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Abstract

The aim of this paper is to investigate the relationship between parental dietary habits and child and adolescent diet quality in Italy by adopting a parent-child perspective. We apply quantile regression modelling to an original database developed within the DEDIPAC knowledge hub, integrating multiple sources of information on the aspects of Italian households' daily lives, food consumption frequency, and calorie intake. Given the relevance of maternal care in shaping children's eating patterns, we focus on mothers' lifestyles and time-use. Results show that the intergenerational transmission of diet quality is a gendered process, especially involving mothers and their daughters. Our findings also highlight the pivotal role schools play in the fight against child malnutrition and indicate that, contrary to what is found in the international research literature, maternal employment is not correlated with a deterioration in their children's diet quality.

Keywords Diet quality; Intergenerational transmission of dietary habits; Child health; Maternal lifestyle

1. Introduction

The growing prevalence of overweight and obese children is considered one of the most serious public health challenges of the century. In the past 40 years, the number of obese school-age children and adolescents has risen more than tenfold globally—from 11 million to 124 million individuals (Abarca-Gómez et al., 2017). Overall, the World Health Organization (WHO) estimates that worldwide there are 340 million overweight or obese children and adolescents aged 5-19 years, although the number of overweight or obese children under 5 is also rapidly increasing—from 32 to 41 million between 1990 and 2016 (WHO, 2018). Although most overweight children live in developing countries, developed countries also pay a high toll in terms of childhood obesity. Today in Europe alone, about 14.9 million boys and girls live with being overweight or obese, and as many as 800,000 children—about 1% of the European population aged 0–14—are estimated to suffer from severe obesity (WHO Europe, 2019). As worrying as they are, these figures underline how urgent it is to tackle malnutrition from the earliest stages of life, for several reasons: first, obese children face an increased risk of developing a wide range of health complications and the premature onset of other illnesses, including diabetes and heart disease (WHO, 2016); second, childhood obesity is also often related to psychosocial problems such as poor self-esteem, bullying and underachievement at school, eating disorders, and depression (OECD/EU, 2018); third, in the absence of intervention, obese children will likely continue to be obese through adulthood, leading to prolonged psychological hardship and the insurgence of further health-related risks and economic problems (Abarca-Gómez et al., 2017). Promoting child nutritional well-being is thus of strategic importance both socially and economically, which is why it lies at the core of health policies at global level.

The aim of this paper is to investigate the intergenerational transmission of dietary habits among school-age children and adolescents in Italy by adopting a parent-child perspective. By implementing multivariate quantile regression analysis, we seek to understand if and how parental dietary habits are associated with the quality of their children's diet, depending on a wide range of parental sociodemographic and socioeconomic characteristics. Given the relevance of maternal influence in shaping children's eating patterns, we specifically focus on maternal lifestyles and time-use.

Unhealthy eating patterns and limited physical activity are unanimously deemed responsible for the spread of obesity in today's society, because of the resulting imbalance between calorie intake and calorie expenditure. Social and economic changes are at the heart of this paradigm shift, although eating behaviours do not respond solely to individual food consumption preferences: social and environmental signals also play a role, especially when it comes to children and adolescents. The literature shows that young people's eating patterns are deeply influenced by the characteristics of the social, relational, and physical environment in which they live. Healthy parental dietary habits have been found to be relevant in influencing children in terms of food acceptance, preferences, and intake, as well as their willingness to try new foods (Berge et al., 2017; Fulkerson et al., 2006; Larson et al., 2016; Robinson et al., 2015). Mothers are especially influential in shaping their children's eating behaviours, as highlighted by the positive correlation between maternal diet quality and that of their offspring (Cooke et al., 2003; Johnson et al., 2011; Robinson et al., 2015; Wang et al., 2011). The most comprehensive studies on the intergenerational transmission of dietary habits have been carried out in North American, Canadian and Australian settings (see Berge et al., 2017; Brown et al., 2010; Cawley and Liu, 2012; Datar et al., 2014; Faught et al., 2016; Fisher et al., 2002; Hammons and Fiese, 2011; Morrill, 2011; Robinson et al., 2015). In Europe, the literature is comparatively more limited in scope—see, e.g., studies on children's snack food intake in Southern England (Brown and Ogden, 2004) and on family-related predictors of pre-school children's fruit and vegetables consumption in London (Cooke et al., 2003)—or rather focused on the relationship between parental characteristics and child overweight. In particular, longitudinal analyses focusing on maternal employment found the number of working hours to be positively correlated with child overweight (Anderson et al. 2003; Bianchi, 2000; Fertig et al., 2009; Milovanska-Farrington, 2020;

Ruhm, 2008; Ziol-Guest et al., 2013), although family background—including mothers' socioeconomic status (SES)—is usually associated with better outcomes in terms of childcare and nutrition (Currie and Stabile, 2003; Reinhold and Jurges, 2012). Finally, concerning the evaluation of child diet quality, one rich stream of literature is that of young people's adherence to the Mediterranean diet precepts. Though usually including a selection of sociodemographic variables, this literature—mainly based on Southern European evidence, specifically from Spain, Italy, and Greece (Estruch et al., 2018; Grosso et al., 2013; Kontogianni et al., 2008; Metro et al., 2018; Montero et al., 2017; Papadaki and Mavrikaki, 2015; Serra-Majem et al., 2004)—includes the major drawback of not considering parental characteristics or their influence on children's eating habits.

The novelty of the present study is twofold. First, to empirically test the relationship between the variables under scrutiny, we make use of an original database built within the DEterminants of DIet and Physical ACtivity (DEDIPAC) knowledge hub[1] by integrating multiple sources of statistical information: (i) the individual-level Istat *Multipurpose Survey on Households: Aspects of Daily Lives* 2003–2016; (ii) INRAN-CREA 2005 data on food frequency and calorie intake; and (iii) the Consumer Price Index values for food and beverages at the regional level. Such an integrated data set ensures the coverage of several domains, ranging from dietary habits to lifestyle and everyday activities. Though not including a longitudinal dimension, the repeated cross-section allows us to obtain a pooled sample of more than 41,000 children and adolescents aged 6 to 17, covering 15 years. In addition, the INRAN-CREA data on

[1] The data set was developed and made accessible by DEDIPAC's research unit led by Mario Mazzocchi (University of Bologna). The DEDIPAC knowledge hub is supported by the Joint Programming Initiative *Healthy Diet for a Healthy Life* and by the Italian Ministry of Education, University and Research.

calorie intake makes it possible to compute a diet quality indicator called Recommendation Compliance Index (Irz et al., 2013; Mazzocchi et al. 2008), specifically designed to measure individuals' compliance with WHO's recommendations for a healthy diet. Methodologically, we employ quantile regression modelling in order to study the relationship between each covariate and the dependent variable at different points in the conditional distribution of the outcome. Because of the presence of siblings in the dataset, we specify a cluster-robust estimator to account for the unobserved intra-class variability at household level (Machado et al., 2014; Parente & Santos Silva, 2016).

Second, the Italian setting is still unexplored in terms of intergenerational transmission of dietary habits, though providing an interesting case study in this regard. To begin with, Italy is one of the European countries where the concepts of diet quality and nutritional well-being are more directly associated with family care and food tradition—as recalled by the concept of Mediterranean diet itself. Most importantly, Italy is also one of the European countries with the highest levels of childhood obesity (18%), only exceeded by Cyprus, Spain, and Greece (OECD/EU, 2018). Moreover, according to the Italian National Institute of Statistics (Istat, 2019) one in every four children aged 3 to 17 years old, (25.2%), in the Italian population—that is, slightly more than 2 million young individuals—is overweight. This prevalence is particularly high in the Southern regions, especially Campania (35.4%), Calabria (33.8%), and Sicily (32.5%). Recent research has started to explore the available data to study the relationship between the within-the-family social interaction and child obesity (Crudu et al., 2021). However, deeper investigation on the determinants of child diet quality is needed with the aim of identifying risk and mitigation factors to provide relevant supporting information for policy making.

In the following, we review the existing literature linking child health to dietary habits and the role of family and parental characteristics in shaping children's eating patterns and lifestyles, as well as on the notion of diet quality itself. It is worth noticing that in Italy family ties are culturally strong which makes the role of enlarged family members also a particularly interesting issue to deepen (Section 2). As we deal with Italian data, mention will be inevitably made of the Mediterranean diet concept and the several indicators that were developed to refer to its dietary recommendations. We will then formulate the research questions to be answered in the remainder of the study. In Section 3, we describe the data and methods used to carry out the empirical analysis. In Section 4, we present the descriptive findings and the results of the regression analysis. Section 5 concludes.

2. Literature review

2.1 Parental influence on children's eating patterns and intergenerational transmission of dietary habits

Young people's eating patterns are related to a broad variety of factors, ranging from home food availability (Campbell et al., 2013) to cultural and socioeconomic ones, such as parents' education and time constraints (Patrick and Nicklas, 2005). In general, children tend to eat the foods to which they are routinely exposed and that are readily available in the home (Birch and Marlin, 1982; Fisher et al., 2002; Savage et al., 2007). Since that is related to parents' tastes, beliefs, and attitudes toward food, children's choices might reflect a cultural transmission of preferences—including risk preferences (Alan et al., 2017; Bisin and Verdier, 2001). Children also learn about food by observing the eating behaviours of others. Hence, healthy parental dietary habits—in terms of both intake and diet composition—have a significant impact on their eating patterns (Crudu et al., 2021; Robinson et al., 2015; Stoklosa et al., 2018). Mothers and children in particular show similar patterns of food acceptance and preferences because of the greater time mothers usually spend directly interacting with their children, compared with fathers, across several familial situations (Scaglioni et al., 2008). Moreover, weak-to-moderate correlation is found between mother–child dyads for various components of dietary intake (Cooke et al. 2003, Robinson et al. 2015, Johnson et al. 2011, Wang et al. 2011). However, parents are not the only people children observe when it comes to eating behaviours. Young people are also influenced by their peers, whose eating choices and patterns are especially influential among adolescents (Lieberman et al., 2001; Patrick and Nicklas, 2005; Trogdon et al., 2008). Besides the peer network outside the family home, also peer siblings are capable to affect the child probability to be overweight or obese (Crudu et al., 2021). Though the link between the presence of siblings and child diet quality is still studied fragmentarily, there exists empirical evidence on the positive link between the number of children in the household and lower risks of overweight, explained, for instance, by the increased likelihood for single children of leading a sedentary life or having excess total energy intake (Hesket et al. 2007; Min et al. 2017; Moens et al. 2009). In general, family members influence each other's nutritional health through genetic mechanisms (Faith and Kral, 2006) or via a shared household environment, including some psychological traits of the parents—for instance, impatient time preferences or self-control problems (Stoklosa et. al., 2018)—and general health conditions, depending, among other things, on the presence of chronic illnesses. Mealtime structure and meal patterns also have a bearing. Eating regular family meals appears to play an important role in promoting positive dietary intake among adolescents, resulting as positively associated with the intake of fruits, vegetables, grains, and calcium-rich foods, and negatively associated with soft drink consumption (Neumark-Sztainer, 2003). The mental and physical health of both children and parents also benefit from having regular family meals, (Berge et al., 2017), while parental involvement increases the effectiveness of obesity prevention (Cislak et al., 2011).

