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Title

Food portion at ages 8-11 and obesogeny: The amount of food given to children varies with the mother's education and the child's appetite arousal.

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Abstract

During childhood, the amount of food consumed, associated with adiposity and overweight risk, depends mainly on the amount of food that is served, especially by parents. This study focuses on the food amount served by parents ("Portion"), with two objectives: 1/ to confirm (or not) its link with the food amount eaten ("Intake") by their child; 2/ to identify some of its correlates, i.e., maternal education, and child's appetite arousal. Five hundred and three French children aged between 8 and 11 years and one of their parents completed different self-administrated questionnaires online. Results indicated that Portion and Intake were highly correlated, and that mothers with lower levels of education gave larger portions to their child, especially if he/she had a high appetite arousal. Moreover, these mothers, compared to others, were more concerned by taste preferences and less by health with regard to their child's diet. Such differences in taste and health considerations may contribute to underlie the educational inequality in food portion size.

Key words : Health inequalities; education; portion size; children; intake; obesity; temperament, France.

1. Introduction

Throughout the world, the prevalence of obesity among children aged 5 to 19 rose from 0.77% in 1975 to 5.6% in 2016 (Abarca-Gómez et al., 2017). In France more specifically, pediatric obesity prevalence reached 3.6% in 2015 (Guignon et al., 2017). However, as in other countries (Costa-Font & Joan, 2013; Greves Grow et al., 2010), the weight status of French children is marked by a social gradient. Overweight affects children of workers (or machine operators) more than those of executives (or managerial staff) (Moisy, 2017), and is higher in households with lower incomes and in which the head of a family has only an undergraduate degree (Tavoularis & Hébel, 2017). While these results are classic (Baum & Ruhm, 2009; Castetbon, 2015; Danielzik Czerwinski-Mast, Langnäse, Dilba & Müller, 2004; O’Dea & Caputi, 2001; Parika et al., 2015; Regnier, 2006), the detailed mechanisms that produce them are unclear. This paper goes beyond socio-demographics and BMI and explores the amount of food served to children as a proximal determinant, and its connection to mothers’ education and their beliefs in the food domain.

A strong environmental factor that is believed to contribute to the children’s obesity epidemic is food portion size, the amount of food served on the plate (Portion). Indeed, literature has shown that humans tend to eat more (Intake) if they are served larger portions (see Steenhuis & Vermeer, 2009 for a review), and that is especially the case for children (Birch, Savage, & Fisher, 2015; Fisher et al., 2007; Fisher, Arreola, Birch, & Rolls, 2007). This is consistent with the facts that countries that offer particularly large food sizes have a high prevalence of obesity (Rozin, Kabnick, Pete, Fischler, & Shields, 2003), and that epidemiological surveys have revealed that an increase in food portion sizes has coincided with a rise in the prevalence of obesity (Piernas & Popkin, 2011; Young & Nestle, 2002). Moreover, correlational data have indicated that the amounts served to children are strongly associated with the amounts children consume (Johnson et al., 2014; Nicklas et al., 2013). Finally, experimental studies have shown that increases in portion size lead to increases in energy and/or the risk of becoming overweight, especially during childhood (for a review, see Birch et al., 2015). For example, doubling an age-appropriate portion of one or several starters increased intake of starters by 25% (Fisher et al., 2003) and 23% (Fisher et al., 2007) in children between 2 and 5 years and 5-yr-old children respectively. Thus,

the effect of portion size on food intake is rather well established, especially with regard to its causal arrow.

However, less is known about the distal correlates of food portion size - that is the proximal correlate of intake. During childhood, because most meals are taken at home, the portion size eaten by children depends mainly on the size they are served by their parents or served under the control of parents at the meal table. This is especially the case in France, where family meals are still the norm (Mathé et al., 2009). The question is thus to understand why some parents feed their child large portion sizes, especially of high-energy, palatable foods. In this study, we focused on two correlates: maternal socio-demographic characteristics and a children's food-related temperamental trait. The education level of mothers, and not that of fathers, was considered, insofar as in French families with children, we observe a great disparity between mothers and fathers in the performance of household tasks, and in particular with regard to food (Tavoularis, Hébel, Billman, & Lelarge, 2016).

