Investigating the relationship between family environments and children's adoption of obesity-related behaviours in Italy

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Abstract

This study investigates the association between family-environment and children's adoption of four obesity-related behaviours: regular physical activity, adequate fruit and vegetable (FV) consumption, having an adequate breakfast and daily snack consumption. We perform a cross-sectional analysis using a nationally representative sample of Italian households with children (45,333 children from 30,228 households) collected by ISTAT over the period 2013-2023. Two sets of logit models are estimated to investigate the relationship between children's adoption of the four behaviours under analysis and household characteristics (household models), as well as paternal and maternal habits (parental models). Our results show a statistically significant correlation exists between the adoption of obesity-related behaviours in adults and children within the same household. Moreover, this relationship is found to be stronger for relatively unhealthy behaviours (e.g., snacking) than for healthy ones (e.g., FV consumption) and when maternal behaviour is accounted for.

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Short title: Children's obesity-related behaviours and family environments.

Keywords: Children; Obesity-related behaviours; Family environment; Parental model

JEL codes: I120; Q18; D1

This article has been accepted for publication and undergone full peer review but has not been through the copyediting, typesetting, pagination and proofreading process, which may lead to differences between this version and the Version of Record.

Please cite this article as:

Borgia et al., (*in press*) Investigating the relationship between family environments and children's adoption of obesity-related behaviours in Italy. *Bio-based and Applied Economics*, *Just Accepted*. DOI: 10.36253/bae-18178

1. Introduction

Although Italy has the lowest percentage of adults with obesity in Europe (Eurostat, 2022), childhood overweight and obesity rates are among the highest among the European Union (EU) Member States. In detail, 39% of boys and 29% of girls in Italy are overweight, compared to the European average of 36% and 23%, respectively (WHO, 2025). Childhood obesity leads to a higher risk of poor health during adolescence and adulthood (Rolland-Cachera et al., 2006; Stettler et al., 2002) and lifelong health problems, such as cardiovascular diseases, diabetes, and hypertension (MacMahon et al., 2009; Park et al., 2012; Pulgarón, 2013; Rankin et al., 2016). Further, childhood obesity can increase the likelihood of experiencing behavioural and emotional difficulties, sometimes leading to stigmatization, poor socialization, and reduced educational attainment (Cunningham et al., 2014; Pulgarón, 2013; WHO, 2017). Therefore, understanding the key determinants of childhood overweight and obesity is crucial for the development of effective measures to contain one of today's most urgent public health challenges (Lobstein et al., 2004).

Maintaining a correct balance between energy intake and energy expenditure is at the basis of body weight regulation (Lustig, 2001). Indeed, scientific literature suggests that children engaging in less physical activity (PA) (Andersen et al., 1998, Hernández et al., 1999) are more likely to be overweight and obese (Janssen, 2007). On the other hand, children with a high energy intake and poor diet quality – e.g., low fruit and vegetable consumption (Arcan et al., 2007; Pearson et al., 2009), breakfast skipping (Hallström et al., 2013) and high snack consumption

(Jahns et al., 2001) – are at greater risk of becoming obese and overweight. Therefore, identifying the drivers of such obesity-related behaviours is crucial for designing public health measures aimed at mitigating their adoption.

An informative approach to understanding the mechanisms behind obesity-related habits during childhood is the analysis of children's environments. According to the *ANalysis Grid for Environments Linked to Obesity* (ANGELO) framework developed by Swinburn et al. (1999) and Ferreira et al. (2006) such environments can be primarily categorized in two classes: micro-environments (e.g., family/household, school, workplace, neighbourhood, etc.) and macro-environments (e.g., city/municipality/region, infrastructures, healthcare system, etc.). Each environment can be further classified in four types: physical, socio-cultural, economic, and political. Some previous research has explored how the broader school environment can shape children's eating habits and dietary behaviours (Castellari & Berning, 2016; Castellari et al., 2018; Sogari et al., 2024; Vitali et al., 2023). The present paper specifically focuses on the family micro-environment, since its influence on childhood behaviour adoption is widely recognized in previous scientific studies (Cerroni et al., 2019; Pickard et al., 2024; Wang et al., 2011; Maestri & Macchioni, 2021). Moreover, several studies show that, within the above-mentioned environments, socio-economic status (SES) and the modelling role played by parents are the most frequent aspects investigated within familial settings (Beydoun and Wang, 2009; Ferreira et al., 2006). However, to the best of our knowledge, the individual and combined relevance of the two parents' habits with these behaviours have not been deeply investigated (Ferreira et al., 2006; Goldman et al., 2012; Wang et al., 2011). The observation of only one parent at a time can hide some behavioural interactions and be a potential source of miscomprehension of such familial dynamics (Hart et al., 2010; Kueppers et al., 2018; Ng et al., 2025).