In regard to socioeconomic factors, family background— notably parental socio-economic status (SES), as measured in terms of education—is unambiguously considered influential in the improvement of child and nutritional health (Baum & Ruhm, 2009; Currie et al., 2007; Cislak et al., 2011) and the adherence to a quality diet (Grosso et al. 2013; Kontogianni et al 2008). Analogous evidence is found in the literature on child overweight, for instance in Howe et al. (2013) and Apouey and Geoffard (2016) who use UK longitudinal data, and in Madden's (2017) longitudinal study on Ireland. In contrast, studies on the links between maternal employment and child obesity provide mixed evidence. Most of this research—mainly based on longitudinal and time-use data in North American and Australian contexts—assumes that there is a trade-off between childcare and the number of maternal working hours, which may result in less effective parenting and worse child nutrition and lifestyle outcomes, such as increased time spent watching TV, limited physical activity, and increased snack and sweet beverage consumption (Anderson et al., 2003; Bianchi, 2000; Brown et al., 2010; Cawley and Liu, 2012; Champion et al., 2012; Fertig et al., 2009; Gaina et al., 2009; Greve, 2011; Meyer, 2016; Milovanska-Farrington et al., 2020; Morrill, 2011). However, maternal employment is also believed to positively affect children's health—including their diet and bodyweight—through a variety of mechanisms, for instance income and increased self-esteem (Currie and Stabile, 2003; Reinhold and Jurges, 2012). Moreover, the decision to work itself may signal underlying skills or motivations that make a working mother different in important ways from a mother who does not work, which might also be influential in terms of children's health. The way maternal lifestyle and daily activity level impact their children's diet quality remains unclear (Anderson, 2012; Gwozdz et al., 2013), let alone sufficiently investigated in the Italian context. That is a crucial gap to be filled as a better understanding of what role is played by the parent-child dietary habits linkage could contribute to the rich debate on the determinants of child obesity and malnutrition and provide relevant supporting information for policy making.

2.2 Concepts and measures of diet quality

Quality of diet is a rather abstract concept that has been interpreted scientifically in a wide variety of ways, ranging from total daily energy intake to the effect of food intake on anthropometric indicators. Operationally, it is usually translated by using three main families of indicators, each accounting for different facets of human nutritional health. The first focuses on quantity-related aspects of eating habits and is represented by the total daily calorie intake, which enables the comparison of the individual, daily quantity of calories eaten with a recommended threshold, usually determined considering the expected basal metabolic rate by gender, age, and weight, and the person's activity level. The second family of indicators is composed of anthropometric measures, such as body mass index (BMI), indicating nutritional status based on the weight/height balance, which is also the most used indicator among adults (Drieskens et al., 2018). The last group is composed of quality of diet indicators that account for the composition of the individuals' diet, taking into consideration the intake of specific foods and nutrients or food habits, which need to be compared to a predefined healthy diet standard. One such standard is the Mediterranean diet, a term used to describe the traditional dietary habits of people living around the Mediterranean Sea (Iaccarino Idelson et al., 2017). Although no unique definition of the Mediterranean diet exists, a selection of its ideal dietary components has been identified: a high intake of fruit and vegetables, legumes, seeds and nuts, whole grain cereals; the use of olive oil as the main source of added fat; low consumption of meat, poultry, and dairy products; and a moderate intake of fish (Willett et al., 1995; Trichopoulou, 2004; Serra-Majem et al. 2004; Bach-Faig et al., 2006). It is claimed that the declining adherence to this type of diet in Mediterranean countries over recent decades may explain the insurgence of childhood obesity, as well as the increased risk of developing cardiovascular disease, type 2 diabetes and other chronic diseases from childhood onward (Iaccarino Idelson et al., 2017). That is why the Mediterranean diet has been proposed as a dietary model for preventing malnutrition in adults and children alike. The Mediterranean Adequacy Index (MAI), for instance, belongs to this group of indicators and considers an individuals' proportion of good-to-bad daily kilocalorie intake. Since it is also applicable to children's diets (Metro et al., 2018), the MAI has been used for empirical assessment in the study of both adulthood and childhood obesity (Alberti-Fidanza et al., 1999; Montero et al., 2017), also applied in the case of Italy. Another popular indicator of adherence to the Mediterranean diet, which was specifically developed for children and adolescents, is the KIDMED (Serra-Majem et al., 2004); mostly used to investigate the diet quality of young people in Italy (Grosso et al., 2013), Greece (Kontogianni et al., 2008) and Spain (Serra-Majem et al., 2004).

The robustness of these indicators has been assessed by scrutinizing their relationship with nutrient adequacy and several health outcomes (i.e., nutrient-related diseases), although recent publications have concluded that some of them are not significantly more effective in predicting mortality or disease than single dietary components (Milà-Villarroel, 2011). Moreover, with the aim of explaining intergenerational linkages in nutritional health, such indicators are all flawed in several respects. The total daily calorie intake and the BMI, for instance, fail to convey any information about diet composition and are both increasingly recognized as inaccurate in accounting for child nutritional well-being (Vanderwall et al., 2017). The heterogeneity in individual calorie needs—especially at young ages, where height and weight differences are large, even within the same age category—makes it difficult to use calorie indicators in a meaningful way (Ferro-Luzzi, 2005). In addition, the BMI overlooks the fact that a person's body weight is affected not only by energy intake, but also by factors that are independent of food consumption and eating habits, like socioeconomic conditions and genetic material. In addition, it does not convey any information on body mass composition (Burkhauser & Cawley, 2008). The MAI indicator, in turn, only considers diet composition, but is not informative on the overall quantity of kilocalories eaten per day.

In an endeavour to overcome such drawbacks, in this paper we make use of the Recommendation Compliance Index (RCI), a composite indicator that measures the distance between the dietary habits of each individual and WHO's recommendations for a healthy diet. As per the methodology illustrated in Masotti et al. (2016) and Mazzocchi et al. (2008), the RCI is obtained following two main steps:

- A measure of distance is defined for each recommended nutrient intake listed by the WHO (Table 1). If the individual intake lies in the range defined by the WHO, the corresponding distance is 0; otherwise, the distance is obtained as the difference between the actual intake and the nearest boundary (either lower or upper) of the considered intake, divided by the maximum potential difference. This generates a measure of distance which is equal to 0 when the WHO recommendation is fully respected and equal to 1 when the distance from the nutrition goal is maximum;

- Distances obtained for each nutrient are then aggregated in a weighted average, where weights are defined according to the importance of each nutrition goal. The weighted average is then normalised once again to consider the interdependence of the nutrition goals. The final value of the RCI lies between 0 (maximum distance from the optimal diet composition) and 1 (WHO recommendations perfectly met).

TABLE 1 ABOUT HERE

Unlike the above-mentioned indicators, the RCI is capable of conveying information on both the composition and the threshold quantities individuals should abide by in terms of nutrient intake. Moreover, as the RCI is based on both the frequency and variety of foods consumed during the day, which partly reflect consumption and shared household eating habits, it is also suitable for capturing parent-child transmission of dietary patterns.

2.3 Research questions

Based on the surveyed literature, we formulate the research questions as follows: How are parent-children diets associated? Are maternal eating habits more influential compared to those of fathers' in terms of children's diet quality? Does the strength of the relationship between parent-child diets change over the child life course? Is such a relationship significantly mediated by maternal lifestyle, namely the levels of daily activities carried out both inside and outside the home?

3. Empirical analysis

3.1 Data

This article makes use of an original source of individual-level statistical information, built within the DEDIPAC knowledge hub (Masotti et al., 2016; Mazzocchi et al., 2015) by integrating multiple data sources, namely the Istat *Multipurpose Survey on Households: Aspects of Daily Lives* (AVQ) 2003–2016; the INRAN-CREA[2] 2005 data on food frequency and calorie intake; and values of the Consumer Price Index for food and beverages at the regional level, publicly available on the Istat website. The database covers several domains, including dietary habits, lifestyle and everyday activities, and the role of prices in shaping eating habits of the Italian population. In particular, the INRAN-CREA data enables diet quality to be estimated by combining food frequency data with the corresponding calorie intake. Moreover, the availability of fifteen waves of the Istat AVQ survey enables the construction of a large, pooled database of individuals aged between 6 and 17, which helps to increase the overall sample size and to strengthen the robustness of the results. To avoid possible cases of under-reporting, we excluded any observational units with an estimated daily total kilocalorie intake that is two standard deviations lower than their group mean, by gender and age class. As a result, the final sample is of over 41,000 observations. Unfortunately, repeated cross-sections do not have a longitudinal dimension as the same individuals are not followed through time. The most popular methods for modelling temporal dynamics in such data require to either calculate a sample mean over individuals within each cohort and treat it as an observation in a pseudo-panel (Deaton, 1985) or to adopt a multilevel framework to model time-variant variables within time-invariant clusters or groups.[3] Such methods have the drawback of making the dependent variable only observable at the cohort- (or group-) level rather than at the individual one,

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[2] INRAN-CREA is the former Italian National Institute for Research in Agriculture (INRAN), now *Consiglio per la ricerca in agricoltura e l'analisi dell'economia agraria* (CREA).

[3] See, e.g., Kusano and Kemmelmeier's (2020) application of multilevel modelling to time-series cross-sectional data.

which implies a loss of information on variability at the individual level—in our case, on the variation of diet quality among children. To preserve the individual-level variability of the RCI indicator, we choose not to exploit the repeated cross-section structure of the data and to model the temporal component as an explanatory variable. That means that we cannot evaluate causal links between parental and child dietary habits. Rather, we assess if an association between parents' and children's quality of diet exists and we evaluate its strength and direction, controlling for their main sociodemographic, socioeconomic and lifestyle characteristics.

In our analysis, we separate young individuals into the following age classes: children (6-10 years of age), early adolescents (11-13 years of age), and adolescents (14-17 years of age). We distinguish between such age groups for a twofold reason. First, young individuals belonging to each of the three age spans considered have a rather different daily routine, which may influence their food-related habits (e.g., because they consume one meal per day at the school canteen) and preferences (e.g., due to socially constructed eating behaviours). Second, the intensity of parental control and the relevance of parents as a role model also change as children grow in age, resulting in different degrees of ability to influence children's dietary pattern depending on the child's life stage.

For children and adolescents, the WHO (2003) identifies several strategies to prevent the insurgence of child obesity, which translate to the adoption of both healthy eating habits and active lifestyles. The strategies include promoting an active lifestyle, limiting television viewing, promoting the intake of fruits and vegetables, creating more opportunities for family interaction (e.g., eating family meals), restricting the intake of energy-dense, micronutrient-poor foods (e.g., packaged snacks) and the intake of sugars-sweetened soft drinks. Exploiting the rich information provided by the integrated dataset at our disposal, we explored the prevalence of such outcomes over time among Italian children and adolescents (Figure 1). Overall, young people's adherence to WHO principles has improved in the last fifteen years. Individuals with an active lifestyle—i.e., either playing sports on a regular basis or doing physical activity at least three times a week—increased from an average of 51.3% to 56.8%, while weekly hours of TV viewing decreased from 20 to 17—that is, from 2.8 to 2.4 a day. Concerning eating habits, the prevalence of young people eating a family meal for lunch remained rather steady (with an overall average of 77.9%). Daily consumption of packaged snacks among young people has also been diminishing, by almost 4 percentage point among individuals aged 14-17 and by 3.2 percentage points among those aged 10-13. An even sharper decrease of 6 percentage points was observed among both adolescents and early adolescents in their consumption of sugar-sweetened beverages between 2003 and 2016. However, the proportion of individuals reporting severely insufficient intake of fruits and vegetables rose from 22.1% to 26.4% on average, with the sharpest increase (+5.1%) observed in the 11-13 age group. The latter represents a worrying figure, considering that it is recommended for young and adult populations alike to consume at least five servings of fruits and vegetables per day to prevent obesity and the insurgence of degenerative diseases (CREA, 2019).