Different socio-demographic correlates are used to categorize social class, i.e. education, occupation and income. Winkleby et al. (1992) and Pill et al. (1995) compared these measures for their power to predict health behaviors and reported that, of these, educational level is usually the most reliable correlate. In the food domain, Renzaho et al. (2014) indicated that low caregiver education was consistently associated with poor eating habits. More specifically, regarding intake, Wijtzes et al. (2013) showed that children of mothers with a low and medium-low level of education were significantly more likely to consume excessive amounts of high-calorie snacks and sugary drinks compared to children of highly educated mothers. Hupkens et al. (1998) indicated that the proportion of mothers who restrict their child's intake of sweets, soft drinks, chips and white bread was smaller in lower educated classes than in higher educated classes. The results of a French survey revealed differences by education for eight food groups out of thirty-seven, with larger portions in less educated families (Hébel, 2017); these foods were: sweet biscuits, processed meat, condiments, dried fruits, juices and squashes, vegetables, pasta, ready meals and sandwiches. In short, children of lower educated mothers tend to be more exposed to large servings, especially regarding high energy foods.

Interestingly, Hupkens et al. (1998) examined the mothers' health and taste considerations according to their educational level. The mothers were asked how often they took health into account

when they bought or prepared foods, and to what extent they agreed with the statements that serving tasty food is important to please children. Their results suggested that the proportion of mothers who took health into account increased significantly with education, whereas it decreased with regard to the pleasure motive. These findings are in line with some ecological models that emphasize the role of the social environment, and more specifically the family, in the development of the child (Bronfenbrenner, 1979; Harkness & Super, 1994).

However, more recently, in connection with the issue of overweight, the Parenting X Temperament model has shown its effectiveness, indicating that children's temperamental features such as inhibitory control (Rollins et al., 2014), easiness (Wu et al., 2011; Zeller et al., 2008) and appetite reactivity (Godefroy et al., 2018) must also be considered. Because parents may adapt their serving behavior to the child's temperament, introducing this variable improves the understanding of the system that may produce overweight.

Several appetitive temperamental traits have been related to food approach behaviors: Food responsiveness and Enjoyment of food (Wardle et al., 2001), Appetite arousal (Godefroy, Trinchera, Romo, & Rigal, 2016), and Food addiction (Gearhardt, Roberto, Seaman, Corbin, & Brownell, 2013). High scores on these different scales have been associated with overeating and/or higher BMIs in children (Domoff et al., 2015; Gearhardt et al., 2013; Godefroy et al., 2016). However, their relationship to portion size remains unexplored. We could hypothesize that children with a "high" food approach level would be served large portion sizes in response to their expressions of excitement when presented with palatable foods.

In France, public health policies make nine recommendations with regard to food in order to protect children's health (National Nutrition and Health Program, www.mangerbouger.fr). Two of them concern the limitation of the consumption of energy dense products: those containing fat and sugar, but no indication is given about the size of portions to limit these products. However, parents must be guided when considering the size of portions served. An initial way of achieving this is by identifying the motivation criteria in the size of the portions they serve, namely their education level, their concerns in terms of health and taste preferences, as well as of the expectations their child displays via their food temperament.

This study focused on the food portion size served by parents to their child (Portion), with two objectives: 1/ to assess its links with the food portion size consumed by their child (Intake) (with the hypothesis that the Intake increases with Portion); 2/ to identify some of its correlates: maternal education and concern for health and taste preferences (with the hypothesis that low-educated mothers give larger Portions, and are less concerned by health and more concerned by taste preferences), and the child's food temperament (with the hypothesis that children with high appetite arousal are fed larger Portions).

