

Original Article

Family-Related Characteristics and Childhood Obesity: A Systematic Literature Review

Venetia Notara, MSc, PhD

Assistant Professor Department of Public and Community Health, University of West Attica, Athens, Greece; Research Assistant Department of Nutrition – Dietetics, School of Health Science and Education, Harokopio University, Athens, Greece

Sofia–Panagiota Giannakopoulou, MSc

Department of Nutrition – Dietetics, School of Health Science and Education, Harokopio University, Athens, Greece

Evanthia Sakellari, MSc, PhD

Assistant Professor Department of Public and Community Health, University of West Attica, Athens, Greece

Demosthenes B Panagiotakos, DrMed, FRSPH, FACE

Professor Department of Nutrition – Dietetics, School of Health Science and Education, Harokopio University, Athens, Greece; Adj Prof Faculty of Health, University of Canberra, ACT, Australia

Correspondence: Prof. D.B. Panagiotakos, *DrMed, FRSPH, FACE*, Department of Nutrition and Dietetics, School of Health Science and Education, Harokopio University, Athens 176 71, Greece. E-mail: dbpanag@hua.gr

Abstract

Background: Family seems to play a critical role in children's weight status. However, the evidence is equivocal with most of it suggesting the multifactorial mechanisms of obesity.

Objectives: This systematic review aimed to examine the existing literature on the family factors (i.e., socioeconomic status, feeding practices, etc) as well as family structure that are associated with child's weight status and to introduce the complex interactions between these factors and childhood overweight/obesity.

Methods: A literature search in English language studies with publication framework from 1/1/2000 until 30/09/2019, has been implemented on databases of PubMed and Scopus. The result of the reviewing process was that 58 out of the 3928 initially retrieved unique items, met the inclusion criteria.

Results: Ten factors were identified across the literature as family-related factors that are associated with childhood obesity. These factors are: parental weight, parental educational status, parental occupational status, family structure, family meals frequency, parenting styles, feeding practices, family perception about child's weight and family history of diseases.

Conclusions: The present review recorded several family-related risk factors that may contribute on the childhood obesity epidemic. The basic framework proposed may be used as a key element for future research in order to confirm or reject the proposed associations as well as to evaluate the importance of each determinant on childhood obesity.

Key-words: childhood obesity, family characteristics, parental characteristics, public health, social class.

Introduction

Childhood obesity reached epidemic levels worldwide. According to the Organization for Economic Co-operation and Development (OECD) data for 2017, nearly one in six children

is overweight/obese (OECD, 2017). These rates are even more alarming in the view of the immediate and long-term health risks. Childhood overweight/obesity is associated with non-fatal health problems such as respiratory and musculoskeletal problems, skin conditions and

infertility, as well as with life-threatening conditions such as cardio-vascular disease (CVD), type II diabetes, certain types of cancers, and gallbladder disease (Kosti and Panagiotakos 2006). It is well known that obesity tracks into adulthood and therefore is related with increased risk of premature mortality and adult morbidity, especially cardio-metabolic morbidity (Reilly et al. 2003; Reilly and Kelly 2011; Simmonds et al. 2016). Thus, childhood obesity is not only a developmental phenomenon, but its adverse effects sustain throughout life (Spruijt-Metz 2011). Also, the rising rates of childhood obesity increase the burden of disease, lead to social and economic consequences and contribute to the rising cost of health services (WHO 2016).

Family is the first social environment in which the individual is integrated. Parental characteristics, family composition and family environment shape children's habits, knowledge and physical activity level (Chen et al. 2014; Notara et al. 2018). However, parents also build their children's dietary environment and as carriers have the main responsibility for providing food and shaping eating behavior. Therefore, the family's role is very important in determining the child's dietary life and weight status (Lee, Lee and Park 2016).

The purpose of this systematic review was to record the family factors, like parental weight status, parental socioeconomic status, family dietary habits and perception of child's weight as well as family structure (i.e. one parent family, number of siblings, extended families) and their interactions on the development of overweight and obesity among children and adolescents.

Methods

To review the current literature regarding the role of family structure in relation to obesity in children and adolescents, a systematic literature search was conducted in PubMed and Scopus. Studies concerning children and adolescents and studies published in English were only eligible for review. Searches covered all years available from 1/1/2000 until 30/9/2019. No other exclusion criteria (by the exception of language) applied to study's selection; i.e., all types of observational studies, experimental trials and other scientific reports of relevant data (including position papers, systematic or not reviews and meta-analyses) were included in the searches. Also, reference lists reviewed, and further papers

were identified. The search query included the following terms: ['parental characteristics' AND 'childhood obesity'], ['family characteristics' AND 'childhood obesity'], ['family type' AND 'childhood obesity'] and ['family risk factors' AND 'childhood obesity']. The result of the reviewing process was that 58 out of the 3928 initially retrieved unique items met the inclusion criteria and thus were included in this systematic review. The excluded studies were for various reasons, like, irrelevant topic, lack of reporting results or any other information and duplications. This systematic review followed the procedures suggested by PRISMA reporting guidelines (Moher et al. 2009). The search strategy is depicted in Figure 1.