This study extends the existing literature on childhood overweight/obesity and health-related behaviours in several important ways. While previous research has consistently documented the association between family environments and children's health outcomes (Pickard

et al., 2024; Wang et al., 2011), much of the evidence has focused on obesity prevalence or body mass index (BMI) as outcome measures, rather than on the specific behavioural pathways through which obesity risk is transmitted across generations. This study provides a more nuanced understanding of the mechanisms linking family environments to children's obesity risk by examining four key obesity-related behaviours, namely: regular practice of physical activity (PA-practice), adequate fruit and vegetables consumption (FV-consumption) (Arcan et al., 2007; Pearson et al., 2009), having breakfast (Breakfast-consumption), and daily consumption of savoury snacks (Snacks-consumption) (Jahns et al., 2001). Furthermore, much of the existing literature relies on relatively small samples, regional populations, or data from single countries and time periods, limiting the generalisability of findings. Using a large, nationally representative sample of Italian households collected over the period 2013–2023, this paper offers robust and up-to-date evidence on children's health behaviours in Italy. The large sample size (45,333 children belonging to 30,228 households) also enables a more detailed investigation of behavioural patterns within households. To the best of our knowledge, results of the Italian *Multipurpose Survey on Households Daily Life Aspects* (MHDLA) (ISTAT, 2018, 2021) have not been employed before to investigate the mechanisms behind the adoption of obesity-related habits among children. While prior studies have frequently focused on parental influences as a whole or have primarily examined maternal effects (Hart et al., 2010; Kueppers et al., 2018; Ng et al., 2025), this paper contributes to the growing literature on intergenerational transmission of health behaviours by separately analysing maternal and paternal habits, providing further insight into the gendered dimensions of health behaviour transmission within families. Finally, the study contributes novel evidence by demonstrating that parent-child associations are stronger for unhealthy behaviours, such as snack consumption, than for healthy behaviours, such as fruit and vegetable intake. This finding suggests that the transmission of health behaviours within families may be asymmetric, a dimension that has received limited attention in previous research. By highlighting differences in the

intergenerational transmission of healthy and unhealthy behaviours, the study offers important implications for the design of family-based interventions aimed at preventing childhood obesity.

The rest of the paper is organized as follows: section 2 illustrates materials and methods, section 3 and 4 describe the key results of the analysis, section 5 concludes.

2. Materials and methods

2.1. Sample selection

The study is performed using secondary data from the MHDLA conducted by ISTAT (2018, 2021). The survey annually covers a large sample of Italian households (about 50,000 individuals from 20,000 households every year) and collects individual self-reported information on several aspects of daily life and behaviours, including food consumption patterns and other health-related behaviours. We combine eleven years (2013-2023) of MHDLA data in a unique repeated cross-sectional dataset. Only households with children and both parents are considered, resulting in a final dataset of 45,333 children and 30,228 households, with children being identified as individuals younger than 18.

2.2. Variables and measures

As diet and physical activity are recognized as key factors in affecting the risk of developing overweight and obesity since early childhood (Lustig, 2001), we develop four key indicators of obesity-related behaviours in children using secondary data collected from the MHDLA survey (ISTAT, 2018, 2021). In doing so, we contrast two sets of behaviours based on their potential effect on childhood obesity risk. The first one includes relatively healthy behaviours that may reduce obesity risk, namely PA-practice, Breakfast-consumption and FV-consumption,

while the second one captures a potentially obesogenic behaviour, that is, Snacks-consumption (Lustig, 2001)[1].

Based on the MHDLA survey, each of these behaviours is captured by a binary variable. *PA-practice* takes the value of 1 for respondents who report regularly practising one or more sports throughout the year, and 0 otherwise. *FV-consumption* is constructed using information on the daily number of portions of fruit and vegetables consumed and takes the value of 1 for respondents consuming at least five portions per day, in line with nutritional guidelines (CREA, 2019), and 0 otherwise. *Breakfast-consumption* takes the value of 1 for respondents who report consuming a complete breakfast, while it equals 0 for those who skip breakfast or only drink coffee or tea without eating any food. Finally, *Snacks-consumption* takes the value of 1 for respondents who consume savoury snacks, such as potato chips or popcorn, at least once a day, and 0 for those consuming them less frequently. A detailed description of variable definitions and the original MHDLA questions used to construct them is reported in Supplementary Materials, Section A.

