and dietary intake, using a semi-quantitative food-frequency questionnaire (FFQ). Anthropometric data were measured. Multiple linear and logistic regressions were performed, adjusting for age and gender.

Results The cd-FI was positively associated with sleep, family meals and study hours, and was inversely associated with screen time, eating out and eating while on some screen. Cd-FI's predictive ability of children's weight status remained significant in the total sample (-0.45; 95%CI -0.77, -0.14) and among females (-0.58; 95%CI -1.02, -0.15). Sleep (-8%) and study hours (+6%) were significantly associated with the likelihood of a child being ow or ob.

Conclusion In order to decrease this global public health burden, interventions might need to address dietary patterns via cdFI, sleep and study hours.

Introduction

Almost two decades ago, researchers reported that the prevalence of child obesity was high and has since been studied as a potential public health burden (Birch and Fisher 1998). To date, although many studies have associated childhood overweight (ow) and obesity (ob) with environmental, dietary and behavioral risk factors (Birch and Fisher 1998; Birch and Davison 2001), the phenomenon persists and the reasons are not well understood.

Acknowledged child obesogenic factors include (1) diet & unhealthy eating patterns (Magriplis et al. 2015; Kleisser et al. 2009), (2) television (TV)-viewing and (3) sleep duration (Cappuccio et al. 2008; Chen et al. 2008). TV-viewing has been used as a proxy measure to inactivity and is the behavioral variable most examined, linked to poor health outcomes and unhealthy weight gain (Gable et al. 2007; Martinez-Gomez et al. 2009; Grøntved et al. 2014). The effect of total screen time, however, which is an increasing trend among children (Falbe et al. 2013), including TV and other media types, on weight status is limited. Another inactivity factor that has been suggested (Farajian et al. 2014; Magriplis et al. 2015) includes total study hours. This variable has not been extensively investigated to our knowledge, and is a factor that may need to be accounted for in school-aged children, since it adds to total inactivity hours.

Behaviors secondarily associated with TV-viewing and eating patterns, have also been investigated in relation to children's BMI including frequency of eating while watching TV, total meals per day, frequency of eating with other family members and frequency of eating out (Dubois et al. 2008; Gable et al. 2008). Short sleep duration has been linked to increased risk childhood obesity by 58% to 89% (Cappuccio et al. 2008; Chen et al. 2008). Unhealthy food patterns associated with TV-viewing (Lazarou and Soteriades 2010) and sleep duration have been reported (Nedeltcheva et al. 2009; Kjeldsen 2014; Golley et al. 2013), including high fat & sugars and low fruit & vegetable intake.

The heterogeneity in dietary behaviors makes it difficult to provide an evidence-based association between BMI status and child-behaviors in relation to dietary intake (Te Velde et al. 2012). Dietary and behavioral factors, therefore, have been mostly investigated separately. The use of a previously validated child derived Food Index (cdFI), designed to predict child OW & OB, can account for diet heterogeneity. A study that incorporates all these factors can provide a greater understanding on the reasons behind the child epidemic.

The objective of the study was therefore to examine the association of known obesogenic behavioral factors with a child derived dietary pattern and how these are related children's weight status when addressed together. The study addressed and total studying hours in addition to total screen time as proxy measures to inactivity. To the best of our knowledge, a study that examines the effect of sleep duration, total screen time, total study hours, and other eating behaviors, on children's weight status in association with a previously validated dietary pattern, designed to detect childhood OW&OB, has not been reported.

Methods

The study was carried out from October 2008 to May 2009, from the whole district of Greece, via stratified sampling scheme weighted by age, sex, and region, according to the population distribution (National Statistical Services, 2001 census). Precise details on the stratification scheme have been previously published (Farajian et al. 2013). The number of children required to increase the power of the study to 85% (5% type I error) was considered prior to the study with odds ratio (OR) evaluated to equal 1.10. The study included a random sample of 117 schools from 10 selected regions, with a total of 5000 children aged 10-12 years old, studied. A participation rate of 85% was achieved. After data inspection, a total of 452 children were excluded; 117 children had all data missing; 95 children had left unanswered over 20% of the FFQ (>=10 questions); and 240 individuals had reported implausible energy intake (<600 kcal/day or >6000kcal/day). The present study was conducted in accordance with ethical principles and guidelines laid down in the Declaration of Helsinki. The Agricultural University of Athens research committee approved procedures as well as the Hellenic Ministry of Education (Department of Primary Education) as the law provides in Greece for any studies conducted at school during formal working hours. All children, teachers and primary caregiver were informed of the aims and study procedures, and primary caregivers, usually parents, were asked to sign consent forms.

Questionnaire

The questionnaire was split into two sections. The first section contained descriptive information, including age, gender, anthropometric measurements, and questions relating to behavior & activity. The second section contained a 48 item, previously validated, picture aided Food Frequency Questionnaire (FFQ) (Farajian et al. 2011). The FFQ was self-administered and was used to construct the validated childhood derived FI, designed to predict child OW&OB (Magriplis et al. 2011).

Behavioral data were obtained on total screen time, hours of sleep, eating behaviors and hours of studying. Total study-hours were assessed by averaging hours reported over weekdays and weekends.

The questionnaire was structured to provide information on overall screen time during weekdays and weekends, separately. Total screen time was defined as the amount of time spent watching TV, playing videogames and computer in hours per day. Children reported how much time they spent on screen (TV/DVD/computer/games) on a typical school day (Monday to Friday) and on a typical weekend (Saturday and Sunday). Average reported hours per weekday and per weekend were summed and divided by two (2) to create an average viewing of hours per day. Implausible screen hours, defined as: >120 hours per week in accordance to Falbe et al. (2013) were not reported and therefore no children were further excluded from the sample.

Children were asked to record the time they went to sleep at night and the hour they usually wake up, during weekdays and weekends. Total hours of sleep were then mathematically calculated for weekdays and weekends. The two were averaged in order to obtain total hours of sleep per week.

Eating Behavior

The questionnaire included questions on various eating behaviors, including number of meals per day, frequency of having meals while on a screen (watching TV, DVD, playing video games/consoles, using computer), frequency of having family meals with family members, and frequency of eating/ordering out. Response categories for the former two behaviors, ranged from 1 to 6 times a day. The latter three behaviors had the following response options: Everyday, 5-6 times/week, 3-4 times/week, 1-2 times/week, and seldom/never.

Anthropometric Measurements

Anthropometrics gathered included measurements by trained personnel, on body weight (kg) to the nearest 100 g (Tanita TBF 300), wearing light clothing, body-standing height without shoes (Leicester height measure) to the nearest 0.1 cm, and waist circumference to the nearest 0.1 cm (Seca, non elastic tape, Germany). Body mass index (BMI) was calculated by dividing weight (kg) by standing weight squared (m^2). Detailed information on sampling and measurements has been already published (Farajian et al. 2011). Children's BMI cutoffs were defined based on International Obesity Taskforce (IOTF) standards (IV) (Cole and Lobstein 2012). Details on sample categorization have been published (Magriplis et al. 2015).

Food Index

A total of 14 foods, categorized as positive - non-obesogenic or negative – potentially-obesogenic foods, were included in the cdFI, based on a priori knowledge of food items and food patterns for children. Specifically the cdFI included eight (8) positive - non-obesogenic foods: fruit, vegetables, whole grains, fish, nuts, legumes/pulses, milk and yogurt; and six (6) negative – potentially-obesogenic foods include: cheese, red meat, sugared sweet beverages (ssb's), processed food, fast food, and sweets. The cdFI was validated and its sensitivity of detecting ow and ob prediction was tested by randomly splitting the study sample (75%-25%). A detailed description of the cdFI score derivation has been previously published (Magriplis et al. 2015). Theoretically a minimum of 16 to a maximum of 64 was the range of total FI score the children could achieve. This index was purely food based in order to understand how dietary patterns may predict child ow/ob risk.

Statistical Analysis

Descriptive statistics, including frequencies, means, range (minimum, maximum) and standard deviations were calculated for all continuous study variables. Chi-square tests were used for categorical variables in order to assess gender differences and Student t-test for mean differences between normally distributed variables.

All continuous variables were assumed to follow a Normal distribution according to the central limit theorem, due to the large sample size. Scatter plots and studentized residuals were used to detect outliers.

The influence of behavioral variables on the relationship between cdFI score and child BMI was assessed via multiple linear regression. BMI was used as an indicator variable in this model, distinguishing OW & OB children from normal weight peers. The model included total sleep time, screen time, study-hours and other behavioral variables stated, and was adjusted further adjusted for, age and stratified by gender. Variance inflation factor (VIF) was performed to test the independency of the variables and avoid collinearity.

Total cdFI score, was further split into quintiles and box plots were used to assess variable distribution by upper and lower FI split into the lower 2 quintiles (Q1&Q2) and the upper 3 quintiles (Q3-Q5) and graphed by gender.

Univariate and multiple logistic regression analysis was used to examine the relationship between child's weight status and the multiple explanatory variables viewed in this paper. Odds ratios (OR) with their corresponding 95% confidence intervals (95% CI) of crude and adjusted results are presented. Likelihood Ratio test (LR test) was used to test the significance of the model. All reported P-values were based on two-sided hypothesis tests, with significance level at 5%. The statistical models were computed using STATA 12.0 (STATA corp. Texas)

Results

The basic total and gender specific characteristics of the study population are shown in Table 1. Mean values along with their standard deviation (SD) are depicted for continuous variables, and frequencies with percentages presented for, categorical variables. Significant gender differences in anthropometric measurements were found in the means values for height, age, waist-circumference (wc) and BMI. BMI categories, as per IOTF standards, did not significantly differ (p=0.091).

Gender differences were also found in sleep duration, total screen and study time, frequency of eating while watching TV per day, in family meals and frequency of eating out on a weekly basis.

The multiple regression model was statistically significant (p<0.001). The total cdFI score was well predicted by all explanatory variables in the model, other than meals per day (Table 2). Ow and ob children had a lower cdFI score, compared to their normal weight peers (-0.45 (0.16) 95% CI -0.77, -0.14), when the mean of the other variables was kept constant as seen in Table 2. Total screen time (-0.34 (0.05) 95% CI -0.45 -0.24), frequency of eating while on some screen (-0.25 (0.07) 95% CI -0.4 -0.11) and frequency of eating/ordering out (-0.83 (0.09) 95% CI -1.01 -0.65), decreased as cdFI score increased. Sleep duration (0.13 (0.05); 95% CI 0.03 0.24), total study hours (0.22 (0.06) 95% CI 0.09 0.34), and frequency of having family meals per week (0.27 (0.06) 95% CI 0.15 0.38) increased as cdFI increased. Significant gender differences were found in BMI status, total sleep time and total study hours.

Mean BMI was lower among children scoring at the upper quintile range compared to the lower 2 quintiles (p=0.03), with mean BMI being 0.25 units lower in children scoring at the upper quintile range versus the lower 2 quintiles.

The box plot (Figure 1) presents in detail the distribution of behavior variables in respect to the cdFI. Total screen hours per day were lower in both genders, while the median for sleep duration was significantly higher in males but not females, among children scoring at the upper 3 quintiles. An increasing trend across the FI quintiles was found for total sleep and study hours. A decreasing trend was observed for total screen time and BMI (data not shown). Boys in the upper quintiles, but not girls, reported more study hours.

In Table 3, results from univariate and multiple logistic regression are depicted of behavioral variables and FI score on children's weight status. All crude explanatory variables were significantly associated with children's weight status. When entered in the model as shown in the table, the effect of total screen time was nulled (OR: 1.04; 95% CI: 0.99, 1.08).

Age was also significant in the model; the higher the age the less likely the overweight (22%) risk, whereas gender was not. The Likelihood Ratio test performed for the model as a whole was significant ($p<0.001$).

Discussion

The study investigated the effect of a dietary pattern with obesogenic eating and behavioral factors on children's weight status, using a previously validated cdFI developed to predict child ow and ob (Magriplis et al. 2015). Results showed that sleep, screen, frequency of family meals, frequency of eating out, and frequency of eating while watching TV, adjusted for age, are associated with cdFI and significantly increase its predictive ability of childhood ow and ob. Also, when cdFI is accounted for and kept constants, the likelihood of children being ow or ob decreased when they slept more, studied less, had a higher FI score, had more frequent family meals and consumed more meals per day. In this study, for each hour increase in total study hours the likelihood of child ow and ob increased by 6%, while with each hour of sleep duration the likelihood decreased by 8%. Meals per day, and frequency of family meals were also significant to BMI status. Crude total screen time was significantly associated with increased odds of ow or ob in children, but the effect was nulled in the model that included cd-FI and total study time. Study time is a new inactivity factor that was accounted for, and has not been extensively studied.

In more detail, the association of weight status and total cdFI score was evaluated while keeping behavioral and eating variables constant, in a multiple linear regression model. This was done to examine the association of these obesogenic behavioral variables on the cdFI, since the latter was derived to predict ow and ob in children (Magriplis et al. 2015) and it can be argued that behavioral factors may decrease its sensitivity if not accounted for. Results indicated that it's predictive ability increased. The expected FI score was 0.45 units lower among overweight and obese children compared to their normal weight peers in the adjusted model compared to 0.057 when eating and behavioral factors were not accounted for, as has been previously published (Magriplis et al. 2015). This association was significant in the total sample and for females, whereas not in males. Moreover, the model was not altered when physical activity was included (data not shown) hence was not accounted for, to decrease risk of over-adjusting, and in order to maintain the model simple.

When seen in relation to behavioral factors and BMI was kept constant, cdFI score was inversely associated with total screen time and positively associated with sleep duration and total study hours. Child derived FI decreased by 0.33 for every hour increase in screen time, whereas with every extra hour children slept or studied the total cdFI increased by 0.15 and 0.21 respectively. Other researchers have also found sleep and food intake relations with Hart et al. (2013) reporting lower food intake among children that increased sleep duration, and Kjeldsen et al. (2014) reporting that short sleep duration may be associated with poor-obesity promoting diet in children upon adjusting for screen time and physical activity.

Moreover, it was found that the greater the mean frequency of eating while on some screen and eating out the lower the cdFI score, whereas more frequent family meals resulted to a significantly higher cdFI. Total meals per day did not affect the score. Some associations differed between genders, with cdFI score being significantly lower among ow and ob girls but not boys, and higher in boys that reported to sleep and study more, but not in girls. This may partly be explained by significant wc differences observed between genders, by reported mean behavioral differences, seen in Table 1, and/or due to psychosomatic gender differences.

Distribution plots of behavior variables among children with a cdFI score at the upper 3 quintiles versus those scoring at the lower 2 quintiles were performed to assess the distribution of the whole sample. Total screen time distribution significantly differed, irrespective of gender, with children at the upper 3 FI quintiles, reporting less screen time, and the range on total sleep hours was larger among boys.

In contrast with other researchers (Borghese et al. 2014; Mitchell et al. 2013; Fuller-Tyszkiewicz et al. 2012), the effect of total screen time on children's weight status was not significant when entered in a multiple logistic regression model. In support to our findings, studies have also found an inverse association of specific dietary patterns and TV-viewing (Sisson et al. 2012) or total screen time (Lazarou et al. 2011). Furthermore, Dubois et al. (2008) did not find an association between watching TV and BMI status, but reported an association between a child's BMI and the frequency of eating while watching TV. Researcher have also related screen time or "TV-viewing" with elements of a less healthy diet supported by this study which associates total screen time with a lower cdFI. In more detail, children with greater TV or screen time were found to consume less fruit and vegetables (Lipsky and Iannoti 2012; Gebremariam et al. 2013; Pearson et al. 2014), more fast food (Lipsky and Iannoti 2012; Borghese et al. 2014; Pearson et al. 2014, more energy dense food, drink more sodas, and have a higher energy intake (Campbell et al. 2006; Utter et al. 2006; Dubois et al. 2008); foods that are included in the cdFI. These findings may suggest that the types and quantity of food, and the frequency that children eat while watching TV, and not total screen time, may be the factors leading to ow and ob. This is further supported by Olafsdottir et al. (2014) that found that the likelihood of consuming sweetened beverages increased with TV total hours but also by commercial exposure.

The effect of total study time, remained significant, and was inversely associated with an increased likelihood of children being ow or ob. Study hours were negatively associated with children's BMI status, as has been shown by Farajian et al. (2014) in a simpler model, but positively with total cdFI score. The mechanism behind this association is not clear since to date study time has not been well studied, although it seems that study time greatly increases total inactivity time. From these study's results study time seems may be related to BMI status via a larger food intake and not only via an obesogenic dietary pattern. More studies evaluating similar child age populations may increase the understanding behind this new potential obesogenic factor.

It must be underlined that in contrast to our study that examined total screen time, most studies have assessed TV-viewing in relation to the child overweight epidemic (Fuller-Tyszkiewicz et al. 2012; Mitchell et al. 2013; Borghese et al. 2014). This along with the incorporation of total study time as an extra inactivity variable that children accommodate in their daily lives may explain the different results obtained in relation to other researchers. By assessing total screen time other media types, including gaming, tablets and computer use were assessed, accounting for the decrease in TV viewing time that has been reported and the increase in other media types (Falbe et al. 2013), and therefore strengthening the results of the study.

Although no causal associations can be drawn due to the cross-sectional nature of the study, the study's large sample size, balances this limitation, since it can be analyzed as a case control study, therefore inferences can be drawn. Also, although, behavioral data were self-reported, hence prone to reporting bias, graphs were plotted to investigate extreme outliers that may affect results of the study. Potential errors in reported food intake were also accounted for by assessing the sensitivity of the cdFI, when the latter was developed, through random sampling.

In this study, BMI and behavioral factors were viewed in accordance to the child derived FI score, that includes the most recent data on healthy and potential obesogenic foods. Using a previously validated cdFI for children strengthens the results of this study, since it is an index designed to detect ow and ob and because heterogeneity of the diet, a problem in comparing study results, is accounted for. These results underline that behavioral and specific dietary patterns need to be addressed together in order to control unhealthy weight gain in children.

To further strengthen the study's results, steps were taken from the design phase to decrease bias and random errors. The sample was randomly sampled, as stated in methods, from the whole region of Greece therefore selection bias was limited. Trained personnel measured weight and height, reducing measurement error. During the analysis stage, steps were taken to avoid bias and confounding. Statistical tests (vif) were run to assess collinearity and assure that pairs of variables provide independent information of predicting the cdFI score.

By performing a separate univariate logistic regression for each independent variable in the beginning, we investigated confounding and provided an initial «unadjusted» view of the importance of each variable by itself. The LR test was used to test the strength of the logistic model used. This was significant, demonstrating that the independent variables entered in the model were related to children's weight status and increased the model's likelihood of predicting child ow and ob.

Although the temporal effect of this association can not be determined due to the nature of the study, health professionals can use this information to add to their research strategies and implementations since this is the first study to our knowledge to have studied the relationship of ow and ob in children in relation to known obesogenic behavioral factors in relation to a childhood derived FI score.

Conclusion

This study reveals that behavioral and specific dietary patterns contribute to the child epidemic but total screen time, and not TV-viewing, as well as total hours of study need to be accounted for when evaluating children's inactivity state and how this may affect weight status. Sleep duration and specific eating patterns need to be addressed as well in relation to the cdFI score. Gaps remain, however, in the mechanism of action, gender differences and the potential temporal effects. Results of this study suggest that public health prevention programs and other intervention studies, aiming to reduce or prevent the OW childhood epidemic should target a cluster of behaviors and eating patterns, while accounting for probable gender differences and although life changes may have occurred the past years in Greece the results of this study should not be disregarded by public health officials.

Conflict of Interest

The authors declare that they have no conflicts of interest. AZ has received a consultancy fee from Coca Cola Company post study completion.

Compliance with ethical standards

Ethical Standards The Agricultural University of Athens research committee approved procedures as well as the Hellenic Ministry of Education (Department of Primary Education) as the law provides in Greece for any studies conducted at school during formal working hours. Data protection regulations were observed in the survey. Signed informed consent was obtained from main caregiver prior to enrolling the children in the study.

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Table 1: Participant Characteristics including continuous (mean) and categorical variables (%)

	Total	SD	Boys	Girls	P-value [c]
Child Characteristics					
Age (years)	10.9	0.74	10.96	10.88	<0.001[d]
Height (m)	1.50	0.08	1.49	1.5	<0.001[d]
Weight (kg)	45.7	10.86	45.7	45.69	0.971[d]
Waist circumference (cm)	68.6	9.6	69.8	67.4	<0.001[d]
BMI (kg/m^2)	20.24	3.74	20.37	20.13	0.034[d]
BMI category [a,b] (%)					
Under- & Normal weight	58.36		56.93	59.72	0.091[e]
Overweight	29.71		30.18	29.26	
Obese & morbid obese	11.93		12.89	11.02	
Total cdFI score	34.81	5.01	34.93	34.7	0.069[d]
Self reported sleep time (hours/day)					
Total sleep time	9.1	1.5	8.9	9.3	<0.001[d]
Weekdays	9.0	8.9	8.8	8.9	<0.001[d]
Weekends	9.9	1.5	9.6	10.3	<0.001[d]
Self reported screen time (hours/day)					
Total screen time	2.41	1.56	2.52	2.31	<0.001[d]
Weekdays	1.99	1.38	2.0	1.98	0.576[d]
Weekends	2.96	2.11	3.18	2.76	<0.001[d]
Self reported study time (hours/day)					
Total	2.61	1.3	2.47	2.76	<0.001[d]
Weekdays	2.61	1.27	2.44	2.78	<0.001[d]
Weekends	2.71	1.67	2.6	2.82	<0*001[d]
Meals per day [b] (%)					
1	10.62		11.02	10.25	0.088[e]
2	20.97		21.99	20.0	
3	31.45		31.49	31.42	
4	23.06		22.23	23.84	
5	10.55		9.54	11.51	
6	3.34		3.72	2.98	

Eat while watch TV or other screen [b] (%)				
0 meals/day	20.0	22.6	17.6	<0.001[e]
1 meal/day	43.0	40.2	45.7	
2 meals/day	22.7	22.5	22.8	
3 meals/day	9.7	9.7	9.8	
4-6 meals/day	4.6	5.1	4.1	
Family meals [b] (%)				
Never-rarely	6.0	5.34	6.63	0.017[e]
1-2 times/wk	20.22	20.0	20.43	
3-4 times/wk	18.08	19.67	16.58	
5-6 times/wk	14.75	15.41	14.11	
every day	40.95	39.57	42.25	
Ordering Eating out [b] (%)				
Never	8.65	8.36	8.96	0.02[e]
1-2 times/month	58.3	60.61	55.86	
1 time/wk	21.68	20.7	22.71	
2 times/wk	8.77	8.32	9.25	
3-6 times/wk	2.04	1.54	2.57	
every day	0.55	0.47	0.64	

BMI, Body Mass Index; cdFI, child derived Food Index

[a] BMI categorized as per IOTF (International Obesity Task Force) standards

[b] categorical variables, depicted with frequencies and percentages in ()

[c] Significant at 0.05 level, compared by gender

[d] Tested via Student t-test

[e] Tested via chi-square test

Table 2: Linear Regression of total FI score, BMI† and Behavioral Variables, stratified by gender

	Total		Males		Females	
cdFI total score	β-coefficient	95% CI	β-coefficient	95% CI	β-coefficient	95% CI
BMI[a]	-0.45 **	-0.77, -0.14	-0.34	-0.8, 0.12	-0.58 **	-1.02, -0.15
Total sleep time (hrs/d)	0.13 *	0.03, 0.24	0.237 **	0.09, 0.39	0.03	-0.13, 0.18
Total screen time[b] (hrs/d)	-0.34 ***	-0.45, -0.24	-0.2 ***	-0.43, -0.14	-0.42 ***	-0.5, -0.26
Total study hours[c] (hrs/d)	0.22 ***	0.09, 0.34	0.26 **	0.09, 0.44	0.17 *	0.01, 0.34
Eating while watching TV-other screen [d]	-0.25 ***	-0.4, -0.11	-0.105	-0.31, 0.1	-0.4 ***	-0.61, -0.19
Meals per day [d]	0.02	-0.11, 0.14	-0.04	-0.23, 0.15	0.05	-0.12, 0.22
Family meals[e]	0.27 ***	0.15, 0.38	0.3 ***	0.12, 0.47	0.25 **	0.09, 0.4
Order / Eat out[e]	-0.83 ***	-1.01, -0.65	-0.79 ***	-1.04, -0.53	-0.86 ***	-1.12 -0.6
Age	-0.36	-0.57, -0.15	-0.49	-0.79, -0.18	-0.16	-0.45, 0.13

OW, overweight children; OB, obese children; cdFI, child derived Food Index; BMI, Body Mass Index; hrs/d, hours per day

[a] OW&OB children relative to Healthy weight children (reference level); BMI used as an indicator variable

[b] Measured as total screen time, in hours/day, including TV-viewing, pc and video games

[c] Measured as total studying, in hours/day; used as a proxy for other sedentary times

[d] Frequency per day: 1 to 6 times per day

[e] Frequency per week: Never-rarely, 1-2 times/wk, 3-4 times/wk, 5-6 times/wk, every day

Values were significantly different between the reference level and other levels within a given characteristic: * P<0*05; ** P<0*01; *** P<0*001

Table 3: Crude and Adjusted Logistic regression analysis of children's weight status in relation to FI score and other behavioral factors

BMI (kg/m^2)	OR[a]	95% CI	OR[b]	95% CI
cdFI total score	0.98	0.97, 0.99	0.98	0.97, 0.99
Total sleep time (hrs/d)	0.91	0.88, 0.95	0.92	0.88, 0.96
Total screen time[c] (hrs/d)	1.05	1.01, 1.1	1.04	0.99, 1.08
Total study hours[d] (hrs/d)	1.05	1.01, 1.1	1.06	1.01, 1.12
Meals per day [e]				
1-3 meals/day	Reference		Reference	
4-6 meals/day	0.84	0.74, 0.95	0.86	0.75, 0.97
FamilyMeals per week [f]				
1-3 f. meals/wk	Reference		Reference	
4-6 f. meals/wk	0.83	0.73, 0.94	0.84	0.74, 0.95
LRtest for model	p<0.001			

OR, Odds Ratio; CI, Confidence Interval; BMI, Body Mass Index; cdFI, child derived Food Index; LR test: Likelihood Ratio test

[a] Crude odds ratios; Reference baseline category: healthy weight children

[b] Adjusted Odds ratios for all variables in the model as shown in the table including age and gender

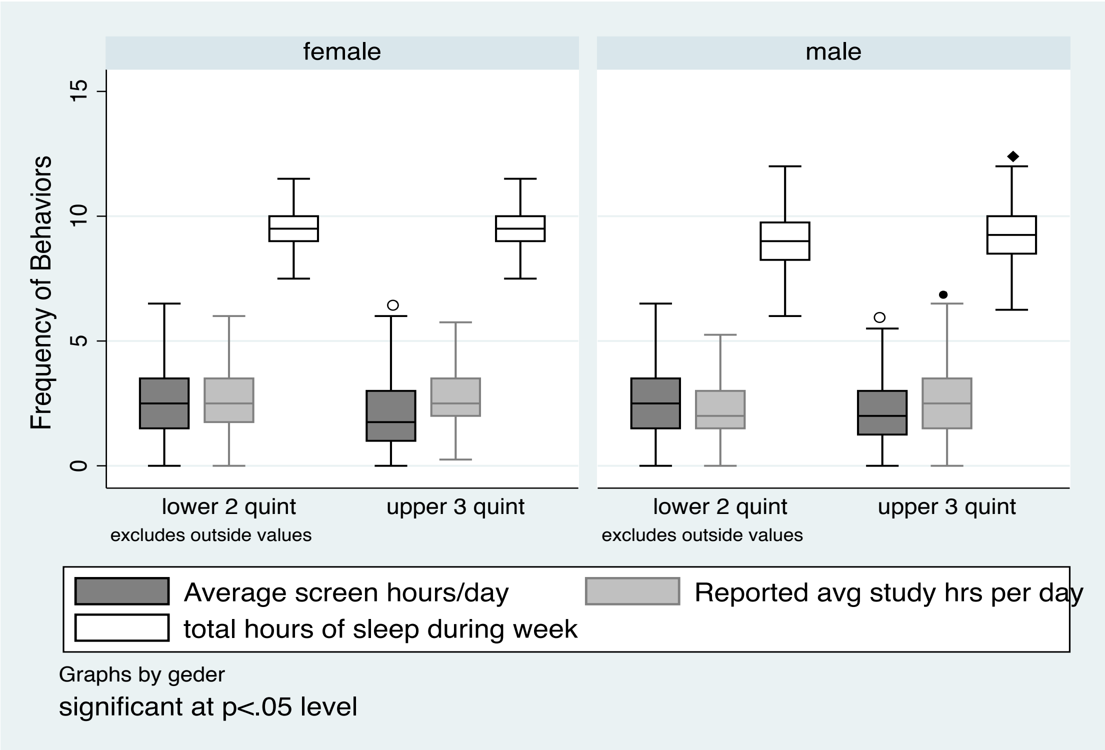
[c] Measured as total screen time, in hours/day, including TV-viewing, pc and video games

[d] Measured as total studying, in hours/day; used as a proxy for other sedentary times

[e] Meals per day in two categories

[f] FamilyMeals per week in two categories

Graph: Children's Sleep, Screen and Study hour distribution by FI quintile level



PAPER III

Magriplis E., Farajian P., Panagiotakos DB., Grigoris Risvas, Zampelas A. (2016). Maternal smoking and school children's weight status: investigating Early Life Theory from the GRECO study. (Submitted manuscript in the Maternal & Child Nutrition)

Title

Maternal smoking and school children's weight status: investigating Early Life Theory from the GRECO study

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Abstract

Overview: Based on the Early Life Theory Maternal smoking may be a factor affecting child weight status, adiposity level and blood pressure, later in life.