Results

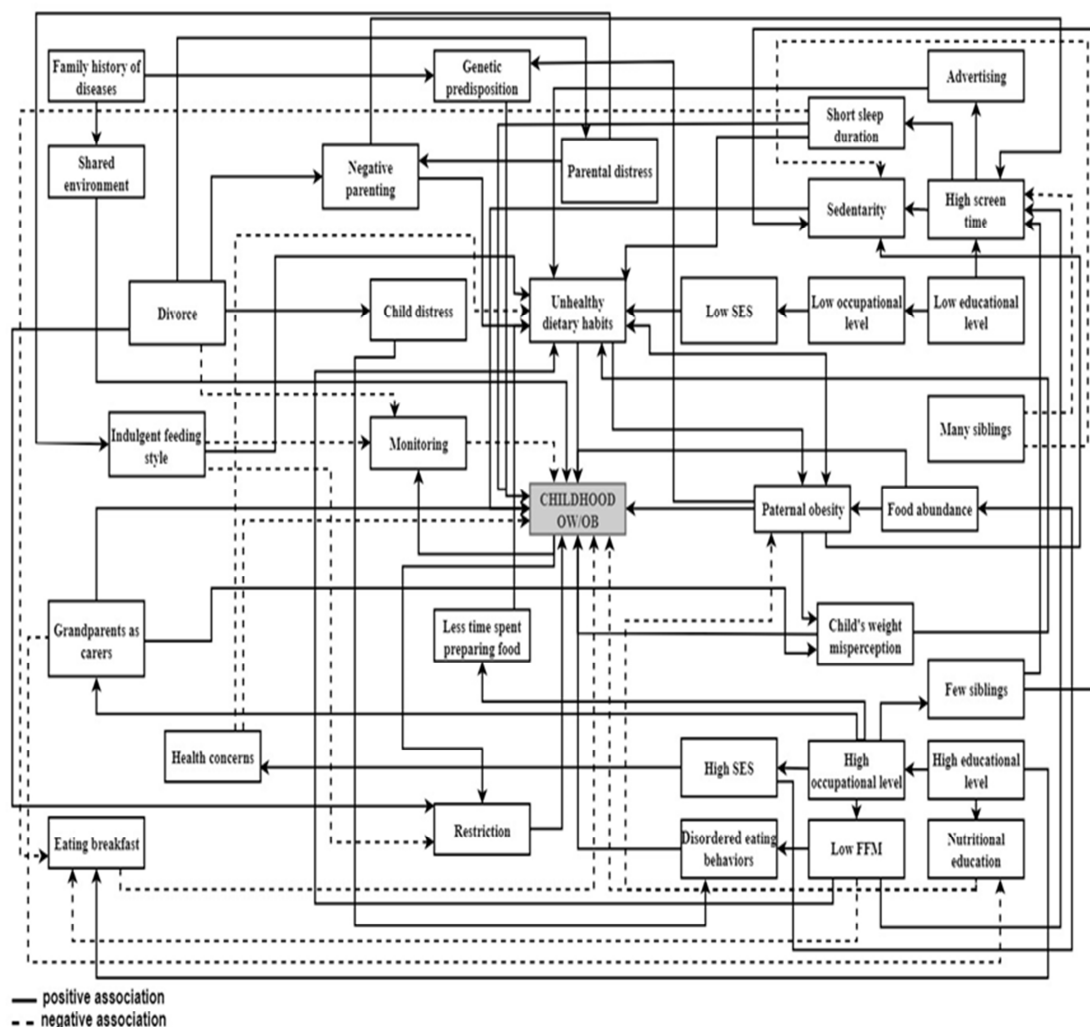
Initially 3928 scientific papers were retrieved; after identifying and removing duplicates, 1983 remained for evaluation. The 1820 papers were removed based on the Title/Abstract as they were irrelevant with the aim of the present study. Of the remaining 163 papers those with irrelevant methodology of study sample (i.e. clinical trials, post adolescence and infant weight status) were excluded. Thus, 58 papers were finally considered as the most relevant.

Parental weight status

Many studies examined the association between parental and child's weight status. A prospective study of 150 children from birth since 9.5 years of age identified parent overweight as the strongest risk factor for childhood overweight (Agras et al. 2004). Similarly, a longitudinal study of 595 children from 2 to 15 years old showed that maternal overweight/obesity was significantly associated with higher risk for a childhood obese/overweight and excess weight maintenance (Demment et al. 2014). A cross-sectional study in Greek children aged 10-12 years suggested that parental obesity status is a highly influential factor on children's obesity status. Particularly when one parent was overweight/obese the odds of having an overweight/obese child were 1.62 (95% CI:1.22-2.14) times higher odds compared to normal-weight parents, whilst, when both parents were overweight/obese the odds were three times higher (OR=3.24, 95% CI:2.39-4.38) (Farajian et al. 2013). A Greek cross-sectional survey that included 1190 children aged 10–12 years and their parents showed that the odds of child

overweight were 1.8 (95%CI:1.265-2.614) times higher for maternal overweight and 1.9 (95%CI:1.033-3.563) times higher for maternal obesity.

Figure 1. The pathways of possible associations between family-related risk factors and childhood overweight/obesity (OW/OB).



Childhood obesity likelihood was even greater for both maternal overweight (OR=3.13, 95%CI:1.425-6.897) and obesity (OR=10.38, 95%CI:4.118-26.173). Paternal overweight and obesity status were associated with greater children's overweight likelihood (OR:1.9; 95%CI:1.237-2.752 and OR:2.5; 95%CI:1.559-4.053, respectively). Also, children with two overweight parents, were twice (95%CI:1.302-3.368) more likely to be overweight (Notara et al. 2019). These findings are in concordance with results from other studies conducted in Greek children population (Panagiotakos et al. 2008; Manios et al. 2007; Manios et al. 2011). Some

cross-sectional studies observed a linear relation between parental weight status with child's overweight prevalence i.e. the heavier the parental body weight, the higher the overweight prevalence in children (Li et al. 2007; Notara et al. 2019). A recent systematic review shows relation between the parent-child weight status, with differentiated strength according to the study type, child age, type of parent-child pair (i.e. mother-male child) etc (Wang 2017).

Parental and children weight changes are also related to children weight status. Parental BMI change significantly predicts child's BMI

change; when parental BMI is reduced by one unit, a 0.255 reduction in child's BMI is observed (Boutelle, Cafri and Crow 2012). An earlier study also concluded that parental z-BMI change significantly predicts child's z-BMI change (Wrotniak et al. 2004).

Parental Socioeconomic Status (SES)

SES can be evaluated through “social” indicators that describe class position such as educational or occupational level, financial factors such as annual income, or both. Family's SES and child's weight status remains unclear. Some studies concluded that low SES is positively related with childhood overweight/obesity (Noh et al. 2014; Rogers et al. 2015; Manios et al. 2018), others related higher SES with higher risk of obesity (Kondolot et al. 2017; Khashayar et al. 2018), while some indicate both low and high SES as childhood obesity risk factors (Zong, Li and Zhang 2015).