2. Methods and material

2.1 Study design and procedure

This cross-sectional study was based on reports by the children and one of their parents. The responses of mothers (93%) and fathers (7%) were taken into account in the analyses. The participants were selected in 2014 by the Research Center for the Study of Living Conditions (CREDOC) from an access panel of 378 000 French households. CREDOC offered the participants 'points' that were convertible into gift-certificates in exchange for their participation and selected two-parent families living in the Ile de France region with children between 8 and 11 years of age without any severe food allergies or chronic medical problems.

After being recruited for the study, parents received an e-mail with a link to the questionnaire. Firstly, parents had to answer a few questions about the socio-demographic background of their family, including the maternal level of education (see below). Then, they were invited to complete the questionnaire on the food portions they give their child and their child's height and weight. After an automatic message asking parents to leave their child on their own, the child answered questions about his/her eating temperament and the food portion sizes he/she consumed.

2.2 Measurements

2.2.1 Maternal education

Four levels were used to categorize the maternal level of education (Education): Middle school ($\leq 9^{\text{th}}$ grade), High school (10^{th} to 12^{th} grades), College (13 to 15 yrs. of education) and Master's (minimum of 16 yrs. of education).

2.2.2 Portion and Intake

Portion sizes were assessed using 10 food items considered as high-energy dense, either savory (breaded fish, roast beef, sausage, pasta, chips) or sweet (pound cake, chocolate cake, pastries, chocolate and sweets). These 10 items were selected because, as they are common in the French diet and high in energy content, their consumption in large amounts puts children at risk of becoming overweight.

Two types of portion sizes were assessed: the one usually served by the parents and the one usually consumed by the child. Both types were assessed on the basis of the 10 food images extracted from the photographic document used for the SU.VI.MAX study (LeMoullec et al., 1996). Each food was presented in seven increasing portion sizes, quoted from size A (=1) to size G (=7) (Figure 1).

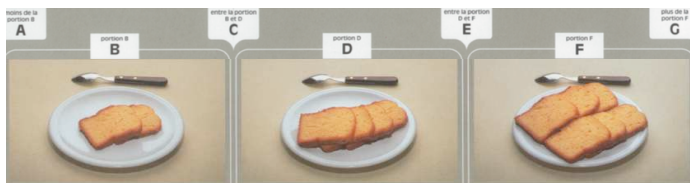


Figure 1. Example of SU.VI.MAX food pictures

Parents were invited to imagine a normal family meal and asked to choose between one of the seven portion sizes for each of the 10 foods in answer to the question: "Which amount do you generally give your child at home?". Children had to complete the same task but in answer to the question "Which amount do you generally eat at home?". We therefore have an estimation of Portion by the parent, and of Intake by the child.

With these data for the 10 food items, the mean food portion size served by parents (Portion) and the mean food portion size usually consumed by the child (Intake) were calculated for each child. Through the use of Cronbach's Alpha, we checked the validity of these two mean food portion sizes. It showed that the Portion ($\alpha = .72$) and the Intake ($\alpha = .69$) were reliable measures.

2.2.3 Child's appetite arousal

Appetite arousal was measured through the six items of one subscale of the Adolescent Eating Temperament Questionnaire (Godefroy et al., 2016) (e.g., "As soon as I think about food, I feel like eating"). Answers were recorded using a 4-point frequency scale from 1 (never) to 4 (always). The reliability of the subscale was acceptable for the present data ($\alpha = .75$).

2.2.4 Health and Preferences concerns

Parents had to complete two subscales of the Child Food Motivation Questionnaire (Rigal, Chabanet, Issanchou, & Monnery-Patris, 2012). All questions required responses to the phrase: "For my child, I am careful to buy foods which are ...". Three items were proposed for the Health dimension (e.g., "... high in vitamins") and for the Child's preferences dimension (e.g., "... accepted by my child"). Answers were recorded using a 4-point frequency scale from 1 (never) to 4 (always). In the actual study, the reliability of these subscales was satisfactory ($\alpha = .78$ and $\alpha = .70$).