Objectives: To examine the effect of maternal-smoking on school children's weight status, as defined by the International Obesity Task Force (IOTF) BMI cutoffs, central adiposity, defined by waist circumference (wc), and total adiposity, measured with bio-impedance analysis (BIA). Secondarily, the potential association of maternal-smoking with children's blood pressure (BP) was investigated.

Methods: Data from 2017 parental questionnaires gathered during a national cross sectional study were used in the analysis. Anthropometrics variables and children's BP were measured. Dietary information was gathered via a semi-quantitative food-frequency questionnaire (FFQ). Multivariate logistic regression using 4 models and linear regression analysis was conducted, adjusting for multiple covariates.

Results: Mean birth-weight, BMI, total body fat, and wc of siblings of maternal-smokers were significantly higher compared to non-smokers. When adjusted, children of maternal-smokers were more likely to be overweight or obese compared to children of non-smokers (from 1.6 to 1.82) in all models used. Children of maternal-smokers were also more likely to have a larger waist circumference (1.73 to 1.85) compared to their peers of non-smokers. Total fat percentage was not significantly associated with maternal smoking in any of the models used. Systolic and diastolic blood pressure, were not significantly associated with maternal smoking either.

Conclusion: Maternal smoking was found to increase the odds of being overweight or obese and was associated with a higher adiposity level in school-aged children.

What is already known: Maternal smoking is associated with low birth weight babies and is likely to be associated with higher BMI among school-aged children. Gestational weeks are associated with birth weight. Childhood overweight is influenced by socioeconomic factors, behavior factors and dietary patterns.

What this study adds: Maternal smoking is associated with children's weights status, as per IOTF BMI categories, but it is also associated with a central adiposity. The association remained significant when maternal covariates were accounted for but remained so when 3 more models were used in an additive format, to address residual confounding i. caffeine and alcohol intake, ii. behavioral variables, shown to be associated with children's weight status, including, total screen, sleep and study hours, and iii. Child-derived food-index, and index created to detect childhood overweight and obesity. The above add to the strength of the association between maternal smoking and child weight and adiposity.

Introduction

The global epidemic of child overweight and obesity has been linked to an increased risk of chronic diseases in adulthood (Barton et al, 2012; Berenson et al, 2012). Based on the Early Life Theory, a great number of chronic diseases that occur later in life start from in utero fetal development (Barker et al. 1994), due to fetal adaptation in structure, physiology and metabolism (Bakker et al., 2011). Observational studies from 1990's reported a possible association between maternal smoking and children's BMI status later in life, with a high BMI prevalence found in children among mothers who smoked (Riedel et al., 2014). There is increasing evidence that child health and weight-status may be «programmed» from in utero life, with maternal smoking, one of the most modifiable factors linked to children's BMI status, blood pressure (BP) and cardiovascular disease (Law et al. 1996, Bakker et al., 2011).

These findings, however, remain controversial, since underlying mechanisms remain obscure and many researchers debate the strength of the "Early Life Theory" due to possible residual confounding by genetic and environmental factors, the latter including children's diet and behavior, with the former having a high heterogenic variation.

Researchers have found higher BMI and adiposity levels in children whose mothers smoked during pregnancy (Salsberry et al. 2005, Florath et al., 2014, Li et al. 2015), while other studies have associated childhood overweight and obesity with environmental, dietary (Kleisser et al. 2009, Magriplis et al, 2015) and behavioral risk factors (Birch and Fisher 1998; Birch and Davison 2001, Cappuccio et al. 2008, Grøntved et al. 2014). Limited studies have assessed the effect of maternal smoking on children's weight status adjusting for behavioral variables (Ino et al., 2011, Riedel et al., 2014) and dietary intake (Al Mamun et al., 2006).

In relation to blood pressure, researchers have found a higher mean systolic blood pressure (SBP) in young children whose mother smoked during pregnancy, compared to non-smokers (Law et al. 1996, Lawlor et al. 2004) but others have not confirmed these findings (Bergel et al. 2000).

The question therefore remains as to whether maternal smoking is associated with children's weight status, even when other known and modifiable obesogenic patterns factors are present. To our knowledge, no studies to date have addressed the effect of maternal smoking, on children's weight status and adiposity, as well as their blood pressure while addressing the potential effect of behavioral and dietary patterns, via a validated obesogenic food index (FI) on these associations.

The aim of the study, therefore, was to examine the effect of maternal smoking on school children's weight status, as defined by the International Obesity Task Force (IOTF) BMI cutoffs (Cole et al. 2012), and on total body fat percentage (%), while adjusting for the potential residual confounding effect of behavioral factors and dietary patterns via child derived FI (cdFI). Secondarily, the potential association of maternal smoking with children's blood pressure (BP) in relation to children's weight status and diet quality was also investigated.

Participants and Methods

Data from parental questionnaires given throughout the Greek Childhood Obesity (GRECO) study, a nationwide cross sectional study, were used in the analysis. The GRECO study was carried out throughout the district of Greece from October 2008 to May 2009, via stratified sampling scheme weighted by age, sex, and region, according to the population distribution (National Statistical Services, 2001 census). Precise details on the stratification scheme have been previously published (Farajian et al. 2013). The study included a random sample of 117 schools from 10 selected regions, with a total of 5850 children aged 10-12 years old, invited to participate. A participation rate of 85% was achieved, from children (4965), with valid information for 4547 gathered. Parents or children's primary care givers were also asked to complete a questionnaire about family characteristics, child behaviors, and dietary patterns. 2318 parental questionnaires were returned (51% of the working sample), with responders to maternal smoking question adding up to 2017 parents responded (44.4%) of the total child sample.

The present study was conducted in accordance with ethical principles and guidelines laid down in the Declaration of Helsinki. The Agricultural University of Athens research committee approved procedures as well as the Hellenic Ministry of Education (Department of Primary Education) as the law provides in Greece for any studies conducted at school during formal working hours. All children, teachers and primary caregiver were informed of the aims and study procedures, and primary caregivers, usually parents, were asked to sign consent forms.

Questionnaire

Children's questionnaire was split into two sections. The first section contained descriptive information, including age, gender, anthropometric measurements, and questions relating to behavior & activity. The second section contained a 48 item, previously validated, picture aided Food Frequency Questionnaire (FFQ) (Farajian et al. 2009). The FFQ was self-administered and was used to construct the validated childhood derived FI (cdFI), designed to predict child overweight and obesity (Magriplis et al. 2015), and was used in this study to adjust for children's dietary patterns. The index was purely food based in order to understand how dietary patterns may predict child overweight or obese risk by incorporating healthy and potentially obesogenic foods based on a-priory knowledge.

Behavioral data were obtained on total screen time, hours of sleep, eating behaviors and hours of studying. Detailed information have been previously been published by (Farajian et al., 2014). Eating behavior information were also obtained including, frequency of having meals while on a screen (watching TV, DVD, playing video games/consoles, using computer), frequency of having meals with family members, and frequency of eating/ordering out.

Anthropometric Data

Anthropometrics gathered included measurements by trained personnel, on body weight (kg) to the nearest 100 gr (Tanita TBF 300), body-standing height without shoes using a portable stadiometer (Leicester height measure) to the nearest 0.1 cm, waist circumference (cm) to the nearest 0.1 cm (Seca, non elastic tape, Germany), and body fat (%) to the nearest 0.1% was estimated by foot to foot biompedence analysis while standing (Tanita TBF 300). All measurements were performed morning hours and with children wearing light clothing. Waist circumference and estimated total body fat were reported as continuous values and then assessed as binary, based on the samples median value. Body mass index (BMI) was calculated by dividing weight (kg) by standing weight squared (m^2). Children's BMI cutoffs were defined based on International Obesity Taskforce (IOTF) standards (IV) (Cole and Lobstein 2012). Details on sample categorization have been published (Magriplis et al. 2015).

Parents or Primary health care givers characteristics

A parental questionnaire was attached with the consent forms and parents or primary care givers were asked to respond and return the questionnaire along with the consent forms. Of the total consent forms obtained, 2318 responded to the parental questionnaire (51% participation). Information on socio-demographic and socio-economic characteristics were inquired, including parents' age, weight, height, mother's age at pregnancy, mother's weight at pregnancy, weight gain throughout pregnancy, and education level. Parental weight status was classified by calculating BMI values (kg m^{-2}) for each individual from self reported data on weight and height.

Maternal smoking

Information on maternal smoking was inquired in the parental questionnaire. Parents were asked to report whether or not the mother smoked during pregnancy, and number of cigarettes smoked per day, defined as "none"; "1-9 cigarettes per day; "10-20 cigarettes per day"; and "≥20 cigarettes per day". Pre-conception smoking habits, using the same categories were also inquired. Data per smoking category were reported. Women were further categorized in two groups: (i) none-smokers if none was reported and (ii) smokers if >1 cigarette per day was reported for regression and logistic analysis.

Blood pressure

Blood pressure (BP) was measured in a single occasion within the schools' settings, using validated oscillometric devices (UA-787 oscillometric blood pressure monitor, A&D Company). The cuff used was chosen in order for the length of the bladder in the cuff to cover 80%-100% of the children's arm circumference. Prior to blood pressure measurements children were asked to be calm and were placed in a sitting position to rest for at least 10 minutes with their back supported. During BP measurement, children's right arm rested on a solid supporting surface at heart level. Two subsequent measurements were taken within a 5 minutes interval in order to familiarize children with the procedure. The second measurements of systolic BP (SBP) and diastolic BP (DBP) were recorded in mmHg.

In the absence of established criteria for children, and due to the fact that measurements were performed in the field, children were not classified normotensives or hypertensives. The distribution mostly of SBP, the BP that rises during childhood, and of DBP was examined, with appropriate adjustments made (i.e. height, gender and age).

Covariates

Several potential confounders on the basis of their potential association with maternal smoking during pregnancy and offspring's weight status or increase in BP, were examined. These included maternal age at childbirth, maternal weight and weight change during pregnancy, maternal education. Education was split to, (i) completed elementary school, (ii) did not complete secondary school, (iii) completed secondary school and (iv)completed further/higher education. Furthermore, information on alcohol intake and coffee intake during gestational period was also gathered. Women were asked to respond whether they consumed «none»; «1 unit/day»; or «≥ 2 units/day" of alcohol or coffee. Children's characteristics considered included, infant's birth weight (grams) and height (cm), age, gender, behavioral and dietary patterns.

Statistical Analysis

Kernel density plots were performed for all variables of interest, to observe distribution and the distribution of the independent variables was further compared for maternal smokers and non-smokers using box plots. Descriptive statistics, including frequencies (%), means (±sd), and medians for skewed data were calculated for categorical, normally distributed and skewed variables, respectively. Chi-square tests were used to test differences between smokers and non-smokers for categorical variables. Student t-test was used for mean differences between normally distributed variables, and the non-parametric U-test suggested by Mann and Whitney, was used for skewed continuous variables.

Due to large data number variability in variables of interest, parental responding bias was assessed. Dummy variables were created to screen the sample whether they (i) had all variables of interest (covariates) missing, (ii) had all maternal variables of interest missing, (iii) had maternal variables missing and/or had overweight children. None were detected, suggesting that data were missing randomly and therefore no exclusions from the sample were made. Furthermore, no differences on smoking status were found between responders and non-responders.

The association of maternal smoking and child weight status, total and central adiposity was tested using multivariate logistic regression models. Linear multivariate regression models were used to assess maternal smoking to children's BP.

Due to the large number of variables used in the model, and in order to avoid collinearity, Variance Inflation Factor (VIF) test was performed after regression. The mean VIF for the model was 1.98 and all variables had a VIF value of <2.5. To increase the power of the analysis and validate the model, bootstrap was conducted with 10 random replications; Data remained significant. All reported P-values were based on two-sided hypothesis tests, with significance level at 5%. The statistical models were computed using STATA 12.0 (STATA corp. Texas)

Results

Demographic characteristics are given in Table 1. Among the 2017 parental questionnaires gathered, 1767 (87.6%) reported as non-smokers during pregnancy, and 250 (12.4%) were smokers. Mothers who smoked during pregnancy had higher mean age (p=0.001). Significant differences were observed in the distribution of maternal BMI and weight increase of smokers compared to non-smokers, with smokers having a higher rank, as per Man Whitney test. No other significant differences were found among maternal smokers and non-smokers.

Among child characteristics, no age or gender differences were found between maternal smokers and non-smokers, but children's mean BMI and infant's birth weight, adiposity % and waist circumference significantly differed (Table 1).

In Table 2, the odds of children being overweight or obese are shown among women who smoked over 1 cigarette per day are compared to non-smokers, using 4 different models. Children were more likely to be overweight or obese among mothers who smoked during pregnancy, as depicted among all models. In the first model, children were 1.6 times more likely to be overweight or obese (95% CI: 1.03, 2.47) compared to their healthy weight peers, and this increased to 1.82 (95% CI: 1.09, 3.04), if their mother smoked during pregnancy. The models used were adjusted in an additive way, as shown in Table 2, starting from a priory known confounding factors (model 1), adding for maternal alcohol and coffee intake (model 2), children's behavior (model 3) and dietary patterns (model 4). Coffee and alcohol intakes, added in the second model, led to a significant increase in the odds of overweight or obese in children among smokers. When behavioral variables were accounted for as well (Model 3), the OR of overweight or obese in childhood further increased (OR: 1.82). Total sleep hours were lower among children whose mothers smoked during pregnancy compared to offsprings of non-smokers (OR: 0.8±0.07, p=0.014). When the model was adjusted for total FI score also, the odds for overweight or obese in children among maternal smokers slightly dropped, but maternal smoking remained a significant risk factor (OR: 1.81; 95% CI: 1.09, 3.03).

The same model was used for children's waist circumference (above or below the median value). WC was found to be associated with maternal smoking and maternal BMI at pregnancy, not current BMI. The odds of having a higher than the median wc was higher in children whose mothers smoked during pregnancy (OR: 1.96; p=0.007), and whose mothers had a higher BMI at pregnancy (OR: 1.12; p=0.004).

Children's total body fat percentage and waist circumference was positively associated with maternal smoking, in a univariate analysis seen in Table 1. When these were incorporated in the 4 logistic models, offspring's of maternal smokers were more likely to have a wc above the median compared to offspring's of maternal non-smokers (Table 3). The relationship between maternal smoking status and wc remained significant in all models, although it slightly decreased when behavioral and dietary variables were added. No significant effect was found between maternal smoking status and total body fat.

In Figure 2, mean systolic and diastolic BP measures are depicted in a bar graph by maternal smoking status. As can be seen from the graph, no differences were found in univariate analysis, and this remained when the other covariates were added.

Discussion

The main outcome of the present study is that maternal smoking, one of the most important modifiable factors during pregnancy, was found to be significantly associated with children's weight status and central adiposity in all models tested, including maternal and child characteristics, coffee and alcohol intake during pregnancy, child behavioral factors and dietary patterns. The association however, was not significant for total body adiposity (%).

This suggests direct effect of maternal smoking during pregnancy on children's risk of overweight or obesity later in life as well as an increased risk for higher central adipocity. In agreement to these findings, other researchers have also found a significant higher mean BMI among offspring of mothers who smoked during pregnancy (Al Mamun et al., 2006, Wang et al., 2013) reporting a direct effect; observations strengthened by a meta-analyses reporting higher effect estimates on childhood obesity for maternal smoking when compared to paternal smoking (Riedel et al., 2014).

The argument that these effects may be due to residual confounding (Young et al., 2013, Harris et al., 2013, Florath et al., 2014), are further contradicted by observations reporting positive association between maternal smoking and children's weight status upon multi-level adjustments, as performed in this study. Detailing, maternal smoking remained a significant risk factor for child overweight or obese upon accounting for after birth influences, including behavioral factors and dietary pattern, in agreement with other authors (EL Mamun et al. 2006, Ino et al., 2012, Power et al., 2002). Furthermore, compared to previous studies, total study time and screen time, were used as proxy measures to inactivity, in order to further decrease probability of residual confounding via child behavior. Study hours, is a basic characteristic of school-aged children, adding to inactivity time, and screen time included TV- viewing hours and other media types (i.e. gaming, tablets and computer); the latter accounting for the decrease in TV viewing time among children, and the increase in other media types, that has been reported (Falbe et al. 2013). In addition to behavior, researchers to date have also adjusted for some food items, including frequency of salad, fast food and red meat intake (Al Mamun et al., 2006), as well as fried food, chips, fruits & vegetables and sweets (Power et al., 2002), but to our knowledge no studies have accounted for diet via a child derived food index as was performed in this study. The child derived Food Index cdFI used in the analysis of the present study, includes the for-mentioned foods along with a more elaborate food intake on healthy and potentially obesogenic food items, therefore strengthening the detected association of maternal smoking and childhood overweight or obese risk. Although cdFI attenuated the odds of the effect, the association remained significant, possibly suggesting different mechanisms of action of maternal smoking, and behavior and dietary risk variables on children's' weight status. The potential for residual confounding, was therefore limited in this study.

Central adiposity and total estimated body fat, were used to examine the effect of maternal smoking on children's fat distribution and body fat (%), respectively. This was done to decrease the random error that BMI calculations may incorporate in the results. Waist circumference was used as a measure of central adiposity as has been recommended (Maffeis et al., 2001). In order to account for confounding, the model included low birth weight; a variable linked to maternal smoking (Suzuki et al., 2010, Bakker et al., 2011, Bergel et al., Riedel et al., 2014, Timmermans et al., 2014), to an increased weight status (Suzuki et al., 2011), and central adiposity development (Simmons et al., 2008) later in childhood. Upon adjusting, however, for birth weight and length the results remained significant, as has been shown by other researchers also (Oken et al., 2006, Widerøe et al., 2003).

Women are often aware or they are made aware that smoking during pregnancy is «fetal unhealthy». A large amount of women usually quit smoking right before pregnancy if this is planned or during their pregnancy when it comes to their knowledge. Bias was therefore avoided by including prenatal smoking habits in the analysis. Coffee intake during pregnancy was a significant factor taken into consideration in the models, since it was found to significantly differ among maternal smokers and non-smokers; This was not adjusted for by many researchers, although coffee intake can be a proxy for smoking habits, hence limiting maternal underreporting of smoking, considering the two are highly associated.

In discordance to other researchers (Wang et al., 2013) maternal education level did not differ among smokers and non-smokers and did not have a significant effect when entered in the models for BMI category, adiposity and waist circumference. This may be due to recall bias, although all statistical measures were taken to decrease this effect. Responding bias may also be another possible reason.

Fetal and neonatal period is crucial for organ development. Smoking in early pregnancy may not influence birth size, whereas women who smoke throughout, or even in the third trimester have smaller babies. Simmons et al. (2008) reviewed epidemiological data and found that excess and reduced nutrient bioavailability during fetal development, can lead to later onset of central adiposity. Findings from this study suggest that the risk of overweight associated with maternal smoking may be attributed to specific effects of cigarette smoke on fetal development. It has been hypothesized that maternal smoking may influence the hypothalamic centers, which in turn influence appetite and activity, as has been shown in adults (Oken et al., 2006). The effect of nicotine and carbon monoxide, both teratogenic toxins, found in cigarettes have been investigated, however ethical constraints involving human studies, makes the underlying mechanism difficult to investigate.

Controversial findings between maternal smoking and child weight status may also be age related. As longitudinal studies have shown, the age of onset may be a significant factor to address when assessing the effect of maternal smoking on the epidemic of child overweight with child obesity developing with age, and differences over time increasing (Riedel et al., 2014, Timmermans et al. 2014). Researchers have found higher adiposity levels in children whose mothers smoked during pregnancy, among older children (Li et al. 2015, Salsberry et al. 2005), and in toddlers (Oken et al. 2005; Salsberry et al. 2005), although others that tested infant BMI (Durmus et al. 2011) found no association, suggesting possible later onset. Furthermore, another longitudinal studies reported a stronger association of maternal smoking with BMI in adulthood (Power et al., 2002). This may further enlighten the possible mechanism that underlies maternal smoking and child weight status.

Although systolic and diastolic blood pressure has been found to be associated with overweight and obesity in children (Farajian et al., 2015), as well as waist circumference (Maffeis et al., 2001), it was not associated with maternal smoking as other researchers have also reported (Bergel et al., 2000, Law et al., 1991). Lawlor et al., (2004) however, found that maternal smoking was associated with a 1mmHg increase in mean SBP, among 5 to 6 year old children, an effect supported by others as well (Law et al. 2000, Oken et al., 2005). Studies on BP have shown that parental prenatal smoking have the same effect on children's BP as maternal smoking during pregnancy, suggesting that childhood BP may be due to other than intra-uterine programming, and that associations found by other studies may have been due to minimally adjusted models used, hence confounding (Brion et al., 2007).

Strengths

Analyses conducted accounted for variables, such as age and gender and gestational weeks at birth, birth weight and length; factors shown to be related with child overweight and obesity. The effect of dietary intake, via a specific pattern that has been shown to increase the risk of child obesity was also accounted for by adjusting for child-derived Food Index score (cd-FI) that the children had scored (Magriplis et al., 2015).

The association between maternal smoking and children's weight status was found significant with BMI category and with fat percentage. BMI has been criticized as a theoretical indicator, prone to errors, since does not account for the variability in muscle mass. The association with measures waist circumference, shown in this study, strengthens the association found between maternal-smoking suggesting potential increased likelihood specifically for central obesity among 10-12 year old children.

Limitations

Paternal smoking was not assessed therefore second hand smoking was not accounted for. Due to the nature of the questionnaire, great variability was found among the responses gathered from the parental questionnaire. Data however were cross tabulated and dummy variables were created to address responding bias, with none being observed.

Maternal smoking was assessed in categories therefore the risk per cigarette intake was not possible to be derived. Another potential limitation was blood pressure measurements, which were performed in the field therefore direct association with high or low child BP was not possible. This may be potentially the reason why no association was found between maternal smoking and BP, via logistic regression.

Lastly parental anthropometric data were self-reported, although the large sample size decreases potential reporting bias.

Social desirability concerns may have caused under-reporting of smoking behavior, although this limitation would have lead to a further increase of the association. Due to the nature of the study, and as in all observational studies, unmeasured systematic differences between smokers and non-smokers that are possibly associated with the outcome, may partly explain the findings. This was controlled for, by adjusting for a-priory known variables that have been associated with children's weight status and adiposity, without however over-controlling. Furthermore, the results were tested via random sampling (bootstrap, 10 replications) further increased the studies results.

Conclusion

The findings of the present study suggest that intrauterine exposure to maternal smoking increases the likelihood for an increased body weight and central adiposity in school aged children. Although BMI does not provide information on fat distribution, waist circumference measured, as well as total body adiposity, measured in this study may suggest that maternal smoking may affect central adiposity more specifically.