Results from a longitudinal study suggested that children in low-income families throughout childhood were more likely to remain overweight (AOR=2.55, 95%CI:1.03-5.42) whilst children of families that became low-income during childhood years are more likely to be obese (AOR =2.36, 95%CI:1.12-5.93) compared to children who never low-income (Demment, Haas and Olson 2014). Based on the UK Millennium Cohort Study at age 5, children in the low-income quintile had 2.0 (95%CI:1.4–2.8) increased relative obesity risk, whilst at the age of 11 years old they had 3.0 (95%CI:2.0–4.5) increased risk compared to children in the high-income quintile. Factors such as physical activity and diet played significant role in explaining those inequalities (Goisis, Sacker and Kelly 2016).

Some studies show discrepancy between developed and developing societies. In developing societies, an early review suggested that the obesity prevalence increases with rising wealth (Sobal and Stunkard 1989), whereas a most recent one showed the practical disappearance of this positive relationship (Barriuso et al. 2015). Among developed societies, three reviews agreed that the SES/childhood obesity relationship was mostly negative and only few positive associations were observed (Sobal and Stunkard 1989; Shrewsbury and Wardle 2008; Barriuso et al. 2015).

The association between parental occupational status and childhood overweight/obesity seems vague. UK Millennium Cohort Study suggests that, parents' employment is associated with lower risk (adjusted RR:0.71), whilst prolonged maternal full-time employment with increased risk (adjusted RR:1.46) (Hope et al. 2015). The Western Australian Pregnancy Cohort (Raine) Study show that the likelihood of childhood overweight/obesity among children aged 2-5 years was lower when mother worked weekly less than 24 hours. However among children aged 8-14 years, 35-40 hours seemed beneficiary. These non-linear effects were more prominent among low to medium income families in which fathers worked overtime (Li et al. 2017). A systematic review showed higher rate of childhood overweight when mothers belonged to higher income households and worked overtime (Mindlin, Jenkins and Law 2009).

The effect of parental educational status on child's weight status is not yet completely understood. Some studies indicated that lower parental education level increases the likelihood of childhood overweight/obesity (Lamerz et al. 2005; Gopinath et al. 2012; Androustos et al. 2018), others suggested that higher parental educational level is associated with childhood overweight/obesity (Liu et al. 2016; Pirincci et al. 2017), while in some studies no statistically significant relation was observed (Gray et al. 2007; Yannakoulia et al. 2008; Burgi et al. 2010). The cross-sectional Health Behavior in School-aged Children (HBSC) study resulted in reverse association, as students with two low-educated parents were more likely to be overweight than those with at least one high-educated parent (OR=1.63, 95%CI:1.38-1.91 in boys; OR=2.07, 95%CI:1.70-2.51 in girls) irrespectively of gender and age (Lazzeri et al. 2014). However, results from a multinational cross-sectional study indicated a negative correlation in higher economic status countries and a positive correlation in countries with deprived economies (Muthuri et al. 2016).

Family structure

A typical modern family often consists of two out-of-home working parents and one or two children in contrast to earlier times when often one parent remained at home to look after the children. Modern times are also associated with

the emersion of altered family structures, i.e. single-parent families (Formisano et al. 2014).

In a Chinese cross-sectional study, children whose care responsibility belonged to their grandparents were more likely to be overweight/obese (adjusted OR=2.03; 95%CI:1.19-3.47) (Li, Adab and Cheng 2015). The Identification and prevention of Dietary- and lifestyle-induced health Effects In Children and infantS (IDEFICS) project similarly showed significantly higher BMI Z-score (0.63; 95%CI:0.33-0.92 vs. 0.19; 95%CI:0.17-0.22; $p<0.001$) (Formisano et al. 2014).

Moreover, the number of children seemed to play an important role; lower BMI Z-score was associated with higher number of siblings (only child 0.31; 95%CI:0.24- 0.38; 1 sibling 0.19; 95%CI:0.16-0.23; 2 siblings 0.15; 95%CI:0.09-0.20; >2 siblings 0.07, 95%CI:0.04-0.19; $p<0.001$). Differences were also observed at weight gain, over time. Children living with one parent and new partner or with other cohabiting adults had significantly less BMI increase compared to children living with one or two parents. The same was observed according to the number of siblings i.e. the more siblings, the less BMI increase (Formisano et al. 2014). The Early Childhood Longitudinal Study-Kindergarten Cohort (ECLS-K) showed that children living with single mothers had greater obesity likelihood at fifth grade than children living with both parents (26% vs. 22%, $p=0.05$) whereas children with siblings had lower BMI and were less likely to be obese. Moreover, children living only with mother or had no siblings increased their BMI over time (Chen and Escarce 2010). Children with no siblings had greater weight gain than those with siblings. However, no similar association was found for single-mother families, suggesting that this factor is attenuated as the child grows older and becomes more independent (Chen and Escarce 2010). The Gene-Diet Attica investigation on childhood obesity (GENDAI) study revealed a significant association between divorced families and children's overweight, as children with divorced parents had significantly higher BMI levels. Even after controlling for confounding factors, such as SES and physical activity level, divorce remained a significant predictor of higher BMI (Yannakoulia et al. 2008). In a Norwegian study, overweight (including obesity) was 1.54

(95%CI:1.21-1.95) times more prevalent among children of divorced parents compared to children of married ones (Biehl et al. 2014).

Family dietary habits and behaviors

It has been suggested that the frequency of family meals (FFMs) can be associated with a healthier dietary pattern in children, thus affecting child's weight status (Valdes et al. 2013). A South Korean cross-sectional study concluded that the FFM is strongly and inversely associated with childhood overweight/obesity. The odds ratio of overweight/obese students who only dined with their family was 1.21 (95%CI:0.89–1.64), who had family breakfast only was 3.20 (95%CI:1.70–6.02), and who had neither of these meals was 4.17 (95%CI:1.98–8.78) compared to those who had both. Having only family breakfast was significantly related to overweight/obesity, while having only family dinner was not (Lee et al. 2016). Greek population results suggested that family meals are an eating habit that protects against obesity. Meals with at least one family member five or more times/week had 14% reduced risk for childhood overweight/obesity (Farajian et al. 2014). Similar results were observed in a meta-analysis where 3 or more meals with family per week had about 12% reduced odds for overweight (Hammons and Fiese 2011). However a systematic review regarding FFMs and childhood/adolescent overweight risk, revealed inconsistent and weak evidence of an inverse association (Valdes et al. 2013).