FIGURE 1 ABOUT HERE

The average energy intake of Italian young people (Figure 2), however, seems to be significantly lower than the reference levels issued by the Italian Society of Human Nutrition SINU (2014). On the one hand, the caloric intake might be underestimated by the proposed approach as the Istat survey only records food frequencies for selected food groups (Masotti et al., 2016).[4] On the other hand, such evidence recalls the importance of not relying entirely upon energy intake data, which might overlook other relevant and informative aspects, such as diet composition. The use of an index like the RCI proves

[4] According to Masotti et al. (2016), calorie intake estimated for individuals under 18 years of age might be 25% lower than the true one. Moreover, it is worth noticing that the ISTAT survey does not consider beverages' consumption for individuals under the age of 10.

to be more useful to investigate child diet quality, as it summarises both facets—i.e., food intake quantity and quality—of a healthy diet. Moreover, because the RCI is age-independent, it can be compared among different age groups and over the life course at individual level. Observing the distribution of the RCI for the same population (Figure 3) leads to the conclusion that, overall, the adherence to WHO recommendations is quite high for all age groups and genders considered. Girls show higher levels of the RCI in all three life stages and especially during adolescence, likely due to the greater social pressure to control their bodyweight to which they are usually subjected (Lieberman et al., 2001). The least compliant sub-group is that of male children aged between 6 and 10, which, as also reported by Istat, is the population showing the highest proportion (34.1%) of overweight or obese individuals among young people (Istat, 2019).[5]

FIGURE 2 ABOUT HERE

FIGURE 3 ABOUT HERE

Average RCI levels by gender and age group plotted against parental BMI category generally point at confirming that children of overweight or obese parents have a higher probability to be overweight or obese themselves (Cislak et al., 2011), as shown by the consistently higher blue dot in Figure 4. However, those parents who are overweight according to the BMI indicator—either father, mother, or both—appear to only have a bearing on male children in the 6-10 age class. In fact, the latter

[5] The figure is compared to girls in the same age band—30.5% of which are overweight—and to early adolescent and adolescent males, among which the proportions of overweight individuals are 26.4% and 18.7% respectively (Istat, 2019).

category seems to be particularly vulnerable when it comes to unhealthy eating habits and more sensitive to the intergenerational transmission of parental health status (OECD/EU, 2018).

FIGURE 4 ABOUT HERE

3.2 Estimation strategy: quantile regression modelling

To investigate the relationship between parental and child dietary habits, we apply multivariate linear regression on the child RCI, a continuous variable ranging in the [0, 1] interval. Since plots in Figure 3 show a highly skewed distribution of the RCI indicator, we employ quantile regression modelling to analyse associations between explanatory variables on different quantiles in the distribution of the outcome variable. Quantile regression consists in specifying a conditional quantile of the dependent variable as a linear function of a set of covariates, which enables to study the relationship between the dependent variable and the regressors at representative points in the conditional distribution of the outcome. Using quantile regression has several advantages. First, contrary to ordinary least squares estimation, which focuses on the conditional means of the distribution, quantiles are in fact "inherently local" (Koenker, 2017) and can be used to describe even small local changes in a skewed distributional mass. Second, quantile regression is also relatively robust to the presence of outliers as it does not require to assume a specific distributional assumption or homoskedasticity for the error term (Hanandita and Tampubolon, 2015).

As a first step, we compare maternal and paternal association with children's RCI using the sub-sample of children who cohabit with both parents (Model 1). We assume that children's diet quality will depend on both children's individual characteristics and parental features that are clustered at household level. Since the dataset contains children of the same parents who will supposedly show highly correlated features in terms of daily food consumption, we use a cluster-robust estimator (Machado et al., 2014;

Parente & Santos Silva, 2016) to account for the unobserved intra-class variability of eating habits at the household level. The two main explanatory variables are the RCI of the child's mother and father, accounting for the diet quality of the parents. An interaction between each parent's RCI and the child age class is also included in the model to investigate the association between children's diet and parental characteristics over the life course. The remaining independent variables account for parental background characteristics (educational level and socioeconomic status, presence of two or more cohabiting households in the family home, number of siblings in the household, objective and subjective health statuses reported by the parents as measured by the presence of chronic illnesses and the self-rated health (SRH) respectively), individual characteristics and lifestyle of the child (gender, age class, area of residence, level of physical activity, objective and subjective health statuses, place where they usually have lunch, hours of TV viewing per week), and controls (year of the survey). Formally, we denote by y_i the continuous response for the i^{th} observational unit; $Q_\tau(y_i)$ is the τ-th conditional quantile of the child RCI; X is the matrix of individual-level regressors including a constant term; $\beta^{(\tau)}$ is the vector of parameters indicating the effect of each covariate on the corresponding τ-th conditional quantile, all else held constant; and $e_i^{(\tau)}$ is the asymmetrically weighted absolute residual. The equation for the quantile regression model with cluster-robust estimates is given as follows:

$$Q_\tau(y_i) = X\beta^{(\tau)} + e_i^{(\tau)}, \qquad \tau = 0.01, 0.02, \dots, 0.99$$

As a second step, we investigate the relationship between child RCI and maternal lifestyle by focusing on the sub-group of children who live with their mother regardless of maternal cohabitation status—that is, despite the child's mother is partnered and cohabiting with the child's father or is a living-alone mother (Model 2). Besides the individual characteristics of the child and usual control variables, in this case the equation includes independent variables accounting for maternal time-use (hours in paid work per week, hours in domestic work/child care per week, hours of paid help per week), maternal socioeconomic background (highest educational level attained, high professional profile, objective and subjective health statuses reported by the mother, and a dummy variable for playing sports on a regular basis), the number of children in the household and maternal cohabitation status, distinguishing between partnered and single mothers.

4. The determinants of diet quality among children and adolescents in Italy

This section reports the results from the quantile regression models of the intergenerational transmission of dietary habits conditioned on parental and child lifestyle. Tables 2 and 3 show the coefficients associated to representative quantiles from Models 1 and 2 respectively, estimated with the `qreg2` package available in Stata 17 (Machado et al., 2014; Parente & Santos Silva, 2016).

Estimates from Model 1 (Figure 5) show that, other things being equal, parents' RCI is significantly and positively associated with that of their offspring. When compared with fathers', maternal diet quality is more strongly associated to that of their children, which confirms what found in the international empirical literature about the greater importance played by mothers as both caregivers and role models in terms of nutritional health. The intensity of such relationship increases for subjects in higher RCI quantiles ($q25 = 0.34$; $q50 = 0.45$; $q75 = 0.46$), even if it seems to become less relevant for children whose RCI falls in the top 10% of the distribution, as shown in Figure 5 where the complete set of estimates for 99 quantiles are plotted for each of the covariates. Paternal diet quality, on the other hand, is rather steadily associated with that of their children throughout the RCI distribution ($q25 = 0.24$; $q50 = 0.24$; $q75 = 0.23$) and is relatively less important than maternal diet quality across the child RCI distribution. Anyhow, for children whose RCI falls in the top decile, such positive association seems to weaken for fathers as well ($q90 = 0.15$; $q95 = 0.10$). The interaction effect between parental

RCI and children's age indicates that the effect of maternal RCI on their children's diet quality does not change significantly over the child life course for kids whose RCI falls in the first 70% of the distribution. On the other hand, compared with children aged 6 to 10 years old and especially for children whose RCI falls in the lower 60% of the distribution, paternal RCI increases its positive effect on their children's when the latter are in the 11-13 ($q25 = 0.07$; $q50 = 0.07$) and in the 14-17 age bands ($q25 = 0.09$; $q50 = 0.08$). In fact, the sparse evidence on the influence of fathers on children's eating patterns remains conflicting. Empirical research on the relationship between parent-child intakes conducted on dyads shows that parental influences over child food habits may be related to specific food groups. For Australian fathers and children, for instance, intakes are more related for foods that are high in fat and saturated and total carbohydrate (Robinson et al., 2015). Our results might be read in this light, hypothesizing that such an influence might be delimited to certain age groups, for instance when the likelihood of an increased consumption of poor-nutrient foods is higher—as during the transition from primary to lower secondary school in Italy. According to this interpretation, cohabiting with fathers who are more attentive to maintaining healthy dietary habits might represent a protective factor for young people's nutritional health. It is worth noticing, however, that older children who are highly compliant with WHO's recommendations show RCI levels that tend to diverge from both maternal and paternal RCIs. That could be explained by the increasing relevance of individual preferences—including tastes, values, and beliefs—reflected in food choice and consumption of young people who are approaching the transition to adulthood. In terms of family background, when the child RCI falls in the lower 50% of the distribution, having cohabiting siblings in the household and university-educated parents are, *ceteris paribus*, significantly and positively associated with children's diet quality ($q25 = 0.01$ and $q25 = 0.01$, respectively), while having both parents who are overweight or obese according to the BMI ($q25 = -0.01$) or having at least one parent reporting to have a chronic health condition ($q25 = -0.01$) are negatively associated with children's diet quality, other things held constant. Concerning child individual characteristics, compared with children aged 6-10, being an early adolescent or an adolescent is more negatively associated to low RCI values, while the opposite is true for RCI values that fall in the top quantiles of the distribution. That means that primary school-aged children in Italy tend to report worse dietary habits than young people in the 11-17 age bands, *ceteris paribus*. Moreover, children living in Southern regions have lower diet quality levels compared to those who live in the North ($q25 = -0.01$; $q50 = -0.02$; $q75 = -0.02$), which is consistent with the figures on childhood obesity reported by Istat highlighting that excess weight—as measured by the BMI—is more widespread in the South of the country (Istat, 2019). In addition, girls tend to show significantly higher average levels of RCI compared with boys, especially for lower values of the RCI distribution ($q25 = 0.02$; $q50 = 0.01$). The nutritional health gap between genders, as also confirmed by recent empirical evidence on child obesity in Italy (Crudu et al., 2021), could be explained by the literature on the role of peer modelling and social reinforcement in shaping girls' dietary habits (Lieberman et al., 2001; Trogdon et al., 2008), and suggests the idea that the intergenerational transmission of diet quality is a gendered process involving mothers and their daughters in particular. Our estimates provide insights also about child lifestyle. Weekly hours of TV watching, for instance, are negatively yet weakly correlated with child RCI throughout the RCI distribution, as is the dummy variable for reporting chronic health conditions ($q25 = -0.01$; $q50 = -0.01$) up to the higher quartile, *ceteris paribus*. Moreover, compared with children who have lunch at home, those who have lunch in the school canteen rather consistently report significantly better dietary habits throughout the whole child RCI distribution ($q25 = 0.02$; $q50 = 0.02$; $q75 = 0.01$). Conversely, having lunch at one's relatives' or friends' house—or in other places, like cafes and restaurants, in the case of adolescents—is negatively associated with RCI levels. Such a finding suggests that Italian schools might in fact offer important opportunities for incentivizing children to adopt and maintain healthy eating habits, as also advocated by the WHO (2018).