2.3. Statistical analysis

To explore the relationship between the adoption of obesity-related behaviours by adults and children within the same household, we estimate two sets of logit models, namely *household models* and *parental models* (Cramer, 2003). The first set of models – *household models* – investigates the association between the adoption of obesity-related behaviours by children and overall household characteristics. The second set of models – *parental models* – evaluates separately the relationship between the adoption of obesity-related behaviours by children and by their mothers and fathers, respectively.

[1] These four habits have been selected considering their widely recognised relevance in scientific literature in affecting the likelihood of incurring overweight and obesity, especially among children (Jahns et al., 2001, Arcan et al., 2007; Pearson et al., 2009, Hallström et al., 2013). Indeed, observing the consumption of other food items, as eggs, meat, and dairy products, would have turned the interpretation of the results less univocal against the scope of this study. Other obesity-related behaviours as smoking and alcohol consumption, are not suitable for a children-centred study.

More specifically, the *household models* study the association between presence of the identified children's behaviours and the characteristics of the household from a socio-economic, health (i.e., presence of adults with overweight/obesity) and behavioural perspective. Considering the scientific literature on the role of the family socio-economic status (SES) in influencing children's dietary behaviours (Fernández-Alvira et al., 2015; Hallström et al., 2012), the following variables are employed as socio-economic proxies: level of education (*Education*) and employment (*Employment*) of the head of the household; number of children living in the household (*Children number*); and geographical area of residence (*Geographical*). To capture the health status of the household's components, we include the presence of adults with overweight/obesity within the family nucleus as a regressor (Lauria et al., 2015) (*Overweight/obese*). Moreover, a specific variable indicating the adoption of the investigated obesity-related behaviour at the household level is also accounted for (*Adults' behaviour*). Lastly, in line with previous literature (e.g., O'Loughlin et al., (1999), Story et al. (2002), and Videon & Manning (2003)), children's characteristics such as age (*Age*) and gender (*Gender*) are included as regressors, together with dummy variables accounting for the survey year (*Year*).

The *parental models* also account for the parental relationship in explaining childhood obesity/overweight. In these models, for each of the two parents – father and mother – we control for the level of education (*Father education; Mother education*), employment (*Father employment; Mother employment*), and weight status (*Father with overweight/obesity; Mother with overweight/obesity*), as well as the adoption of the four targeted behaviours (*Father behaviour; Mother behaviour*). The rest of the control variables are unchanged with respect to the *household models*. The summary statistics of the key variables used in this analysis are reported in the Supplementary Materials, section B (Table S2-S4).

Given the dichotomous nature of the dependent variables of these models, we estimate the relationship between children's adoption of each of the four obesity-related behaviours of interest and household level (*household models)* and parental (*parental models*) engagement in these

behaviours through a multivariate logistic regression approach (Cramer, 2003). The probability of each child *i* adopting a certain obesity-related behaviour *j* ($y_i \neq 0$) given all the explanatory variables included in the *Household* and in the *Parental models,* X_i's, can be expressed as follows:

$$P(y_i \neq 0|\mathrm{X_i}) = \frac{\exp(X_i\beta)}{1+\exp(X_i\beta)} \quad (1)$$

where $\beta's$ are the estimated coefficients of interest (Pindyck and Rubinfeld, 1998).

3. Household and parental models' estimation results

Tables 1 and 2 report the estimated marginal effects from the logistic regression of the *household* and *parental models*. The estimated coefficients from the corresponding logistic regressions are reported in the Supplementary Materials, Section C (Table S5 and Table S6). Sections 3.1, 3.2 and 3.3 illustrate the key findings of the current analysis focusing on the association between obesity-related behaviours and children's and household characteristics (sections 3.1 and 3.2, respectively), as well as adults' behaviours (section 3.3) referring to the results of both the *household* (Table 1) and the *parental* model (Table 2).