Parenting styles and feeding practices

Parenting styles, as proposed by Baumrind, are used to describe the level of responsiveness and demandingness in the parent-child interaction (Kakinami et al. 2015; Shloim et al. 2015). The results on the effect of parenting styles and feeding practices on childhood obesity remain inconclusive. A large cross-sectional Canadian youth study concluded authoritarian, compared to authoritative, parenting resulted in greater obesity likelihood (AOR=1.35, 95%CI:1.2–1.5, $p=0.0001$ and AOR=1.41, 95%CI:1.1–1.8, $p=0.007$, respectively) (Kakinami et al. 2015).

Moreover, parenting style changes seem to play an important role in the long-term outcome of childhood obesity treatment. Parenting style alteration from rejection to acceptance was

related to reduced childhood overweight percentage, over 12 months Stein et al. 2005).

However, UK pre-school children study observed that parenting styles were not related to child's BMI (Blissett and Haycraft 2008). Many recent reviews correlate authoritative parenting with lower BMI levels, reduced risk for obesity and less weight-related adverse outcomes (Sleddens et al. 2011; Vollmer and Mobley 2013; Sokol, Qin and Poti 2017), whilst indulgent or uninvolved parenting with higher child's BMI (Shloim et al. 2015).

Feeding practices refer to parental behaviors focused directly on influencing children's eating i.e. eating pressure (Shloim et al. 2015). Indulgent feeding styles were associated with greater risk of overweight and obesity and increases children's BMI z-score, irrespectively of confounding factors (Shloim et al. 2015; Hughes et al. 2016). Similarly, maternal food restriction (physical or verbal) was associated with higher child's BMI Z-scores (Farrow, Haycraft and Blissett 2016).

Also parental behaviors such as modeling healthy eating habits and praising, were independent predictors of child's overweight percentage change, over 24 months (Wrotniak et al. 2005).

A recent review suggests that restrictive/controlling feeding practices are related to higher child's BMI while pressure to eat is linked to lower child's BMI, especially when restriction referred to unhealthy foods and pressure to eat on healthy foods. Thus, obesity risk seems associated with the method used by parents to control and modify their children's eating (Shloim et al. 2015).

Family perception of child's weight

Parents of overweight/obese children often cannot recognize their child's overweight (Robinson 2017). A multi-year survey study concluded that more than 2 out of 5 parents misperceived their children's weight status.

Within kindergartners, the 83.9% of parents categorized their children as "healthy", however only 28.3% actually had healthy weight. Parental misperception was one great childhood obesity predictor, as it resulted in 12-fold childhood obesity likelihood (OR=11.61; 95%CI: 10.05–13.41). Also, overweight and obese parents were

more likely to have an obese child (OR=1.39, 95%CI:1.19–1.62 and OR=2.23, 95%CI: 1.93–2.60, respectively) (McKee et al. 2016). Similarly, data from Greek population suggested that children's BMI misclassification seems to be an important predictor of childhood overweight/obesity (OR=6.22, 95%CI:3.62–10.71) (Farajian et al. 2014).

Family history of diseases

Family history (FH) is an independent risk factor for many chronic diseases and it's assessment suitable for disease prevention and health promotion interventions (Valdez et al. 2010). Cross-sectional study results, suggested that the positive FH of cardiovascular/metabolic diseases, should be considered risk factor for both early onset and severity of childhood obesity (Corica et al. 2018).

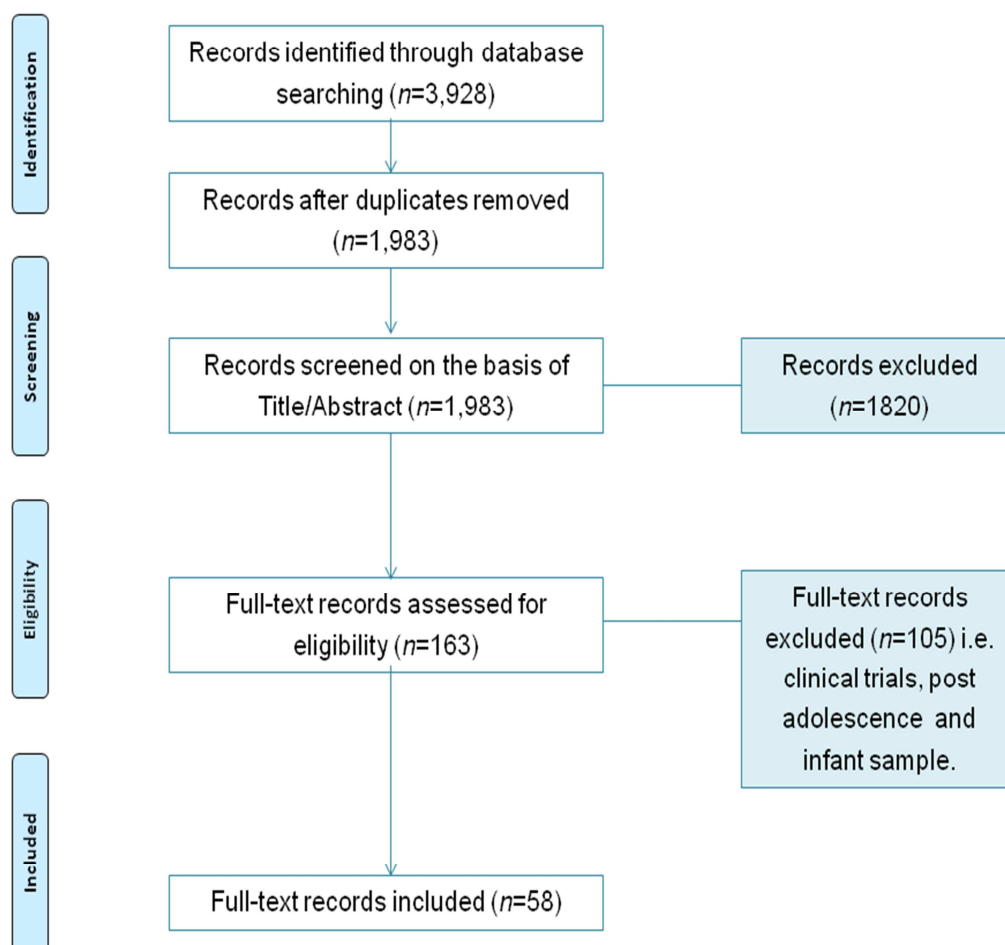
The Bogalusa Heart Study showed positive correlation between diabetes FH and offspring overweight and obesity, irrespectively of age. Also offspring with heart attack FH were significantly overweight after 10 years of age (Bao et al. 1995). The Toyama Birth Cohort Study, showed that maternal FH of hypertension had positive association with the risk of overweight in children at age 12. Also, the higher the number of family members with hypertension, the higher the adjusted OR (1 member 1.16; 95%CI:0.99–1.35; 2 members 1.42; 95% CI:1.04–1.92; 3 members 4.75; 95% CI:1.35–16.69) (Liu et al. 2014).