TABLE 2 ABOUT HERE

FIGURE 5 ABOUT HERE

Turning to Model 2, estimates in Table 3 and plotted in Figure 6 largely confirm what found in Model 1. Maternal dietary habits are highly and positively significant in determining their children's diet quality ($q25 = 0.42$; $q50 = 0.55$; $q75 = 0.55$). In this case too, the estimated relationship between maternal and child RCIs seems to be less relevant for children whose RCI falls in the top 10% of the distribution ($q90 = 0.37$; $q95 = 0.25$). Due to the different sample analysed, the interaction effect with the child age becomes now significant across the whole child RCI distribution. The interaction term shows an especially strong and positive association between maternal RCI and early adolescents' RCI and whose intensity starts lowering and becoming negative approximately starting the 70th quantile ($q25 = 0.09$; $q50 = 0.10$; $q75 = -0.07$). To answer our research question about the role of maternal employment and time-use in affecting children's diet, we analyse the coefficients of the explanatory variables for weekly hours spent in paid work, domestic and child-care, and for weekly hours benefiting from paid help. Other things held constant, these variables do not provide any hint about the role of maternal lifestyle, as none of them are significantly different from zero, indicating that child diet quality does not depend on how many hours mothers spend in paid or care work (Gwozdz et al., 2013). That might be linked to the relevance that food preparation and meal sharing—both usually fulfilled by mothers—have in the context of Mediterranean cultures, regardless of maternal activity status. Among the other family background predictors, maternal education confirms to be, *ceteris paribus*, highly and positively significant for children's diet quality (Baum & Ruhm, 2009; Currie et al., 2007; Madden, 2017), although only for the lower half of the RCI distribution ($q5 = 0.01$; $q25 = 0.02$; $q50 = 0.01$). Conversely, the dummy variable for mothers reporting chronic health conditions is significantly and negatively associated only for children with RCIs in the first quartile of the distribution ($q5 = -0.01$; $q25 = -0.01$), other things held constant. Finally, the analysis of child individual characteristics confirms what found in Model 1, highlighting that children residing in the South of the country, boys, children who report chronic health conditions and those who have lunch at their friends' or relatives' house are the most likely to have a non-compliant diet with respect to WHO's recommendations.

As a last step and as a further verification of a possible gendered process of transmission of dietary habits, we rerun Model 1 on the sub-samples of male and female children separately and then we plot the coefficients associated with parental RCIs and their interactions with the child age group by gender. Looking at Figure 7, it seems that mothers tend to consistently influence more their daughters' dietary habits than their sons' across the whole child RCI distribution. Concerning fathers, on the other hand, their dietary habits become significantly more correlated with those of their sons whenever the child has a relatively higher level of compliance with WHO's recommendations ($q75$ panel). Focusing on the case of children with high RCI levels, the interaction terms reveal that, compared with primary school-aged children, the relatively weaker correlation between maternal dietary habits and their early adolescent and adolescent children is especially driven by daughters. Conversely, for fathers the same divergent relationship is found for boys only.[6]

TABLE 3 ABOUT HERE

[6] As a further robustness check, we rerun our analysis with different model specifications—i.e., a multilevel model with a random intercept set at the household/maternal ID level and an ordinary least squares regression with clustered standard errors at household/maternal ID level. Results from these analyses confirm those presented here in terms of both relative strength and significance of the coefficients. Results are made available to the reader in the Appendix.

FIGURE 6 ABOUT HERE

FIGURE 7 ABOUT HERE

5. Conclusions

Child overweight is increasing rapidly in every country around the world (WHO, 2018). Not only is tackling this phenomenon urgent due to the problems it causes for young children at both the psychosocial and physiological level; it is also of paramount importance for its public health relevance (Abarca-Gómez et al., 2017) and it needs to be seriously addressed.

In this paper, we scrutinized diet quality levels among children and adolescents in Italy, a country where childhood obesity is widespread, and the proportion of overweight children—especially aged 3-10—is well above the European average (OECD/EU, 2018). Focusing on Italian data, our aim was to understand if and how parents' dietary habits influence the diet quality of their children. Given that the current literature highlights how mothers are especially influential in shaping their children's eating behaviours, we wanted to investigate the role of maternal dietary habits, socioeconomic conditions and lifestyle in influencing child diet quality. Empirically, we exploited an original database at individual level built by Mazzocchi and colleagues (Masotti et al., 2016; Mazzocchi et al., 2015) within the DEDIPAC knowledge hub, integrating multiple sources of statistical information on aspects of the daily lives of Italian households, as well as on food consumption, frequency and calorie intake. Covering the period from 2003 to 2016, the integrated dataset includes a pooled sample of over 41,000 records of Italian children and adolescents aged 6 to 17. As per the concept of diet quality, we employed the Recommendation Compliance Index, a composite indicator developed to measure individuals' compliance with WHO's recommendations for a healthy diet (Irz et al., 2013; Mazzocchi et al., 2008). We applied quantile regression modelling to the data to study the relationship between each covariate and the dependent variable at representative points in the outcome distribution. Moreover, we specified a cluster-robust estimator in order to capture the variability of dietary habits clustered at household level. Our results confirmed that, other things being equal, parental dietary habits are significantly and positively associated with those of their offspring and that, compared with fathers, maternal diet quality is more strongly correlated to that of their children. Moreover, while paternal diet quality is rather steadily associated with their children's throughout the child RCI distribution, the intensity of the relationship between maternal diet and their children's increases as the child RCI increases, indicating an underlying process of increasing positive reinforcement between mothers and their children, especially their daughters. However, both maternal and paternal influences seem to become less relevant for children with the highest levels of compliance with WHO's recommendations, especially for older ones. Together with the evidence that the parent-child diet correlation is not constant over the child life course, we provide the interpretation that, at sufficiently high levels of child diet quality, individual preferences—including tastes, values, and beliefs—become increasingly relevant and start to affect food choice and consumption of young people who are approaching the transition to adulthood. Healthy eating habits of mothers and fathers are found to be especially crucial in shaping their children's dietary habits during early adolescence, a crucial phase of the life course where peer pressure and increased autonomy challenge acquired eating patterns and preferences. On the other hand, scarce or no evidence is found concerning the effect that maternal employment and lifestyle have on their children's diet. Bearing in mind that the international literature focusing on child obesity finds mixed evidence in this regard (Anderson, 2012; Gwozdz et al., 2013), we provide the explanation that child diet quality and the number of weekly hours spent by mothers in paid work might be independent of one another, under the hypothesis that culturally dominant views about the centrality of food preparation and meal sharing in caregiving in the Italian context might offset the time spent by mothers outside the family home. Moreover, we found that boys consistently show lower average levels of RCI compared with girls. Such gender gap can be connected to the role of peer modelling and social reinforcement in shaping girls' dietary habits (Lieberman et al., 2001; Trogdon et al., 2008), and supports the idea that the intergenerational transmission of dietary habits is gender-assortative (Costa-Font & Jofre-Bonet, 2020), especially involving mothers and their daughters. Nonetheless, fathers who are more attentive to maintaining healthy dietary habits seem to play a key role in mitigating the potentially negative effects of unhealthy eating behaviours, especially for early adolescent children. Finally, we found interesting results concerning children's mealtime structure and patterns: compared with children who have lunch at home, those who have lunch at the school canteen consistently report better dietary habits throughout the whole child RCI distribution. This underlines the pivotal role schools play in the fight against childhood obesity, which calls for strong public policy partnerships in the health and education sectors, with the aim of creating a healthy school environment especially targeted at those most vulnerable to nutritional deprivation—namely primary school children in general and young people from Southern Italy. Controlling these estimates for a wide range of sociodemographic and socioeconomic variables offered further robustness to our findings. Certainly, integrating our data with statistical information coming from proper time-use diaries could represent an opportunity to validate these results and to motivate further research on the matter, although unfortunately there is currently limited availability of this type of data in Italy.

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Appendix

Robustness checks: Multilevel vs. ordinary least squares with cluster-robust standard errors regression modelling

In order to check the robustness of our results, we rerun our analysis using different model specifications—i.e., we apply (i) multilevel regression modelling, and (ii) ordinary least squares with cluster-robust standard errors modelling. Since plots in Figure 3 show a highly skewed distribution of the RCI indicator, we transform the outcome variable by taking the logarithm of its complement to 1 in order to make it normally distributed. Such transformation implies that the dependent variable becomes an indicator of *distance from*—rather than compliance with—the target diet. We use the transformed variable as the outcome of both multilevel and OLS regression analyses.

Multilevel regression can be employed to model clustered data by introducing a random intercept corresponding to the household ID, accounting for the unobserved intra-class variability of eating habits at the household level. Formally, we denote by y_{ij} the continuous response for the i^{th} observational unit—i.e., the child—belonging to the j^{th} household. Equation (1) for the two-level random-intercept model is specified as follows:

$$y_{ij} = \beta_0 + \beta_1 X_{1ij} + \beta_2 X_{2j} + u_{0j} + \epsilon_{ij} \tag{1}$$

where β_0 is the fixed intercept; β_1 is the slope of the individual-level covariates X_{1ij} associated to child i in household j; β_2 is the slope of the group-level covariates X_{2j} associated to household j; $u_{0j} \sim N(0, \sigma_u^2)$ is the group effect or the second-level residuals representing the unobserved variability at the j^{th} household level; and $\epsilon_{ij} \sim N(0, \sigma_\epsilon^2)$ is the error term for the first-level residuals.

To investigate the relationship between child RCI and maternal lifestyle in particular (Model 2), we specify equation (2), where the response variable for the i^{th} observational unit varies at the m^{th} mother-level, the 'mother effect' $z_{0m} \sim N(0, \sigma_m^2)$ represents the intra-class unobserved variability shared by the children of the same mother, and $\eta_{im} \sim N(0, \sigma_\eta^2)$ is the error term for the individual-level residuals.

$$y_{im} = \beta_0 + \beta_1 X_{1im} + \beta_2 X_{2m} + z_{0m} + \eta_{im} \quad (2)$$

The number of groups (households/mothers) and observations per group (children) is displayed for both models in Table A1.

Table A1 Summary statistics of the two-level random-intercept linear regression model

Model	Group variable	No. of Observations	No. of Groups	Observations per Group		
				Minimum	Mean	Maximum
(1)	Household ID	41,118	29,933	1	1.4	6
(2)	Maternal ID	41,319	30,412	1	1.4	5

Source: Own elaborations on Istat/INRAN-CREA data.

Ordinary least squares regression, on the other hand, estimates the conditional means of the distribution of the transformed RCI, while accounting for the clustered structure of the data through the adjustment of standard errors as in equation (3):

$$y_i = \boldsymbol{x}_i \boldsymbol{\beta} + e_i \quad (3)$$

Multilevel and OLS estimates from Models 1 and 2 are shown in Tables A2 and A3 below. Note that, being the dependent variable an indicator of distance from the ideal diet recommended by the WHO, both in the case of multilevel and OLS estimates negative coefficients represent protective factors of healthy dietary habits, while positive coefficients are associated to variables that are detrimental to children's nutritional well-being.

Results from the robustness checks show that both the relative magnitude and significance of the estimated coefficients confirm those presented in the main analysis.