Table 1 *Household models:* Discrete marginal effect of the explanatory variables expressed as absolute percentage change (n=45,333)

Variables (Reference class in brackets)	**Classes**	**Investigated children's behaviours**			
		Breakfast-consumption	*PA-practice*	*Snacks-consumption*	*FV-consumption*
Age (3 - 5 y)	6 - 10 y	-0.55	36.62***	3.63***	0.69***
	11 - 13 y	-8.39***	39.09***	6.40***	0.95***
	14 - 17 y	-13.90***	30.41***	5.50***	1.99***
Gender (Male)	Female	-3.09***	-7.70***	-0.89***	0.38**
Overweight/obese (No one)	At least one	-0.16	-0.89*	1.37***	-0.34**
	All	-1.17**	-2.43***	1.43***	-0.33*
Education (Elementary school license or lower)	Secondary school license	-2.01**	11.47***	-1.33*	-0.63
	High school diploma	-1.04	19.52***	-4.33***	-0.50
	University degree or higher	1.17	27.11***	-8.39***	0.27
Employment (Unemployed)	Employed	0.80*	6.23***	-1.19***	0.23
Geographical (Northern Italy)	Central Italy	-0.61	0.49	-1.28***	-0.23
	Southern Italy and Isles	-1.86***	-11.93***	3.22***	-1.58***
Children number (1)	2	0.28	-0.65	0.36	-0.13
	3 or more	0.09	-7.68***	1.11***	0.36
Adults' behaviour (No one)	At least one	9.08***	14.96***	16.59***	4.98***
	All	17.41***	25.37***	28.72***	8.67***
Goodness of fit statistics					
Pseudo R^2		0.073	0.153	0.084	0.143
Likelihood χ^2 ratio test p-value		0.000	0.000	0.000	0.000

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

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Table 2 *Parental models:* Discrete marginal effect of the explanatory variables expressed as absolute percentage change (n=45,333)

Variables (Reference class in brackets)	**Classes**	**Investigated children's behaviours**			
		Breakfast-consumption	*PA-practice*	*Snacks-consumption*	*FV-consumption*
Age (3 - 5 y)	6 - 10 y	-0.47	36.55***	3.58***	0.71***
	11 - 13 y	-8.26***	39.25***	6.26***	0.99***
	14 - 17 y	-13.75***	30.85***	5.24***	2.04***
Gender (Male)	Female	-3.12***	-7.80***	-0.88***	0.37**
Father with overweight/obesity (No)	Yes	0.34	-0.15	0.80**	-0.15
Mother with overweight/obesity (No)	Yes	-1.63***	-1.56***	0.38	-0.20
Father education (Elementary school license or lower)	Secondary school license	-0.67	6.91***	-0.99	-0.77
	High school diploma	0.41	10.85***	-2.56***	-0.71
	University degree or higher	1.85	14.01***	-4.89***	-0.52
Mother education (Elementary school license or lower)	Secondary school license	-2.99***	4.52	-0.31	0.46
	High school diploma	-3.25**	11.88***	-2.64***	0.40
	University degree or higher	-1.67	16.82***	-5.59***	1.27**
Father employment (Unemployed**)**	Employed	1.13**	5.37***	-0.65	0.40
Mother employment (Unemployed)	Employed	-1.19***	6.27***	-0.86***	0.04
Geographical (Northern Italy)	Central Italy	-0.66	0.74	-1.37***	-0.25
	Southern Italy and Isles	-2.19***	-10.13***	2.85***	-1.57***
Children number (1)	2	0.19	-0.98*	0.52	-0.15
	3 or more	-0.13	-7.03***	0.97**	0.34
Father behaviour (Not present)	Present	6.68***	10.81***	13.20***	3.88***
Mother behaviour (Not present)	Present	10.80***	14.85***	17.61***	4.96***
Goodness of fit statistics					
Pseudo R^2		0.075	0.164	0.088	0.144
Likelihood χ^2 ratio test pvalue		0.000	0.000	0.000	0.000

*** p < 0.01; ** p < 0.05; * p < 0.1.

3.1. Associations between obesity-related behaviours and children's characteristics

Age

Our results show the likelihood of incurring obesity-related behaviours generally increases with children's age. Children aged 11-13 years have lower probability of Breakfast-consumption and are more likely to have daily Snacks-consumption compared to children aged 6-10 years. Our findings also suggest that children increase PA-practice starting from the age of 5, while this habit reduces from the age of 14 (Table 1 and Table 2). In contrast, FV-consumption is positively associated with age. Furthermore, children aged 14–17-year-olds are 13.9% less likely to have adequate Breakfast-consumption than 3–5-year-old children. However, comparing the same age classes, the likelihood of Snack-consumption or FV-consumption increases by 5.5%, and by 1.99%, respectively.