An Italian study of primary school children show higher adiposity level in children with positive FH of diabetes and hypertension (Giampietro et al. 2002). Likewise, in a survey of 259 children aged 7-20 years, the majority of the obese children were offsprings of both diabetic parents (Linares Segovia et al. 2012).

Discussion

The objective of the present review was to study and discuss family-related factors and family structure in relation to childhood overweight/obesity. The results indicated that family can play an important role through at least ten different ways. The complex pathways of the possible associations between these factors and childhood overweight/obesity, as well as the interactions of all these factors are represented in Figure 2.

Flow Diagram



The majority of the studies suggested that parental weight status is strongly and positively associated with children's weight. Genetic predisposition may be responsible for obesity susceptibility. As the gene-environment hypothesis suggests parental chronic exposure to "obesogenic" environments, may lead to metabolic adaptations that produce epigenetic changes which are responsible for the emergence of altered phenotypes more susceptible to obesity, such as insulin or leptin resistant. These phenotypes are inheritable and, therefore, could put offsprings at risk of overweight/obesity. This could explain why having both parents overweight/obese carries higher risk for children than having just one. Even though this finding might be a consequence of the double genetic burden, it is also highly possible to be a result of

common family environment. Apart from genetics, "obesogenic" lifestyle characterized by unhealthy eating and low physical activity levels can easily be transmitted through the family socialization and interaction process (Wang et al. 2017).

A parental characteristic that seems to affect children's weight status is educational level. It is suggested that high parental educational level leads to better decisions regarding health and directly motivate parents to adopt a healthier lifestyle as role models⁷¹. Moreover, children with well educated parents seem more likely to eat breakfast, which is inversely associated with the prevalence of childhood overweight/obesity (Panagiotakos et al. 2008; Liu et al. 2018). Cultural and social differences between high and

low educated parents could be a possible explanation. Higher education is usually associated with better economic status, therefore highly educated parents may be more able to afford a healthy diet and provide financial support for children's physical activity pursuits. On the other hand, less educated parents are more likely to live in low-income neighborhoods that are known to be more "obesogenic", i.e. more fast-food restaurants (Gopinath et al. 2012). However, some researchers suggest that highly educated parents by giving better opportunities for their children, provide a high-energy inactive lifestyle resulting in childhood overweight/obesity (Pirincci et al. 2010).

Education, occupation and income cannot be presumed to operate independently of each other considering their high correlation. According to a proposed framework, education is related with knowledge and beliefs, occupation with lifestyle and shared peer values, and income with access to resources (Noh et al. 2014). High occupational and educational level is often linked with more time-consuming and mentally demanding careers (Liu et al. 2018). The limited time spent in eating with children and the low FFMs are positively associated with childhood obesity, as family meals seem to lead to greater fruit and vegetable consumption, lower consumption of foods high in calories, better family cohesion and less behavioral problems. Time dedicated to family meals helps children to establish a general healthy lifestyle i.e. limited screen time, limited exposure to food industry advertising, regular breakfast eating etc. Additionally, during family meals parents have the opportunity to serve as models of healthy eating habits (Valdes et al. 2013). The ambiguous relationship between family SES and child weight status can be explained by the "Obesity Kuznets curve" and nutrition transition. As income rises, due to food abundance people have high-energy diets and obesity rates increase. But as income rises even higher, people seem to be more health-conscious; therefore a decrease in obesity levels is observed. At this process, education seems to act as mediator that leads to a decrease of the obesity level above a certain income threshold⁷¹.

The possible decreased attention from career-oriented mothers may be associated with nutritional care by other relatives such as grandparents (Liu et al. 2018). Children mainly

cared for by their grandparents, were more likely to be overweight/obese. The proposed mechanisms include poor knowledge of the adverse effects of overeating or unhealthy diet in children, the preference for "fat" children among grandparents of certain nationalities, as well as the under-recognition and misperception of children's weight status (Li et al. 2015).

Family structure, such as number of children and marital status, seems to play an important role in the childhood obesity epidemic. Evidence has shown that siblings through encouragement can increase physical activity and outdoor pursuits. Boys with no siblings have been shown to spend more time watching TV, a factor associated with childhood adiposity (Chen and Escarce 2014; Alghadir et al. 2016). Increases in total screen time seem related with declines in sleep duration, a factor associated with childhood obesity and unhealthy habits such as breakfast skipping, fast food consumption etc (Tambalis et al. 2018). It should be noted that children with no siblings were mostly children of working mothers (Mitsuhashi et al. 2012). Children from divorced families were more likely to exhibit disordered behaviors i.e. non-compliance and emotional stress (Yannakoulia et al. 2008). The disruption in the parent-child relationship, the conflict between former spouses, as well as other negative events could induce emotional stress, which may affect eating behaviors and physical activity level (Biehl et al. 2014). Parenting style changes may also mediate the potential association between marital dissolution and children's weight changes. Divorce affects parenting as increases restrictiveness and diminishes monitoring (Yannakoulia et al. 2008).

Compared to authoritative parenting, authoritarian parenting was associated with increased obesity risk among children. One possible mechanism to interpret this association is through the child's ability to self-regulate his/her energy intake. Authoritarian parents are not responsive to their children's cues of hunger and/or satiety and are highly characterized by controlling the child's energy intake. Thus, children's ability to regulate their own energy intake is underdeveloped and when given the opportunity these children may be more susceptible to overeat (Kakinami et al. 2015). From the general parenting literature it is suggested that parenting styles and child's

characteristics and behaviors are bidirectional (Ventura and Birch 2008).