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Table 1

Demographic characteristics with mean (SD) and frequency (%) for maternal and child characteristics among maternal smokers and non smokers

Characteristics	N[a]	Mean (SD) or Median[b] -- Frequency (%)	Non smokers (1767)	Smokers (250)	Difference* (p-value)
Maternal BMI (kg m^{-2})	1861	23.5	23.6	23.2	**0.044**
Maternal age at pregnancy (years)	1695	28.2 (4.7)	28.1 (4.7)	29.2 (5)	**0.001**
Pregnancy weight gain	1738	13	13	15	**0.039**
Maternal BMI at pregnancy	1729	21.5	21.5	21.5	0.633
Gestational age (week)	1325				0.973
• <32 weeks		28 (2.1)	25 (2.2)	3 (1.7)	
• 32-36 weeks		193 (14.6)	167 (14.5)	26 (14.9)	
• 36-38		383 (28.9)	331 (28.8)	52 (29.7)	
• ≥38 weeks		721 (54.4)	627 (54.5)	94 (53.7)	
Maternal education	1802				0.107
• primary		123 (6.8)	108 (6.9)	14 (6.1)	
• secondary		761 (42.2)	642 (41.3)	111 (48.7)	
• university		918 (50.9)	805 (51.8)	103 (45.2)	
Drinking of alcohol	2001				0.07
• none		1916 (95.7)	1688 (96.1)	228 (93.1)	
• 1 unit/day		85 (4.3)	67 (3.8)	17 (6.9)	
• >1 unit/day		1 (0.1)	1 (0.1)	0 (0)	
Child Characteristics					
Age	2017	10.9 (0.7)	10.9 (0.7)	10.8 (0.8)	0.415
BMI	1950	20.2 (3.7)	20.1 (3.6)	20.9 (4.0)	**0.002**
Gender	2017				0.390
• boys		909 (45.1)	790 (44.7)	119 (47.6)	
• girls		1108 (54.9)	977 (55.3)	131 (52.4)	
Birth weight	1400	3268.3 (542.2)	3283.1 (549)	3156.8 (483.5)	**0.004**
Birth length	1245	51.3 (3.7)	51.4 (3.7)	51.1 (4.2)	0.507
Body fat (%)	1938	21.3 (8.8)	21.1 (8.7)	22.9 (9.2)	**0.002**
Waist circumference (cm)	1937	68.9 (9.7)	68.7 (9.7)	70.4 (10.2)	**0.013**

*P<0.05 for difference in main characteristics among smokers and non smokers during pregnancy, based on t-test or Mann Whitney tests for continuous normal and skewed variables, respectively. Chi-square test was used for categorical variables.

BMI: Body Mass Index; SD: Standard deviation

[a] N: Total of data per characteristic

[b] Mean(SD) or median values depicted for continuous variables and frequencies(%) for categorical variables

Table 2

Multivariate logistic regression of children's weight status and maternal characteristics among smokers versus non-smokers

BMI,

Maternal smoking status Non smokers versus Smokers	**Odds Ratio (SE)***	**95% CI**	**P value[±]**
BMI category*[1]			
• **healthy wt**	--	--	
• **ow & ob**	1.60 (0.36)	1.03, 2.47	**0.036**
BMI category*[2]			
• **healthy wt**	--	--	
• **ow & ob**	1.80 (0.45)	1.10, 2.94	**0.019**
BMI category*[3]			
• **healthy wt**	--	--	
• **ow & ob**	1.82 (0.48)	1.09, 3.04	**0.021**
BMI category*[4]			
• **healthy wt**	--	--	
• **ow & ob**	1.81 (0.47)	1.09, 3.03	**0.023**

Body-- Mass Index; OR, Odds Ratio; SE, Standard Error; 95%CI, 95% Confidence Interval
*overweight (ow) and obese (ob) children compared to healthy weight peers
[a] women having completed secondary education and university or higher compared to women having completed elementary level education
[b] significance level at $p<0.05$

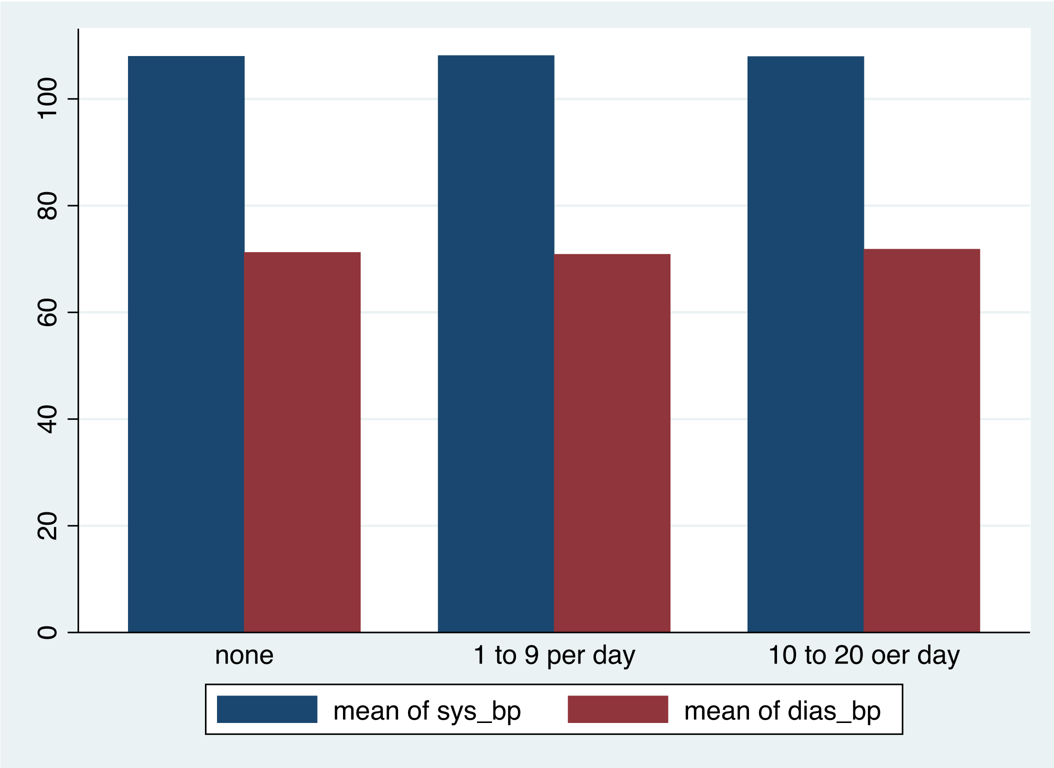
[1] model adjusted for children's age & gender, children's birth weight & length, gestational weeks, maternal education, maternal BMI, weight increase during pregnancy and maternal age
[2] model adjusted for the above and maternal alcohol & coffee intake during pregnancy
[3] model adjusted for the above and children's sleep, screen and study time
[4] model adjusted for all of the above and total FI score

Table 3:
Multivariate logistic regression of children's percent adiposity and waist circumference with maternal smoking status

	Children's Adiposity % [a]			Children's waist circumference [b]		
	Odds Ratio (SE)*	**95% CI**	**P value[±]**	**Odds Ratio (SE)***	**95% CI**	**P value[±]**
Model 1	1.28 (0.3)	0.82, 1.20	0.280	1.73 (0.4)	1.17, 2.69	**0.014**
Model 2	1.34 (0.3)	0.82, 2.19	0.244	1.85 (0.5)	1.13, 3.02	**0.015**
Model 3	1.29 (0.3)	0.78, 2.13	0.326	1.84 (0.5)	1.11, 3.05	**0.017**
Model 4	1.28 (0.3)	0.77, 2.11	0.338	1.82 (0.5)	1.09, 3.01	**0.021**

[±] Significant at the P<0.05 level
[a] Comparing children above and below the median value of the sample. Measured with bioimpedence analysis
[b] Comparing children above and below the median value of the sample. Measured by trained personnel, using a with a non elastic standardized tape (Seca)
[1] model adjusted for children's age & gender, children's birth weight & length, gestational weeks, maternal education, maternal BMI, weight increase during pregnancy and maternal age
[2] model adjusted for the above and maternal alcohol & coffee intake during pregnancy
[3] model adjusted for the above and children's sleep, screen and study time
[4] model adjusted for all of the above and total FI score

Figure:
Mean Systolic and Diastolic blood pressure of children by maternal smoking status



PAPER IV

Magriplis E., Farajian P., Panagiotakos DB., Grigoris Risvas, Zampelas A. (2016). Children’s food perceptions and assertiveness to change in respect to their weight status and self-esteem. (Under submission)

Title

Children's food perceptions and assertiveness to change in respect to their weight status and self-esteem.

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Introduction

Childhood overweight is a multifactorial problem. Familial resemblance in weight is well established as a result of genetics and environmental factors (ref). The latter is an integration of physical activity, dietary patterns, and eating behavior, school and home environment; all highly modifiable factors that can increase the risk for child overweight, as widely perceived in the 21st century. Therefore, the question remains: why does childhood overweight and obesity remain an epidemic.

Over the past 30 years childhood obesity has quadrupled in children 6-11 years old, from 6.5% in 1976 to 18.8% in 2004 (Ogden et al., 2009 –National Health and Nutrition Examination Surveys). Many researchers have investigated a series of questions pertaining to eating behavior and there is evidence supporting the theory that certain such behaviors may precede overweight in some children (Birch et al., 1998, Fischer et al., 2003, Pearson et al., 2009). It has been shown via a systematic review, that home availability of fruit and vegetable and intake, were positively associated (Pearson et al., 2009). Kral et al. 2014 & Fischer et al., 2003, found that environments that offer larger portions of palatable foods affect all children's intake irrespective of their weight status or how reinforcing they find food to be. Some studies have linked childhood obesity with poorer quality of life and low self-esteem (refs).

Temporal relationship to this theory however is difficult to be determined since it may be a result of stigmatization of childhood obesity. Eating beliefs and food behaviors however can and should be examined in order to assess children's beliefs and potential patterns that may be preventive or may increase their risk to overweight or obesity. In order to promote change and increase the likelihood of a healthier lifestyle, the willingness of children to change may need to be investigated.

The objective of the study was to examine school children's willingness to ameliorate eating behaviors in relation to their weight-status and their current eating patterns, as well as to assess potential gender differences.

Methods

Sample Population and sampling

Data were used from the GRECO (Greek Childhood Obesity) study a school based cross-sectional study across the area of Greece, including pupils 10 to 12 years of age. The study was carried out from October 2008 to May 2009, from the whole district of Greece, including a random sample of 117 schools from 10 selected regions, with a total of 4786 children aged 10-12 years old, studied. A participation rate of 95% was achieved. All children, teachers and primary care-giver were informed of the aims and study procedures, and primary care-givers, usually parents, were asked to sign consent forms. A more detailed description of the sampling procedure has been published (Farajian et al., 2011). After data inspection, a total of 452 children were excluded; 117 children had all data missing; 95 children had left unanswered over 20% of the FFQ (>=10 questions); and 240 individuals had reported implausible energy intake (<600 kcal/day or >6000kcal/day).

Children that had all 23-behavior questions missing were excluded from the analysis. Furthermore, dummy variables were created to detect children that had responded to <20% of the behavior questionnaire (must have at least 19 questions). These children were also excluded from the analysis in order to reduce response bias. A total of 79 children were excluded from the analysis, of which 42 were normal weight, 17 overweight and 6 obese. 14 children out of the 79 had missing BMI values. This left 4355 (98,2% of the sample) students in the analysis.

A total of 8 eating behavior questions and 12 questions related to eating habits were assessed with children asked to respond using a 1-5 score gradient pertaining to their readiness and willingness to alter their eating or food related behavior. The gradient used was the following:

1 "not sure at all"

2 "a little sure"

3 "sure"

4 "very sure"

5 "absolutely sure"

All responses were assessed by weight category (overweight and obese versus healthy weight) and by gender. In order to avoid information loss, all frequencies (%) were reported by score and then categorized.

Questionnaire

The questionnaire was split into two sections. The first section contained descriptive information, including age, gender, anthropometric measurements, and questions relating to behavior & activity. The second section contained the Food Frequency Questionnaire (FFQ) and was used to construct the validated childhood derived FI, designed to potentially detect child OW&OB (Magriplis et al., 2015).

Behavioral section

The questions were latter split into two categories (1 and 2), where “1” was for children responding not sure at all or a little and “2” to those responding, sure, very sure or absolutely sure.

“How happy are you with your weight” question was used as a proxy measure of a child’s self-esteem level. The response was rated in a scale from 1 to 5, with 1 being not happy at all and 5 being very happy. This was further related to actual body weight and BMI I order to assess correlation with actual measurements. It was then used in the analysis of the study in order to examine the relationship between children’s assertiveness-readiness to change various eating behaviors and their self-esteem.

Statistics

Demographic characteristics were assessed with mean values ±SD (standard deviation), for continuous variables, and frequencies with percentages, for categorical variables, with t-test depicted by gender. Children of differing weight status-group were then compared to assess their responsiveness and belief of nutritional behavior change, according to weight category.

Data were also stratified by gender and differences in level of assertiveness were compared among males and females as well.

Chi squared tests were used to examine potential significant associations between eating behavior questions and the children's feelings about their weight. To assess the children's weight perception compared to their actual as measured by trained personnel, and paired t-test was used. Weight perception was also correlated with BMI and fat percentage.

Student t-test was used to examine mean differences among groups for continuous variables and chi-square (x^2) tests to examine differences in categorical variables. Mean BMI and FI total score (a proxy of their eating pattern) was assessed in relation to the children's willingness/assertiveness to change eating behavior (1-2 score) using ANOVA, one way analysis, with tabulation command to assess mean differences between the two (2) groups. Chi-square test was used to examine potential significant differences between eating behavior binary outcomes and weight-perception/self-esteem score.

Stata 12.0 was used for the analysis with significance stated at the 0.05 level.

Results

Table 1 depicts the methods used to categorize children based on the respective adult BMI, as defined by the IOTF (International Obesity Task Force) standards (Cole et al., 2012).

The basic total and gender specific characteristics of the study population are shown in Table 2, where two P values were given; one unadjusted and the other adjusted for gender in order to decrease confounding in the results obtained**.** Statistical gender differences were found for age, height, waist circumference, BMI but not in BMI categorization. Mean values were lower in all previous variables in females.

In Table 3, 8 eating behavior questions in questionnaire were tabulated by weight status and gender with P values given in both cases. A greater percentage of overweight & obese children reported ready to alter 4 eating behaviors including "eat smaller portions"; take a snack from home to school; reduce sweet intake if these are not available at home; eat more F&V if these are available at home; eat more frequently healthy snacks if these are TV advertised. Moreover, more overweight and obese children reported that their friend's opinion affected their snack selection. Gender differences were found in all eating behavior questions, with the exception of friend opinion on snack selection with females responding a higher assertiveness to change.

In table 4 the same 8 eating behaviors were categorized in 2 groups, as explained in methods and were examined in relation to mean BMI, mean cd-FI (child derived Food Index) and self-esteem. In crude analysis differences were found in 3 behaviors (eating smaller portions, more healthy snacks if advertised and peer opinion) and mean BMI; these remained significant when adjustments were made for age and gender, during which sweet reduction was also significant. Children achieving a higher mean cd-FI, also reported higher readiness to change, in all cases other than peer opinion, with associations remaining in all behaviors when adjustments were made. Lastly self-esteem was only associated with portion size and peer opinion, with more children reporting good weight perception being more assertive to change, and a lower percentage of the same reporting affected by their peers opinion on their snack selection.

Table 4 depicts children's readiness to alter specific eating habits in relation to weight status and gender. A greater percentage of overweight & obese children reported ready to change 5 out of 12 eating habits, and a higher percentage of females reported sure to change 8 out of these 12 habits. In both cases, reducing fried & fatty foods, eat whole-wheat cereal and biscuits, drink sugar free sodas, eat margarine instead of butter, and have fish once a week. Further results can be seen in Table 4.

Discussion

Overall the results indicate that a greater percentage of females and overweight & obese children express greater assertiveness to alter various eating behaviors and habits.

A systematic review reported that home availability and fruit and vegetable intake were positively associated (Pearson et al., 2009), in accordance to the current study's findings.

Researchers have suggested that environmental control may be an important factor in order to support children in weight loss, or prevent overweight and obesity development (Pearson et al., 2009, Briefel et al., 2009, Fox et al., 2009, Luszczynska et al., 2013). The results of this study that referred to the children's perceptions and beliefs on home availability of fruit and vegetables and taking, healthy options at school, limiting sweet items at home, are in agreement to these findings. These beliefs however were higher among overweight and obese children and females since eating behaviors were assessed based on gender differences and weight status, to assess the possible effect that a child's weight may have on their response.

It has been estimated that middle school children that attend schools that do not offer food or snacks, greatly decrease in ssb intake (Briefel et al., 2009) and by limiting children's access to low-nutrient, energy-dense foods at school may hold promise as a tactic for reducing children's total calorie intake and controlling children's BMI (Fox et al., 2009). Children in the GRECO study also reported this, responding sure or very sure in increasing healthy snack intake and replacing ssb's with their no sugar counterpart, if this was offered. Luszczynska et al, 2013, have also confirmed this finding reporting associations between the use of self-regulatory strategies and lower ssb intake become significantly stronger with age (Luszczynska et al., 2013). However authors reported that accessibility was related negatively to self-regulation, whereas higher social pressure was associated with higher self-regulation, suggesting that if ssb's are limited only, then once offered it can lead to overconsumption.

Suggestions to combat childhood overweight and obesity include modification of the home environment to increase access to healthy food and activity choices, and decrease access to unhealthy options.

Total cd-FI score was also investigated and findings suggest that the higher the mean score, the more assertive children are in change. Awareness and knowledge may be the reason behind this finding.

Weight perception was assessed for, as a proxy for self-esteem, in relation to eating behaviors Children with high weight perception-self-esteem were more likely to reduce portion size and responded that peer opinion did not affect their snack selection. In all previous cases, significant differences remained when these were adjusted by gender, which was shown in the previous table to affect response, and age, therefore reducing confounding.

Differences were also found in children's assertiveness on changing specific eating habits based on their weight status, and their gender, with females overall responding more assertive to change. In both cases children responded sure or very sure in reducing fatty and fried items, consume whole-wheat cereal and biscuits, drink sugar free sodas instead of normal, replace butter with soft margarine.

Girls also responded that they could eat a fruit and a salad daily, have a fruit for desert, and eat fish once a week; whereas overweight and obese children further reported that they can add their favorite vegetable in a sandwich. Responses and differences in findings may be suggestive on factors that health and weight interventions should consider prior to implementation. Although in this study overweight and obese children reported more willing to alter specific eating habits, Roseman et al., 2007, found that healthy weight was associated with consuming fruits, vegetables, breakfast, and milk. Underweight and healthy-weight students consumed more fruits than students who were at risk of being overweight and overweight. Healthy-weight students consumed more "other vegetables" than students who were at risk of being overweight and more "other vegetables" and carrots than overweight students. This was however accounted for when data were analyzed based on total cd-FI score. Results were in confirmation with findings reported by Roseman et al., (2007), since the higher the score the more assertive children responded to change. Therefore although overweight & obese children may consume less frequently "healthy foods" stated above, they did respond willing to add fruits and vegetables in a specific way. Methods used to formulate the change and home & school availability may some factor that should be considered as this study showed.

Eating out of home has been associated with increased EI and fat intakes and lower micronutrient intakes (Orfanos et al, Lachat et al 2012) and has been found as an independent factor of obesity (Burke et al 2007). How eating out in relation to other eating behaviors further affect weight gain or the rate of weight gain in children requires further investigation. Eating out however needs to account for the frequency by which children buy snacks from the schools café. In this study overweight & obese children responded that they were sure they would eat more frequently healthy snacks if these were offered more often in the schools café. The actual frequency of selection should be investigated, since studies have shown that children tend to choose higher E dense snacks compared to healthier ones (Kenney et al, 2014) even when Cafés offer healthier options.

As children grow, their beliefs and choices become stronger and are often mediated by family and peers with individual characteristics, including eating behaviors and assertiveness making a child more or less susceptible to various external stimuli. The results of this study suggest in children and pre-adolescent age that mostly food availability may affects their selection, and peer opinion to a lower extent. In adolescence peer opinion should be re-evaluated.

“How happy are you with your weight” question was used as a proxy measure of a child’s self esteem level. This was done in order to account for psychological factors that have been shown to trigger binging in children.

Individual characteristics may make a child more or less susceptible to various external stimuli, and many studies may have failed to show an effect or lead to prevention due to this limiting step – understand their study population and their readiness for change. Programs may need to be modified and adapted to these characteristics.

Conclusion

In order to promote change and increase the likelihood of a healthier lifestyle, the willingness of children to change may need to be investigated. Studies investigating a series of these factors- behaviors and child's beliefs and readiness to ameliorate these, may help investigators increase their understanding on childhood obesity. By implementing strategies that will create parental awareness and lead them to increase home availability of healthy snacks, including fruits and vegetables, and whole-wheat snacks, low in sugar, children may be keener in their selections. Restriction of high-energy dense food may not be the answer but increasing availability of high nutrient dense items in a child friendly manner (ie: fruit salads and rice puddings instead of whole fruits and plain milk or yogurt). The influential effect that peers have, as well as children's education around snack options and selection is an area that needs further investigation.

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Table 1: Children's weight categorization based on Adult's BMI according to IOTF standards and BMI categories used in FI validation

Children's classification	Respective Adult BMI	BMI category
Normal weight	18.5-<25	
Underweight	<18.5	1
Overweight	25-<30	2
Obese	30-<35	
Morbidly obese	>35	3
Total	n/a	

Table 2: Participant Characteristics including continuous (mean (SD)) and categorical variables (frequency (%))

	Total	**Boys**	**Girls**	**p-value****
Child Characteristics*				
Age (years)	10.9 (0.74)	10.96 (0.76)	10.88 (0.73)	<0.001^
Height (m)	1.50 (0.08)	1.49 (0.76)	1.50 (0.79)	<0.001^
Weight (kg)	45.7 (10.86)	45.70 (10.91)	45.69 (10.82)	0.971^
Waist circumference (cm)	68.56 (9.6)	69.76 (9.91)	67.41 (9.14)	<0.001^
BMI	20.24 (3.74)	20.37 (3.8)	20.13 (3.67)	0.034^
BMI category* (freq (%))				
Under- & Normal weight	2475 (58.36)	1175 (56.93)	1300 (59.72)	0.091#
Overweight	1260 (29.71)	623 (30.18)	637 (29.26)	
Obese & morbid obese	506 (11.93)	266 (12.89)	240 (11.02)	

*t-test used for continuous variables & chi-square test for categorical variables
**significance at $p<0.05$ level

Table 3: Assertiveness to change 8 eating behaviors in relation to weight and gender

	Weight status		**Gender**		**P-value[1]**	
Eating Behavior Question	HW^	OW&OB^	Males	Females	OW vs HW	By Gender
"Can you eat smaller food portions"						
1	210 (8.6)	91 (5.2)	190 (8.9)	130(5.8)	**<.001**	**<.001**
2	654 (26.8)	438 (25.0)	548 (25.7)	579(25.9)		
3	636 (26.1)	426 (24.4)	567 (26.6)	545(24.4)		
4	476 (19.5)	424(24.2)	426 (19.9)	520(23.2)		
5	463 (18.9)	370(21.2)	402 (18.9)	464(20.7)		
"Take to school a snack from home"						
1	302 (12.5)	225(13.1)	281(13.3)	273(12.4)	**.006**	**.029**
2	319 (13.2)	212(12.3)	265(12.6)	292(12.8)		
3	370 (15.4)	224(13.0)	331(15.7)	282(12.8)		
4	435 (18.0)	269(15.6)	340(16.1)	402(18.2)		
5	985 (40.9)	793(46.0)	890(42.2)	960(43.5)		
"Eat more frequently healthy snacks at school if more were sold at the canteen"						
1	220(9.17)	166(9.7)	218(10.37)	191(8.72)	.066	**<.001**
2	329(13.71)	202(11.8)	301(14.31)	259(11.83)		
3	466(19.42)	332(19.39)	450(21.4)	388(17.72)		
4	603(25.12)	393(22.96)	481(22.87)	549(25.1)		
5	782(32.58)	619(36.16)	653(31.05)	803(36.7)		
"Can reduce sweet intake if these are not present at home"						
1	302(12.65)	209(12.32)	289(13.89)	242(11.09)	**.003**	**<.001**
2	348(14.57)	210(12.38)	334(16.05)	261(11.96)		
3	479(20.06)	305(17.98)	444(21.34)	376(17.22)		
4	455(19.05)	301(17.75)	362(17.4)	423(19.38)		
5	804(33.67)	671(39.56)	652(31.33)	881(40.36)		
"Eat more F&V per day if have more at home"						
1	191(7.94)	148(8.64)	200(9.51)	157(7.15)	.671	**<.001**
2	319(13.26)	204(11.91)	320(15.22)	236(10.75)		
3	452(18.79)	315(18.39)	398(18.93)	396(18.03)		
4	523(21.74)	374(21.83)	460(21.88)	459(20.9)		
5	921(38.28)	672(39.23)	724(34.44)	948(43.17)		
"Eat more freq. healthy snacks if these were TV advertised"						
1	357(14.81)	212(12.25)	320(15.15)	271(12.27)	**.003**	**.001**
2	462(19.17)	277(16.0)	379(17.95)	398(18.02)		
3	544(22.57)	436(25.19)	520(24.62)	495(22.41)		
4	495(20.54)	368(21.26)	438(20.74)	467(21.14)		
5	552(22.9)	438(25.3)	455(21.54)	578(26.17)		
"Can eat different food item compared to your friends when you are together"						
1	382(15.91)	238(13.85)	343(16.36)	307(13.94)	.448	**<.001**