Gender

Our results also show the existence of gender differences regarding the presence of obesity-related behaviours among children. Females are less likely to have an adequate Breakfast-consumption and regular PA-practice. On the other hand, females show higher FV-consumption and lower occurrence of daily Snacks-consumption (Table 1 and Table 2).

3.2. Associations between obesity-related behaviours and household characteristics

Geographical area of residence

Children from southern Italy and Italian isles are more at risk of adopting obesity-related behaviours than those living in Northern Italy. This tendency is particularly pronounced for low PA-practice and high Snacks-consumption, while it is less evident for low FV-consumption (Tables 1 and 2).

Number of children in the household

The number of children in the household is not related to the probability of Breakfast- and FV-consumption, though its relationship with Snacks-consumption is slightly positive. Conversely, the probability of PA-practice seems to be negatively associated with the number of children in the household, although this relationship is only statistically significant for households with three or more children (Table 1 and 2).

3.3. Associations between obesity-related behaviours and adults/parents' characteristics

Weight status

Overall, our results show that children living in households with adults who are affected by overweight/obesity are more likely to engage in obesity-related behaviours (Table 1). Focusing on the results from the *parental models'*, we find that children with a mother with overweight/obesity are less likely to regularly engage in PA-practice or adequate Breakfast-consumption but are slightly more prone to Snacks-consumption in the case of a father experiencing overweight/obesity (Table 2).

Educational level

We find that the educational level of the head of household is negatively associated with the adoption of Snacks-consumption among children, while the opposite is true for the probability of children practicing PA regularly (Table 1). Results from the *parental models* are similar: higher parental education is associated with a higher probability of children engaging in regular PA-practice and a lower probability of Snacks-consumption, although this effect is not always statistically significant (Table 5). Only mother's educational attainment is positively related with children's likelihood of FV-consumption, while negatively related with children's Breakfast-consumption.

248 *Employment*

249 Children are less likely to engage in obesity-related behaviours when the household head
250 is employed, except for FV-consumption, for which no significant association is found (Table 1).
251 The correlation between employment and children's Breakfast-consumption is weak, while it is
252 more marked for regular PA-practice and Snacks-consumption.

253 Results also show that the relationship between parental employment and children's
254 behaviour differs by parent's gender (Table 2). The presence of a working father in the household
255 is positively associated with the probability of children's Breakfast-consumption, while maternal
256 employment shows the opposite association. We also find strong association between parental
257 employment and children PA-practice, with a stronger link observed for mothers' employment
258 status. Lastly, only maternal employment appears to be negatively associated with Snacks-
259 consumption, while FV-consumption is not significantly associated by parental employment.

260

261 *Adult behaviours*

262 As shown in Table 1, a positive correlation exists between children's and adults' adoption
263 of the four investigated behaviours, with this relationship being the strongest when both parents
264 engage in the same obesity-related behaviour. For instance, children living in a household where
265 only one parent engages in daily snacking are 16.59% more likely to engage in the same behaviour
266 than peers living in a family where neither adult exhibits this behaviour. This probability increases
267 up to 28.72% when we look at families in which both parents engage in daily Snacks-consumption.
268 We also find that the correlation between children's and adults' behaviours is the strongest for
269 Snacks-consumption (i.e., larger marginal effect), followed by PA-practice and Breakfast-
270 consumption, and the weakest for FV-consumption (Table 1). This pattern is also confirmed by
271 the results of the *parental models* where fathers' and mothers' behaviours are considered
272 separately (Table 2).

Table 3 reports the results of the test used to investigate whether the estimated marginal effects associated with the four investigated behaviours differ significantly between the two parents in the *parental models*. Results show that differences between the estimated mothers' and fathers' marginal effects are positive and statistically significant for the four targeted behaviours, meaning that a higher correlation exists between mothers and children in their behaviour than with fathers. For instance, children are 4.12% more likely to consume breakfast regularly when their mothers do so, than when their fathers' behaviour is considered. A similar result is found for PA practice (4.04%) and snack consumption (4.41%). On the other hand, this difference is milder when focusing on FV consumption (1.1%). This may imply that mothers have a stronger influence than fathers on children's adoption of the investigated behaviours.

Table 3 Differences between the estimated parental marginal effects for the four investigated behaviours [a]

	Coefficient	Standard Error	P-value
Breakfast-consumption	4.12***	0.59	0.000
PA-practice	4.04***	0.88	0.000
Snacks-consumption	4.41***	0.89	0.000
FV-consumption	1.08***	0.32	0.001

[a] Difference between the estimated mothers' and fathers' marginal effects. ***, **, * indicates statistically significance at 1%, 5% and 10% confidence level respectively.