Table A2 Estimates of the intergenerational transmission of dietary habits, children of co-habiting parents: ordinary least squares with robust standard errors vs. two-level random intercept linear regression

Covariates	2-level random intercept linear model		Ordinary least squares with robust standard errors	
	Coef.	*SE*	*Coef.*	*SE*
Parental dietary habits				
Mother's RCI	-1.73***	(0.06)	-1.75***	(0.05)
Father's RCI	-1.01***	(0.05)	-1.03***	(0.05)
Interaction effect (ref. Child)				
Early adolescent × Mother's RCI	-0.15+	(0.08)	-0.16+	(0.09)
Adolescent × Mother's RCI	-0.10	(0.08)	-0.09	(0.09)
Early adolescent × Father's RCI	-0.35***	(0.08)	-0.32***	(0.09)
Adolescent × Father's RCI	-0.25**	(0.08)	-0.22*	(0.09)
Family background				
Type of family: 2+ HHs (ref. Couple w/children)	-0.05	(0.04)	-0.04	(0.04)
Number of children in HH (ref. 1)				
2	0.01	(0.01)	0.01	(0.01)
3 or more	-0.00	(0.01)	-0.01	(0.01)
Highly educated parents (ref. No)	-0.03**	(0.01)	-0.03**	(0.01)
High parental SES (ref. No)	-0.02+	(0.01)	-0.02*	(0.01)
Parents are overweight or obese (ref. No)				
Only the mother	0.00	(0.01)	-0.00	(0.01)
Only the father	-0.01	(0.01)	-0.02	(0.01)
Both	0.02+	(0.01)	0.01	(0.01)
Mother's self-rated health: Good/Very good (ref. No)	0.00	(0.01)	0.00	(0.01)
Father's self-rated health: Good/Very good (ref. No)	-0.02*	(0.01)	-0.02*	(0.01)
Parents report chronic illnesses (ref. No)	0.01+	(0.01)	0.01*	(0.01)
Parents smoke (ref. No)	-0.01	(0.01)	-0.01	(0.01)
Child individual characteristics				
Life stage (ref. Child)				
Early adolescent	0.16*	(0.08)	0.15+	(0.09)
Adolescent	0.02	(0.08)	-0.02	(0.08)
Area of residence (ref. North)				
Centre	0.00	(0.01)	0.00	(0.01)
South	0.10***	(0.01)	0.10***	(0.01)
Gender: Female (ref. Male)	-0.04***	(0.01)	-0.04***	(0.01)
Plays sports regularly (ref. No)	-0.01	(0.01)	-0.01	(0.01)
Self-rated health: Good/Very good (ref. No)	0.01	(0.02)	0.02	(0.02)
Reports chronic illnesses (ref. No)	0.03***	(0.01)	0.03**	(0.01)
Place lunch is taken (ref. Home)				
School canteen	-0.08***	(0.01)	-0.08***	(0.01)
Relatives or friends' house/Other	0.08***	(0.01)	0.09***	(0.02)
TV viewing (hours per week)	0.00***	(0.00)	0.00***	(0.00)
Controls				
Year of the survey (ref. 2003)				
2005	0.04	(0.02)	0.04+	(0.02)
2006	0.04+	(0.02)	0.05+	(0.02)
2007	0.03	(0.02)	0.03	(0.02)
2008	0.04	(0.02)	0.04	(0.02)
2009	0.04+	(0.02)	0.04+	(0.02)
2010	0.06*	(0.02)	0.06*	(0.02)
2011	0.05+	(0.02)	0.05*	(0.02)
2012	0.03	(0.02)	0.03	(0.02)
2013	0.03	(0.02)	0.03	(0.03)
2014	0.01	(0.02)	0.02	(0.03)
2015	-0.01	(0.03)	-0.01	(0.03)
2016	0.03	(0.03)	0.03	(0.03)
Constant	0.73***	(0.06)	0.76***	(0.06)
Household-level variance	-0.89***	(0.01)		
Intra-class correlation	0.45	(0.01)		
r2			0.17	
AIC	74297.99		76803.12	
BIC	74677.45		77165.34	
N	41118		41118	

Notes: Being the transformed RCI in logarithmic scale, coefficients are to be read as semi-elasticities. OLS regression estimates' standard errors are clustered at the household ID level to account for the intrahousehold correlation in siblings' dietary habits. Significance at 10% (+), 5% (*), 1% (**), and 0.1% (***). Source: Our elaborations on Istat/INRAN-CREA data.

Table A3 Estimates of the intergenerational transmission of dietary habits controlling for maternal lifestyle: ordinary least squares with robust standard errors vs. two-level random intercept linear regression

Covariates	**2-level random intercept linear model**		**Ordinary least squares with robust standard errors**	
	Coef.	***SE***	***Coef.***	***SE***
Parental dietary habits				
Mother's RCI	-2.09***	(0.05)	-2.12***	(0.05)
Interaction effect (ref. Child)				
Early adolescent × Mother's RCI	-0.41***	(0.08)	-0.41***	(0.08)
Adolescent × Mother's RCI	-0.28***	(0.08)	-0.24**	(0.08)
Family background				
Type of family: Single mother (ref. In a couple)	-0.01	(0.01)	-0.01	(0.01)
Number of children in HH (ref. 1)				
2	0.00	(0.01)	0.00	(0.01)
3 or more	-0.01	(0.01)	-0.01	(0.01)
Maternal work intensity (hours per week)	0.00	(0.00)	0.00	(0.00)
Maternal domestic work/child-care (hours per week)	0.00	(0.00)	0.00	(0.00)
Paid domestic help (hours per week)	-0.00	(0.00)	-0.00	(0.00)
Highly educated mother (ref. No)	-0.04***	(0.01)	-0.04***	(0.01)
High maternal SES (ref. No)	0.00	(0.01)	-0.00	(0.02)
Mother regularly plays sports (ref. No)	0.01	(0.01)	0.01	(0.01)
Mother's self-rated health: Good/Very good (ref. No)	-0.01	(0.01)	-0.01	(0.01)
Mother reports chronic illnesses (ref. No)	0.00	(0.01)	0.01	(0.01)
Mother smokes (ref. No)	0.01	(0.01)	0.01	(0.01)
Child individual characteristics				
Life stage (ref. Child)				
Early adolescent	0.08	(0.07)	0.09	(0.07)
Adolescent	-0.04	(0.07)	-0.08	(0.07)
Area of residence (ref. North)				
Centre	-0.01	(0.01)	-0.00	(0.01)
South	0.09***	(0.01)	0.09***	(0.01)
Gender: Female (ref. Male)	-0.05***	(0.01)	-0.05***	(0.01)
Plays sports regularly (ref. No)	-0.01+	(0.01)	-0.02*	(0.01)
Self-rated health: Good/Very good (ref. No)	-0.01	(0.02)	-0.01	(0.02)
Reports chronic illnesses (ref. No)	0.04***	(0.01)	0.04***	(0.01)
Place lunch is taken (ref. Home)				
School canteen	-0.07***	(0.01)	-0.07***	(0.01)
Relatives or friends' house/Other	0.07***	(0.01)	0.07***	(0.02)
TV viewing (hours per week)	0.00***	(0.00)	0.00***	(0.00)
Controls				
Year of the survey (ref. 2003)				
2005	0.02	(0.03)	0.03	(0.03)
2006	0.03	(0.02)	0.03	(0.02)
2007	0.01	(0.02)	0.01	(0.02)
2008	0.02	(0.02)	0.03	(0.02)
2009	0.03	(0.02)	0.02	(0.02)
2010	0.04+	(0.02)	0.04+	(0.02)
2011	0.03	(0.02)	0.03	(0.02)
2012	0.03	(0.02)	0.03	(0.02)
2013	0.02	(0.02)	0.01	(0.03)
2014	0.00	(0.02)	0.01	(0.03)
2015	-0.00	(0.03)	-0.01	(0.03)
2016	0.03	(0.03)	0.03	(0.03)
Constant	0.18***	(0.06)	0.20***	(0.05)
Maternal-level variance	-0.86***	(0.01)		
Intra-class correlation	0.46	(0.01)		
r2			0.14	
AIC	76098.22		78722.54	
BIC	76452.02		79059.08	
N	41319		41319	

Notes: Being the transformed RCI in logarithmic scale, coefficients are to be read as semi-elasticities. OLS regression estimates' standard errors are clustered at the maternal ID level to account for the intrahousehold correlation in siblings' dietary habits. Significance at 10% (+), 5% (*), 1% (**), and 0.1% (***). Source: Our elaborations on Istat/INRAN-CREA data.

Figure captions

Figure 1*: Strategic indicators for obesity prevention (years 2003-2016)*

Figure 2*: Distribution and kernel density function of the daily total Kilocalorie intake (g) by gender and age class*

Figure 3*: Distribution and kernel density function of RCI values by gender and age class*

Figure 4*: Mean RCI by gender, age class, and parental overweight/obese status*

Figure 5*: Model estimates of the child RCI conditional distribution, children of cohabiting parents (point estimates for 99 quantiles with 95% CIs)*

Figure 6*: Model estimates of the child RCI conditional distribution controlling for maternal lifestyle (point estimates for 99 quantiles with 95% CIs)*

***Figure** 7: Model estimates of the child RCI conditional distribution at representative quantiles, male vs. female sub-samples (point estimates with 95% CIs)*

Table 1

Table 1 World Health Organization's daily nutrient intake recommendations

	Lower Bound	Upper Bound	Weight
% of Kcal intake from fats	15%	30%	0.20
% of Kcal intake from proteins	10%	15%	0.05
% of Kcal intake from carbohydrates	55%	75%	0.05
% of Kcal intake from saturated fats	None	10%	0.20
% of Kcal intake from trans-fats	None	1%	0.10
% of Kcal intake from raw sugar	None	10%	0.20
Fruit and vegetables intake (g)	400g	None	0.20

Source: WHO (2003).

Table 2

Table 2 Quantile regression model with robust standard errors estimates of the intergenerational transmission of dietary habits, children of co-habiting parents (Model 1)