2.2.5 Child's BMI

Parents were asked to report their child's current height and weight, only if they knew these measurements from recent entries in their child's Health Record. Their BMI-for-age and sex was calculated according to WHO guidelines (Onis et al., 2007).

2.3 Ethics

The independent Ethics Committee of Paris Nanterre University approved this study. Parents' and children's consent were required for participation. In order to guarantee privacy, questionnaires were anonymous.

2.4 Statistical analysis

A Bravais-Pearson correlation was used to test the association between the two amount variables (Portion and Intake) and between Portion and the two Concern variables (Health and Preferences).

Three ANOVAs were also performed : 1/ One 2 way ANOVA, with Maternal education (4) and Appetite arousal (2) as independent variables and Portion as the outcome variable, to test the interaction between Maternal education and Appetite arousal -Appetite arousal being dichotomized at the median- ; 2/ Two 1 way ANOVAs, with Maternal education (4) as the independent variable and Health concern (or Preferences concern) as the outcome variable, to test the differences of concern by Maternal education. For Portion, Age was entered as a covariate. LSD was used as a post hoc test.

3. Results

3.1 Participants

The characteristics of the 503 dyads who completed the questionnaires are presented in Table 1. The mean age of the children was 9.44 yrs. (± 1.12), with equal distribution by Gender. No difference with Gender was observed on any variables, whereas differences with Age were noted for Portion and Intake, $F(3, 499) = 4.75, p = .003$ and $F(3, 499) = 5.02, p = .005$, respectively, with portion sizes increasing with age.

Missing data for the child's weight and/or height were reported for 80 children. The distribution of weight status for the 423 remaining children was close to the French standard population, as was the distribution of maternal education level (4 missing data, $n = 499$).

3.2 Served and eaten amounts (Portion and Intake)

The overall distribution (minimum, maximum, mean and standard deviation) of the two variables Portion and Intake were quite similar, with for Portion: $Min = 1.75, Max = 6.00, M = 3.24 \pm 0.57$, and for Intake: $Min = 1.63, Max = 6.29, M = 3.42 \pm 0.63$.

The correlation between the two variables was very strong and positive, $r(503) = .73, p = .000$ (Figure 2).

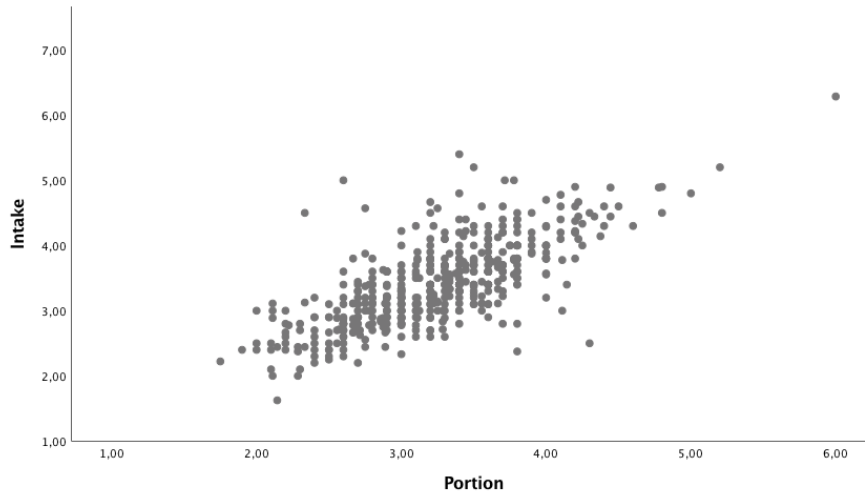


Figure 2. Correlations between Portion and Intake (Scatter-plot)

The correlations between BMI z-scores and Portion and Intake respectively were significant though modest, $r(423) = .13$, $p = .007$ and $r(423) = .15$, $p = .002$. Also significant but modest were the correlations between Portion and Health and Preferences concerns respectively, $r(502) = -.13$, $p = .003$ and $r(502) = .14$, $p = .002$.