2 3 4 5	383(15.95) 531(22.12) 489(20.37) 616(25.66)	279(16.23) 387(22.51) 350(20.36) 465(27.05)	346(16.5) 508(24.23) 397(18.93) 503(23.99)	341(15.49) 447(20.3) 477(21.66) 630(28.61)		
Total (missing=135)	2401	1719	2097	2202		
"To your opinion how much do your friends affect your snack selection"						
1	694(28.45)	421(24.14)	576(27.04)	586(26.23)	**.002**	.468
2	605(24.81)	429(24.6)	543(25.49)	531(23.77)		
3	545(22.35)	382(21.9)	467(21.92)	508(22.74)		
4	335(13.74)	277(15.88)	295(13.85)	342(15.31)		
5	260(10.66)	235(13.47)	249(11.69)	267(11.95)		
Total (missing=70)	2439	1744	2130	2234		

OW, Overweight; OB, Obese; BMI, Body Mass Index; F&V, Fruits and vegetables
P value by weight status and gender, using chi square test

Table 4: Readiness to alter Eating behaviors in relation to mean BMI, Reported usual Intake and Self esteem

Question	BMI[1]	P value	cdFI total [1]	P value	Self esteem (%)[2]	P value
"Can you eat smaller food portions" Sure* (n=2795/4188) Not sure (n=1393/4188)	20.42 19.93	**<.001** **<.001***	35.17±4.96 34.09±5.0	**<.001** **<.001***	47.44 43.46	**.017**
Take to school a snack from home" Sure* Not sure	20.28±3.76 20.19±3.74	.943 .593*	35.04±4.89 34.24±5.25	**<.001** **<.001***	46.51 44.51	.269
"Eat more frequently healthy snacks at school if more were sold at the canteen" Sure Not sure	20.3±3.68 20.09±3.76	.146 .180*	34.99±4.9434.28±5.15	**<.001** **<.001***	46.71 44.84	.325
"Can reduce sweet intake if these are not present at home Sure* Not sure	20.3±3.69 20.04±3.81	.054 **.041***	35.01±4.95 34.4±5.11	**<.001** **.0002***	46.15 46.69	.765
"Eat more F&V per day if have more at home" Sure* (%) Not sure (%)	20.27±3.73 20.18±3.78	.489 .456*	35.19±5.01 33.41±4.76	**<.001** **<.001***	46.31 45.36	.623
"Eat more freq. healthy snacks if these were TV advertised" Sure* (%) Not sure (%)	20.39±3.78 19.98±3.66	**.001** **<.001***	35.16±5.0 34.03±4.93	**<.001** **<.001***	46.13 46.06	.967
"Can eat different food item compared to your friends when you are together" Sure* (%) Not sure (%)	20.3±3.68 20.15±3.85	.231 .215*	35.07±4.88 34.33±4.88	**<.001** **<.001***	46.86 44.41	.151
"To your opinion how						

much do your friends affect your snack selection" Sure* (%) Not sure (%)	20.44±3.82 20.07±3.65	**.002** **<.001**	34.79±4.98 34.81±5.01	.904 .858	43.57 48.44	**.002**

BMI, Body mass index; cdFI, child derived Food Index; F&V, Fruits and vegetables
*children reporting above level 3 were grouped in «sure» category; Whereas children reporting 1 or 2 category were categorized as not sure
[1] Using ANOVA one way analysis with tabulation by category; Mean values reported and the P value with level of significance <.05; *p-value when adjusted for gender and age category
[2] Via chi square test (categorical variables); % of children that have responded either «sure», «very sure» or «absolutely sure» and were happy with their weight Pearson chi^2 reported; Significance level: P<.05

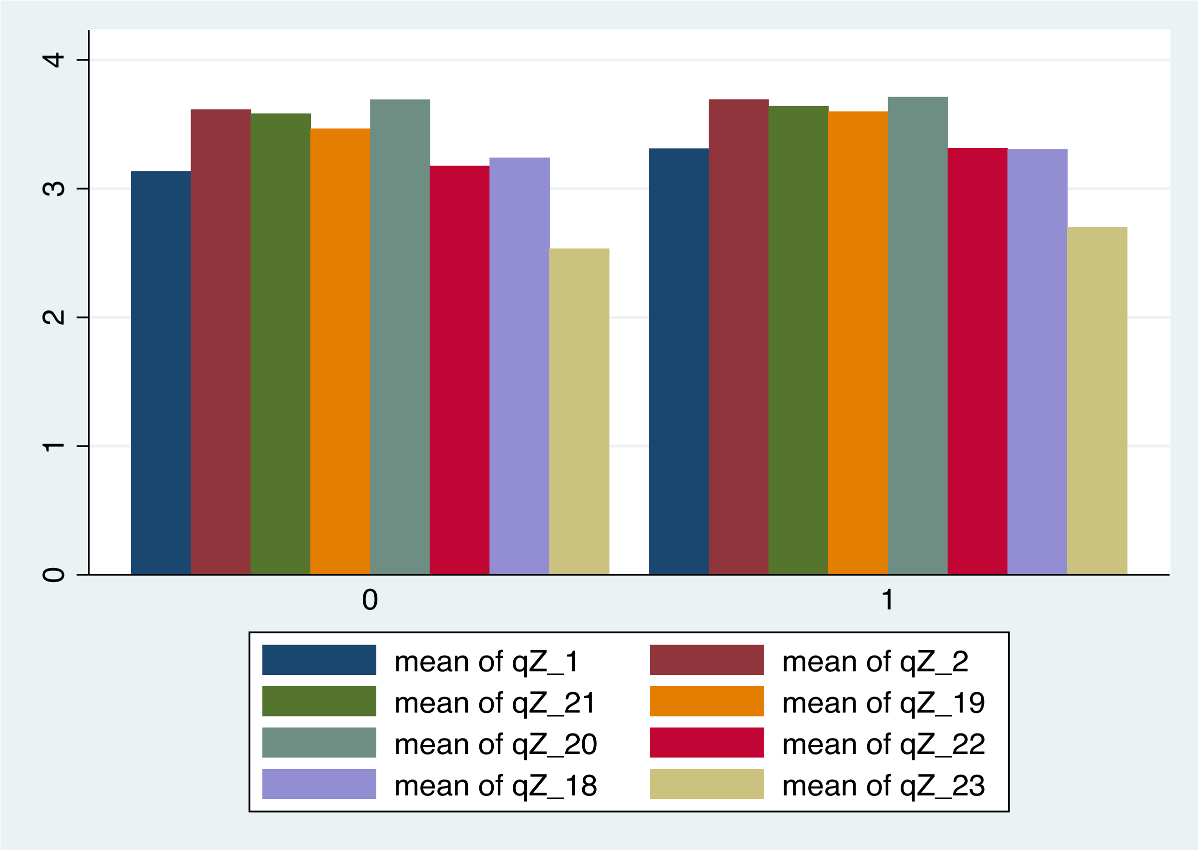
Table 5: Willingness to alter specific Food intake in relation to weight status and gender

Eating Behavior Question		Weight status				P-value	Gender				P-value
		HW (freq)		OW&OB^			Females		Males		
Can you...		Freq	%	Freq	%		Freq	%	Freq	%	
Reduce fried & fatty food (qZ_3)											
	1	256	10.64	160	9.28	**0.015**	200	9.05	236	11.24	**0.005**
	2	458	19.04	288	16.71		382	17.29	401	19.1	
	3	497	20.66	329	19.08		424	19.19	435	20.71	
	4	496	20.62	374	21.69		483	21.86	413	19.67	
	5	699	29.05	573	33.24		721	32.62	615	29.29	
Total		4130					4310				
Eat a Fruit every day (qZ_4)											
	1	80	3.33	62	3.58	0.348	55	2.49	94	4.45	**<0.001**
	2	193	8.02	119	6.87		129	5.83	198	9.38	
	3	273	11.35	209	12.07		246	11.12	255	12.09	
	4	393	16.33	312	18.01		347	15.69	385	18.25	
	5	1467	60.97	1030	59.47		1435	64.87	1178	55.83	
Total		4138					4322				
Eat your favorite Fruit for desert (qZ_5)											
	1	286	11.82	196	11.35	0.325	234	10.55	272	12.9	**0.001**
	2	341	14.09	249	14.42		287	12.93	333	15.8	
	3	439	18.14	277	16.04		374	16.85	371	17.6	
	4	474	19.59	371	21.48		461	20.78	416	19.73	
	5	880	36.36	634	36.71		863	38.89	716	33.97	
Total		4147					4327				

Eat salad every day (qZ_6)										
	1	298	12.37	189	11.06	0.238	210	9.55	294	14.01	**<0.001**
	2	377	15.65	247	14.45		306	13.92	352	16.78	
	3	399	16.56	274	16.03		328	14.92	369	17.59	
	4	451	18.72	315	18.43		434	19.75	361	17.21	
	5	884	36.7	684	40.02		920	41.86	722	34.41	
Total		4118					4296				
Add your favorite vegetable in a sandwich qZ_7)											
	1	417	17.46	254	14.75	**0.031**	335	15.28	369	17.58	0.243
	2	374	15.66	280	16.26		342	15.6	343	16.34	
	3	439	18.38	347	20.15		422	19.25	392	18.68	
	4	494	20.68	320	18.58		443	20.21	411	19.58	
	5	665	27.84	521	30.26		650	29.65	584	27.82	
Total		4111					4291				
Eat cooked vegetables 2-3 times per week (qZ_8)											
	1	614	25.53	438	25.58	0.052	551	25.1	539	25.68	0.892
	2	537	22.33	365	21.32		475	21.64	463	22.06	
	3	497	20.67	308	17.99		430	19.59	422	20.1	
	4	367	15.26	273	15.95		349	15.9	320	15.25	
	5	390	16.22	328	19.16		390	17.77	355	16.91	
Total		4117					4294				
Drink fruit juice for breakfast (qZ_11)											
	1	133	5.49	86	4.96	0.525	109	4.91	116	5.48	0.491
	2	173	7.15	116	6.69		154	6.93	156	7.38	
	3	289	11.94	191	11.01		269	12.11	229	10.83	
	4	376	15.53	297	17.13		374	16.84	336	15.89	
	5	1450	59.89	1044	60.21		1315	59.21	1278	60.43	
Total		4155					4336				
Drink fruit juice for snack (qZ_12)											
	1	237	9.93	165	9.69	0.54	199	9.13	215	10.31	0.055
	2	278	11.65	190	11.16		231	10.6	262	12.57	
	3	446	18.69	308	18.1		396	18.17	391	18.75	
	4	552	23.13	371	21.8		519	23.82	438	21.01	
	5	873	36.59	668	39.25		834	38.27	779	37.36	
Total		4088					4264				
Eat whole wheat cereal and biscuits (qZ_13)											
	1	410	17.26	275	16	**<0.001**	343	15.73	372	17.8	**0.008**
	2	417	17.55	264	15.36		332	15.22	379	18.13	
	3	538	22.64	328	19.08		467	21.41	444	21.24	

	4	446	18.77	342	19.9		433	19.85	383	18.33	
	5	565	23.78	510	29.67		606	27.79	512	24.5	
Total		4095					4271				
Drink sugar free soda instead of regular (qZ_14)											
	1	610	25.89	304	17.88	**<0.001**	446	20.55	508	24.66	**<0.001**
	2	329	13.96	181	10.65		261	12.03	274	13.3	
	3	369	15.66	237	13.94		310	14.29	323	15.68	
	4	335	14.22	271	15.94		330	15.21	297	14.42	
	5	713	30.26	707	41.59		823	37.93	658	31.94	
Total		4056					4230				
Have margarine instead of butter (qZ_15)											
	1	850	35.86	545	31.85	**<0.001**	695	31.88	755	36.4	**0.005**
	2	382	16.12	232	13.56		318	14.59	325	15.67	
	3	343	14.47	253	14.79		327	15	296	14.27	
	4	297	12.53	225	13.15		294	13.49	251	12.1	
	5	498	21.01	456	26.65		546	25.05	447	21.55	
Total		4081					4254				
Have fish once a week (qZ_16)											
	1	231	9.73	161	9.46	0.3	203	9.34	201	9.7	**0.01**
	2	214	9.01	162	9.52		189	8.7	209	10.08	
	3	331	13.94	207	12.16		256	11.78	306	14.76	
	4	370	15.58	246	14.45		340	15.65	291	14.04	
	5	1229	51.75	926	54.41		1185	54.53	1066	51.42	
Total		4077					4246				
In total 12 food related questions											

Bar graph by weight status



where 0 for underweight & NW; 1 for OW & OB children

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qZ_1 "can you eat smaller food portions"; qZ_2 "take to school a snack from home;
qZ_18 "Can eat different food item compared to your friends when you are together";
qZ_19 "Can reduce sweet intake if these are not present at home"; qZ_20 "eat more
F&V per day if have more at home"; qZ_21 "eat more frequently healthy snacks at
school if more were sold at the canteen"; qZ_22 "eat more freq. healthy snacks if
these were TV advertised"; qZ_23 "to your opinion how much do your friends affect
your snack selection"
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4. General Discussion

The Centers of Disease Control and Prevention (CDC) categorizes most chronic diseases, including obesity, as largely preventable and related to behavioral risk factors and poor dietary habits (Centers for Disease Control and Prevention, 2016), as the results of this dissertation has shown. Obesity is a complex disease that results from the interactions of a variety of hereditary and environmental factors. Childhood obesity has reached epidemic levels, with US officials reporting one in three children being overweight or obese (Ogden et al., 2015, Wifley et al., 2016).

Conventional treatments of obesity including: various «diets» and «Medical treatments» in adults have been greatly unsuccessful. The Total Energy Balance defined as Energy Intake (EI) minus Energy Expenditure (EE) has been used to explain the increase in overweight and obesity in children and adults. This has been argued to be an oversimplification of the process by many scholars and investigators, since the weight burden most likely tends to be a multifactorial process that includes genetic predisposition, food intake and environmental factors (Birch et al 2001). Food and environmental factors have been found to account for 95% of the obesity burden. Many researchers have reported short and long term beneficial effects for obese children undergoing a combined dietary-behavioral-physical activity intervention plan (Nemet et al., 2005), highlighting the importance of early intervention and multidisciplinary effects.

Intervening at an earlier stage may therefore be of great importance. This has lead researchers to the study of the vulnerable age of childhood, since this may be the key to combating overweight and obesity. This has also been the basis for this thesis, where data from the GRECO study were used in order to identify factors from a long a time span from in uterine life based on the Early Life Theory, until the date the study took place. Data gathered were analyzed based on ‘a priori’ knowledge and specific aims were investigated, as stated in the section of Scope.

The rise in childhood overweight and obesity is a major public health burden that should be addressed since it increases the risk for the development of various chronic diseases later in adult life (Dietz el al., 1998., Freedman et al., 2005, Freedman et al., 2015, Berenson et al., 1998). Overweight 2-5 year old children were >4 times as likely to become overweight adults, compared to their healthy weight peers (Freedman et al., 2005). Furthermore, recent data suggest that childhood overweight and obesity is also associated with immediate health problems, such as asthma (Gilliland et al., 2003), hypertension and other cardiovascular risk factors (Reilley et al., 2003), psychological or psychiatric problems (Reilly et al., 2003), and type 2 diabetes mellitus (Luppino et al., 2013, Reilly et al., 2003). It is well known that even modest increases in weight have implications for long-term adiposity related metabolic diseases (Mozafarian et al., 2011) therefore a food index that can screen children at risk for higher childhood weight based on BMI percentiles was of great importance. Upon performing and analytic literature review, significant findings on obesogenic and protective foods were obtained for children and a dietary pattern with high sensitivity was constructed that can detect children at risk for overweight and obesity. Data for Index development used was based on population wide evidence: Mediterranean and National Healthy eating guidelines. A total of 14 foods, categorized as positive - non-obesogenic or negative – potentially-obesogenic foods, were included in the FI, based on a priori knowledge of food items and food patterns for children. An index with a large but not complex scoring scale was created for greater sensitivity. Specifically the FI included eight (8) positive - non-obesogenic foods: fruit, vegetables, whole grains, fish, nuts, legumes/pulses, milk and yogurt; and six (6) negative – potentially-obesogenic foods include: cheese, red meat, sugared sweet beverages (ssb's), processed food, fast food, and sweets. Considering suggestions that it is preferable to design scoring ranges or let the score be proportional to intake, instead of using simple cut-off values, not only because this is more subtle but also with regard to foods that have shown a U-shaped correlation with health outcome (Waijers et al., 2007), a scale of 1-4 was used in the cd-FI development, according to intake, with a weighting system in order to increase its discriminating power. In all child-based indices that have been developed to date, all individual variables are given the same weight therefore all foods contributed equally to the score. It has been suggested that it is not plausible for all index components to have the same health impact (Weijers eta al, 2006) and moreover the same obesogenic or non-obesogenic effect. Therefore, based on the population studied, and considering their growth needs, higher weights were given to milk and yogurt, due to their Calcium and Phosphorus content, as well as to whole grains, to vegetables and fruits, considering the overwhelming evidence for their health benefits, in the development cd-FI. Since this is the first time to our knowledge, that weights are given to food items, and since the exact "health" impact is difficult to ascribe, the weights given may be underestimated. Research specifically testing the Risk Ratio (RR) of the individual index components on obesity may be warranted in order to determine more specifically the exact differences in weights of each individual component in the index. Energy intake was not adjusted for due to the age group studied, since although Energy is a probable strong confounder in the adult population, in children it may lead to misclassification since children's Energy needs are related to their growth and activity level, a difficult variable to measure.

The FI was validated and sensitivity of overweight detection was tested by randomly spltting the study sample (75%-25%). A detailed description of the FI score derivation has been previously published (Magriplis et al., 2015). Theoretically the final FI score can range from a minimum of 16 to a maximum of 64. Higher child derived FI values indicate a lower risk of overweight and obesity risk, and healthier dietary intakes among children.

The cd-FI constructed adequately distinguished overweight and obese children, from their healthy weight peers among a nation wide sample of school-aged children.

The relative contribution of each individual component to the total score has been addressed only once to date for adults, upon our knowledge (Kim et al 2003).

At this point of the discussion the controversial use of BMI in children should be referred to. Various standards have been proposed for defining overweight in adolescence, but few studies have evaluated their diagnostic accuracy (Neovius et al, 2004). They found that the IOTF (year

2000) and the WHO standards (1991) have very high specificity, therefore few are mistakenly classified overweight, but a low specificity, especially in female adolescents (Neovius et al, 2004). In order to minimize this potential misclassification, BMI data derived were scattered with measured body fat percentage and measured weight and height. Any extreme variables were omitted from the data, as has been suggested (Ogden et al, 2006), hence increasing the strength of our results.

As stated earlier, childhood overweight and obesity is multifactorial. Therefore, although the cd-FI adequately predicted the children at higher risk for overweight and obesity, it could be argued that the effect of a dietary pattern with obesogenic eating and behavioral factors on children's weight status, using the previously validated cd-FI developed to predict child overweight and obesity (Magriplis et al. 2015), may be due to other residual factors.

The first factors accounted for were behavioral factors, shown by researchers to increase likelihood of child weight gain and obesity. The behavioral factors addressed, included sleep duration, total screen time (average per day) and total study hours. The latter is a new variable, first used, to our knowledge, by the team in GRECO study, that adds to the 'proxy' of inactivity in school-aged children. Other behaviors examined included number of meals per day, frequency of having meals while on a screen (watching TV, DVD, playing video games/consoles, using computer), frequency of having family meals with family members, and frequency of eating/ordering out.

Results showed that total sleep & screen duration, frequency of family meals, frequency of eating out, and frequency of eating while watching TV, when adjusted for age, were associated with cd-FI score, significantly increasing it's predictive ability of childhood overweight and obesity. Also, when cd-FI was accounted for in a model relating children's weight status and behavioral factors, this was found to be associated with FI score, with the likelihood of children being overweight or obese decreased when they slept more, studied less, and had a higher FI score, had more frequent family meals and consumed more meals per day.

In this study, for each hour increase in total study hours the likelihood of child overweight and obesity increased by 6%, while with each hour of sleep duration the likelihood decreased by 8%. Meals per day and frequency of family meals were also significant to BMI status. It must be underlined that although crude total screen time was significantly associated with increased odds of overweight and obesity in children, the effect was nulled in a the model that included cd-FI and total study time. As previously stated, total study time is a new inactivity factor that was accounted for, and has not been extensively studied. The nulled association between total screen time and weight status is supported by other researchers reporting controversial findings on TV-viewing, BMI status and food intake or patterns (Fuller-Tyszkiewcz et al., 2012, Carson et al., 2012). Intervention studies on total screen time targeting overweight and obese children have not found a significant change in BMI (Maddison et al., 2014). Researchers have found that dietary patterns mediate the association between TV-viewing and BMI in children (Fuller-Tyszkiewcz et al., 2012), while others did not find a significant mediating effect on the relationship between TV snacking and junk food intake on TV-BMI relationship (Carson et al., 2012). In the latter case however, participants self reported their weight and height and like Borghese et al., (2015) only food items consumed while watching TV were determined; BMI was not related to other dietary patterns. Information that assesses food intake as a whole, along with the children's' total screen time is therefore required and the potential mediating effect of diet through the FI score should be further determined, in relation to screen time and to sleep. The extent of the mediation should be further investigated. An association, however, between having a TV in the bedroom and waist circumference, used as a proxy measure of abdominal obesity, was found, as has been reported by others (Rey Lopez et al., 2008, Dubois et al., 2008). This finding suggests that TV-viewing may need to be distinguished from total screen time. In further support to these findings, researchers have found an inverse association of specific dietary patterns and TV-viewing (Sisson et al., 2012); total screen time (Lazarou et al., 2011); Elements with a less healthy diet (Dubois et al, 2008, Campbell et al., 2006, Utter et al., 2006, Pearson et al., 2014, Gebremariam et al., 2013);or the child's BMI and the frequency of eating while watching TV (Dubois et al., 2008). These findings further strengthen the suggestion that dietary patterns act as a mediator in the association between TV viewing in the to child overweight and obesity risk, with the types & quantity of food, and the frequency that children eat while watching TV, and not total screen time itself. This may also explain the association of having a TV in the room and increased waist circumference.

The association between having a TV in the bedroom and waist circumference remained even when sleep duration was accounted for, which can be seen as a possible confounder. Whether sleep duration is a factor in the potential causal path of screen and obesity remains to be investigated.

The effect of total study time, remained significant, and was inversely associated with an increased likelihood of children being OW or OB. Study hours were negatively associated with children's BMI status, as has been shown by Farajian et al., (2014) in a simpler model, but positively with total FI score. The mechanism behind this association is not clear since to date study time has not been well studied, although it seems that study time greatly increases total inactivity time. From these study's results study time seems may be related to BMI status via a greater food consumption and not only via an obesogenic dietary pattern. More studies evaluating similar child age populations may increase the understanding behind this new potential obesogenic factor.

The knowledge of factors that may highly increase children's risk for overweight and obesity is greatly improving and most if not all of previously reported dietary and behavioral obesogenic factors have been assessed upon intervention programs on children. However interventions that target these factors have minimal to no effects. For example, results from systematic reviews and meta-analyses show significant but small effect of interventions studies performed to reduce children's sedentary behavior (Biddle et al, 2015). The major flaws of most interventions may be the self-perception of the child in general and more likely, once they reach the overweight/obese status. This hypothesis is strengthened by a study that promoted active game interventions and found a small but significant reduction in BMI and body composition of overweight and obese children (Maddison et al 2011). Technology based interventions in children and adolescents, has recently been used by other researchers as well to improve weight status (Chen et al., 2011). Furthermore, cognitive mediators of self-efficacy and planning were found to increase fruit and vegetable intake among normal weight and overweight/obese adolescents, but planning alone did not result in a decrease of energy dense food (Luszczynska, et al., 2016). These findings lead to the next section important section of the discussion, which is 'getting to know the children'. The GRECO study was used to examine school children's willingness to ameliorate eating behaviors in relation to their weight-status and their current eating patterns, as well as to assess potential gender differences and found that a greater percentage of females and overweight & obese children express greater assertiveness to alter various eating behaviors and habits. Eating behaviors were assessed based on gender differences and weight status, to assess the possible effect that a child's weight may have on their response. Total cd-FI score was also investigated and findings suggest that the higher the mean score, the more assertive children are in change. Awareness and knowledge may be the reason behind this finding.

A high percentage of children in the GRECO study responding sure or very sure in increasing healthy snack intake and replacing ssb's with their no sugar counterpart, if this was offered, as has been suggested by other researchers (Briefel et al., 2009, Fox et al., 2009). Luszczynska et al, 2013, also, found that the associations between the use of self-regulatory strategies and lower ssb intake become significantly stronger with age (Luszczynska et al., 2013). However authors reported that accessibility was related negatively to self-regulation, whereas higher social pressure was associated with higher self-regulation, suggesting that if ssb's are limited only, and then once encountered, may lead to overconsumption. This has been reported 18 years ago, when research suggested that ¼ child feeding strategies that restrict children's access to snack foods actually make the restricted foods more attractive (Birch, 1999), and that when food is made freely available children will choose more of the restricted than the unrestricted foods particularly when the mother is not present (Fisher and Birch, 1999). Suggestions on limiting food access, however, continue to prevail.

Although in this study overweight and obese children reported more willing to alter specific eating habits, Roseman et al., 2007, found that healthy weight was associated with consuming fruits, vegetables, breakfast, and milk. Underweight and healthy-weight students consumed more fruits than students who were at risk of being overweight and overweight. Healthy-weight students consumed more "other vegetables" than students who were at risk of being overweight and more "other vegetables" and carrots than overweight students. This was however accounted for when data were analyzed based on total cd-FI score. Results were in confirmation with findings reported by Roseman et al., (2007), since the higher the score the more assertive children responded to change. Therefore although overweight & obese children may consume less frequently “healthy foods” stated above, they did respond willing to add fruits and vegetables in a specific way. On the other hand a study found that children tend to choose higher E dense snacks compared to healthier ones (Kenney et al, 2014) even when Cafés offer healthier options.

Methods used to formulate the change and home & school availability may some factor that should be considered as this study showed.

Weight perception was also assessed for, as a proxy for self-esteem, in relation to eating behaviors. It must be noted that 34% of obese girls have been reported to have low self esteem compared to 8% among non obese girls, aged 13-14 years of age (Strauss et al., 2000). Recent findings, via a meta-analysis, have linked depression to the development of obesity (Luppino et al., 2010). Children in this study with high weight perception-self-esteem were more likely to reduce portion size and responded that peer opinion did not affect their snack selection, and overweight and obese children are willing to alter some eating behaviors and habits. “How happy are you with your weight” question was used as a proxy measure of a child’s self esteem level. This was done in order to account for psychological factors that have been shown to trigger binging in children. Individual characteristics may make a child more or less susceptible to various external stimuli, and many studies may have failed to show an effect or lead to prevention due to this limiting step – understand their study population and their readiness for change. Programs may need to be modified and adapted to these characteristics.