Covariates	q5		q25		q50		q75		q95	
	Coef.	*SE*	*Coef.*	*SE*	*Coef.*	*SE*	*Coef.*	*SE*	*Coef.*	*SE*
Parental dietary habits										
Mother RCI	0.23***	(0.03)	0.34***	(0.02)	0.45***	(0.02)	0.46***	(0.01)	0.21***	(0.02)
Father RCI	0.17***	(0.02)	0.24***	(0.02)	0.24***	(0.02)	0.23***	(0.01)	0.10***	(0.01)
Interaction effect (ref. Child)										
Early adolescent × Mother RCI	-0.00	(0.05)	0.03	(0.03)	0.03	(0.03)	-0.09***	(0.02)	-0.12***	(0.02)
Adolescent × Mother RCI	-0.04	(0.03)	0.03	(0.03)	0.00	(0.02)	-0.13***	(0.02)	-0.11***	(0.02)
Early adolescent × Father RCI	0.04	(0.05)	0.07*	(0.03)	0.07**	(0.03)	-0.04+	(0.02)	-0.03+	(0.02)
Adolescent × Father RCI	0.01	(0.03)	0.09**	(0.03)	0.08***	(0.02)	-0.07***	(0.02)	-0.05**	(0.02)
Family background										
2+ HHs (ref. Couple w/children)	0.04***	(0.01)	0.00	(0.01)	0.00	(0.01)	0.00	(0.00)	0.00	(0.00)
Number of children in HH (ref. 1)										
2	-0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	-0.00	(0.00)	-0.00	(0.00)
3 or more	-0.00	(0.01)	0.01**	(0.00)	0.00	(0.00)	-0.00	(0.00)	-0.00	(0.00)
Highly educated parents (ref. No)	0.01+	(0.00)	0.01*	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
High parental SES (ref. No)	0.01	(0.00)	0.00	(0.00)	0.00+	(0.00)	0.00+	(0.00)	0.00	(0.00)
Parents overweight/obese (ref. No)										
Only the father	-0.01*	(0.00)	-0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Only the mother	0.00	(0.01)	0.00	(0.00)	0.01+	(0.00)	0.00	(0.00)	0.00	(0.00)
Both	-0.01	(0.00)	-0.01*	(0.00)	-0.00	(0.00)	-0.00	(0.00)	0.00	(0.00)
Mother SRH: Good (ref. No)	0.00	(0.00)	0.00	(0.00)	-0.00	(0.00)	-0.00	(0.00)	-0.00	(0.00)
Father SRH: Good (ref. No)	0.00	(0.00)	0.00	(0.00)	0.01*	(0.00)	0.00	(0.00)	0.00	(0.00)
Parents w/chronic illness (ref. No)	-0.00	(0.00)	-0.01***	(0.00)	-0.00*	(0.00)	0.00	(0.00)	0.00*	(0.00)
Parents smoke (ref. No)	0.00	(0.00)	0.00	(0.00)	0.00+	(0.00)	0.00	(0.00)	0.00*	(0.00)
Child individual characteristics										
Life stage (ref. Child)										
Early adolescent	-0.01	(0.05)	-0.04	(0.03)	-0.02	(0.02)	0.16***	(0.02)	0.15***	(0.02)
Adolescent	0.05	(0.03)	-0.06*	(0.03)	-0.01	(0.02)	0.23***	(0.02)	0.16***	(0.02)
Area of residence (ref. North)										
Centre	-0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	-0.00	(0.00)	-0.00	(0.00)
South	0.01*	(0.00)	-0.01***	(0.00)	-0.02***	(0.00)	-0.02***	(0.00)	-0.01***	(0.00)
Female (ref. Male)	0.02***	(0.00)	0.02***	(0.00)	0.01***	(0.00)	0.00	(0.00)	-0.00***	(0.00)
Plays sports regularly (ref. No)	-0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00+	(0.00)	0.00*	(0.00)
Child SRH: at least Good (ref. No)	-0.00	(0.01)	0.00	(0.00)	-0.00	(0.00)	-0.00	(0.00)	-0.00	(0.00)
Reports chronic illness (ref. No)	-0.01*	(0.00)	-0.01***	(0.00)	-0.01**	(0.00)	-0.00	(0.00)	-0.00	(0.00)
Place lunch is taken (ref. Home)										
School canteen	0.02***	(0.00)	0.02***	(0.00)	0.02***	(0.00)	0.01***	(0.00)	0.01***	(0.00)
Relatives/friends' house/Other	-0.02***	(0.01)	-0.03***	(0.01)	-0.02***	(0.00)	-0.01**	(0.00)	-0.00	(0.00)
TV viewing (hrs/week)	-0.00**	(0.00)	-0.00***	(0.00)	-0.00***	(0.00)	-0.00***	(0.00)	-0.00***	(0.00)
Controls										
Year of the survey (ref. 2003)										
2005	0.00	(0.01)	-0.01+	(0.01)	-0.01	(0.00)	-0.01*	(0.00)	-0.00	(0.00)
2006	-0.00	(0.01)	-0.01	(0.01)	-0.01*	(0.00)	-0.01**	(0.00)	-0.00	(0.00)
2007	-0.00	(0.01)	-0.01+	(0.01)	-0.01*	(0.00)	-0.00	(0.00)	0.00	(0.00)
2008	-0.01	(0.01)	-0.02**	(0.01)	-0.01	(0.00)	-0.00	(0.00)	0.00	(0.00)
2009	-0.01	(0.01)	-0.01+	(0.01)	-0.01	(0.00)	-0.01*	(0.00)	-0.00	(0.00)
2010	-0.01	(0.01)	-0.02**	(0.01)	-0.01*	(0.00)	-0.01*	(0.00)	-0.00	(0.00)
2011	-0.01	(0.01)	-0.02*	(0.01)	-0.01+	(0.00)	-0.01*	(0.00)	-0.00	(0.00)
2012	0.00	(0.01)	-0.01	(0.01)	-0.01	(0.00)	-0.01	(0.00)	0.00	(0.00)
2013	-0.01	(0.02)	-0.02*	(0.01)	-0.01+	(0.00)	-0.00	(0.00)	0.00	(0.00)
2014	0.00	(0.01)	-0.01+	(0.01)	-0.00	(0.01)	-0.00	(0.00)	0.00	(0.00)
2015	0.01	(0.02)	-0.01	(0.01)	-0.00	(0.00)	-0.00	(0.00)	0.00	(0.00)
2016	-0.02	(0.01)	-0.02*	(0.01)	-0.01+	(0.01)	-0.00	(0.00)	0.00	(0.00)
Constant	0.20***	(0.03)	0.19***	(0.02)	0.18***	(0.01)	0.26***	(0.01)	0.66***	(0.02)
N	41118		41118		41118		41118		41118	

Notes: Standard errors are clustered at the household ID level to account for the intrahousehold correlation in siblings' dietary habits. Significance at 10% (+), 5% (*), 1% (**), and 0.1% (***). Source: Our elaborations on Istat/INRAN-CREA data.

Table 3

Table 3 Quantile regression model with robust standard errors estimates of the intergenerational transmission of dietary habits controlling for maternal lifestyle (Model 2)

Covariates	**q5**		**q25**		**q50**		**q75**		**q95**	
	Coef.	***SE***	***Coef.***	***SE***	***Coef.***	***SE***	***Coef.***	***SE***	***Coef.***	***SE***
Parental dietary habits										
Mother RCI	0.28***	(0.03)	0.42***	(0.02)	0.55***	(0.01)	0.55***	(0.01)	0.25***	(0.01)
Interaction effect (ref. Child)										
Early adolescent × Mother RCI	0.02	(0.04)	0.09***	(0.02)	0.10***	(0.02)	-0.07**	(0.03)	-0.11***	(0.02)
Adolescent × Mother RCI	-0.03	(0.04)	0.09***	(0.03)	0.07***	(0.02)	-0.13***	(0.02)	-0.12***	(0.02)
Family background										
Single mother (ref. In a couple)	0.01	(0.01)	0.00	(0.00)	0.01*	(0.00)	0.00	(0.00)	-0.00	(0.00)
Number of children in HH (ref. 1)										
2	-0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	-0.00	(0.00)
3 or more	0.00	(0.00)	0.01**	(0.00)	0.00	(0.00)	0.00	(0.00)	-0.00	(0.00)
Maternal work intensity (hrs/week)	0.00	(0.00)	-0.00*	(0.00)	-0.00	(0.00)	0.00*	(0.00)	0.00	(0.00)
Maternal domestic/child (hrs/week)	-0.00	(0.00)	-0.00*	(0.00)	-0.00	(0.00)	0.00	(0.00)	-0.00	(0.00)
Paid domestic help (hrs/week)	0.00***	(0.00)	0.00	(0.00)	0.00	(0.00)	-0.00	(0.00)	-0.00**	(0.00)
Highly educated mother (ref. No)	0.01**	(0.00)	0.02***	(0.00)	0.01**	(0.00)	0.00+	(0.00)	0.00	(0.00)
High maternal SES (ref. No)	-0.01	(0.01)	-0.00	(0.00)	-0.00	(0.00)	0.00	(0.00)	0.00	(0.00)
Mother plays sports (ref. No)	-0.01**	(0.00)	-0.01+	(0.00)	-0.00	(0.00)	-0.00	(0.00)	0.00	(0.00)
Mother SRH: Good (ref. No)	0.00	(0.00)	0.00	(0.00)	0.00	(0.00)	-0.00	(0.00)	-0.00	(0.00)
Mother w/chronic illness (ref. No)	-0.01*	(0.00)	-0.01*	(0.00)	-0.00*	(0.00)	0.00	(0.00)	0.00	(0.00)
Mother smokes (ref. No)	-0.00	(0.00)	-0.00	(0.00)	-0.00	(0.00)	-0.00	(0.00)	0.00	(0.00)
Child individual characteristics										
Life stage (ref. Child)										
Early adolescent	0.01	(0.03)	-0.03	(0.02)	-0.02	(0.02)	0.11***	(0.02)	0.11***	(0.02)
Adolescent	0.04	(0.03)	-0.03	(0.02)	0.00	(0.02)	0.17***	(0.02)	0.13***	(0.01)
Area of residence (ref. North)			-0.03	(0.02)	-0.02	(0.02)	0.11***	(0.02)	-0.00	(0.00)
Centre	0.01	(0.00)	0.00	(0.00)	-0.00	(0.00)	0.00	(0.00)	-0.01***	(0.00)
South	0.01**	(0.00)	-0.01**	(0.00)	-0.02***	(0.00)	-0.01***	(0.00)	-0.00***	(0.00)
Female (ref. Male)	0.02***	(0.00)	0.02***	(0.00)	0.01***	(0.00)	0.00+	(0.00)	-0.00***	(0.00)
Plays sports regularly (ref. No)	-0.00	(0.00)	-0.00	(0.00)	0.00*	(0.00)	0.00	(0.00)	0.00	(0.00)
Child SRH: Good (ref. No)	0.01	(0.01)	0.01	(0.01)	0.00	(0.00)	0.00	(0.00)	-0.00	(0.00)
Reports chronic illness (ref. No)	-0.01*	(0.00)	-0.01***	(0.00)	-0.01**	(0.00)	-0.00+	(0.00)	-0.00	(0.00)
Place lunch is taken (ref. Home)										
School canteen	0.02***	(0.00)	0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)	0.01***	(0.00)
Relatives or friends' house/Other	-0.02*	(0.01)	-0.02***	(0.00)	-0.02***	(0.00)	-0.01**	(0.00)	-0.00	(0.00)
TV viewing (hrs/week)	-0.00***	(0.00)	-0.00***	(0.00)	-0.00***	(0.00)	-0.00***	(0.00)	-0.00***	(0.00)
Controls										
Year of the survey (ref. 2003)										
2005	0.01	(0.01)	0.00	(0.01)	-0.01+	(0.01)	-0.00	(0.00)	0.00	(0.00)
2006	0.01	(0.01)	0.01	(0.01)	-0.01	(0.01)	-0.00	(0.00)	0.00	(0.00)
2007	0.01	(0.01)	-0.00	(0.01)	-0.01+	(0.01)	0.00	(0.00)	0.00	(0.00)
2008	0.00	(0.01)	-0.01	(0.01)	-0.01	(0.01)	-0.00	(0.00)	0.00	(0.00)
2009	-0.01	(0.01)	-0.00	(0.01)	-0.01	(0.01)	-0.00	(0.00)	0.00	(0.00)
2010	-0.01	(0.01)	-0.01	(0.01)	-0.01*	(0.01)	-0.00	(0.00)	0.00	(0.00)
2011	-0.00	(0.01)	-0.00	(0.01)	-0.01	(0.01)	-0.00	(0.00)	0.00	(0.00)
2012	0.00	(0.01)	-0.00	(0.01)	-0.01+	(0.01)	-0.00	(0.00)	0.00	(0.00)
2013	-0.01	(0.01)	-0.00	(0.01)	-0.01	(0.01)	0.00	(0.00)	0.00	(0.00)
2014	0.01	(0.01)	-0.00	(0.01)	-0.00	(0.01)	0.00	(0.00)	0.00	(0.00)
2015	0.01	(0.01)	0.00	(0.01)	-0.00	(0.01)	0.00	(0.00)	0.00	(0.00)
2016	-0.01	(0.01)	-0.01	(0.01)	-0.01*	(0.01)	0.00	(0.00)	0.00	(0.00)
Constant	0.28***	(0.02)	0.31***	(0.02)	0.31***	(0.01)	0.38***	(0.01)	0.71***	(0.01)
N	41319		41319		41319		41319		41319	

Notes: Standard errors are clustered at the maternal ID level to account for the intrahousehold correlation in siblings' dietary habits. Significance at 10% (+), 5% (*), 1% (**), and 0.1% (***). Source: Our elaborations on Istat/INRAN-CREA data.