3.3 Correlates of Portion

A 2 between-subjects ANOVA (Education (4) X Appetite arousal (2)) was performed on Portion. The two main effects were significant, $F(3, 495) = 4.57$, $p = .004$ and $F(1, 495) = 4.93$, $p = .027$, with higher portions being served by middle school-educated mothers and to children with a higher level of Appetite arousal. Moreover, an interactive effect was observed, $F(3, 495) = 2.65$, $p = .048$: Portion was not different by children's level of Appetite arousal, except for the Middle school-educated mothers who fed a larger portion to their children with a higher level of Appetite arousal than to those with a lower level of Appetite arousal (Figure 3).

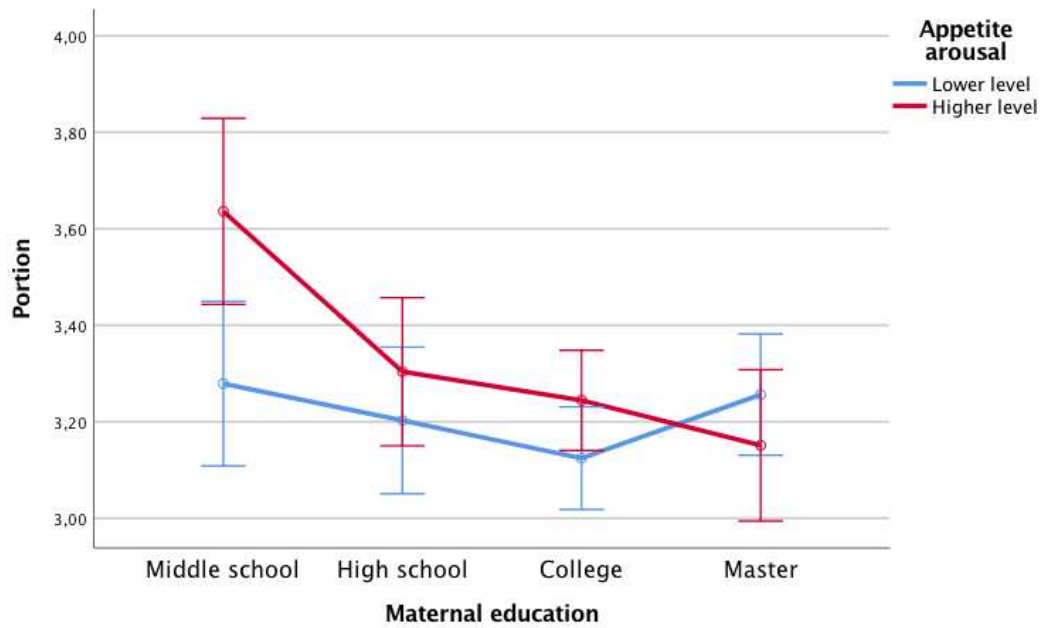


Figure 3. Portion size by Maternal education level and Child's appetite arousal

Differences were also noted by Education for Health and for Preferences concerns (Figure 4). Mothers with no college education were less concerned by Health than more educated mothers (either college or master's degrees), $F(3, 495) = 4.77, p = .003$. Moreover, they were more concerned by Preferences than mothers with a postgraduate education (only in tendency for College-educated mothers), $F(3, 495) = 3.19, p = .023$.