Improved care-coordination, clinical-community integration, and interprofessional education, are some of the factors that have been proposed in order to provide comprehensive, multi-component treatment to the children in need (Wifley et al., 2016). The child's readiness to change and factors affecting their assertiveness however needs to be taken into account, as findings suggest, in order to develop strategies and interventions that will be effective.

Dietary, behavioral and self-esteem factors have been identified in this thesis as factors that need to be addressed in order to decrease or even prevent childhood overweight and obesity. Researchers however have identified early life factors, such as maternal smoking, that may also lead to an increased risk of overweight and obesity later in life. The question, therefore, asked was how does maternal smoking relate to the previous findings. based on data obtained from parents or primary care givers, maternal smoking, one of the most important modifiable factors during pregnancy, was found to be significantly associated with children's weight status and central adiposity in all models tested, including maternal and child characteristics, coffee and alcohol intake during pregnancy, child behavioral factors and dietary patterns. The association however, was not significant for total body adiposity (%).This suggests direct effect of maternal smoking during pregnancy on children's risk of overweight or obesity later in life as well as an increased risk for higher central adiposity as has also been reported by Simmons et al., (2008). Controversial findings, however remain, between maternal smoking and child weight status, and these may also be age related. As longitudinal studies have shown, the age of onset may be a significant factor to address when assessing the effect of maternal smoking on the epidemic of child overweight with child obesity developing with age, and differences over time increasing (Riedel et al., 2014, Timmermans et al. 2014). Researchers have found higher adiposity levels in children whose mothers smoked during pregnancy, among older children (Peters et al. 2015, Salsberry et al. 2005), and in toddlers (Oken et al. 2005; Salsberry et al. 2005), although others that tested infant BMI (Durmus et al. 2011) found no association, suggesting possible later onset. Furthermore, another longitudinal studies reported a stronger association of maternal smoking with BMI in adulthood (Power et al., 2002). This may further enlighten the possible mechanism that underlies maternal smoking and child weight status.

In discordance to other researchers (Wang et al., 2013) maternal education level did not differ among smokers and non-smokers and did not have a significant effect when entered in the models for BMI category, adiposity and waist circumference. This may be due to recall bias, although all statistical measures were taken to decrease this effect. Responding bias may also be another possible reason.

No effect was found between systolic or diastolic blood pressure and maternal smoking. Studies on BP have shown that parental prenatal smoking have the same effect on children's BP as maternal smoking during pregnancy, suggesting that childhood BP may be due to other than intra-uterine programming, and that associations found by other studies may have been due to minimally adjusted models used, hence confounding (Brion et al., 2007). Of course, this also remains controversial.

Social desirability concerns may have caused under-reporting of smoking behavior, although this limitation would have lead to a further increase of the association. Due to the nature of the study, and as in all observational studies, unmeasured systematic differences between smokers and non-smokers that are possibly associated with the outcome, may partly explain the findings. This was controlled for, by adjusting for a-priory known variables that have been associated with children's weight status and adiposity, without however over-controlling.

5. Conclusions

Childhood obesity, today termed a disease, has been linked with many chronic diseases. The younger the age overweight and obesity occurs, the longer the individuals have the outcome hence the longer they «carry» obesity related risk factors in their life span. The earlier detected and treated, the lower the potential complications and disease outcomes. Early intervention is also important because less weight change is needed at younger ages to achieve a healthy weight compared with the amount of weight loss necessary at older ages. To date, however, most children with obesity do not receive evidence based care and many health care professionals continue to believe that obesity in childhood is relatively unimportant, and view it as a largely cosmetic problem.

Although a causal effect nor a temporal effect among factors investigated throughout this thesis, due to its nature, many important associations were derived adding the knowledge and understanding of childhood obesity. The child derived Food Index can be a useful tool for health care professionals, in the prevention of child obesity. The dietary aspect that should probably be addressed by health care professionals, includes the amount of obesogenic in relation to potentially protective foods, and not the complete restriction of the former. Relating food choices via the cd-FI to children's current life style behavior is also necessary, other than focusing only on increasing physical activity, since TV, gadgets and social media are most probably here to stay. A child may be more open to cooperate if an intervention is aimed based on their habits instead on past "known" healthy lifestyles.

Furthermore, the development of children's food preferences involves a complex interplay of innate, familial and environmental factors, not all of which are likely to promote a healthy and varied diet. It may therefore not be enough to limit the access to competitive foods and beverages, or to enforce strong school wellness policies. Awareness is probably the key to effective implementation and in order to create awareness one needs to understand children's perceptions, family food environment and their readiness to change is therefore warranted. A public health team approach, developing strategies that include manufacturers and family members, including children may be more effective.

Lastly, self efficacy and perception, a predictor of behavioral performance across a range of health domains. Determinants of self-efficacy in eating behavior is an area that has not been readily examined. What has been examined is food availability and food policies, which although important, are at the tip of the pyramid, if one can view it along the food pyramid distribution. Understanding children’s needs and perceptions may be the base of the pyramid along with parental training leading to the main goal which is the treatment of the outcome, and more so to the prevention of childhood obesity.

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7. Future work

The GRECO study is a study that has much more information to extract from. Further research areas that have been already identified and need further examination include:

i. The effects of maternal usual dietary intake, maternal smoking and breastfeeding on children's food patterns and risk of central obesity
ii. The potential mediating effect of total screen time and study time on sleep duration in the increase of child weight status or adiposity level
iii. The effect that parental feeding habits have on children's weight status: ad lib versus restrictive versus in moderation
iv. Are children termed overweight based on BMI cut-offs classified correctly? Associating overweight classification with other anthropometric indices (waist circumference, total fat percentage, waist to hip ratio).
v. Identifying behavioral patterns that increase the likelihood of obesity among school aged children, using assertiveness to change questionnaire

Appendix 1 (Abstracts presented in conferences)

ΓΕΩΠΟΝΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
AGRICULTURAL UNIVERSITY OF ATHENS

Ref: 149 / 1263

TITLE: Newly Derived Children Based Food Index. An Index That May Detect Childhood Overweight and Obesity

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INTRODUCTION

Obesity in children is of Global concern and is currently termed an epidemic. Studies have shown the importance of diet on overweight (OW) and obesity (OB), hence Food Indexes (FI) mostly for adults have been developed to assess dietary patterns while accounting for food interactions. Children remain understudied and a simple tool to detect OW/OB is still warranted.

OBJECTIVES

To develop a FI for children, that detects OW/OB based on: (1) a-priory knowledge, (2) USDA data and (3) the Mediterranean Food Pyramid guidelines.

METHODS / DESIGN

The FI included 14 foods : 8 «positive: non-obesogenic» and 6 «negative: obesogenic» foods. Scores were set according to intake, from 1 to 4 or 4 to 1 respectively with weights of 1.5 given to some. Statistical tests, such as Adjusted Coefficient of variation (R2), Cronbach-α, Random sampling via splitting data into two new sets (75%/25%), were used to test the index's sensitivity. The FI was validated using the GRECO study.

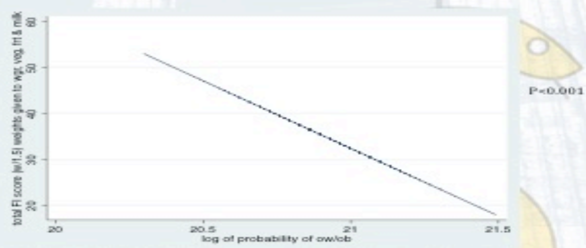
Table 2: FI scoring system with GRECO frequency

Score	4	3	2	1
Food group*				
Whole grains (x 1.5)**	≥4	≥3,<4	≥2,<3	<2
Vegetables (x 1.5)**	≥4	≥3,<4	≥2,<3	<2
Fruit^ (x 1.5)**	≥3	≥2,<3	≥1,<2	<1
Milk (x 1.5)**	≥2	≥1,<2	>0, <1	0
Yogurt	≥2	≥1,<2	>0, <1	0
Fish	≥2	≥1,<2	>0, <1	0
Nuts	≥3	≥2,<3	≥1, <2	<1
Legumes	≥2	≥1,<2	>0, <1	0
Red meat	<1	≥1,<2	≥2,<3	≥3
Processed food	<1	≥1,<2	≥2,<3	≥3
Cheese	≤1	>1-≤2	>2, <3	≥3
Fast-food	0	>0-≤1	>1, ≤2	>2
Sugar sweet beverages (ssb's)	<1	≥1, <2	≥2, <3	≥3
Sweets	<1	≥1, <2	≥2, <3	≥3

RESULTS

All food variables in the FI added to the model (adj. R2= 0.989) and a good intercorrelation was found (Cronbach-a= 0.7). In the GRECO population, the score ranged from 17 to 53.5 (mean 34.8 ±5.01), was inversely associated with BMI (-0.057 ±0.02; 95%CI -0.098, -0.017) and waist circumference (WC) (-0.08± 0.03, 95% CI: -0.137, -0.022). Associations remained significant upon adjusting for age, gender and inactivity (p=0.02 and p=0.013, respectively). Sensitivity analysis showed that the probability of children being OW/OB decreases significantly (p<0.001) as the FI score increases.

Graph: The log probability of children being overweight/obese vs the total weighted FI score.



CONCLUSIONS

The FI developed has high sensitivity, strengthening its power in detecting OW in children. It adequately distinguished OW/OB children, from normal weight. The weights given to specific foods require further validation.

Title: Butter Or Margarine? A Dietary Patterns Approach Of The Controversy

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Abstract

Overview: Many scientists, health care professionals and researchers are still debating whether to recommend butter or margarine, although soft margarines contain mono- and poly-unsaturated, and no trans-fatty acids.

Objectives: A nationwide cross-sectional study was used to identify food patterns potentially associated with children's BMI, and to investigate how these patterns relate to butter and margarine intake. Secondary objective was to assess the children's assertiveness in butter or margarine intake based on their BMI status.

Methods: Data from 3098 children, 10-12 years of age, were included in the analysis. Anthropometric measurements were performed. Dietary information were obtained via a semi-quantitative Food Frequency Questionaire (FFQ). Principal component analysis on 15 food groups, selected based on previous relevant studies, was applied to identify dietary patterns. Multiple nested linear and logistic regression analyses were performed using STATA 12.0.

Results: Four (4) dietary patterns were identified, explaining 44% of the variation in intake. KMO (Kaiser-Meyer-Olkin measure of sampling adequacy) of 0.81 was derived and all food group had KMO>0.67. The components were characterized as follows: 1st pattern: higher simple sugars intake (fruit and sweets); 2nd pattern: higher consumption of vegetables and legumes and lower fast-food and sweet intake; 3rd pattern: higher protein and saturated fat intake (red meat and pulses) and lower liquid calories intake (milk and juice); And 4th pattern: higher fiber intake and polyunsaturated fatty acids (PUFA) and lower animal protein and saturated fats (red meat) and sugar sweetened beverages.

Multiple linear regression analysis, adjusted for age and gender, revealed that children's BMI was positively associated with components 2 and 3 (0.25 ±.05; $p<0.001$ and 0.12 ±.06; $p<.04$, respectively) and negatively associated with components 1 and 4 (-0.29±.04; $p<.001$ and -0.34 ±.06; $p<.001$, respectively). When adjusted for over and under-reporting the association between BMI and pattern 1 was nulled, but remained significant in the others. Multiple logistic regression analysis revealed that dietary patterns and BMI status, differ between frequency of butter and margarine consumption. The 3rd pattern was associated with 14% higher odds of butter consumption, whereas no significant association was found with margarine. Differences in butter and margarine intake were not significantly different with patterns 1 and 4 (30% and 16% for butter versus 28% and 14% for margarine, respectively). The second pattern was not significantly associated with either butter or margarine intake. Furthermore, ow and ob children reported more likely of replacing butter intake to margarine ($p<.001$).

Conclusion: A dietary pattern characterized by high protein and red meat intake is associated with a higher BMI and with butter consumption but not with margarine. These findings remained when under-reporters were excluded.

Score coefficients as per principal component analysis of 15 food groups

Food groups	**Component 1**	**Component 2**	**Component 3**	**Component 4**
Fruit	**0.3113**	0.1940	-0.1153	-0.1805
Vegetables	0.2919	**0.4177**	0.2129	-0.0100
Legumes	0.1339	**0.4624**	**0.3837**	0.1274
Nuts	0.2380	-0.0794	0.0835	**0.4786**
Fish	0.2525	0.1531	0.1168	-0.1930
Red-meat	0.2109	-0.1190	**0.4982**	**-0.3538**
Processed food	0.1139	-0.2938	0.2140	0.0518
Fast food	0.2917	**-0.4371**	0.2076	-0.1054
Cheese	0.2925	0.0835	0.0473	0.0855
Sugared sweetened beverages	0.2495	-0.2432	-0.2127	**-0.3404**
Whole grains	0.2784	0.0478	-0.1030	**0.5087**
Sweets	**0.3460**	**-0.3693**	0.0297	0.1877
Milk	0.2217	-0.0324	**-0.3601**	0.1955
Yogurt	0.2492	0.1744	-0.2019	-0.1987
Fruit Juice (100%)	0.2840	0.1288	**-0.4550**	-0.2257

KMO (Kaiser-Meyer-Olkin measure of sampling adequacy) of 0.81 was derived and all food group had KMO>0.67

Maternal smoking and school children's weight status and adipocity level: the basis of Early Life Theory from the GRECO study

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Abstract

Overview: Based on the Early Life Theory, a great number of chronic diseases that occur later in life start from in utero fetal development. There is increasing evidence that children's health and weight-status may be «programmed» from in utero life, therefore affected by maternal behavior. Maternal smoking may be one such factor affecting child weight status, adipocity level and blood pressure, later in life.

Objectives: The aim of the study was to examine the effect of prenatal and maternal smoking on school children's weight status, as defined by the International Obesity Task Force (IOTF) BMI cutoffs, central adipocity, defined by waist circumference (wc), and total adipocity, measured with bio-impedance analysis (BIA). Secondarily, the potential association of maternal smoking with children's blood pressure (BP) in relation to children's weight status and diet quality was investigated, since BP is a heart disease marker.

Methods: Data from parental questionnaires given during national cross sectional study were used in the analyses. A total of 2001 parental questionnaires were gathered with complete data available in a sample of 837 which were included in the final analysis. Anthropometric measurements were performed. Children's BP was measured via two consecutive measurements, after 10 min relaxation period, in the field. Children's dietary information were gathered via a semi-quantitative food frequency questionnaire (FFQ). Multivariate logistic and

linear regression analysis were conducted, adjusting for multiple covariates including, age & BMI at pregnancy, current maternal BMI, weight gain during pregnancy, maternal education, alcohol and coffee intake during pregnancy, birth weight and height, gestational weeks, as well as children's age and gender.

Results: Children were 1.8 times more likely to be ow (95% CI:1.04, 3.12, p=0.037) and 2.3 times more likely to be obese (95% CI:1.05, 5.13, p=0.035) if their mother smoked during pregnancy compared to their healthy weight peers. The model was adjusted for known confounding factors, including caffeine which was also highly significant with smoking (p<0.001). Maternal smoking was also found positively associated with children's total body fat percentage (95%CI 0.338, 4.118), as well as maternal current BMI (95% CI: 0.104, 0.533), and negatively associated with age at pregnancy (95% CI: -0.312, -0.042). Systolic and diastolic blood pressure, were associated with overweight and obesity, height at birth, but not maternal smoking. SBP was also positively associated with age whereas diastolic was positively associated with sleep duration.

Conclusion: Maternal smoking, was found to increase the odds of being ow or ob and was associated with a higher adipocity level in school aged children. This remained significant upon adjusting for known covariates that increase risk of childhood ow. Fetal programming may therefore be greatly affected by maternal smoking one of the most important modifiable risk factors, and affect not only weight status but adipocity levels as well, which is highly linked with increased risk of chronic diseases.

Maternal Smoking & BMI status association: 4 Models

Model 1

- Model adjusted for: children's age & gender, children's birth weight & length, gestational weeks, maternal education, maternal BMI, weight increase during pregnancy and maternal age

Model 2

- Model 1 + maternal alcohol & coffee intake during pregnancy

Model 3

- Models 1,2 + children's sleep, screen and study time

Model 4

- Models 1,2,3 + Total cd-FI score

Appendix 2 (Questionnaires used for the GRECO study)

ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΜΑΘΗΤΗ

ΚΩΔΙΚΟΣ:

ΗΜΕΡΟΜΗΝΙΑ ΣΥΜΠΛΗΡΩΣΗΣ ΕΡΩΤΗΜΑΤΟΛΟΓΙΟΥ: _ _/_ _/_ _ _ _ — **ΤΑΞΗ:** ☐ Ε’ Δημοτικού ☐ ΣΤ’ Δημοτικού

ΣΧΟΛΕΙΟ:

Α. ΔΗΜΟΓΡΑΦΙΚΑ ΧΑΡΑΚΤΗΡΙΣΤΙΚΑ

ΦΥΛΟ 1. Αγόρι ☐ 0. Κορίτσι ☐ — **ΗΛΙΚΙΑ:**

ΗΜΕΡΟΜΗΝΙΑ ΓΕΝΝΗΣΗΣ: _ _/_ _/_ _ _ _

Διεύθυνση κατοικίας: — **Νομός:** — **Πόλη:** — **Τ.Κ:**

Β. ΚΟΙΝΩΝΙΚΟ-ΟΙΚΟΝΟΜΙΚΑ ΧΑΡΑΚΤΗΡΙΣΤΙΚΑ

1. Ποια μέλη της οικογένειά σου μένουν μαζί σου στο σπίτι;

α. Μητέρα	1. ΝΑΙ ☐	0. ΟΧΙ ☐	
β. Πατέρας	1. ΝΑΙ ☐	0. ΟΧΙ ☐	
γ. Αδέρφια	1. ΝΑΙ ☐	0. ΟΧΙ ☐	Αν ΝΑΙ, πόσα; ....
δ. Παππούς	1. ΝΑΙ ☐	0. ΟΧΙ ☐	
ε. Γιαγιά	1. ΝΑΙ ☐	0. ΟΧΙ ☐	
στ. Άλλος (διευκρίνισε)	…………...		

2. Στο δωμάτιό σου κοιμάσαι μόνος σου; 1. ΝΑΙ ☐ 0. ΟΧΙ ☐

3. Έχεις στο δωμάτιό σου τηλεόραση; 1. ΝΑΙ ☐ 0. ΟΧΙ ☐

4. Έχεις στο δωμάτιο σου ηλεκτρονικό υπολογιστή; 1. ΝΑΙ ☐ 0. ΟΧΙ ☐

5. Πόσα αυτοκίνητα έχετε στην οικογένεια; ………..

Γ. ΧΑΡΑΚΤΗΡΙΣΤΙΚΑ ΤΡΟΠΟΥ ΖΩΗΣ

1α. Πόσες ώρες <u>μελετάς</u> τα μαθήματά σου τις <u>καθημερινές</u>;	………..	**1β. Πόσες ώρες <u>μελετάς</u> τα μαθήματά σου το <u>Σαββατοκύριακο</u>;**	……….
2α. Πόσες ώρες <u>βλέπεις τηλεόραση</u>/DVD, παίζεις ηλεκτρονικά παιχνίδια και σερφάρεις στο ίντερνετ τις <u>καθημερινές</u>;	……….	**2β. Πόσες ώρες <u>βλέπεις τηλεόραση</u>/DVD, παίζεις ηλεκτρονικά παιχνίδια και σερφάρεις στο ίντερνετ το <u>Σαββατοκύριακο</u>;**	…………
3α. Τι ώρα κοιμάσαι συνήθως το βράδυ τις <u>καθημερινές</u>;	………..	**3β. Τι ώρα κοιμάσαι συνήθως το βράδυ το <u>Σαββατοκύριακο</u>;**	…………..
4α. Τι ώρα ξυπνάς συνήθως το πρωί τις <u>καθημερινές</u>;	....	**4β. Τι ώρα ξυπνάς συνήθως το πρωί το <u>Σαββατοκύριακο</u>;**	………….
5. Κοιμάσαι συνήθως το μεσημέρι;	1. ΝΑΙ ☐ 0. ΟΧΙ ☐	**5.α. Εάν <u>ΝΑΙ</u> γράψε πόσες ώρες κοιμάσαι:**	…………
6. Έχεις δοκιμάσει ποτέ αλκοολούχο ποτό (μπύρα, κρασί, βότκα ουίσκι);	1. ΝΑΙ ☐ 0. ΟΧΙ ☐	**6.α. Εάν <u>ΝΑΙ</u>, δήλωσε πόσο συχνά πίνεις κάποιο ποτό;**	1. Σπάνια ☐ 2. Λίγες φορές το μήνα ☐ 3. 1 φορά/εβδομ. ☐ 4. 2 ή περισσότερες φορές / εβδομ. ☐
7. Έχεις δοκιμάσει ποτέ να καπνίσεις;	1. ΝΑΙ ☐ 0. ΟΧΙ ☐		
8α. Σημείωσε ποιο πιστεύεις οτι είναι το βάρος σου	………..	**8β. Σημείωσε ποιο πιστεύεις οτι είναι το ύψος σου**	…………...

9. Από το 1-5 σημείωσε πόσο ευχαριστημένος είσαι από το βάρος σου; (1=καθόλου, 5=πολύ) ○ 1 ○ 2 ○ 3 ○ 4 ○ 5

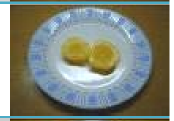
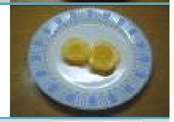
Δ. ΑΞΙΟΛΟΓΗΣΗ ΣΩΜΑΤΙΚΗΣ ΔΡΑΣΤΗΡΙΟΤΗΤΑΣ

1.Έχεις κάνει κάποια ή κάποιες από αυτές τις δραστηριότητες <u>την προηγούμενη εβδομάδα (7 ημέρες)</u>; Εάν ναι σημείωσε <u>πόσες φορές</u> (σημείωσε μόνο μια φορά σε κάθε σειρά).