Figure 1

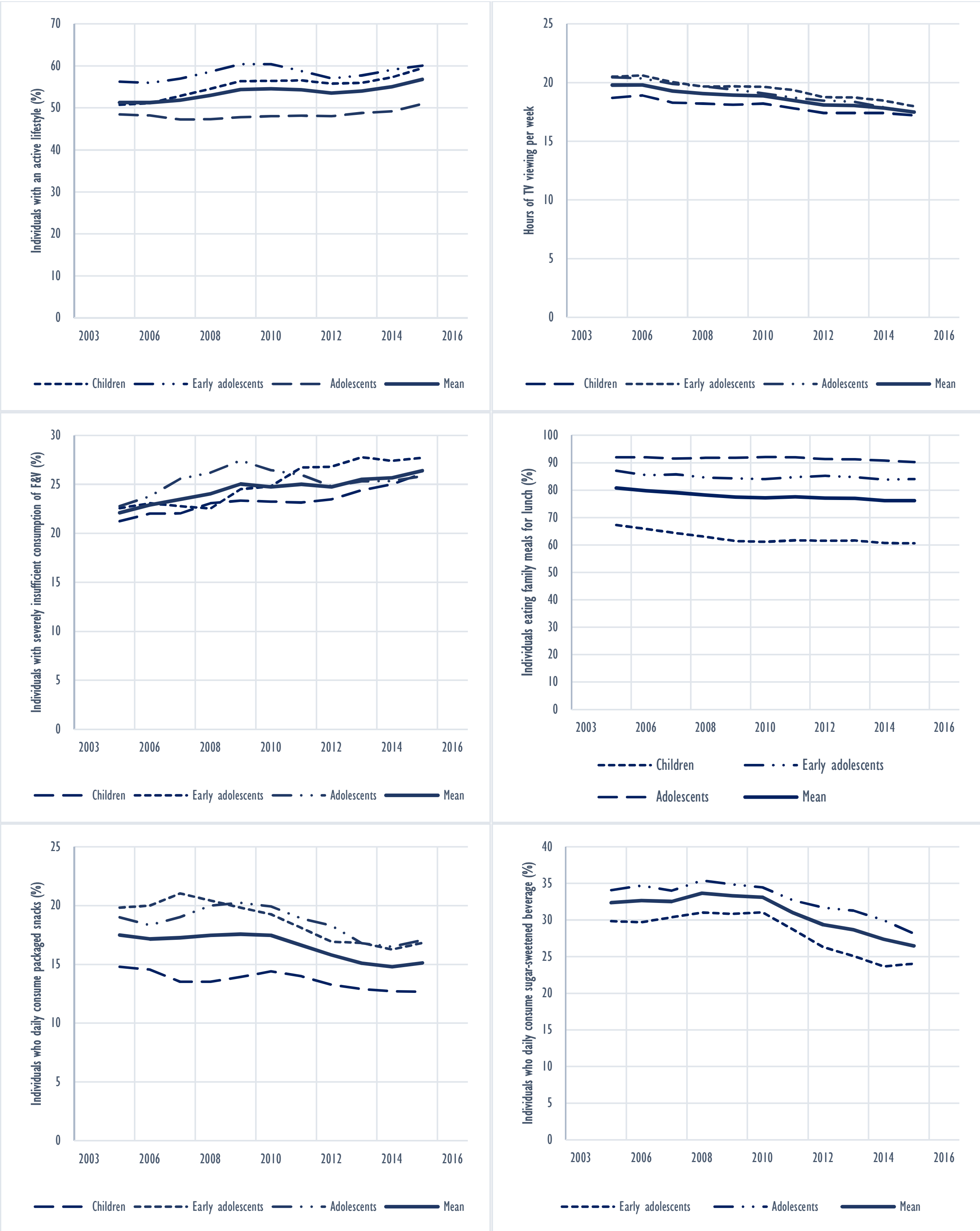

Fig 1 Strategic indicators for obesity prevention (years 2003-2016)

Figure 2

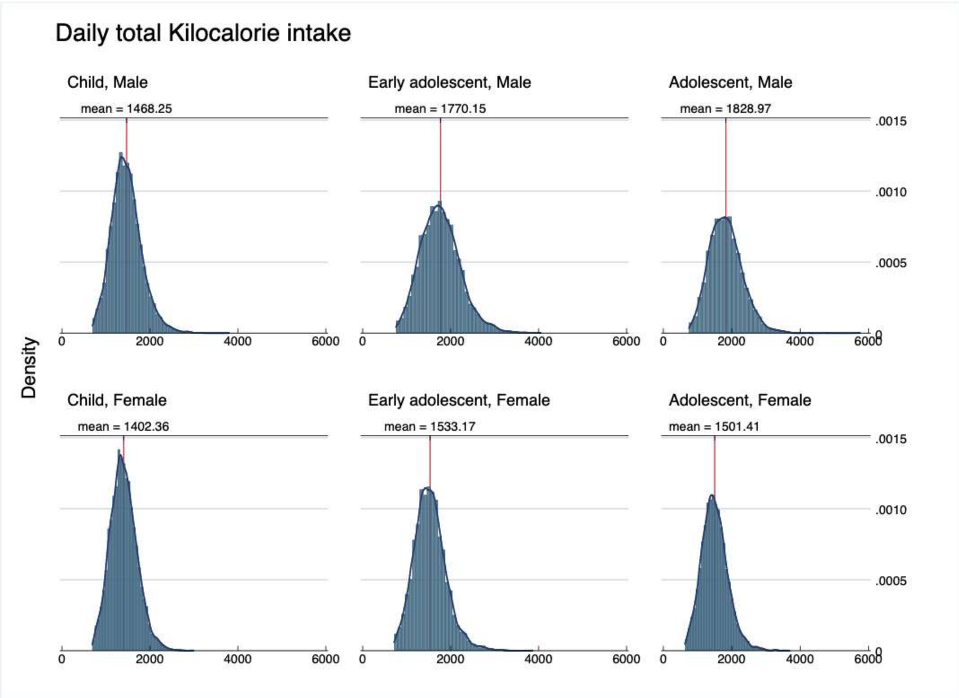

Fig 2 Distribution and kernel density function of the daily total Kilocalorie intake (g) by gender and age class

Notes: Blue lines denote Kernel density functions. Source: Our elaborations on Istat /INRAN-CREA data.

Figure 3

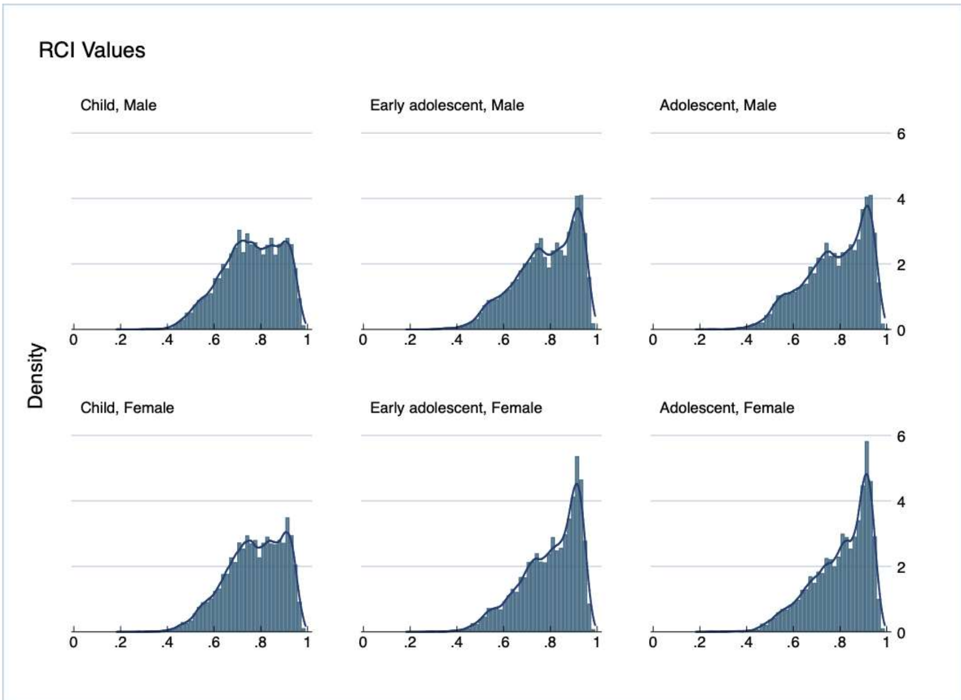

Fig 3 Distribution and kernel density function of RCI values by gender and age class

Notes: Blue lines denote Kernel density functions. Source: Our elaborations on Istat /INRAN-CREA data.

Figure 4

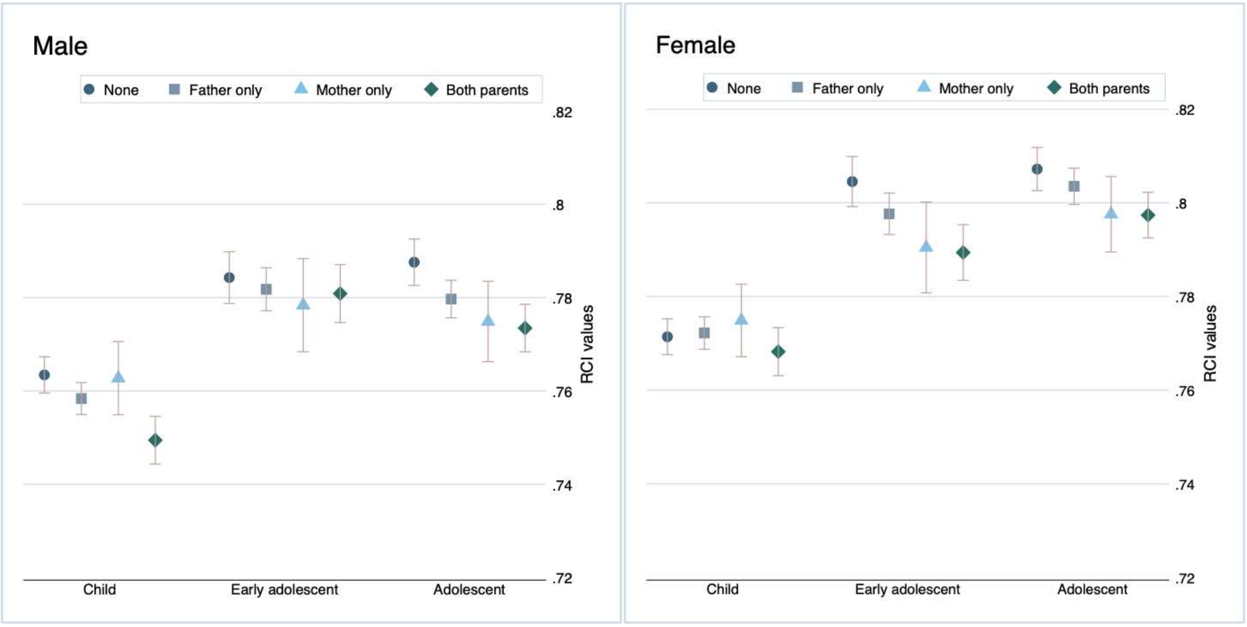

Fig 4 Mean RCI by gender, age class, and parental overweight/obese status

Source: Our elaborations on Istat/INRAN-CREA data.