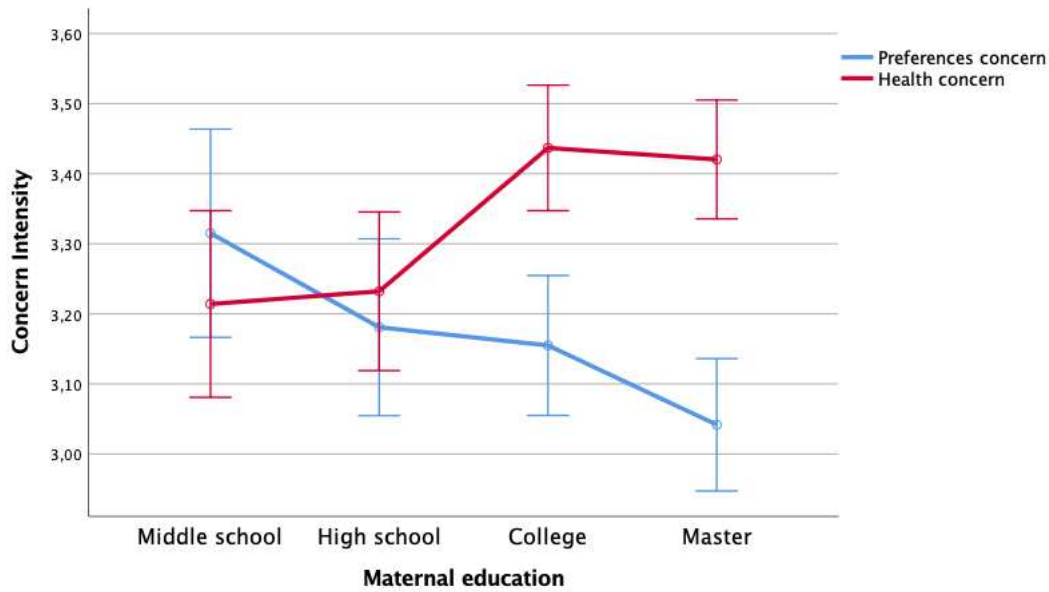


Figure 4. Health and Preferences concerns by Maternal educational

4. Discussion

The objective of our study was to explore how variations in amounts of high energy-dense foods offered by parents are related to some children's (amount consumed, appetite arousal) and mothers' characteristics (level of education, motivations related to their child's diet).

Our results indicated firstly that the amount of food offered by parents was positively and highly correlated with the amount of food consumed by their child. These results are consistent with those of Johnson et al. (2014) and Nicklas et al. (2013) obtained with younger US children. However, methodological differences should be noted between studies. Whereas the results of Johnson and Nicklas relied on observational data with foods being weighted, ours were based on self-reported responses. Both measurements present advantages and disadvantages. Observational data are highly objective but are not convenient for large samples of subjects and are susceptible to context variations. Self-reported responses may be biased by under-reporting, especially in overweight subjects, but may address the "usual" portion size, as in our study, and hence are less susceptible to context variations such as the respondents' level of hunger (Lock et al., 2016). Besides, our measurement seems reliable as parents' and children's responses are highly correlated (convergent validity). Moreover, Martin et al.

(2007) have demonstrated the validity of measuring children's food intake using photography. However, while our data suggest the existence of a familial pattern in food portion sizes for 8-11-year-old children, the causal arrow between parental and children's behaviors needs to be checked.

Then, we observed that the two types of portion sizes (served and consumed) differed by maternal education, with the larger portion sizes found in families of the less educated mothers in accordance with the results of Hupkens et al. (1998), Wijtzes et al. (2013) and Hébel (2017). This is to be related to the finding that pediatric adiposity decreases with parental education (Tavoularis & Hébel, 2017). Indeed, our results suggested that the familial pattern in portion sizes may be one of the determinants of overweight risk in children of low-educated parents as children of low-educated parents are served (and eat) larger portions. However, this suggestion should be confirmed by longitudinal data.