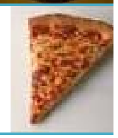
	Όχι	1-2	3-4	5-6	7 ή περισσότερες
Κυνηγητό	☐	☐	☐	☐	☐
Έντονο περπάτημα	☐	☐	☐	☐	☐
Ποδήλατο	☐	☐	☐	☐	☐
Τρέξιμο ή τζόκινγκ	☐	☐	☐	☐	☐
Μάθημα αερόμπικ	☐	☐	☐	☐	☐
Κολύμβηση	☐	☐	☐	☐	☐
Χορό-Μπαλέτο	☐	☐	☐	☐	☐
Ποδόσφαιρο	☐	☐	☐	☐	☐
Μπάσκετ	☐	☐	☐	☐	☐
Σκέιτ	☐	☐	☐	☐	☐
Βόλεϊ	☐	☐	☐	☐	☐
Σκι	☐	☐	☐	☐	☐
Πολεμικές τέχνες	☐	☐	☐	☐	☐
Τένις	☐	☐	☐	☐	☐
Κάποιο άλλο άθλημα (Γράψε ποιο;)………………….........	☐	☐	☐	☐	☐

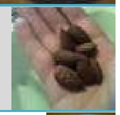
2. Ποια από τις παρακάτω προτάσεις πιστεύεις οτι σε περιγράφει καλύτερα <u>για την περασμένη εβδομάδα;</u> Διάβασε και τις πέντε προτάσεις πριν επιλέξεις τη μια που σε περιγράφει καλύτερα.	1. Όλο μου τον ελεύθερο χρόνο τον πέρασα κάνοντας δραστηριότητες που χρειάζονταν λίγη σωματική προσπάθεια.	☐
	2. Μερικές φορές (1-2 φορές την περασμένη εβδομάδα) έκανα έντονες δραστηριότητες (κάποιο σπορ-άθλημα, έτρεξα, κολύμπησα, έκανα ποδήλατο, χορό) στον ελεύθερο μου χρόνο.	☐
	3. Συχνά (3-4 φορές την περασμένη εβδομάδα) έκανα έντονες δραστηριότητες (κάποιο σπορ-άθλημα, έτρεξα, κολύμπησα, έκανα ποδήλατο, χορό) στον ελεύθερο μου χρόνο.	☐
	4. Αρκετά συχνά (5-6 φορές την περασμένη εβδομάδα) έκανα έντονες δραστηριότητες (κάποιο σπορ-άθλημα, έτρεξα, κολύμπησα, έκανα ποδήλατο, χορό) στον ελεύθερο μου χρόνο.	☐
	5. Πολύ συχνά (7 ή περισσότερες φορές την περασμένη εβδομάδα) έκανα έντονες δραστηριότητες (κάποιο σπορ-άθλημα, έτρεξα, κολύμπησα, έκανα ποδήλατο, χορό) στον ελεύθερο μου χρόνο.	☐
3. <u>Την προηγούμενη εβδομάδα (7 ημέρες)</u> στο μάθημα της γυμναστικής πόσο συχνά ήσουν πολύ δραστήριος (έπαιζες έντονα, έτρεχες, πήδαγες); (Σημείωσε μόνο μία απάντηση)	1. Δεν συμμετέχω στο μάθημα της γυμναστικής..	☐
	2. Σχεδόν ποτέ..	☐
	3. Μερικές φορές..	☐
	4. Πολύ συχνά...	☐
	5. Πάντα..	☐
4. <u>Την προηγούμενη εβδομάδα (7 ημέρες)</u> τι έκανες συνήθως:		
Α. Στα διαλείμματα; (Σημείωσε μόνο μία απάντηση)	1. Καθόμουνα (Διάβαζα, μιλούσα)..	☐
	2. Στεκόμουνα και τριγυρνούσα..	☐
	3. Έτρεχα και έπαιζα..	☐
	4. Έτρεχα και έπαιζα αρκετά..	☐
	5. έτρεχα και έπαιζα έντονα την περισσότερη ώρα...	☐
Β. Την ώρα του φαγητού (κολατσιού) (εκτός από το να τρως); (Σημείωσε μόνο μία απάντηση)	1. Καθόμουνα (Διάβαζα, μιλούσα)..	☐
	2. Στεκόμουνα και τριγυρνούσα..	☐
	3. Έτρεχα και έπαιζα..	☐
	4. Έτρεχα και έπαιζα αρκετά..	☐
	5. Έτρεχα και έπαιζα έντονα την περισσότερη ώρα...	☐
5.<u>Την προηγούμενη εβδομάδα (7 ημέρες)</u> πόσες φορές ακριβώς έπαιξες κάποιο άθλημα ή κάποιο παιχνίδι ή χόρεψες έντονα;		
Α. Μετά το σχολείο (Σημείωσε μόνο μία απάντηση)	Καμία...	☐
	1 φορά την περασμένη εβδομάδα..	☐
	2 ή 3 φορές την περασμένη εβδομάδα...	☐
	4 φορές την περασμένη εβδομάδα...	☐
	5 φορές την περασμένη εβδομάδα..	☐
Β. Το απόγευμα (Σημείωσε μόνο μία απάντηση)	Κανένα...	☐
	1 φορά την περασμένη εβδομάδα..	☐
	2 ή 3 φορές την περασμένη εβδομάδα...	☐
	4 φορές την περασμένη εβδομάδα..	☐
	5 φορές την περασμένη εβδομάδα..	☐
6. <u>Το περασμένο Σαββατοκύριακο</u> πόσες φορές έπαιξες κάποιο άθλημα ή κάποιο παιχνίδι ή χόρεψες έντονα; (Σημείωσε μόνο μία απάντηση)	Καμία...	☐
	1 φορά το Σαββατοκύριακο..	☐
	2 ή 3 φορές το Σαββατοκύριακο	☐
	4 ή 5 φορές το Σαββατοκύριακο	☐
	6 ή περισσότερες το Σαββατοκύριακο...	☐
7. Ήσουνα άρρωστος την περασμένη εβδομάδα ή σε εμπόδισε κάτι άλλο από το να κάνεις τις φυσικές δραστηριότητες που κάνεις συνήθως; 1. ΝΑΙ ☐ 0. ΟΧΙ ☐ **7.Α Εάν <u>ΝΑΙ</u>, γράψε μας τι σε εμπόδισε:** ……………………………………………..........................		
8. Πως πηγαίνεις στο σχολείο;	Α) Με το σχολικό	☐
	Β) Με το αυτοκίνητο του μπαμπά ή της μαμάς	☐
	Γ) Με τα πόδια	☐
	Εάν πηγαίνεις με τα πόδια, πόσα λεπτά κάνεις για να φτάσεις;	

	Καμία	1 -2 φορές/ μήνα	1 φορά την εβδομάδα	2 φορές την εβδομάδα	3-6 φορές την εβδομάδα	Κάθε μέρα		
ωϊνού (κορν φλέικς σκέτα ή φρούτα)	○	○	○	○	○	○	Βλέπε εικόνα	
τριακά πρωϊνού ολικής άλεσης;		1. ΝΑΙ ☐		0. ΟΧΙ ☐			2.ΜΕΡΙΚΕΣ ΦΟΡΕΣ ☐	
	○	○	○	○	○	○	Βλέπε εικόνα	
όνια ολικής άλεσης;		1. ΝΑΙ ☐		0. ΟΧΙ ☐			2. ΜΕΡΙΚΕΣ ΦΟΡΕΣ ☐	
αμβάνονται και τα τοστ)	○	○	○	○	○	○	Πόσες φέτες;	
λικής άλεσης;		1. ΝΑΙ ☐		0. ΟΧΙ ☐			2. ΜΕΡΙΚΕΣ ΦΟΡΕΣ ☐	
α ή φακές ή ρεβύθια ή φάβα)	○	○	○	○	○	○	Βλέπε εικόνα	
ή, ψητή ή πουρές)	○	○	○	○	○	○	Βλέπε εικόνα	
	○	○	○	○	○	○	Βλέπε εικόνα	
υκό ή καστανό;		1. ΛΕΥΚΟ ☐		2. ΚΑΣΤΑΝΟ ☐			3.ΑΝΑΜΙΚΤΟ ☐	
ξιμάδια ή κράκερ ή κριτσίνια ή λούρι	○	○	○	○	○	○	Πόσα τεμάχια;	

			εροομαοα	εροομαοα	εροομαοα			
ιές, τα παξιμάδια, τα κράκερ, τα σουσαμένιο κουλούρι ολικής		1. ΝΑΙ ☐		0. ΟΧΙ ☐				
	O	O	O	O	O	O	Πόσα τεμάχια;	
ή πορτοκάλι ή μανταρίνια	O	O	O	O	O	O	Πόσα τεμάχια;	
άσια ή βερίκοκα	O	O	O	O	O	O	Βλέπε εικόνα	
όνι ή ροδάκινο ή σταφύλια	O	O	O	O	O	O	Βλέπε εικόνα	
ρούτα (Δαμάσκηνο ή βερίκοκο ή	O	O	O	O	O	O	Βλέπε εικόνα	
0%	O	O	O	O	O	O	Πόσα ποτήρια;	
οποτό	O	O	O	O	O	O	Πόσα ποτήρια;	
τα, αγγούρι, πιπεριά)	O	O	O	O	O	O	Βλέπε εικόνα	

		εβδομάδα	εβδομάδα	εβδομάδα			
άκια ή μπάμιες ή αγκινάρες ή οκυθάκι ή σπανακόρυζο)	O	O	O	O	O	O	Βλέπε εικόνα	
	O	O	O	O	O	O	Πόσα τεμάχια;	
κολο ή Κουνουπίδι	O	O	O	O	O	O	Βλέπε εικόνα	
κάς ή καλαμπόκι	O	O	O	O	O	O	Βλέπε εικόνα	
α ή ανθότυρο)	O	O	O	O	O	O	Βλέπε εικόνα	
ισέρι, γραβιέρα ή γκούντα)	O	O	O	O	O	O	Πόσες φέτες;	
λιπαρά	O	O	O	O	O	O	Πόσες φέτες;	
	O	O	O	O	O	O	Πόσα ποτήρια;	
ύχο ή γάλα με κακάο ή ρόφημα	O	O	O	O	O	O	Πόσα ποτήρια;	

			εροομαοα	εροομαοα	εροομαοα			
λήρες ή χαμηλών λιπαρών (μπλε		2. ΠΛΗΡΕΣ (Μπλε) ☐			1. ΧΑΜΗΛΩΝ ΛΙΠΑΡΩΝ (Πράσινο) ☐			
	O	O	O	O	O	O	Πόσα κεσεδάκια; …………….	
ι πλήρες ή χαμηλών λιπαρών;		2. ΠΛΗΡΕΣ ☐				1. ΧΑΜΗΛΩΝ ΛΙΠΑΡΩΝ ☐		
ρτιού ή ρυζόγαλο ή κρέμα	O	O	O	O	O	O	Πόσα μπωλάκια; …………….	
	O	O	O	O	O	O	Πόσα τεμάχια; …………..	
ν ή μπέικον	O	O	O	O	O	O	Πόσες φέτες; …………..	
ινό	O	O	O	O	O	O	Βλέπε εικόνα …………….	
λοπούλα	O	O	O	O	O	O	Βλέπε εικόνα ……………….	
	O	O	O	O	O	O	Βλέπε εικόνα …………..	
	O	O	O	O	O	O	Πόσα κομμάτια; ……………….	

			εροομαοα	εροομαοα	εροομαοα			
		1. ΑΠΛΗ ☐				2. ΣΠΕΣΙΑΛ ☐		
	O	O	O	O	O	O	Πόσα τεμάχια;	
κι σε πίτα ή ψωμί	O	O	O	O	O	O	Πόσα τεμάχια;	
ίρα δημητριακών	O	O	O	O	O	O	Πόσα τεμάχια;	
το ή η μπάρα ολικής άλεσης;	1. ΝΑΙ ☐			0. ΟΧΙ ☐			2.ΜΕΡΙΚΕΣ ΦΟΡΕΣ ☐	
	O	O	O	O	O	O	Πόσα κουταλάκια;	
	O	O	O	O	O	O	Πόσα κουταλάκια;	
οιμη σος	O	O	O	O	O	O	Πόσα κουταλάκια;	
ζα ή σος χαμηλή σε λιπαρά;	1. ΝΑΙ ☐			0. ΟΧΙ ☐			2.ΜΕΡΙΚΕΣ ΦΟΡΕΣ ☐	
έλι	O	O	O	O	O	O	Πόσα κουταλάκια;	
	O	O	O	O	O	O	Βλέπε εικόνα	
ετες	O	O	O	O	O	O	Βλέπε εικόνα	

			εροομαοα	εροομαοα	εροομαοα			
π κορν ή γαριδάκια	○	○	○	○	○	○	Βλέπε εικόνα	
	○	○	○	○	○	○	Πόσες μπάλες;	
ν	○	○	○	○	○	○	Πόσες φέτες;	
νακόπιτα ή μπουγάτσα	○	○	○	○	○	○	Πόσα τεμάχια;	
	○	○	○	○	○	○	Πόσα κουτάκια;	
τικό λάιτ;	1. ΝΑΙ ☐			0. ΟΧΙ ☐				
φρέτα	○	○	○	○	○	○	Βλέπε εικόνα	
	○	○	○	○	○	○	Πόσα κουταλάκια;	
ς εκτός σπιτιού ή παραγγέλνετε	○	○	○	○	○	○		

ύματα και μικρογεύματα ις συνήθως σε μια μέρα;	○ 1	○ 2	○ 3	○ 4	○ 5	○ 6	Πόσα κάνεις μπροστά στην TV ή τον υπολογιστή; ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6
ς το γεύμα σου μπροστά στην τηλεόραση ή	○ Ποτέ/Σπάνια	○ 1-2 φορές/ εβδομάδα	○ 3-4 φορές/ εβδομάδα	○ 5-6 φορές/εβδ	○ Κάθε μέρα		
ν εβδομάδα τρως συνήθως πρωινό γεύμα;	○ 1 ημέρα	○ 2 ημέρες	○ 3 ημέρες	○ 4 ημέρες	○ 5 ημέρες	○ 6 ημέρες	○ 7 ημέρες
ς τα γεύματά σου μαζί με όλη την κάποιο γονέα σου (μητέρα, πατέρας);	○ Ποτέ/Σπάνια	○ 1-2 φορές/ εβδομάδα	○ 3-4 φορές/ εβδομάδα	○ 5-6 φορές/εβδ	○ Κάθε μέρα		

Ζ. Ερωτηματολόγιο αξιολόγησης τάσεων απέναντι στο φαγητό

Για κάθε μια από τις παρακάτω ερωτήσεις κυκλώστε τον αριθμό που υποδεικνύει το βαθμό σιγουριάς που δίνετε στον εαυτό σας ώστε να κάνετε αυτά που ζητούνται στην κάθε ερώτηση (και όχι το αν θα θέλατε να τα κάνετε). Έτσι π.χ για το **1**: καθόλου σίγουρος/η να κάνω αυτό που αναφέρεται στην ερώτηση και για το **5** : πάρα πολύ σίγουρος/η να κάνω αυτό που αναφέρεται αντίστοιχα. Σημειώστε μια μόνο απάντηση.

	Καθόλου σίγουρος 1	**Λίγο σίγουρος 2**	**Απλά σίγουρος 3**	**Πολύ σίγουρος 4**	**Πάρα πολύ σίγουρος 5**
Κατά πόσο είσαι σίγουρος/η ότι... :					
1. μπορείς να καταναλώσεις **μικρότερες μερίδες** φαγητού;	☐	☐	☐	☐	☐
2. μπορείς να φας ένα σνακ στο σχολείο **από το σπίτι**;	☐	☐	☐	☐	☐
3. μπορείς να **περιορίσεις τα τηγανητά και λιπαρά τρόφιμα**, όπως τσιπς, πίτσες, σοκολάτα;	☐	☐	☐	☐	☐
4. αν αποφασίσεις να φάς **φρούτο κάθε μέρ**α μπορείς να το κάνεις;	☐	☐	☐	☐	☐
5. θα κατανάλωνες για **επιδόρπιο** το **αγαπημένο σου φρούτο** στη θέση ενός **γλυκού**;	☐	☐	☐	☐	☐
6. αν αποφασίσεις να φας **σαλάτα κάθε μέρα** μπορείς να το κάνεις;	☐	☐	☐	☐	☐
7. μπορείς να προσθέσεις **τα αγαπημένα σου λαχανικά στο αγαπημένο σου σάντουιτς**;	☐	☐	☐	☐	☐
8. μπορείς **να φας μαγειρεμένα λαχανικά με το φαγητό σου** 2 με 3 φορές την εβδομάδα;	☐	☐	☐	☐	☐
9.μπορείς **να προετοιμάσεις μόνος σου/μόνη σου το αγαπημένο σου φρούτο ή λαχανικό** για να φας;	☐	☐	☐	☐	☐
10. θα κατανάλωνες στο **πρωινό σου δημητριακά**;	☐	☐	☐	☐	☐
11. μπορείς να πιεις **ένα ποτήρι από τον αγαπημένο σου 100% χυμό φρούτων για πρωινό**;	☐	☐	☐	☐	☐
12. θα κατανάλωνες ένα **ποτήρι φρέσκου χυμού φρούτων ή 100% φυσικό χυμό φρούτων** ως σνακ;	☐	☐	☐	☐	☐
13. θα κατανάλωνες **δημητριακά ή μπισκότα ολικής άλεσης** στη θέση **κανονικών**;	☐	☐	☐	☐	☐
14. θα κατανάλωνες ένα **αναψυκτικό light** στη θέση **κανονικού αναψυκτικού**;	☐	☐	☐	☐	☐
15. θα έβαζες στο ψωμί **μαργαρίνη** στη θέση **βουτύρου**;	☐	☐	☐	☐	☐
16. αν αποφασίσεις να φας **ψάρι 1 φορά την εβδομάδα** μπορείς να το κάνεις;	☐	☐	☐	☐	☐
17. **θα αγόραζες προϊόντα χαμηλά σε λιπαρά** στη θέση **κανονικών προϊόντων** κατά την επίσκεψή σου στο σούπερ μάρκετ;	☐	☐	☐	☐	☐
18. θα κατανάλωνες για σνακ ή φαγητό **κάτι διαφορετικό** από τους φίλους σου όταν είσαι μαζί τους;	☐	☐	☐	☐	☐
19. αν **δεν υπήρχαν γλυκίσματα** στο σπίτι, **δεν θα τα κατανάλωνες** και εσύ συχνά;	☐	☐	☐	☐	☐
20. αν υπήρχαν **περισσότερα φρούτα και λαχανικά** στο σπίτι, θα κατανάλωνες και **εσύ** περισσότερα την ημέρα;	☐	☐	☐	☐	☐
21. αν υπήρχαν **πιο υγιεινά σνακ στο κυλικείο** του σχολείου, θα τα **κατανάλωνες και εσύ** πιο συχνά;	☐	☐	☐	☐	☐
22. αν στην τηλεόραση **διαφημίζονταν πιο συχνά τα υγιεινά τρόφιμα, θα τα κατανάλωνες** κι εσύ συχνά;	☐	☐	☐	☐	☐
23. Κατά πόσο πιστεύεις ότι επηρεάζεσαι από τους φίλους σου στην επιλογή σου για κάποιο σνακ;	☐	☐	☐	☐	☐

ΣΤ. ΣΩΜΑΤΟΜΕΤΡΗΣΕΙΣ

(συμπληρώνεται από τους ερευνητές)

1. Βάρος (χωρίς παπούτσια) σε Kg		2. Ύψος (χωρίς παπούτσια) σε cm	
3. Περιφέρεια μέσης σε cm		4. Περιφέρεια λεκάνης (cm)	
5. % Λίπος σώματος (αποτελέσματα από TANITA):		6. Λιπώδης μάζα σώματος:	
7. Συστολική πίεση:	8. Διαστολική πίεση:	9. Σφυγμοί	

ΓΕΩΠΟΝΙΚΟ ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΘΗΝΩΝ
ΤΜΗΜΑ ΕΠΙΣΤΗΜΗΣ ΚΑΙ ΤΕΧΝΟΛΟΓΙΑΣ ΤΡΟΦΙΜΩΝ
ΜΟΝΑΔΑ ΔΙΑΤΡΟΦΗΣ ΤΟΥ ΑΝΘΡΩΠΟΥ
Ιερά Οδός 75, 11855 Αθήνα, Τηλ: 210 5294945

Αγαπητέ γονέα / κηδεμόνα,

Η Μονάδα Διατροφής του Ανθρώπου του Τμήματος Επιστήμης και Τεχνολογίας Τροφίμων του Γεωπονικού Πανεπιστημίου Αθηνών με την άδεια του Υπουργείου Εθνικής Παιδείας και Θρησκευμάτων και την υποστήριξη της Γενικής Γραμματείας Καταναλωτή και άλλων φορέων έχουν ξεκινήσει μία Πανελλήνια Έρευνα με τίτλο: «**Εκτίμηση επιπέδων και αιτιολογίας παιδικής και εφηβικής παχυσαρκίας στην Ελλάδα**», που έχει την έγκριση του Παιδαγωγικού Ινστιτούτου.
Στα πλαίσια αυτής της έρευνας διανέμεται στο σχολείο του παιδιού σας ερωτηματολόγιο, το οποίο εκτιμά τις διατροφικές συνήθειες, την σωματική δραστηριότητα και την διατροφική συμπεριφορά των μαθητών. Με την παρούσα επιστολή θα σας παρακαλούσαμε να δώσετε τη συναίνεσή σας, ώστε το παιδί σας να απαντήσει στο προαναφερόμενο ερωτηματολόγιο. Θα θέλαμε να σας ενημερώσουμε ότι τα στοιχεία είναι απόρρητα και θα μας βοηθήσουν στην προαγωγή της επιστημονικής γνώσης στο χώρο της Υγείας και της διατροφής ειδικότερα. Παράλληλα, παρακαλούμε να απαντήσετε κι εσείς στο επισυναπτόμενο ερωτηματολόγιο που απευθύνεται στους γονείς. Τα στοιχεία που θα μας δώσετε θα διευκολύνουν την ορθότερη εξαγωγή συμπερασμάτων.

Σας ευχαριστούμε εκ των προτέρων για τη συνεργασία.

Ο Επιστημονικός Υπεύθυνος

Αντώνης Ζαμπέλας
Αναπληρωτής Καθηγητής

Ο/Η κάτωθι υπογεγραμμένος/-η

……………………………………...του…...………….......... δηλώνω ότι επιτρέπω στον/-ην υιό/θυγατέρα μου……………………………….................. να απαντήσει στο ερωτηματολόγιο, που διανέμεται στο σχολείο του, για τις ανάγκες της έρευνας με τίτλο «**Εκτίμηση επιπέδων και αιτιολογίας παιδικής και εφηβικής παχυσαρκίας στην Ελλάδα**».

Ημερομηνία:…/…/……
Τόπος:…………..
Υπογραφή:

ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΓΟΝΕΩΝ

ΗΜΕΡΟΜΗΝΙΑ: __/__/____	**ΚΩΔΙΚΟΣ:**

Το ερωτηματολόγιο συμπληρώθηκε από:

Μητέρα ☐

Πατέρα ☐

Τους 2 γονείς ☐

Α. ΔΗΜΟΓΡΑΦΙΚΑ & ΑΝΘΡΩΠΟΜΕΤΡΙΚΑ ΧΑΡΑΚΤΗΡΙΣΤΙΚΑ ΓΟΝΕΩΝ

1.Υπηκοότητα πατέρα:				**2.Υπηκοότητα Μητέρας:**							
3. Ηλικία πατέρα:			**4. Βάρος πατέρα (κιλά):**				**5.Ύψος πατέρα (εκατοστά):**				
6. Ηλικία μητέρας:			**7. Βάρος μητέρας (κιλά):**				**8.Ύψος μητέρας (εκατοστά):**				
9.Τόπος κατοικίας πατέρα:	**Νομός:**			**Πόλη:**			**Τ.Κ:**				
10.Τόπος κατοικίας μητέρας:	**Νομός:**			**Πόλη:**			**Τ.Κ:**				

Β. ΚΟΙΝΩΝΙΚΟ-ΟΙΚΟΝΟΜΙΚΑ ΧΑΡΑΚΤΗΡΙΣΤΙΚΑ ΓΟΝΕΩΝ

1. Επάγγελμα πατέρα:

1. Άνεργος ☐
2. Ελεύθ. Επαγγελματίας ☐
3. Ιδιωτ. Υπάλληλος ☐
4. Δημ. Υπάλληλος ☐
5. Συνταξιούχος ☐

2. Περιγράψτε το είδος εργασίας του πατέρα σημειώνοντας ένα μόνο νούμερο στην παρακάτω κλίμακα:

Χειρωνακτική			Μεικτή				Πνευματική		
1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3. Εισόδημα πατέρα:

1. <10500€ ☐
2. 10500-12000 € ☐
3. 12000-30000 € ☐
4. 30000-70000€ ☐
5. Άνω των 70000€ ☐

4. Επάγγελμα μητέρας:

1. Άνεργη ☐
2. Οικιακά ☐
3. Ελεύθ. Επαγγελματίας ☐
4. Ιδιωτ. Υπάλληλος ☐
5. Δημ. Υπάλληλος ☐
6. Συνταξιούχος ☐

5. Περιγράψτε το είδος εργασίας της μητέρα σημειώνοντας ένα μόνο νούμερο στην παρακάτω κλίμακα:

Χειρωνακτική			Μεικτή				Πνευματική		
1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

6. Εισόδημα μητέρας:

1. <10500€ ☐
2. 10500-12000 € ☐
3. 12000-30000 € ☐
4. 30000-70000€ ☐
5. Άνω των 70000€ ☐

7. Σημειώστε στην παρακάτω κλίμακα πόσο ικανοποιημένος είναι ο πατέρας από το εισόδημά του;

1. Καθόλου	2. Λίγο	3. Μέτρια	4. Πολύ	5. Πάρα πολύ
☐	☐	☐	☐	☐

8. Σημειώστε στην παρακάτω κλίμακα πόσο ικανοποιημένη είναι η μητέρα από το εισόδημά της;

1. Καθόλου	2. Λίγο	3. Μέτρια	4. Πολύ	5. Πάρα πολύ
☐	☐	☐	☐	☐

9. Συνολικά έτη σπουδών πατέρα (Συνυπολογίστε τις σπουδές σας από το δημοτικό, γυμνάσιο, λύκειο, ΑΤΕΙ, Πανεπιστήμιο, επιμορφώσεις, μεταπτυχιακά):			**10. Συνολικά έτη σπουδών μητέρας (Συνυπολογίστε τις σπουδές σας από το δημοτικό, γυμνάσιο, λύκειο, ΑΤΕΙ , Πανεπιστήμιο, επιμορφώσεις, μεταπτυχιακά):**		

11. Η κατοικία σας είναι ιδιόκτητη;

1.ΝΑΙ ☐

0. ΟΧΙ ☐

2

Γ. ΠΛΗΡΟΦΟΡΙΕΣ ΣΧΕΤΙΚΑ ΜΕ ΤΗΝ ΕΓΚΥΜΟΣΥΝΗ

1. Βάρος μητέρας πριν την εγκυμοσύνη (κιλά):				**2. Αύξηση βάρους κατά την εγκυμοσύνη (κιλά):**			
3. Εβδομάδες κύησης:				**4. Ηλικία μητέρας κατά τον τοκετό**			

5. Κάπνισμα κατά την εγκυμοσύνη:

0. Όχι ☐
1. 1-9 τσιγάρα / ημέρα ☐
2. 10-20 τσιγάρα / ημέρα ☐
3. 20 ή περισσότερα τσιγάρα/ημέρα ☐

6. Κάπνισμα πριν την εγκυμοσύνη:

0. Όχι ☐
1. 1-9 τσιγάρα / ημέρα ☐
2. 10-20 τσιγάρα / ημέρα ☐
3. 20 ή περισσότερα τσιγάρα / ημέρα ☐

7. Κατανάλωση αλκοόλ κατά την εγκυμοσύνη (ημερησίως):

0. Καθόλου ☐
1. 1 μερίδα ποτού ☐
2. 2 η περισσότερες μερίδες ποτών ☐

8. Κατανάλωση καφέ κατά την εγκυμοσύνη (ημερησίως):

0. Καθόλου ☐
1. 1 φλιτζάνι καφέ ☐
2. 2 ή περισσότερα φλιτζάνια καφέ ☐

9. Βάρος γέννησης παιδιού (γραμ.):				**10. Ύψος γέννησης παιδιού (εκατ.):**			

Δ. ΠΛΗΡΟΦΟΡΙΕΣ ΣΧΕΤΙΚΑ ΜΕ ΤΟΝ ΘΗΛΑΣΜΟ

1. Πόσους μήνες θήλασε συνολικά η μητέρα;			**2. Πόσους μήνες θήλασε η μητέρα αποκλειστικά;**			
3. Σε ποιο μήνα έγινε η εισαγωγή σκόνης γάλακτος:						

4. Κάπνισμα κατά τον θηλασμό:

0. Όχι ☐
1. 1-9 τσιγάρα / ημέρα ☐
2. 10-20 τσιγάρα / ημέρα ☐
3. 20 ή περισσότερα τσιγάρα / ημέρα ☐

5. Κατανάλωση αλκοόλ κατά τον θηλασμό (ημερησίως):

0. κανένα ποτήρι ☐
1. 1 ποτήρι ☐
2. 2 ή περισσότερα ποτήρια ☐

Ε. ΠΛΗΡΟΦΟΡΙΕΣ ΣΧΕΤΙΚΑ ΜΕ ΤΗ ΔΙΑΤΡΟΦΗ ΤΟΥ ΠΑΙΔΙΟΥ

1. Σημειώστε ποιος ασχολείται περισσότερο με τη σίτιση-διατροφή του παιδιού στο σπίτι; Σημειώστε μόνο δύο (2) από τις πιθανές απαντήσεις, επιλέγοντας αυτούς που ασχολούνται περισσότερο.