Regarding feeding styles, indulgent style seems associated with lower intake of fruit, vegetables, and dairy, providing one possible mechanism through which feeding styles could impact child's weight status, over time. Also indulgent feeding style puts children at higher risk for excessive weight gain over time suggesting other involved mechanisms. The basic hypothesis is that parents with indulgent feeding style may use food as a way to be affectionate towards their child, contributing to high-energy intake. The indulgent feeding style has also been associated with child's eating behaviors including self-selection of larger portion sizes and extensive consumption of foods high in calories (Hughes et al. 2016).

The results of this narrative review concluded that family can affect child's weight status through at least ten different ways. However, the present findings should be considered in the context of their limitations. The main purpose of this paper was to have an overview and explore the existing literature in the field of family-related risk factors in relation to childhood obesity. Due to its narrative nature, this review may be subject to author bias which in general terms is an aspect of the narrative review approach. Also, it should be noted that the possible associations and interactions are primarily hypothetical and mainly based on results from cross-sectional studies; therefore they cannot establish causal relationships due to potential reverse causality. Despite limitations, this narrative review broadens the understanding between family-related factors and childhood obesity by examining multiple family domains. Due to its novelty, this narrative review can make an important contribution to this expanding area of relative research.

Conclusion: It is obvious that family can affect children's weight status through many different ways. However, as present scientific evidence suggests, the majority of the reviewed factors have ambiguous effect on childhood obesity. This narrative review attempted to put together most of the existing knowledge on family-related risk factors for childhood overweight/obesity. There is no doubt that this knowledge needs to be extended. There is a need for more longitudinal studies in order to establish causal associations.

The complexity in the interaction between family-related risk factors and child's weight status creates a challenge in guiding parents and adequately developing health programs and policies to remedy childhood obesity.

References

- Alghadir AH, Gabr SA, Iqbal ZA. (2016) Television watching, diet and body mass index of school children in Saudi Arabia. *Pediatrics international : official journal of the Japan Pediatric Society*,58(4):290-294.
- Agras WS, Hammer LD, McNicholas F, Kraemer HC. (2004) Risk factors for childhood overweight: a prospective study from birth to 9.5 years. *The Journal of Pediatrics*,145(1):20-25.
- Androutsos O, Moschonis G, Ierodiakonou D, et al. (2018) Perinatal and lifestyle factors mediate the association between maternal education and preschool children's weight status: the ToyBox study. *Nutrition*,48:6-12.
- Bao W, Srinivasan SR, Wattigney WA, Berenson GS. (1995) The Relation of Parental Cardiovascular Disease to Risk Factors in Children and Young Adults. *Circulation*, 91(2):365-371.
- Barriuso L, Miqueleiz E, Albaladejo R, Villanueva R, Santos JM, Regidor E. (2015) Socioeconomic position and childhood-adolescent weight status in rich countries: a systematic review, 1990-2013. *BMC Pediatrics*,15:129.
- Biehl A, Hovengen R, Groholt EK, Hjelmessaeth J, Strand BH, Meyer HE. (2014) Parental marital status and childhood overweight and obesity in Norway: a nationally representative cross-sectional study. *BMJ Open*,4(6):e004502.
- Blissett J, Haycraft E. (2008) Are parenting style and controlling feeding practices related? *Appetite*,50(2-3):477-485.
- Boutelle KN, Cafri G, Crow SJ.(2012) Parent predictors of child weight change in family based behavioral obesity treatment. *Obesity*,20(7):1539-1543.
- Burgi F, Meyer U, Niederer I, et al. (2010) Socio-cultural determinants of adiposity and physical activity in preschool children: a cross-sectional study. *BMC Public Health*,10:733.
- Chen AY, Escarce JJ. (2010) Family structure and childhood obesity, Early Childhood Longitudinal Study - Kindergarten Cohort. *Preventing Chronic Disease*,7(3):A50.
- Chen AY, Escarce JJ. (2014) Family structure and childhood obesity: an analysis through 8th grade. *Maternal and Child Health Journal*,18(7):1772-1777.
- Corica D, Aversa T, Valenzise M, et al. (2018) Does Family History of Obesity, Cardiovascular, and Metabolic Diseases Influence Onset and Severity