Maternal motivation related to their child's diet may provide insight as to why educational differences exist in the familial pattern of portion sizes. Our results indicated that, compared to other mothers, those with no college education reported themselves more concerned by children's preferences and less concerned by health when buying foods for their children, in accordance with the findings of Hupkens et al. (1998). These child-centered (versus health-centered) mothers would find it difficult to disappoint their children insofar as high energy dense foods induce strong and immediate pleasure, and furthermore would not be stopped in this tendency by their health beliefs which are less of a concern to them. This interpretation is in line with previous findings indicating that low-educated mothers are more permissive compared to other mothers in the food domain (Vereecken, Keukelier, & Maes, 2004). While social norms (in terms of what is appropriate to feed a child or to how to raise a child) likely play an important role in the understanding of these results, our findings shed a light on the values underlying such norms, as they make explicit what mothers of different levels of education pay attention to in their decision to size the portions.

This interpretation is also supported by our result indicating that the Education x Portion size effect was reinforced by the child's level of appetite arousal. Low-educated/child-centered mothers would have difficulty resisting expressions of excitement from their high appetite arousal child when presented with palatable foods. Whereas mothers with a postgraduate education, more health-centered, would tend to inhibit their desire to satisfy their child in order to protect their long-term health, because

they would feel rewarded as mothers in doing what they believe is good for the child. Again, this interpretation should be confirmed by future research.

Limitations

Our results are only valid for the ten food items included in the study and therefore cannot be generalized for the children's entire diet.

It is possible that other variables have confounded the association between maternal education and the outcome variables such as children eating lunch at school, and parents' social norms with respect to nutrition or contextual variables, for example the proportion of fast food restaurants in the neighborhood.

Parents reported their child's height and weight, and thus may have reported wrong values, either because they did not have access to recent ones or because of a social desirability bias.

Finally, because of our cross-sectional design, the causal arrow between the served and consumed portions remains uncertain. On the one hand, parents may provide the norm of the "usual portion" which, if too large, puts the child at risk of becoming overweight. On the other hand, parents may adjust the portion they serve to their child's needs, which increase with adiposity. There is a need for longitudinal designs to validate causal relationships and reciprocal influences between the two variables.

Conclusion

This paper explored the relation between portions served to children and some characteristics of families and children. It indicated that larger portions are correlated with a higher food intake, and that in low educated families, children are served large portions of energy dense foods. While this causal chain may account for a higher prevalence of obesity in lower educated groups, it was less clear why these children were served larger portions. This research showed that the serving of larger portions among low-educated families is linked to more attention to the child's desires (preferences and appetite for food), as well as less concern for health. This suggests that one causal mechanism involved would be that less educated mothers' conception of care when they serve food is based on satisfying

their child's appetite (including for palatable but energy dense foods), while for more educated mothers the same tendency might be counterbalanced by another social norm that gives more importance to long-term benefits than immediate satisfaction.

The paper introduces some hypotheses that may have, if verified by other studies, a significant impact on public health policies and communications by health personnel. Indeed, it showed that there is a need to explore specific food habit drivers when considering less educated families who are the ones that present the highest prevalence of overweight. It seems that some parents, especially those with a low level of education, should be guided to the "right portion size". In France, no recommendation along these lines has been made by public healthcare services. Through the PNNS program (National Nutrition and Health Program, www.mangerbouger.fr), French parents are encouraged to limit the consumption of fats and sugars, but no indication is given about the size of portions. The results of a study seeking to assess the effects of this program showed that the program has had no effect among more deprived families (de Batz, Faucon & Voynet, 2016), probably due to the fact that the program is based on nutritional knowledge without taking into account the social norms of people with a lower level of education.

With this in mind, top-down guidance may be ineffective in this population. Indeed, if our interpretations are correct, the issue is not simply a "deficit" of knowledge in nutrition among uneducated parents, but a matter of social norms that parents use to measure their own worth as parents. This suggests that for a public health and clinical strategy, parental motivations and social norms around food should be considered from this broader perspective of "being a good parent". It would be worth giving more consideration to the importance given to immediate child satisfaction vs long-term health benefits in families with lower educated mothers.

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