α. Μητέρα:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
β. Ο πατέρας:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
γ. Η γιαγιά/ο παππούς:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
δ. Βοηθητικό προσωπικό:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
ε. Άλλος:	1. ΝΑΙ ☐	0. ΟΧΙ ☐

2. Σημειώστε παρακάτω κατά πόσο καλή/υγιεινή θεωρείτε τη διατροφή του παιδιού σας; (1: Καθόλου καλή/υγιεινή, 10: Πολύ καλή/υγιεινή).

1	2	3	4	5	6	7	8	9	10
☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

3. Σημειώστε ποια από τα παρακάτω τρόφιμα δεν αρέσουν στο παιδί σας και δεν τα καταναλώνει καθόλου ή τα καταναλώνει σπάνια:

α. Φρούτα:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
β. Λαχανικά:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
γ. Όσπρια:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
δ. Τρόφιμα ολικής αλέσεως:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
ε. Κρέας:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
στ. Ψάρι:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
ζ. Γιαούρτι:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
η. Τυριά:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
θ. Γάλα:	1. ΝΑΙ ☐	0. ΟΧΙ ☐

4. Σημειώστε ποια από τα παρακάτω τρόφιμα αρέσουν στο παιδί σας και τα καταναλώνει πολύ συχνά;

α. Γλυκά (σοκολάτα, γκοφρέτες, παγωτά)	1. ΝΑΙ ☐	0. ΟΧΙ ☐
β. Λαχανικά	1. ΝΑΙ ☐	0. ΟΧΙ ☐
γ. Φρούτα	1. ΝΑΙ ☐	0. ΟΧΙ ☐
δ. Αλμυρά σνακ (πατατάκια, κράκερς, γαριδάκια)	1. ΝΑΙ ☐	0. ΟΧΙ ☐
ε. Κρέας:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
στ. Ψάρι	1. ΝΑΙ ☐	0. ΟΧΙ ☐
ζ. Γιαούρτι	1. ΝΑΙ ☐	0. ΟΧΙ ☐
η. Τυριά	1. ΝΑΙ ☐	0. ΟΧΙ ☐
θ. Γάλα	1. ΝΑΙ ☐	0. ΟΧΙ ☐
ι. Αναψυκτικά:	1. ΝΑΙ ☐	0. ΟΧΙ ☐

5. Πόσο συχνά βγαίνετε έξω για φαγητό ή παραγγέλνετε απ' έξω;

1. Ποτέ ☐
2. 1-2 φορές το μήνα ☐
3. 3-4 φορές το μήνα ☐
4. 2 φορές την εβδομάδα ☐
5. 3 ή περισσότερες φορές την εβδομάδα ☐

6. Τι επιλέγεται συχνότερα όταν τρώτε εκτός σπιτιού ή παραγγέλνετε φαγητό απ' έξω; Σημειώστε μόνο δύο (2) από τις πιθανές απαντήσεις, αυτές που επιλέγεται συχνότερα.

α. Κρεατικά:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
β. Σουβλάκια:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
γ. Πίτσα:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
δ. Ζυμαρικά:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
ε. Ψάρι:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
στ. Θαλασσινά:	1. ΝΑΙ ☐	0. ΟΧΙ ☐
ζ. Fast Food:	1. ΝΑΙ ☐	0. ΟΧΙ ☐

7. Πόσο συχνά κατά τη διάρκεια της εβδομάδας τρώει όλη η οικογένεια μαζί;

1. Ποτέ ☐
2. 1-2 φορές /εβδομάδα ☐
3. 3-4 φορές /εβδομάδα ☐
4. 5-6 φορές / εβδομάδα ☐
5. Καθημερινά ☐

8. Ποιο γεύμα της ημέρας τρωει συνήθως όλη η οικογένεια μαζί ;

1. Κανένα ☐
2. Πρωινό ☐
3. Μεσημεριανό ☐
4. Βραδινό ☐
5. Όλα τα παραπάνω ☐

9. Πόσο συχνά τρωει όλη η οικογένεια μαζί βλέποντας τηλεόραση;

1. Ποτέ ☐
2. 1-2 φορές/εβδομ ☐
3. 3-4 φορές/εβδομ ☐
4. 5-6 φορές/εβδομ ☐
5. Καθημερινά ☐

10. Ποια πηγή πληροφόρησης για την διατροφή του παιδιού σας εμπιστεύεστε περισσότερο; Σημειώστε μόνο δύο (2) από τις πιθανές απαντήσεις, αυτές που εμπιστεύεστε περισσότερο

α. ΜΜΕ (τηλεόραση, ραδιόφωνο, έντυπος τύπος) 1. ΝΑΙ ☐ 0. ΟΧΙ ☐
β. Παιδίατρος ή άλλος επιστήμονας υγείας (π.χ. άλλοι ιατροί, διαιτολόγοι) 1. ΝΑΙ ☐ 0. ΟΧΙ ☐
γ. Γονείς 1. ΝΑΙ ☐ 0. ΟΧΙ ☐
δ. Συγγενείς, φίλοι 1. ΝΑΙ ☐ 0. ΟΧΙ ☐
ε. Άλλο (διευκρινίστε) ……………………............... ....

11. Αν θα μπορούσατε να αλλάξετε κάτι στην καθημερινή διατροφή του παιδιού σας τι θα ήταν αυτό; Ποια τρόφιμα/ ροφήματα θα μειώνατε και ποια θα αυξάνατε; Σημειώστε μόνο δύο (2) από τις πιθανές απαντήσεις, αυτές που θεωρείται σημαντικότερες.

Τρόφιμο	Αύξηση	Μείωση
α. Αμυλούχα-Δημητριακά (ψωμί, μακαρόνια, ρύζι, πατάτες)	1. ΝΑΙ ☐ 0. ΟΧΙ ☐	1. ΝΑΙ ☐ 0. ΟΧΙ ☐
β. Γαλακτοκομικά	1. ΝΑΙ ☐ 0. ΟΧΙ ☐	1. ΝΑΙ ☐ 0. ΟΧΙ ☐
γ. Γλυκά	1. ΝΑΙ ☐ 0. ΟΧΙ ☐	1. ΝΑΙ ☐ 0. ΟΧΙ ☐
δ. Αναψυκτικά	1. ΝΑΙ ☐ 0. ΟΧΙ ☐	1. ΝΑΙ ☐ 0. ΟΧΙ ☐
ε. Χυμούς	1. ΝΑΙ ☐ 0. ΟΧΙ ☐	1. ΝΑΙ ☐ 0. ΟΧΙ ☐
στ. Λίπη και έλαια	1. ΝΑΙ ☐ 0. ΟΧΙ ☐	1. ΝΑΙ ☐ 0. ΟΧΙ ☐
ζ. Κόκκινο κρέας (μοσχάρι, χοιρινό, αρνί, συκώτι)	1. ΝΑΙ ☐ 0. ΟΧΙ ☐	1. ΝΑΙ ☐ 0. ΟΧΙ ☐
η. Αυγά	1. ΝΑΙ ☐ 0. ΟΧΙ ☐	1. ΝΑΙ ☐ 0. ΟΧΙ ☐
θ. Λαχανικά	1. ΝΑΙ ☐ 0. ΟΧΙ ☐	1. ΝΑΙ ☐ 0. ΟΧΙ ☐
ι. Φρούτα	1. ΝΑΙ ☐ 0. ΟΧΙ ☐	1. ΝΑΙ ☐ 0. ΟΧΙ ☐
κ. Άλλο (διευκρινίστε)	……………………….	………………………..

12. Δίνετε στο παιδί σας συστηματικά κάποιου είδος συμπλήρωμα διατροφής;

α. Πολυβιταμίνες 1. ΝΑΙ ☐ 0. ΟΧΙ ☐
β. Σίδηρο 1. ΝΑΙ ☐ 0. ΟΧΙ ☐
γ. Βιταμίνη Ε 1. ΝΑΙ ☐ 0. ΟΧΙ ☐
δ. Βιταμίνη C 1. ΝΑΙ ☐ 0. ΟΧΙ ☐
ε. Βιταμίνες συμπλέγματος Β 1. ΝΑΙ ☐ 0. ΟΧΙ ☐
στ. Άλλο (διευκρινίστε) ……………………….

13. Θεωρείτε οτι το βάρος του παιδιού σας, για την ηλικία του είναι:

1. Χαμηλότερο του φυσιολογικού ☐
2. Φυσιολογικό ☐
3. Αυξημένο ☐

ΣΤ. ΠΛΗΡΟΦΟΡΙΕΣ ΣΧΕΤΙΚΑ ΜΕ ΤΗ ΣΩΜΑΤΙΚΗ ΔΡΑΣΤΗΡΙΟΤΗΤΑ

1. Πως θα χαρακτηρίζατε την καθημερινή σωματική δραστηριότητα (άσκηση) του παιδιού σας;

1. Πολύ χαμηλή ☐
2. Χαμηλή ☐
3. Κανονική-Ικανοποιητική ☐
4. Έντονη ☐
5. Πολύ έντονη ☐

2. Συμπληρώστε πόσες ώρες συνολικά στον ελεύθερο χρόνο σας βλέπετε τηλεόραση/ DVD ή παίζετε ηλεκτρονικά παιχνίδια ή περιηγείστε στο ίντερνετ ;

	Καθημερινές	Σαββατοκύριακα
Α. Ο πατέρας	……………..	……………..
Β. Η μητέρα	……………..	……………...

3. Στον ελεύθερο χρόνο σας κάνετε κάποιο είδος άσκησης όπως για παράδειγμα περίπατο με έντονο ρυθμό ή τρέξιμο (τζοκινγκ) για <u>τουλάχιστον 30 λεπτά</u>;

Α. Ο πατέρας: 1. ΝΑΙ ☐ 0. ΟΧΙ ☐

Β. Η μητέρα: 1. ΝΑΙ ☐ 0. ΟΧΙ ☐

3.α. Εάν απαντήσατε <u>ΝΑΙ</u> στην <u>ερώτηση 3</u>, τότε πόσο συχνά μέσα στην εβδομάδα κάνετε αυτό το είδος άσκησης;

1. 1 φορά ☐ 2. 2-3 φορές ☐ 3. 4-5 φορές ☐ 4. 6 ή περισ. ☐

1. 1 φορά ☐ 2. 2-3 φορές ☐ 3. 4-5 φορές ☐ 4. 6 ή περισ. ☐

3. β. Εάν απαντήσατε <u>ΝΑΙ</u> στην <u>ερώτηση 3</u>, τότε πόσο συχνά ασκείστε μαζί με όλη την οικογένεια ή με το παιδί σας;

0. Ποτέ/Σπάνια ☐ 1. Μερικές φορές ☐ 2. Συχνά ☐ 3. Πάντα ☐

Η. ΠΛΗΡΟΦΟΡΙΕΣ ΣΧΕΤΙΚΕΣ ΜΕ ΤΗ ΔΙΑΤΡΟΦΗ ΤΟΥ ΓΟΝΕΑ						
Σημείωσε ΠΟΣΟ ΣΥΧΝΑ καταναλώνεις τα παρακάτω τρόφιμα τον τελευταίο μήνα:						
	Συχνότητα κατανάλωσης σε μερίδες / εβδομάδα					
Δημητριακά ολικής άλεσης, πχ. ψωμί, ζυμαρικά, ρύζι (1 φέτα ή 1 φλιτζάνι)	Ποτέ	1-6	7-12	13-18	19-31	>32
Πατάτες (1 μικρή)	Ποτέ	1-4	5-8	9-12	13-18	>18
Φρούτα και χυμούς (1 μερίδα: Μικρά φρούτα κεράσια, φράουλες, σταφύλια - ½ φλ **ή** μεσαία φρούτα- μήλο, πορτοκάλι, αχλάδι - 1 μέτριο **ή** μεγάλα - πεπόνι, καρπούζι - 1 φέτα **ή** 1 ποτήρι χυμό)	Ποτέ	1-4	5-8	9-12	13-18	>18
Λαχανικά και σαλάτες (1 φλ ωμά ή ½ φλ βρασμένα)	Ποτέ	1-6	7-12	13-20	21-32	>33
Όσπρια (1 φλιτζάνι)	Ποτέ	<1	1-2	3-4	5-6	>6
Ψάρι και σούπες (120 γρ ή 1 πιάτο)	Ποτέ	<1	1-2	3-4	5-6	>6
Κόκκινο κρέας και προϊόντα του (120 γρ)	≤1	2-3	4-5	6-7	8-10	>10
Πουλερικά (120 γρ)	≤3	4-5	5-6	7-8	9-10	>10
Γαλακτοκομικά πλήρη σε λιπαρά (1 ποτήρι ή 1 κεσεδάκι ή 40 γρ τυρί)	≤10	11-15	16-20	21-28	29-30	>30
Ελαιόλαδο στην καθημερινή μαγειρική (1 κουτ σούπας)	Ποτέ	Σπάνια	<1	1-3	3-5	Καθημερινά
Αλκοολούχα ποτά (1 μερίδα ποτού: 120 ml κρασί ή 300 ml μπύρα ή 40 ml ουίσκι, βότκα, τζιν, ούζο)	<3	3	4	5	6	>7

Θ. ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΑΝΙΧΝΕΥΣΗΣ ΑΣΘΜΑΤΟΣ ΚΑΙ ΑΛΛΕΡΓΙΚΩΝ ΠΑΘΗΣΕΩΝ ΣΤΑ ΠΑΙΔΙΑ	
1. Είχε ποτέ το παιδί σας στο παρελθόν «βράσιμο» ή σφύριγμα στο στήθος; ΝΑΙ ☐ ΟΧΙ ☐ **Αν απαντήσατε «όχι» παρακαλώ προχωρήστε στην ερώτηση 6**	**2. Είχε το παιδί σας «βράσιμο» ή σφύριγμα στο στήθος τους τελευταίους 12 μήνες;** ΝΑΙ ☐ ΟΧΙ ☐
3. Πόσα επεισόδια με «βράσιμο» ή σφύριγμα στο στήθος είχε το παιδί σας τους τελευταίους 12 μήνες; Κανένα ☐ 1 έως 3 ☐ 4 έως 12 ☐ Περισσότερα από 12 ☐	**4. Τους τελευταίους 12 μήνες, πόσο συχνά, κατά μέσο όρο, ξύπνησε το παιδί σας από «βράσιμο» ή σφύριγμα στο στήθος;** Ποτέ δεν ξύπνησε ☐ Λιγότερο από μία νύχτα την εβδομάδα ☐ Μια ή περισσότερες νύχτες την εβδομάδα ☐
5. Τους τελευταίους 12 μήνες, ήταν ποτέ τόσο σοβαρό το «βράσιμο» ή το σφύριγμα, ώστε να δυσκολεύεται να μιλήσει; ΝΑΙ ☐ ΟΧΙ ☐	**6. Είχε ποτέ το παιδί σας άσθμα;** ΝΑΙ ☐ ΟΧΙ ☐
7. Τους τελευταίους 12 μήνες, ακούστηκε «βράσιμο» ή «σφύριγμα» στο στήθος του παιδιού σας κατά τη διάρκεια ή μετά από άσκηση (τρέξιμο, παιχνίδι); ΝΑΙ ☐ ΟΧΙ ☐	**8. Τους τελευταίους 12 μήνες, είχε ποτέ το παιδί σας ξηρό βήχα τη νύχτα, που δεν οφειλόταν σε κρυολόγημα ή λοίμωξη του αναπνευστικού;** ΝΑΙ ☐ ΟΧΙ ☐
9. Είχε ποτέ το παιδί σας πρόβλημα με φτερνίσματα, συνάχι ή «βουλωμένη» μύτη, ενώ δεν ήταν κρυωμένο ή με γρίπη; ΝΑΙ ☐ ΟΧΙ ☐ **Αν απαντήσατε «όχι» παρακαλώ προχωρήστε στην ερώτηση 14**	**10. Τους τελευταίους 12 μήνες, είχε ποτέ το παιδί σας πρόβλημα με φτερνίσματα, συνάχι ή «βουλωμένη» μύτη, ενώ δεν ήταν κρυωμένο ή με γρίπη;** ΝΑΙ ☐ ΟΧΙ ☐

Η. ΠΛΗΡΟΦΟΡΙΕΣ ΣΧΕΤΙΚΕΣ ΜΕ ΤΗ ΔΙΑΤΡΟΦΗ ΤΟΥ ΓΟΝΕΑ						
Σημείωσε ΠΟΣΟ ΣΥΧΝΑ καταναλώνεις τα παρακάτω τρόφιμα τον <u>τελευταίο μήνα</u>:						
	Συχνότητα κατανάλωσης σε <u>μερίδες / εβδομάδα</u>					
Δημητριακά ολικής άλεσης, πχ. ψωμί, ζυμαρικά, ρύζι (1 φέτα ή 1 φλιτζάνι)	Ποτέ	1-6	7-12	13-18	19-31	>32
Πατάτες (1 μικρή)	Ποτέ	1-4	5-8	9-12	13-18	>18
Φρούτα και χυμούς (1 μερίδα: Μικρά φρούτα κεράσια, φράουλες, σταφύλια - ½ φλ **ή** μεσαία φρούτα- μήλο, πορτοκάλι, αχλάδι - 1 μέτριο **ή** μεγάλα - πεπόνι, καρπούζι - 1 φέτα **ή** 1 ποτήρι χυμό)	Ποτέ	1-4	5-8	9-12	13-18	>18
Λαχανικά και σαλάτες (1 φλ ωμά ή ½ φλ βρασμένα)	Ποτέ	1-6	7-12	13-20	21-32	>33
Όσπρια (1 φλιτζάνι)	Ποτέ	<1	1-2	3-4	5-6	>6
Ψάρι και σούπες (120 γρ ή 1 πιάτο)	Ποτέ	<1	1-2	3-4	5-6	>6
Κόκκινο κρέας και προϊόντα του (120 γρ)	≤1	2-3	4-5	6-7	8-10	>10
Πουλερικά (120 γρ)	≤3	4-5	5-6	7-8	9-10	>10
Γαλακτοκομικά πλήρη σε λιπαρά (1 ποτήρι ή 1 κεσεδάκι ή 40 γρ τυρί)	≤10	11-15	16-20	21-28	29-30	>30
Ελαιόλαδο στην καθημερινή μαγειρική (1 κουτ σούπας)	Ποτέ	Σπάνια	<1	1-3	3-5	Καθημερινά
Αλκοολούχα ποτά (1 μερίδα ποτού: 120 ml κρασί ή 300 ml μπύρα ή 40 ml ουίσκι, βότκα, τζιν, ούζο)	<3	3	4	5	6	>7

Θ. ΕΡΩΤΗΜΑΤΟΛΟΓΙΟ ΑΝΙΧΝΕΥΣΗΣ ΑΣΘΜΑΤΟΣ ΚΑΙ ΑΛΛΕΡΓΙΚΩΝ ΠΑΘΗΣΕΩΝ ΣΤΑ ΠΑΙΔΙΑ	
1. Είχε ποτέ το παιδί σας στο παρελθόν «βράσιμο» ή σφύριγμα στο στήθος; ΝΑΙ ☐ ΟΧΙ ☐ **<u>Αν απαντήσατε «όχι» παρακαλώ προχωρήστε στην ερώτηση 6</u>**	**2. Είχε το παιδί σας «βράσιμο» ή σφύριγμα στο στήθος τους τελευταίους 12 μήνες;** ΝΑΙ ☐ ΟΧΙ ☐
3. Πόσα επεισόδια με «βράσιμο» ή σφύριγμα στο στήθος είχε το παιδί σας τους τελευταίους 12 μήνες; Κανένα ☐ 1 έως 3 ☐ 4 έως 12 ☐ Περισσότερα από 12 ☐	**4. Τους τελευταίους 12 μήνες, πόσο συχνά, κατά μέσο όρο, ξύπνησε το παιδί σας από «βράσιμο» ή σφύριγμα στο στήθος;** Ποτέ δεν ξύπνησε ☐ Λιγότερο από μία νύχτα την εβδομάδα ☐ Μια ή περισσότερες νύχτες την εβδομάδα ☐
5. Τους τελευταίους 12 μήνες, ήταν ποτέ τόσο σοβαρό το «βράσιμο» ή το σφύριγμα, ώστε να δυσκολεύεται να μιλήσει; ΝΑΙ ☐ ΟΧΙ ☐	**6. Είχε ποτέ το παιδί σας άσθμα;** ΝΑΙ ☐ ΟΧΙ ☐
7. Τους τελευταίους 12 μήνες, ακούστηκε «βράσιμο» ή «σφύριγμα» στο στήθος του παιδιού σας κατά τη διάρκεια ή μετά από άσκηση (τρέξιμο, παιχνίδι); ΝΑΙ ☐ ΟΧΙ ☐	**8. Τους τελευταίους 12 μήνες, είχε ποτέ το παιδί σας ξηρό βήχα τη νύχτα, που δεν οφειλόταν σε κρυολόγημα ή λοίμωξη του αναπνευστικού;** ΝΑΙ ☐ ΟΧΙ ☐
9. Είχε ποτέ το παιδί σας πρόβλημα με φτερνίσματα, συνάχι ή «βουλωμένη» μύτη, ενώ δεν ήταν κρυωμένο ή με γρίπη; ΝΑΙ ☐ ΟΧΙ ☐ **<u>Αν απαντήσατε «όχι» παρακαλώ προχωρήστε στην ερώτηση 14</u>**	**10. Τους τελευταίους 12 μήνες, είχε ποτέ το παιδί σας πρόβλημα με φτερνίσματα, συνάχι ή «βουλωμένη» μύτη, ενώ δεν ήταν κρυωμένο ή με γρίπη;** ΝΑΙ ☐ ΟΧΙ ☐

Appendix 3 (Additional Published Papers)

High sodium intake of children through 'hidden' food sources and its association with the Mediterranean diet: the GRECO study

Emmanuella Magriplis[a], Paul Farajian[a], George D. Pounis[a], Grigoris Risvas[a], Demosthenes B. Panagiotakos[b] and Antonis Zampelas[a]

Objectives **Sodium is the mineral that has been, mainly, linked to hypertension and cardiovascular disease. It is found naturally in many foods, but is also used in the food industry and manufacturing. Identification of total sodium intake, as well as 'hidden' sodium intake from food sources early in life is necessary.**

Methods **Four thousand, five hundred and eighty children aged 10–12 years were enrolled, in a cross-sectional, population-based survey. Among other measurements, dietary data were obtained by a semi-quantitative food frequency questionnaire, and sodium intake was calculated. High sodium consumption was considered an intake over 2200 mg/day. Adherence to the Mediterranean dietary pattern was evaluated using the Mediterranean Diet Quality Index for children and adolescent score (KIDMED score).**

Results **Twenty-three percent of Greek children had sodium intake which exceeded the 2200 mg/day recommendation, excluding salt added at table and during cooking. Sodium intake was found elevated in children with moderate and high adherence to the Mediterranean Diet. Additionally, 1 unit increase in KIDMED score (i.e. higher adherence) was associated with 10% [odds ratio (OR) 1.10, 95% confidence interval (CI) 1.07–1.13] increased likelihood of consuming sodium above the median intake (i.e. >1500 mg/day). Thirty-four percent of sodium intake from 'hidden' sources came from bread, processed cereals and white cheese.**

Conclusions **Greek children have an elevated sodium intake from 'hidden' sources and main contributors are foods which are recommended to be consumed on a daily basis according to the Mediterranean Diet Pyramid. These findings should induce manufacturers to reduce the amount of sodium added during processing of 'healthy' foods, especially bread and cheese.** ***J Hypertens*** **29:1069–1076**

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Keywords: children, Mediterranean diet, public health, sodium food sources, sodium intake

Abbreviations: FFQ, Food Frequency Questionnaire; KIDMED, Mediterranean Diet Quality Index for children and adolescents; MVPA, moderate through vigorous physical activity; PAQ-C, Physical Activity Questionnaire for older Children

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Introduction

Hypertension is a global burden which has been associated with renal and cardiovascular disease, the latter being the leading cause of death in developed countries. Worldwide, nearly 1 billion adults have hypertension, and 17–30% of hypertension cases can be attributed to excess dietary sodium [1,2]. Sodium is a mineral found naturally in many foods but is also used greatly in processed foods. It is noteworthy that in some countries, it has been suggested that reducing sodium consumption to the recommended intakes (<2200 mg/day) will likely reduce hypertension and hypertension-related cardiovascular disease by 30 and 8.6%, respectively [3]. High blood pressure (BP) levels can be observed in children and a significant number of children have elevated BP levels without having any underlying disease. High BP levels in childhood should be regularly reassessed and nonpharmacological or pharmacological interventions should be promptly initiated because high BP levels in childhood may lead to hypertension and related cardiovascular diseases in later life [4].

Regarding sodium intake modification, there is controversy as to how sodium intake can be decreased in individuals, as well as in populations, and which public health measures should be taken in order to help reduce total sodium daily intake. Therefore, identification of food sources of sodium in modern diets is critical. To date many researchers have focused on the sodium content of poor nutritional quality foods that children consume [5]. Sodium, however, can also be found hidden in 'healthy' foods such as whole wheat bread and processed cereal, foods consumed largely in a Mediterranean-type diet. Although the health benefits of the Mediterranean diet are widely acknowledged, there is still inconsistency regarding the association of adherence to the Mediterranean diet and total sodium intake. In particular, the

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Mediterranean diet has been described as a diet abundant in plant foods, minimally processed, olive oil as the main fat source, low to moderate dairy and wine intake, low intake of red meat, and sparse sugar intake [6]. Although research has shown that specific foods which characterize the Mediterranean diet have preventive effects on chronic diseases, such as fruits and vegetables, olive oil and nuts and unprocessed cereals [7–16], little is known on the contribution of these foods to the total sodium intake in the modern diet.

Therefore, in the present work, and under the context of the Greek Childhood Obesity study (GRECO), the daily dietary sodium intake (excluding table salt and salt added during cooking) of 10–12 years old Greek children, was studied, within the context of the Mediterranean diet pattern.