4. Discussion

The present study confirms that the prevalence of obesity-related habits among Italian children is rather alarming. According to our sample, only a small portion of children consume the recommended portions of FV daily (2.92%), and barely half of the sample regularly practice PA (53.11%). Furthermore, not having an adequate breakfast and consuming snacks every day are relatively common habits (17.77% and 12.35%, respectively) (Table S4). This picture is largely in line with the findings of the main reports on the nutritional status of Italian children (Cavallo et al., 2016; Lauria et al., 2019; Nardone et al., 2018, 2022; Prandini, 2021).

More specifically, our results indicate that the age of children is associated with a higher adoption of obesity-related behaviours, except for FV-consumption. This result is consistent with the 4th Italian report from the Health Behaviour in School-aged Children (HBSC) study (Cavallo et al., 2016), which showed that the percentage of Italian children skipping breakfast in school days increased from 18.8 at the age of 11 to 30.1 at the age of 15, while the percentage of breakfast eaters fell from 63.6 to 53.6, respectively. Moreover, the findings from the 2017/2018 HBSC survey (Inchley et al., 2020) also showed an increase in daily consumption of sweets and chocolate among Italian children, ranging from 27% at the age of 11 to 31% at the age of 13. Lastly, both the above-mentioned reports observed an age-related fall in PA-practice, with a decline starting from the age of 13 years[2]. The increasing adoption of obesity-related behaviours with age may be related to the different educational stages of Italian children. At the beginning of junior high school (in Italy at age 11), children usually seek more autonomy and independence (Neumark-Sztainer et al., 1999; Story et al., 2002; Videon and Manning, 2003). This desire may have implications on their food choices, resulting, for instance, in higher snack consumption that may have been previously limited by stronger parental surveillance. The beginning of senior high school (at the age of 14), instead, usually implies more time constraints in children's lifestyle. Less time available in the morning might result in a higher risk of not having an adequate breakfast, while less time available in the afternoon implies limited opportunities for PA-practice. In addition, O'Loughlin et al. (1999), Edwards et al. 2015), Farooq et al. (2018) and Marquet et al. (2018) hypothesized that the availability, accessibility, and appeal of free playground activities decline with age. On the other hand, our findings show that FV-consumption is positively related with children's age. This result is consistent with the HBSC study reporting a similar age-related increase in FV consumption among Italian children. Moreover, in line with the HBSC study, we find that the likelihood of Breakfast-consumption decreases to a higher extent with age than FV-

[2] Differently from MHDLA, the HBSC sample (around 65.000 children) includes only 11-, 13- and 15-year-old students attending public schools.

316 consumption. One explanation for these findings could be that unhealthy habits are easier to adopt
317 than healthy ones (Dolgopolova et al., 2022; Kachwaha et al., 2024; Swinburn et al., 2011).

318 In line with the findings from the Italian national surveillance system (Lauria et al., 2015),
319 our results show that females are less likely to have an adequate breakfast-consumption and engage
320 in regular PA-practice[3]. These results are in line with previous studies showing that a gender gap
321 exists regarding physical activity, with females tending to be less physically active than males both
322 in childhood and adulthood. Moreover, our results confirm the existence of a North-South gap in
323 terms of obesity-related behaviours: children from the South of Italy and Italian Isles are more at
324 risk of irregular PA-practice, inadequate FV-consumption and daily Snacks-consumption
325 compared to peers from the north or the centre of Italy (Lauria et al., 2015).

326 As in Fogelholm et al. (1999), the results of the *parental models* also show that the presence
327 of overweight mothers is highly correlated with the uptake of obesity-related behaviours among
328 children, in line with our observations on regular PA practice. In accordance with our findings,
329 Lauria et al. (2015) reported that Italian children aged 8-9 years old with a mother with
330 overweight/obesity were more inclined to skip breakfast and to practice less PA, while the
331 mother's weight status is not correlated with children's FV-consumption (Lauria et al., 2015).

332 Our results also suggest that the level of education of the household head is positively
333 associated with regular PA-practice and lower Snacks-consumption. Moreover, measuring the
334 correlation of each parents' characteristics on children's behaviour (i.e., *parental models*) allows
335 us to also appreciate that children's FV-consumption is significantly associated only with maternal
336 education – as also observed by Nardone et al. (2018), Lauria et al. (2015) and Hanson and Chen
337 (2007).