Figure 5

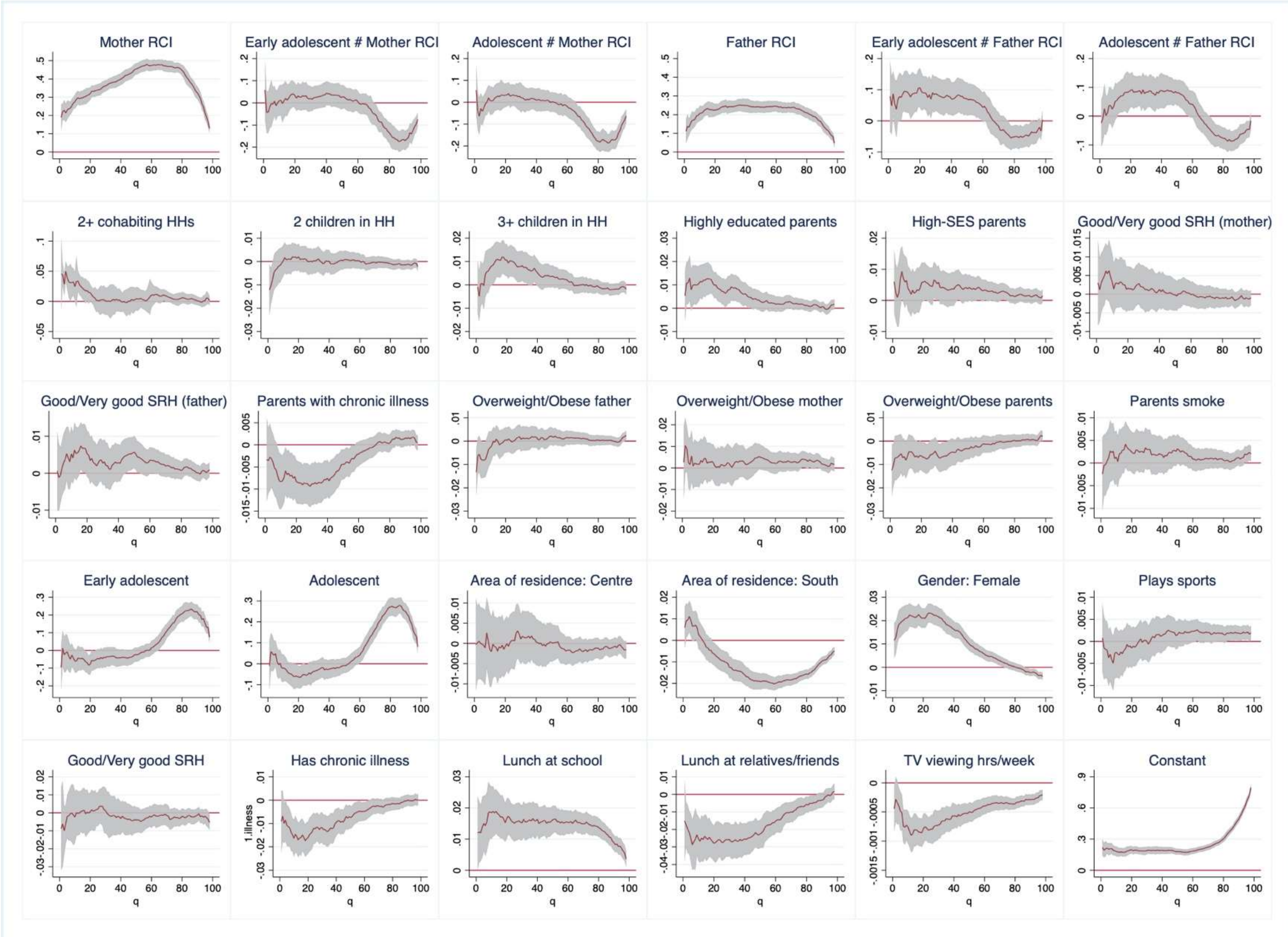

Fig 5 Model estimates of the child RCI conditional distribution, children of cohabiting parents (point estimates for 99 quantiles with 95% CIs)

Notes: Point estimates for the Year of the survey are not graphically shown. Source: Our elaborations on Istat/INRAN-CREA data.

Figure 6

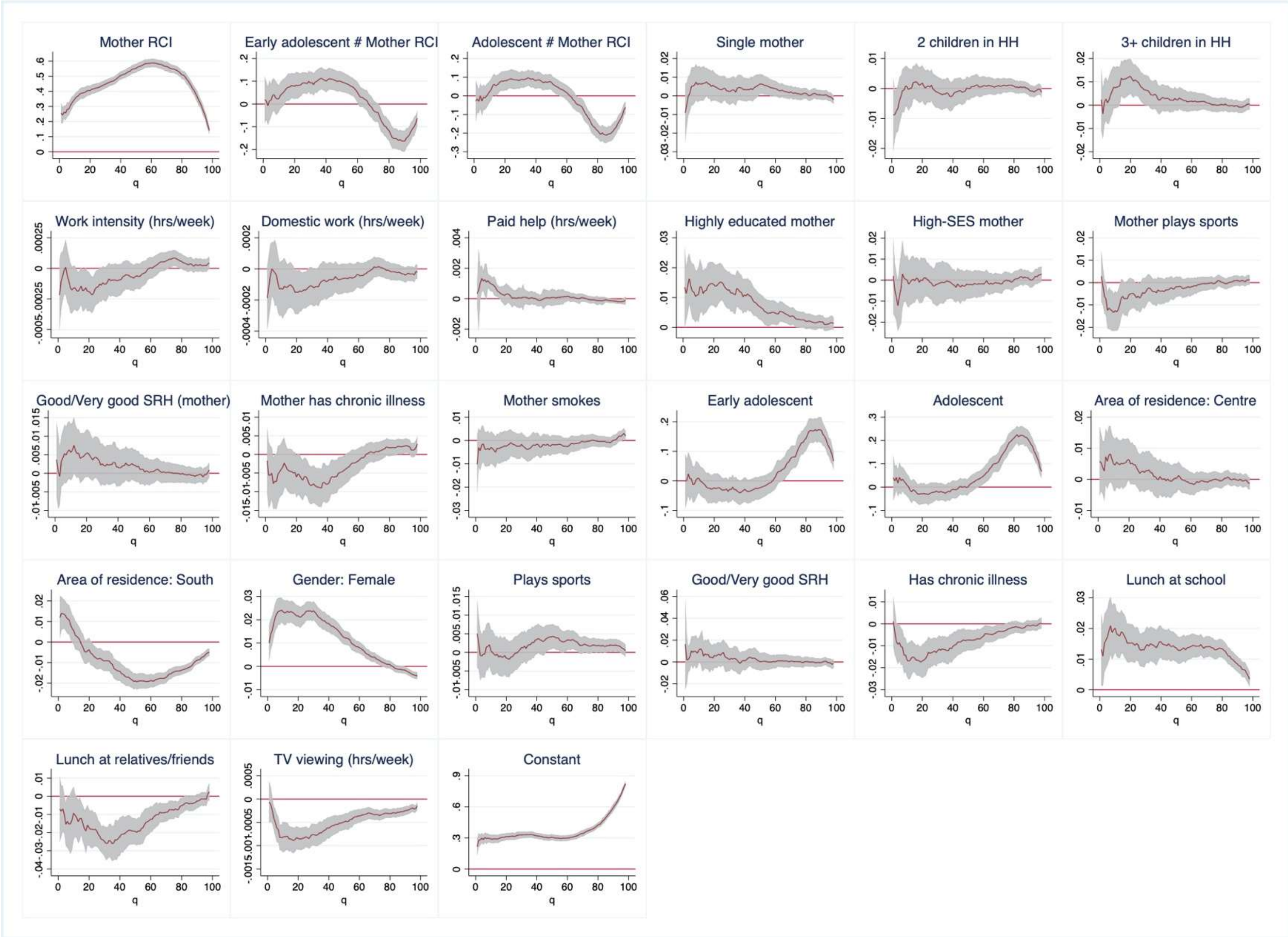

Fig 6 Model estimates of the child RCI conditional distribution controlling for maternal lifestyle (point estimates for 99 quantiles with 95% CIs)

Notes: Point estimates for the Year of the survey are not graphically shown. Source: Our elaborations on Istat/INRAN-CREA data

Figure 7

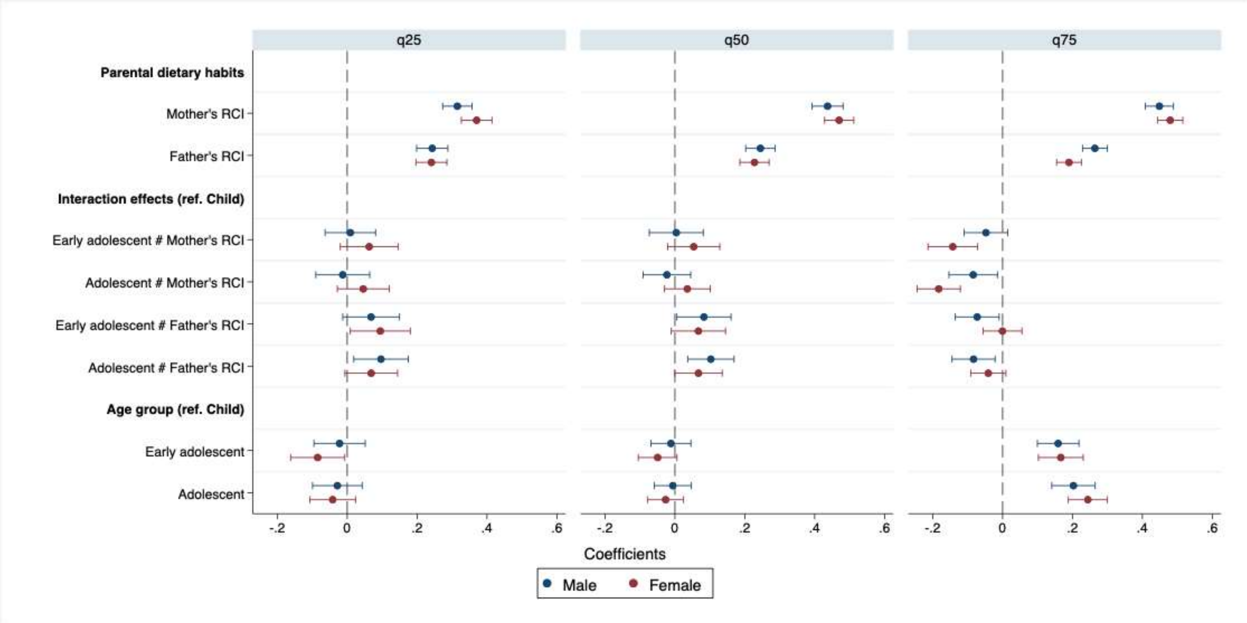

Fig 7 Model estimates of the child RCI conditional distribution at representative quantiles, male vs. female sub-samples (point estimates with 95% CIs)

Notes: All other coefficients estimated although not graphically shown. Source: Our elaborations on Istat/INRAN-CREA data.