- of Childhood Obesity? *Frontiers in Endocrinology*,9:187.
- Demment MM, Haas JD, Olson CM. (2014) Changes in family income status and the development of overweight and obesity from 2 to 15 years: a longitudinal study. *BMC Public Health*,14:417.
- Farajian P, Panagiotakos DB, Risvas G, et al. (2013) Socio-economic and demographic determinants of childhood obesity prevalence in Greece: the GRECO (Greek Childhood Obesity) study. *Public Health Nutrition*,16(2):240-247.
- Farajian P, Panagiotakos DB, Risvas G, Malisova O, Zampelas A. (2014) Hierarchical analysis of dietary, lifestyle and family environment risk factors for childhood obesity: the GRECO study. *European Journal of Clinical Nutrition*,68(10):1107-1112.
- Farrow CV, Haycraft E, Blissett JM. (2018) Observing Maternal Restriction of Food with 3(-)5-Year-Old Children: Relationships with Temperament and Later Body Mass Index (BMI). *International Journal of Environmental Research and Public Health*,15(6). pii: E1273.
- Formisano A, Hunsberger M, Bammann K, et al. (2014) Family structure and childhood obesity: results of the IDEFICS Project. *Public Health Nutrition*, 17(10):2307-2315.
- Giampietro O, Virgone E, Carneglia L, Griesi E, Calvi D, Matteucci E.(2002) Anthropometric Indices of School Children and Familiar Risk Factors. *Preventive Medicine*,35(5):492-498.
- Goisais A, Sacker A, Kelly Y. (2016) Why are poorer children at higher risk of obesity and overweight? A UK cohort study. *European Journal of Public Health*,26(1):7-13.
- Gopinath B, Baur LA, Burlutsky G, Robaei D, Mitchell P. (2012) Socio-economic, familial and perinatal factors associated with obesity in Sydney schoolchildren. *Journal of Paediatrics and Child Health*,48(1):44-51.
- Gray VB, Byrd SH, Cossman JS, Chromiak J, Cheek WK, Jackson GB. Family characteristics have limited ability to predict weight status of young children. *Journal of the American Dietetic Association*. Jul 2007;107(7):1204-1209.
- Hammons AJ, Fiese BH. (2011) Is frequency of shared family meals related to the nutritional health of children and adolescents? *Pediatrics*,127(6):e1565-1574.
- Hope S, Pearce A, Whitehead M, Law C. (2015) Parental employment during early childhood and overweight at 7-years: findings from the UK Millennium Cohort Study. *BMC Obesity*, 2:33.
- Hughes SO, Power TG, O'Connor TM, Orlet Fisher J, Chen TA. (2016) Maternal Feeding Styles and Food Parenting Practices as Predictors of Longitudinal Changes in Weight Status in Hispanic Preschoolers from Low-Income Families. *Journal of Obesity*, 2016:7201082.
- Kakinami L, Barnett TA, Seguin L, Paradis G. (2015) Parenting style and obesity risk in children. *Preventive Medicine*,75:18-22.
- Khashayar P, Kasaeian A, Heshmat R, et al. (2018) Childhood Overweight and Obesity and Associated Factors in Iranian Children and Adolescents: A Multilevel Analysis; the CASPIAN-IV Study. *Frontiers in Pediatrics*,6:393.
- Kondolot M, Poyrazoglu S, Horoz D, et al. (2017) Risk factors for overweight and obesity in children aged 2-6 years. *Journal of Pediatric Endocrinology & Metabolism: JPEM*,30(5):499-505.
- Kosti RI, Panagiotakos DB. (2006) The epidemic of obesity in children and adolescents in the world. *Central European Journal of Public Health*,14(4):151-159.
- Lamerz A, Kuepper-Nybelen J, Wehle C, et al. (2005) Social class, parental education, and obesity prevalence in a study of six-year-old children in Germany. *International Journal of Obesity*,29(4):373-380.
- Lazzeri G, Giacchi MV, Spinelli A, et al. (2014) Overweight among students aged 11-15 years and its relationship with breakfast, area of residence and parents' education: results from the Italian HBSC 2010 cross-sectional study. *Nutrition Journal*,13:69.
- Lee HJ, Lee SY, Park EC. (2016) Do family meals affect childhood overweight or obesity?: nationwide survey 2008-2012. *Pediatric Obesity*,11(3):161-165.
- Li Y, Zhai F, Yang X, et al. (2007) Determinants of childhood overweight and obesity in China. *The British Journal of Nutrition*,97(1):210-215.
- Li B, Adab P, Cheng KK. (2015) The role of grandparents in childhood obesity in China - evidence from a mixed methods study. *The International Journal of Behavioral Nutrition and Physical Activity*,12:91.
- Li J, Akaliyski P, Schafer J, et al.(2017) Non-linear relationship between maternal work hours and child body weight: Evidence from the Western Australian Pregnancy Cohort (Raine) Study. *Social Science & Medicine*,186:52-60.
- Linares Segovia B, Gutierrez Tinoco M, Izquierdo Arrizon A, Guizar Mendoza JM, Amador Licona N. (2012) Long-term consequences for offspring of paternal diabetes and metabolic syndrome. *Experimental Diabetes Research*,2012:684562.
- Liu J, Sekine M, Tatsuse T, Hamanishi S, Fujimura Y, Zheng X. (2014) Family history of hypertension and the risk of overweight in Japanese children: results from the Toyama Birth Cohort Study. *Journal of Epidemiology*,24(4):304-311.
- Liu W, Liu W, Lin R, et al. (2016) Socioeconomic determinants of childhood obesity among primary school children in Guangzhou, China. *BMC Public Health*,16:482.

- Liu Y, Ma Y, Jiang N, Song S, Fan Q, Wen D. (2018) Interaction between Parental Education and Household Wealth on Children's Obesity Risk. *International Journal of Environmental Research and Public Health*,15(8):1754
- Manios Y, Costarelli V, Kolotourou M, Kondakis K, Tzavara C, Moschonis G.(2007) Prevalence of obesity in preschool Greek children, in relation to parental characteristics and region of residence. *BMC Public Health*,7:178.
- Manios Y, Angelopoulos PD, Kourlaba G, et al. (2011) Prevalence of obesity and body mass index correlates in a representative sample of Cretan school children. *International journal of pediatric obesity : IJPO : an official journal of the International Association for the Study of Obesity*,6(2):135-141.
- Manios Y, Androutsos O, Katsarou C, et al.(2018) Prevalence and sociodemographic correlates of overweight and obesity in a large Pan-European cohort of preschool children and their families: the ToyBox study. *Nutrition*,55-56:192-198.
- McKee C, Long L, Southward LH, Walker B, McCown J. (2016) The Role of Parental Misperception of Child's Body Weight in Childhood Obesity. *Journal of Pediatric Nursing*,31(2):196-203.
- Mindlin M, Jenkins R, Law C. (2009) Maternal employment and indicators of child health: a systematic review in pre-school children in OECD countries. *Journal of Epidemiology and Community Health*,63(5):340-350.
- Mitsuhashi T, Suzuki E, Takao S, Doi H. (2012) Maternal working hours and early childhood overweight in Japan: a population-based study. *Journal of Occupational Health*,54(1):25-33.
- Moher D, Liberati A, Tetzlaff J, Altman DG, Group P.(2009) Preferred reporting items for systematic reviews and meta-analyses: the PRISMA statement. *PLoS Medicine*,6(7):e1000097.
- Muthuri SK, Onywera VO, Tremblay MS, et al. (2016) Relationships between Parental Education and Overweight with Childhood Overweight and Physical Activity in 9-11 Year Old Children: Results from a 12-Country Study. *PloS One*, 11(8):e0147746.
- Noh JW, Kim YE, Oh IH, Kwon YD. (2014) Influences of socioeconomic factors on childhood and adolescent overweight by gender in Korea: cross-sectional analysis of nationally representative sample. *BMC Public Health*,14:324.
- Notara V, Antonogeorgos G, Kordoni ME, et al. (2018) Family characteristics and children's knowledge of cardiovascular risk factors. *Pediatrics International: Official Journal of the Japan Pediatric Society*, 60(12):1081-1089.
- Notara V, Magriplis E, Prapas C, et al.(2019) Parental weight status and early adolescence body weight in association with socioeconomic factors. *Journal of Education and Health Promotion*, 8:77.
- OECD. *Obesity Update* (2017). Available at: <https://www.oecd.org/els/health-systems/Obesity-Update-2017.pdf>
- Panagiotakos DB, Papadimitriou A, Anthracopoulos MB, et al. (2008) Birth weight, breast-feeding, parental weight and prevalence of obesity in schoolchildren aged 10-12 years, in Greece; the Physical Activity, Nutrition and Allergies in Children Examined in Athens (PANACEA) study. *Pediatrics International : Official Journal of the Japan Pediatric Society*,50(4):563-568.
- Panagiotakos DB, Antonogeorgos G, Papadimitriou A, et al. (2008) Breakfast cereal is associated with a lower prevalence of obesity among 10-12-year-old children: the PANACEA study. *Nutrition, Metabolism, and Cardiovascular Diseases*,18(9):606-612.
- Pirincci E, Durmus B, Gundogdu C, Acik Y. (2010) Prevalence and risk factors of overweight and obesity among urban school children in Elazig city, Eastern Turkey, 2007. *Annals of Human Biology*,37(1):44-56.
- Reilly JJ, Methven E, McDowell ZC, et al. (2003) Health consequences of obesity. *Archives of Disease in Childhood*, 88(9):748-752.
- Reilly JJ, Kelly J. (2011) Long-term impact of overweight and obesity in childhood and adolescence on morbidity and premature mortality in adulthood: systematic review. *International Journal of Obesity*, 35(7):891-898.
- Robinson E. (2017) Overweight but unseen: a review of the underestimation of weight status and a visual normalization theory. *Obesity reviews : an Official Journal of the International Association for the Study of Obesity*,18(10):1200-1209.
- Rogers R, Eagle TF, Sheetz A, et al. (2015) The Relationship between Childhood Obesity, Low Socioeconomic Status, and Race/Ethnicity: Lessons from Massachusetts. *Childhood Obesity*, 11(6):691-695.
- Shloim N, Edelson LR, Martin N, Hetherington MM.(2015) Parenting Styles, Feeding Styles, Feeding Practices, and Weight Status in 4-12 Year-Old Children: A Systematic Review of the Literature. *Frontiers in Psychology*,6:1849.
- Shrewsbury V, Wardle J.(2008) Socioeconomic status and adiposity in childhood: a systematic review of cross-sectional studies 1990-2005. *Obesity*,16(2):275-284.
- Simmonds M, Llewellyn A, Owen CG, Woolacott N. (2016) Predicting adult obesity from childhood obesity: a systematic review and meta-analysis. *Obesity Reviews: an Official Journal of the International Association for the Study of Obesity*,17(2):95-107.
- Sladdens EF, Gerards SM, Thijs C, de Vries NK, Kremers SP.(2011) General parenting, childhood