338 This analysis also finds significant correlation between adults' employment status and
339 children's adoption of obesity-related habits. Specifically, the employment status of the household

[3] Lauria et al. (2015) refers to a sample (n=46.300) of 8-9-years-old children.

heads is associated with lower presence of children's obesity-related habits. Some key differences emerge when differentiating between parents' employment status. For instance, the likelihood of children's adequate Breakfast-consumption is positively associated with paternal employment. This might reflect the effect of higher familial SES and, hence, greater affordability of healthier dietary choices (Fernández-Alvira et al., 2015). On the other hand, the negative association between Breakfast-consumption and maternal employment may be explained by working mothers having less time to take care of children's breakfast in the morning, a role that tends to be gendered (Lauria et al., 2015). For the other investigated behaviours, the role of parental employment moves in the same direction with different intensity. For example, we find stronger association between children PA-practice and maternal rather than paternal employment. This result may suggest that maternal employment triggers a greater leap in the familial SES, resulting in a more evident adoption of this behaviour by children (O'Loughlin et al., 1999).

In line with O'Loughlin et al. (1999) and Goldman et al. (2012), our analysis confirms adults' household habits are significantly associated with children's adoption of obesity-related behaviours, with mothers and fathers exhibiting different degrees of modelling influence. In detail, children's daily Snacks-consumption is the habit most related to parents' behaviour, while the weakest relationship is found with the adequacy of FV-consumption. Moreover, in line with Vereecken et al. (2004) that found children with a daily-snacking mother were more at risk of adopting the same habit, our results show a higher likelihood of children's Snacks-consumption when this habit is also exhibited by mothers. We also find a stronger correlation between children's habits and those of mothers compared with fathers with respect to positive behaviours namely, PA-practice, Breakfast- and FV-consumption. Similar results were also reported in Fogelholm et al. (1999) and other studies showing that children's overweight and obesity issues are more strongly associated with maternal than paternal weight (Whitaker et al., 2010). In agreement with Goldman et al. (2012) and Vereecken et al. (2004), we also find a positive association between parental and children FV-consumption, with the mother-child association being stronger than the

366 father's one. Furthermore, the parental daily consumption of FV is the habit with the weakest
367 marginal effect on children's behaviours. However, it is also important to point out that FV-
368 consumption is the least adopted behaviour in our sample (2.92% of children, 3.51% of fathers
369 and 5.44% of mothers). Therefore, the low emulation of this behaviour by children may reflect a
370 more general difficulty of adopting it. Other unhealthy behaviours, such as daily Snacks-
371 consumption, instead, tend to be more easily imitated, evidenced by the stronger correlation found
372 in the analysis. A possible interpretation might be that the influence that parents play as models is
373 stronger on unhealthy behaviours than on healthy ones. Vereecken et al. (2004) reported a similar
374 finding in their study: the likelihood of children imitating maternal behaviour was higher for the
375 consumption of soft drinks than for the FV-consumption. A similar dynamic was also reported by
376 Fogelholm et al. (1999) who found that the probability of children's practicing of PA is more
377 influenced by parental inactivity rather than activity.
378
379 **5. Conclusions, limitations, and further developments**
380 This study explores the interconnection between children's and adults' adoption of obesity-
381 related behaviours. In line with previous literature (Cavallo et al., 2016; Steinbeck, 2001), the
382 modelling role of mothers being stronger than fathers suggests the importance of engaging mothers
383 in health promotion interventions. Furthermore, we find a strong correlation between parental
384 behaviours and children's Snacks-consumption, suggesting strong interconnections among family
385 members in the adoption of unhealthy behaviours and highlighting the importance of extending
386 interventions to other contexts, such as schools.
387 Based on the results of this analysis, indications can be drawn about children's age groups
388 who are more at risk of adopting specific obesity-related behaviours, therefore suggesting at which
389 educational stage these habits should be addressed as a priority. In details, we find that Italian
390 children in junior secondary school (age 11-13 years) are more inclined to increase the
391 consumption of snacks, while in senior high school (age 14-17 years) they tend to reduce the PA

practice of PA. The consumption of an adequate breakfast, instead, appears to decrease over time from elementary to high school.