Methods

Participants

The GRECO study was carried out from October to May 2009. The sampling included all regions of the country (i.e. Attica, Sterea Ellada and Evia, Macedonia, Peloponnesus, Epirus, Thessaly, Thrace, Aegean islands, Ionian Islands and Crete). From the aforementioned regions a number of 130 randomly selected public primary schools (through the listings provided by the Ministry of Education) were invited to participate. The number of children to be enrolled in each region was proportional to the total population of the region, based on data provided by the National Statistics Service of Greece. Thus, a total of 5850 schoolchildren (fifth and sixth grade) were invited for potential inclusion. However, the number of schools that agreed to participate in the study was 117 from all over the country and signed parental consent forms were obtained for 4965 of 5850 children (84.9% participation rate) and were finally enrolled in the study. After checking the quality of the data obtained from the enrolled children, the final sample consisted of 4580 children (49% men and 51% women) with a mean age of 10.9 ± 0.75 years, with the 52.0 and 48% coming from large urban (i.e. >1 000 000 pop.) and urban and semi-urban areas (i.e. 10 000 to 1 000 000 pop.), respectively.

Bioethics

The retrieved data were confidential, and the study followed the ethical considerations provided by the World Medical Association (52nd WMA General Assembly, Edinburgh, Scotland, October 2000). The research was approved by the Hellenic Ministry of Education (Department of Primary Education) as the law provides in Greece for any studies conducted in the school environment, during formal school hours, and the Agricultural University of Athens Research Committee. Prior to measurements' initiation an extended letter explaining the aims of the study was sent to the principal of each school and each parent or guardian was provided with a letter explaining the aims of the study and a consent form. Those parents who agreed to participate in the study had to sign the consent form and send it back to the school in order to be collected.

Measurements

The measurements were conducted by investigators and staff of the Unit of Human Nutrition of the Agricultural University of Athens. All investigators followed a series of planning meetings and were trained in survey methods that included practical experience in weighing and measuring techniques. Additionally, before the initiation of the study all investigators followed a 2-week pilot practice period in primary schools that were not included in the final study sample in order to get familiarized with the procedures. All study sites used the same measuring equipment and procedures and in each class the investigators' team consisted of at least two people. All measurements were performed during morning hours.

Dietary and eating behavior assessment

Dietary assessment was based on a validated self-reported, semi-quantitative Food Frequency Questionnaire (FFQ), consisting of 48 food items commonly used in the local Greek cuisine [17]. All participants were asked about their usual frequency of consumption of the food items (average over the past year) with the response categories ranging from never, 1–2 times per month, to everyday. Pictures of standard size of the food portions were used to help participants visualize the regular portion and quantify the portion of the food item they usually consumed. Specifics on the type of food consumed were also asked for (such as whole wheat bread vs. white bread, brown rice vs. white, low-fat dairy products vs. full-fat, sugar-free soft drinks vs. regular, etc.). The assessment of sodium intake through consumption of various food groups was performed using food composition tables of US Department of Agriculture [18]. The evaluation of repeatability of dietary information regarding sodium intake were tested in a sample of 21 girls and 23 boys (aged 10–12 years) from one school unit in Athens, applying the semi-quantitative FFQ two times (within a 30-day interval) in the same children. Results showed very good repeatability between the two measurements (Spearman's rho $= 0.82$, $P < 0.001$, % of agreement using Bland–Altman graphical method $= 93.2\%$). Furthermore relative validity of such information was assessed using 3-day recalls which applied 30 days after the FFQ in a second sample of 20 girls and 13 boys (aged 10–12 years) from the same school unit. Very good relative validity was revealed regarding sodium consumption resulting from FFQ and 3-day recalls (Spearman's rho $= 0.57$, $P < 0.001$, % of agreement using Bland–Altman graphical method $= 91.0\%$).

Assessment of Mediterranean diet pattern

The KIDMED index (Mediterranean Diet Quality Index for children and adolescents) was used to evaluate the degree of adherence to the Mediterranean diet [19]. The index comprises of 16 yes or no questions. Questions denoting a negative connotation with respect to the Mediterranean diet were assigned a value of −1 and those with a positive aspect +1. The total score ranged from −4 to 12.

Physical activity, anthropometric assessment and blood pressure measurements

All participants were asked to complete the Physical Activity Questionnaire for Older Children (PAQ-C) [20]. The instrument is designed for use in older children aged 8–14 years and consists of nine questions structured to discern moderate to vigorous physical activity (MVPA) during the past 7 days. The summary score for the PAQ-C is the average of the sum of the nine questions using a 1–5 scale and it is designed to be used during the school year, rather than summer vacation or holiday periods.

Body weight was recorded to the nearest 100 g with the use of a digital scale (Tanita TBF 300) and with patients standing without shoes in light clothing. Standing height was measured using a portable stadiometer (Leicester height measure) to the nearest 0.1 cm without shoes, with the head positioned according to the Frankfort plane. Body mass index (BMI) was calculated by dividing weight (kg) by standing height squared (m^2). Percentage of body fat (%BF) and body fat mass were estimated by the foot to foot impedance method (Tanita TBF 300) with children standing barefoot. Obesity and overweight among children were evaluated using the International Obesity Task Force (IOTF) age and sex-specific BMI cut-off criteria [21].

Blood pressure was measured using an oscillometric device (UA-787 oscillometric blood pressure monitor, A&D Company), equipped with the right type of cuff for children of this age. During the measurements children were calm, in a sitting position with their back supported, with the right arm resting on a solid supporting surface at heart level, and at least 10 min at rest [22]. Two subsequent measurements were taken with a 5-min interval in order to familiarize children with the procedure and the diastolic and systolic BP values of the second measurements were recorded.

Statistical analysis

Normally distributed continuous variables are presented as mean ± SD, skewed as median (first, third quartiles) and categorical variables as frequencies. The normality of continuous variables was tested graphically according to P-P plots. Comparisons of continuous variables between groups of study were performed using the independent *t*-test or one-way ANOVA, for the normally distributed variables and the Mann–Whitney *U*-test or Kruskal–Wallis test, for the skewed. Associations between categorical variables were tested using the Pearson's chi-squared test. Repeatability and relative validity of dietary information regarding sodium intake were tested using Spearman's rho and Bland–Altman method. High sodium consumption was considered over 2200 mg/day from food sources alone [23]. According to the KIDMED scoring system [19], only 4.5% of the children ($N = 205$) had an optimal score (≥8), therefore children with average and high scores were pooled together into one group of 'moderate and high adherers' to the Mediterranean diet, with a KIDMED score higher than the median for this population (i.e. >4). Whereas children with a KIDMED score equal or lower than the median were classified as 'low adherers'. Multiple logistic regression analysis adjusted for age, sex, BMI and physical activity was used to evaluate the association between adherence to the Mediterranean diet on the likelihood of consuming high sodium intake from different food resources (dependent outcome). Results are presented as odds ratios (ORs) and their corresponding 95% confidence intervals (CIs). Hosmer–Lemeshow statistic was used to test the models' goodness of fit. All tested hypotheses were two-sided. *P*-value less than 0.05 was considered as statistically significant. SPSS version 18 software was used for all calculations (SPSS Inc., Chicago, Illinois, USA).

Results

In Table 1 various socio-demographic, anthropometric and lifestyle characteristics of the children are presented, according to their level of sodium intake, other than table salt. Using the recommended cut-offs it was observed that 23% of the total sample had high sodium intake (>2200 mg/day), without taking into account added salt at the table or while cooking. Moreover, boys were more likely to be categorized in high sodium consumption than girls ($P < 0.001$); 31.6% of children who had high total sodium consumption were overweight or obese; children with high sodium intake were more physically active, but also had better adherence to the Mediterranean diet than participants with low intake. No significant difference was observed as regards the level of sodium intake and age groups, or region of living (urban or rural). Moreover, no association was observed between sodium intake and BP levels, even after adjusting for sex and age of the children. Concerning body fat measurement results, body fat mass was positively correlated with BMI (Pearson's rho = 0.897, $P < 0.001$), and negatively correlated with sodium intake (Spearman's rho = −0.180, $P < 0.001$).

Then, increased sodium intake from different food sources was evaluated by the level of adherence to the Mediterranean diet (Table 2). Children that reported moderate and high adherence to the Mediterranean diet (i.e. KIDMED score >4) had higher sodium intake from the majority of the food groups ($P < 0.001$), by the exception of pizza, hamburgers, souvlaki (a type of meat), saltines (including crisps, crackers, cheese sticks) and cakes ($P > 0.05$).

Table 1 Socio-demographic, anthropometric and lifestyle characteristics of the participants, by sodium consumption from foods other than table salt and cooking salt

	Low total sodium intake (<1500mg/day)[a]	Moderate total sodium intake (1500–2200 mg/day)	High total sodium intake (>2200 mg/day)	Total sample	P^b
N	2570 (56.1%)	959 (20.9%)	1051 (23%)	4580	
Age group (%)					0.14
10 years	25.2	21.6	22.5	23.6	
11 years	47.6	49.7	48.2	48.3	
12 years	27.2	28.7	29.3	28.1	
Male sex (%)	42.2	48.9	60.3**	49.0	<0.001
BMI (kg/m^2)	20.7 ± 3.9	20.2 ± 3.7	19.5 ± 3.6*	20.3 ± 3.8	<0.001
Body fat mass (kg)	11.2 ± 6.6	10.3 ± 6.3	8.9 ± 5.8	10.4 ± 6.4	<0.001
Percentage of body fat (%)	22.4 ± 8.9	20.8 ± 8.7	18.8 ± 8.3	21.1 ± 8.9	<0.001
Overweight/obese (%)	45.0	39.6	31.8**	40.1	<0.001
Physical activity (0–5)	2.92 ± 0.60	2.93 ± 0.58	3.02 ± 0.62*	2.95 ± 0.60	<0.001
KIDMED score (−4 to 12)	3.55 ± 2.17	4.21 ± 2.12**	3.86 ± 2.25*	3.78 ± 2.20	<0.001

[a] Total dietary sodium consumption was classified to low, moderate and high intake (i.e. <1500, 1500–2200, >2200 mg/day) using European Union recommendations. [b] *P* values were derived through one-way ANOVA test for normally distributed variables, Kruskal–Wallis for skewed and Pearson's χ^2 for categorical data. * $P < 0.05$ from post-hoc comparisons between high, moderate vs. low sodium intake, after correcting the *P* value with the Bonferroni rule. ** $P < 0.01$ from post-hoc comparisons between high, moderate vs. low sodium intake, after correcting the *P* value with the Bonferroni rule.

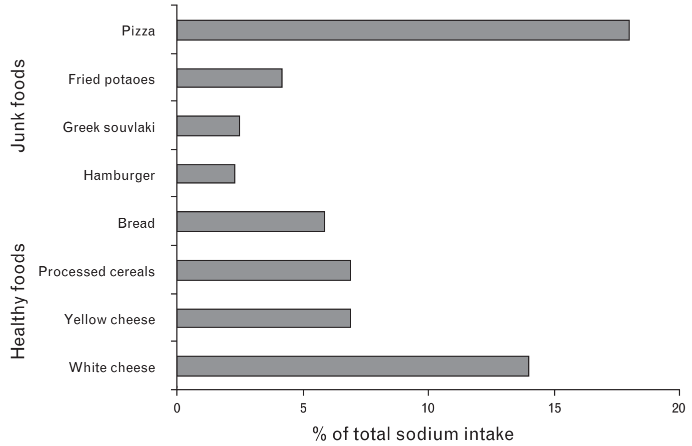
Moreover, in Fig. 1, the major food items that contribute to sodium intake are presented. The greater sources of sodium in children's diet were pizza and white cheese, whereas healthy foods, conferred more in total sodium consumption than junk foods (34 and 27% of total sodium intake, correspondingly). It should be noted that children with moderate and high adherence to the Mediterranean diet (i.e. KIDMED score >4) had higher consumption of

Table 2 Sodium intake from different sources, by level of adherence to the Mediterranean diet using KIDMED score

	Low adherence to Mediterranean diet	Moderate and high adherence to Mediterranean diet	Total sample	P^a
N	2876	1704	4580	
Sex (%)				0.257
Boys	61.9	38.1	49.0	
Girls	63.5	36.5	51.0	
Weight status (%)				0.348
Overweight	64.1	35.9	29.1	
Obese	63.6	36.4	11.0	
BMI (kg/m^2)	20.3 ± 3.8	20.2 ± 3.8	20.3 ± 3.8	0.311
Percentage of body fat (%)	21.2 ± 8.9	20.8 ± 8.8	21.1 ± 8.9	0.193
IPAQ-C	2.9 ± 0.6	3.0 ± 0.6	2.9 ± 0.6	<0.001
DBP (mmHg)	71.2 ± 10.6	70.9 ± 10.4	71.1 ± 10.5	0.47
SBP (mmHg)	108.5 ± 13.0	108.1 ± 13.0	108.4 ± 13.0	0.39
Sodium intake from different food groups (mg/day)[b]				
Processed cereals	29.6 (0, 133)	104 (29.6, 207)	59.2 (10.4, 133)	<0.001
Bread	53.2 (4.7, 120)	59.8 (26.6, 138)	53.2 (9.32, 120)	<0.001
Beans	2.8 (0, 8.3)	11 (2.9, 16.6)	5.5 (0.97, 11)	<0.001
Potatoes	46.4 (16.2, 139)	92.8 (32.5, 186)	48.7 (16.2, 48.7)	<0.001
Bread products	7.3 (0, 18.8)	14.6 (3.6, 29.2)	7.3 (2.55, 29.2)	<0.001
Cabbage family	0 (0, 3.5)	2.5 (47.9, 431)	1.2 (0, 3.5)	<0.001
Cheese, white	95.8 (0, 335)	215 (47.9, 431)	95.8 (16.8, 335)	<0.001
Cheese, yellow	41.5 (0, 166)	82.9 (14.5, 187)	41.5 (0, 166)	<0.001
Cheese, low in fat	0 (0, 13.2)	4.6 (0, 26.3)	0 (0, 13.2)	<0.001
Cold cuts (processed meat)	55.8 (0, 223)	55.8 (19.5, 223)	55.8 (9.8, 223)	<0.001
Meat, red	10 (3.5, 20)	20 (7, 40)	10 (3.5, 20)	<0.001
Meat, white	13.6 (6.8, 38.8)	19.4 (13.6, 38.8)	19.4 (6.8, 38,8)	<0.001
Fish	14 (4.9, 28)	28 (9.8, 42)	14 (4.9, 28)	<0.001
Pizza	188 (65.8, 376)	188 (132, 376)	188 (65.8, 376)	0.34
Hamburger	26.6 (0, 26.6)	26.6 (0, 26.6)	26.6 (0, 26.6)	0.56
Souvlaki	14.4 (14.4, 41)	14.4 (14.4, 41)	14.4 (14.4, 41)	0.58
Potatoes, fried	27.7 (9.7, 83.2)	41.6 (19.4, 111)	27.7 (9.7, 111)	<0.001
Saltines	38.1 (0, 109)	38.1 (19.1, 109)	38.1 (0, 109)	0.38
Cake	23.2 (11.6, 66.4)	31.1 (11.6, 66.4)	23.2 (11.6, 66.4)	0.12
Pies	18.1 (0, 51.8)	45.3 (18.1, 10.4)	18.1 (18.1, 104)	<0.001
Soft drinks	1.4 (0, 8)	2.0 (1.4, 8.0)	1.4 (0, 8)	<0.001
Total sodium intake (mg/day)	1410 (839, 2258)	1576 (1091, 2330)	1481 (932, 2287)	<0.001
Total sodium intake (%)				<0.01
<1500 mg/day	57.7	53.4	56.1	
1500–2200 mg/day	19.2	23.9	20.9	
≥2200 mg/day	23.1	22.6	23.0	

Low MD adherence: KIDMED score ≤4; moderate and high MD adherence: KIDMED >4. [a] *P* values were derived using Mann–Whitney test for skewed variables and Pearson's χ^2 for categorical data. [b] Dietary sodium intake from different sources is presented as median (25th percentile, 75th percentile) because its distribution was skewed in all cases.

Fig. 1



Sodium intake from healthy or junk foods as percentage of total consumption other than table salt and salt added during cooking.

these foods (P values for all <0.05), with the exception of pizza, hamburgers and souvlaki.

In addition, the level of adherence to the Mediterranean diet was associated with sodium intake from various food sources. In particular, unadjusted analyses (Table 3) revealed that 1 unit increase in the KIDMED score was associated with 4–50% (i.e. ORs varied from 1.04 to 1.50, all P values <0.05) increased likelihood of consuming sodium intake above the median value for the majority of foods. These results were confirmed even after adjusting for age, sex, BMI and physical activity. The impact of healthy dietary habits (as assessed through the KIDMED score) on the likelihood of high sodium intake were not significant regarding hamburgers and saltines (P values >0.05). Moreover, 1 unit increase in

Table 3 Results from multiple logistic regression analyses that evaluated the association between children's adherence to the Mediterranean diet (using the KIDMED score as independent variable) on likelihood of consuming high sodium (i.e. above the median as the binary dependent outcome) from different food sources (other than table and cooking salt)

	Unadjusted		Adjusted for age, sex, physical activity and BMI	
Sodium higher than the median intake from various foods[a] (dependent)	OR for 1 unit in KIDMED	95% CI	OR for 1 unit in KIDMED	95% CI
>59.2 mg/day from processed cereals	1.32*	1.28, 1.36	1.31*	1.27, 1.35
>53.2 mg/day from bread	1.20*	1.17, 1.24	1.20*	1.17, 1.23
>7.3 mg/day from bread products	1.22*	1.19, 1.25	1.20*	1.17, 1.24
>5.5 mg/day from beans	1.50*	1.45, 1.55	1.50*	1.45, 1.55
>48.7 mg/day from potatoes	1.19*	1.16, 1.23	1.18*	1.15, 1.22
>1.2 mg/day from cabbage family	1.30*	1.26, 1.33	1.29*	1.26, 1.33
>95.8 mg/day from white cheese	1.26*	1.23, 1.30	1.25*	1.22, 1.29
>41.5 mg/day from yellow cheese	1.19*	1.16, 1.22	1.18*	1.15, 1.21
>0.1 mg/day low in fat cheese	1.13*	1.10, 1.16	1.12*	1.09, 1.15
>55.8 mg/day from cold cuts	1.09*	1.06, 1.11	1.08*	1.05, 1,11
>10 mg/day from red meat	1.18*	1.15, 1.21	1.16*	1.13, 1.20
>19.4 mg/day from white meat	1.19*	1.16, 1.23	1.18*	1.15 1.22
>14 mg/day from fish	1.35*	1.31, 1.39	1.33*	1.30, 1.38
>188 mg/day from pizza	1.04*	1.01, 1.06	1.04*	1.01, 1.07
>26.6 mg/day from hamburger	0.99	0.96, 1.02	0.99	0.96,1.02
>14.4 mg/day from souvlaki	1.23*	1.19, 1.28	1.23*	1.18, 1.27
>27.7 mg/day from fried potatoes	1.13*	1.10, 1.16	1.13*	1.10, 1.16
>38.1 mg/day from saltines	1.02*	1.00, 1.05	1.02*	0.99, 1.04
>23.2 mg/day from cake	1.07*	1.04, 1.10	1.06*	1.03, 1.09
>18.1 mg/day from pies	1.10*	1.07, 1.13	1.10*	1.07, 1.13
>1.4 mg/day from soft drinks	1.12*	1.09, 1.15	1.10*	1.07, 1.14
Total sodium intake over EU upper level (>1500 mg/day)	1.10*	1.07, 1.13	1.10*	1.07, 1.13
Total sodium intake over EU recommended consumption (>2200 mg)	1.02	0.99, 1.05	1.02	0.98, 1.05

[a] Sodium intake over the median for this population was evaluated as high consumption for each food group. * $P < 0.05$.

KIDMED score was associated with 10% increase in likelihood of consuming total sodium greater than 1500 mg/day (which is the EU upper level), although this association was not significant when extreme total sodium intake (i.e. >2200 mg/day) was considered as the outcome ($P > 0.05$). At this point it should be noted that the average level of adherence to the Mediterranean diet was low to moderate in both sexes (Table 1).

Discussion

The main finding of the present work was that dietary sodium intake, other than table salt and salt added during cooking, is above the current guidelines in 23% of the Greek children. A secondary finding was that this high sodium intake was observed even in children that reported to be closer to the Mediterranean dietary pattern. Nevertheless, it should be underlined that only 4.5% of children had an optimal adherence to the Mediterranean diet (KIDMED score ≥8). These extremely low levels of adherence imply that the positive association between dietary sodium intake from food sources and the adherence to the Mediterranean diet scheme, basically concerns children with low and moderate adherence to this traditional dietary pattern, although the main contributors of sodium intake were foods which are recommended to be consumed on a daily basis and are placed at the bottom of the pyramid. Finally, another important finding of the GRECO study was the alarming magnitude of childhood obesity in Greece, since the overall prevalence of overweight and obesity exceeded 40% of the population of schoolchildren aged 10–12 years.

In addition, the fact that a further 20.9% of the children had a moderate sodium intake (between 1500 and 2200 mg/day), but only via foods, and without taking into account the salt added at the table and the salt added during cooking, could imply that a significant and alarming proportion of the children consumes sodium above the guidelines, which makes it an important public health issue, in Greece. Sex and physical activity were also associated with high sodium consumption. In particular, boys and physically active children had higher sodium intakes than girls and less physically active children. The key sodium contributors were pizza, white cheese, processed cereals and breads.

Our results are in agreement with results from studies performed in other countries too [24–27]. In particular, Pavadhgul *et al.* [26] found that dietary sodium intake among Thai University students was two-fold higher than recommended amounts (>2400 mg) and Fischer *et al.* [24] found an average sodium intake of 3412 mg in youths aged 9–18 years with the key food contributors being breads, processed meats and pasta dishes. This was further supported by other studies [25,28].

It is of great interest that children closer to the Mediterranean diet reported a higher sodium intake, whereas a greater proportion of overweight/obese children reported low sodium intake. This may partly be explained by the possible under-reporting seen of overweight/obese individuals; although the questionnaires repeatability was validated prior to use. It must be noted that moderate and high KIDMED score (>4) was observed in 38.8% of overweight/obese children compared to 61.2% of normal weight children. No differences were observed in the mean physical activity index score between these groups of children (data not shown).

In this work we quantified the association between the level of Mediterranean diet adherence and sodium intake by calculating the OR of exposure, in order to better evaluate the main effect of the dietary habits of the participants on the likelihood of consuming higher quantities of sodium from different foods. A strong association between the level of adherence to Mediterranean diet and sodium intake was observed. This may seem controversial after taking into consideration that adherence to a Mediterranean food pattern has been shown to be associated with substantial reductions in total mortality and cardiovascular disease mortality in adults [7–10]. In addition, studies have also found an inverse association between hypertension incidence, as well as BP levels in individuals following the Mediterranean diet [11,12]. Moreover, it has also been observed that a diet high in olive oil and, fruit and vegetable was inversely associated with hypertension [13] and that a dietary pattern rich in fruit, vegetables, and low-fat dairy products and poor in total and saturated fat can be effective in the prevention of hypertension [14,29]. However, Núñez-Córdoba *et al.* [16] did not find an association between hypertension and adherence to the classical Mediterranean diet.

A possible explanation of the high sodium intake of children with moderate and high Mediterranean diet adherence is the total food intake. Thirty-four percent (34%) of total sodium intake was found to be consumed by those foods known as ‘healthy’ (i.e. bread, processed cereal and white cheese), compared with 18% that was observed from pizza. These foods which are recommended to be consumed on a daily basis seem to add substantially to the total dietary sodium of an otherwise healthy dietary pattern, due to sodium addition during manufacturing. Processed foods, including breads/cereals/grains, also contributed heavily to sodium intake in the UK (95%) and the US [25]. It is estimated that approximately 75% of dietary sodium is added during food processing; in addition to taste and palatability, sodium also has functional roles in food manufacturing and preservation, although the amounts used often exceed those required [30]. Due to the high consumption, it may be necessary for manufacturers to reduce sodium use. It has been proposed that the most promising sodium reduction strategy is to adapt the preference of consumers for saltiness by reducing sodium in products in small steps [31].

Lastly, it must be noted that our results include the overall population and are not confined on high-risk individuals only (i.e. obese children). Studies have found a direct relation between the increase in childhood obesity and the increased prevalence of pediatric hypertension [32]; also sodium has been associated with an increase in BP, direct cardiovascular damage and obesity [33]. The evaluation of total sodium intake from foods alone (excluding table and cooking salt) in this study showed that both obese and normal weight children have a high dietary sodium intake, raising important public health questions for the children's population. Although, sodium intake was not associated with BP levels, the fact that 23% of the children's population exceeded the current guidelines from food sources alone makes them exposed to higher risk for future development of hypertension. It is also noteworthy that BMI was positively correlated with BP levels, indicating that children of these age groups are susceptible to risk factors that are documented to elevate BP levels [22,34]. Since the age-related BP rise in both children and adults is well established [34], efforts to reduce sodium intake and decrease the very high prevalence of childhood obesity, which were observed in the GRECO study, are warranted in order to delay or prevent hypertension.

Limitations

The limitations of this work are mostly due to its cross-sectional nature; although a special effort was given during designing the study, implementing and analyzing the results in order to avoid potential confounding. Overweight and obese children may have under-reported food intake leading to information bias. This was addressed by testing the repeatability of the information regarding sodium intake in a sub-sample of schoolchildren of same age and sex. Additionally, it was mentioned that table salt and salt added while cooking was not evaluated on the effect of dietary sodium intake. This would not have been practical since it is difficult to measure it when using a FFQ. Finally, the use of international instead of local food composition tables (due to the incompleteness) may have over-estimated or under-estimated the sodium intake of some foods studied.

In conclusion, high sodium intake from 'hidden' sources was observed in Greek childhood population, with greater intakes found in children closer to the Mediterranean diet. Thus, the childhood population in Greece should be targeted for a sodium reduction program and not only for the ongoing epidemic of obesity. Moreover, the consumption of a dietary pattern close to the Mediterranean seems not to be a panacea for children's health, since greater adherence was associated with higher sodium intake through 'hidden' sources. The later finding does not moderate the undoubtable health benefits gained from this traditional dietary pattern, but should stress manufacturers to reduce the amount of sodium added during processing of 'healthy' foods. This information gathered is valuable for health planners that are aware of the consequences of high sodium intake. Planning population preventive services is essential. Starting at childhood in order to decrease incidence of health issues linked to excess sodium intake seems to be very important.

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