- overweight and obesity-inducing behaviors: a review. *International journal of pediatric obesity : IJPO : an Official Journal of the International Association for the Study of Obesity*,6(2-2):e12-27.
- Sobal J, Stunkard AJ. (1989) Socioeconomic status and obesity: a review of the literature. *Psychological Bulletin*,105(2):260-275.
- Sokol RL, Qin B, Poti JM. (2017) Parenting styles and body mass index: a systematic review of prospective studies among children. *Obesity Reviews : an Official Journal of the International Association for the Study of Obesity*,18(3):281-292
- Spuijdt-Metz D.(2011) Etiology, Treatment and Prevention of Obesity in Childhood and Adolescence: A Decade in Review. *Journal of Research on Adolescence: the Official Journal of the Society for Research on Adolescence*, 21(1):129-152.
- Stein RI, Epstein LH, Raynor HA, Kilanowski CK, Paluch RA. (2005) The influence of parenting change on pediatric weight control. *Obesity Research*, 13(10):1749-1755.
- Tambalis KD, Panagiotakos DB, Psarra G, Sidossis LS. (2018) Insufficient Sleep Duration Is Associated With Dietary Habits, Screen Time, and Obesity in Children. *Journal of Clinical Sleep Medicine : JCSM : official publication of the American Academy of Sleep Medicine*,14(10):1689-1696.
- Valdes J, Rodriguez-Artalejo F, Aguilar L, Jaen-Casquero MB, Royo-Bordonada MA. (2013) Frequency of family meals and childhood overweight: a systematic review. *Pediatric Obesity*, 8(1):e1-e13.
- Valdez R, Yoon PW, Qureshi N, Green RF, Khoury MJ. (2010) Family history in public health practice: a genomic tool for disease prevention and health promotion. *Annual Review of Public Health*, 31:69-87 61
- Ventura AK, Birch LL. (2008) Does parenting affect children's eating and weight status? *The International Journal of Behavioral Nutrition and Physical Activity*, 5:15.
- Vollmer RL, Mobley AR. (2013) Parenting styles, feeding styles, and their influence on child obesogenic behaviors and body weight. *A review. Appetite*, 71:232-241.
- Wang Y, Min J, Khuri J, Li M. (2017) A Systematic Examination of the Association between Parental and Child Obesity across Countries. *Advances in Nutrition*, 8(3):436-448.
- World Health Organization. (2016). Consideration of the evidence on childhood obesity for the Commission on Ending Childhood Obesity: report of the ad hoc working group on science and evidence for ending childhood obesity, Geneva, Switzerland. World Health Organization. Available at: <https://apps.who.int/iris/handle/10665/206549>
- Wrotniak BH, Epstein LH, Paluch RA, Roemmich JN. (2004) Parent weight change as a predictor of child weight change in family-based behavioral obesity treatment. *Archives of Pediatrics & Adolescent Medicine*, 158(4):342-347.
- Wrotniak BH, Epstein LH, Paluch RA, Roemmich JN. (2005) The relationship between parent and child self-reported adherence and weight loss. *Obesity Research*, 13(6):1089-1096.
- Yannakoulia M, Papanikolaou K, Hatzopoulou I, Efsthathiou E, Papoutsakis C, Dedoussis GV. (2008) Association between family divorce and children's BMI and meal patterns: the GENDAI Study. *Obesity*, 16(6):1382-1387.
- Zong XN, Li H, Zhang YQ. (2015) Family-related risk factors of obesity among preschool children: results from a series of national epidemiological surveys in China. *BMC Public Health*,15:927.