Our study also identifies priority targets of intervention regarding children's gender, indicating that girls are at higher risk of inadequate breakfast consumption and low PA, while boys have a higher risk of Snack and low FV consumption. Furthermore, our results show a higher presence of obesity-related behaviours among children from larger families, with low-educated and/or unemployed adults, thus reinforcing the recommendation of promoting healthy habits also in extra-familial environments, which are less influenced by the household SES. Indeed, the results of this analysis confirm the importance of strengthening impactful initiatives such as "*Okkio alla Salute"*, which promotes physical activity and healthy diets within the school setting (Nardone et al., 2018), as well as the *EU School Schemes,* which allocates resources from the Common Agricultural Policy to support the distribution of milk, fruit and vegetables to children from nurseries to secondary schools (European Commission, 2020). In accordance with previous studies (Cavallo et al., 2016; Lauria et al., 2019; Nardone et al., 2018), this study also highlights the importance of prioritizing the South of Italy and Italian Isles in the implementation of health promotion policies among children. In these territories, as well as in the rest of Italy, it would be crucial to leverage health promotion initiatives implemented at local level, including those financed by targeted community funding opportunities such as the LEADER approach (*Liaison Entre Actions de Développement de l'Economie Rurale*), supporting the development of school canteens fed by shorter food supply chains and promoting vegetable gardens at schools (European Commission, 2006).

An important strength of this research is the employment of a large secondary dataset, including 45,333 children belonging to 30,228 households and eleven years of observations from the Italian MHDLA (ISTAT, 2018, 2021). To the best of our knowledge, this secondary data source has never been employed before to investigate children's adoption of obesity-related behaviours. This study therefore contributes to the literature by shedding lights on the mechanism

underlying the adoption of obesity-related habits among children, with a specific focus on the familial environment.

Nevertheless, this study has some limitations, mostly related to the nature of the dataset. First, the Italian MHDLA is based on self-reported measures and, therefore, respondents' answers may be affected by their comprehension, memory and by social desirability (Hebert et al., 1995). Moreover, it is possible that parents complete the survey on behalf of their children. Then, for privacy reasons, information related to child's weight status is omitted, limiting our ability to investigate the association between family environment and childhood obesity and overweight. It should also be recognised that, although unlikely, there is no formal rule preventing the re-selection of the same household across years (ISTAT 2018, 2021). Lastly, the use of a secondary dataset limited our ability to include some variables relevant to this study, such as those addressing the parental role in household/childcare tasks or family income. We therefore rely on the most suitable variables available in the MHDLA data, which are recognized in the literature as valid proxies for these variables, such as the employment status and level of education.

Many aspects of this analysis warrant further investigation. Future studies could examine how habits within a household are formed and transferred to children, considering the interdependence of behaviours. A deeper understanding of household behavioural interactions could provide useful insights for the design of public policies targeting the family environment. As suggested by O'Loughlin et al. (1999), the potential gender-specific modelling role of parents regarding children's obesity-related behaviours deserves further investigation. Moreover, widening the range of investigated habits might enable to generalize the hypothesized dynamics regarding the contrast between healthy and unhealthy behaviours. Future research could further explore the role of the primary caregiver responsible for household and childcare tasks, as well as the co-occurrence of the investigated behaviours, rather than investigating them individually as in the current analysis.

Acknowledgements

This work was partially supported by the Doctoral School in Agri-food System (Agrisystem) of Università Cattolica del Sacro Cuore (Italy).

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Acknowledgements: This work was partially supported by the Doctoral School in Agri-food System (Agrisystem) of Università Cattolica del Sacro Cuore (Italy).

Financial Support: This study was supported by the PhD in Agro-Food System (Agrisystem) of the Università Cattolica del Sacro Cuore (Italy).

Conflict of Interest: None.

Authorship: Riccardo Borgia: Conceptualization, Methodology, Formal analysis, Writing – Original draft; Giulia Tiboldo: Data curation, Formal analysis, Supervision, Writing - Review & Editing; Elena Castellari: Conceptualization, Methodology, Supervision, Writing – Review & Editing.

Ethical Standards Disclosure: This study analyses secondary data and thus obtaining ethical approval is not needed. Data employed in the study are publicly available in the dedicated section of the ISTAT website: https://www.istat.it/en/archive/129934.

Data availability statement: The original data used in this study are publicly available from the Italian National Institute of Statistics (Istat) through the dataset "Aspetti della vita quotidiana: file per la ricerca" available at https://www.istat.it/microdati/multiscopo-sulle-famiglie-aspetti-della-vita-quotidiana/.