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ABSTRACT

Parental Beliefs about Returns to Child Health Investments*

Childhood obesity has adverse health and productivity consequences and poses negative externalities to health services. Its increase in recent decades can be traced back to unhealthy habits acquired in the household. We investigate whether parental beliefs play a role by eliciting beliefs about the returns to a recommended-calorie diet and regular exercise using hypothetical investment scenarios. We show that perceived returns are predictive of health investments and outcomes, and that less educated parents perceive the returns to health investments to be lower, thus contributing to the socioeconomic inequality in health outcomes and the intergenerational transmission of obesity.

JEL Classification: D19, I10, I12, I14

Keywords: parental investments, health, beliefs, inequality, equality of opportunity, obesity

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1 Introduction

124 million children around the world aged 5-19 are obese, more than ten times the number in 1975 (NCD Risk Factor Collaboration 2017; Ng et al. 2014). In relative terms, obesity rates among children increased from being less than 1% to nearly 8%.[1] In the UK, more than one-fifth of children in their first year of primary school are overweight or obese, and there is a strong inverse relationship between socioeconomic background and the prevalence of overweight and obesity (RCPCH 2017), raising concerns about the impact of socioeconomic inequality on future generations. Being overweight or obese poses both health and economic costs to the individual: on one side, obesity is the second leading cause of preventable death in the US (Mokdad et al. 2004) as it significantly increases the likelihood of suffering from type 2 diabetes, heart disease, and mental illnesses such as depression (e.g. Pischon et al. 2008; Abdullah et al. 2010; Go et al. 2014; Gatineau and Dent 2011; Rashad 2006); on the other side, it is associated with lower skills acquisition, lower wages, less attachment to the labor force, and declining productivity (e.g. Cawley 2010; Kline and Tobias 2008; Cawley and Meyerhoefer 2012). The costs to the economy are significant as well, with the UK government spending more each year on the treatment of obesity and diabetes than on the police, fire service, and judicial system combined (HM Government 2016).

This growth in obesity rates can be traced back to unhealthier diets and more sedentary lifestyles (Cutler, Glaeser and Shapiro 2003; Brunello, Michaud and Sanz-de Galdeano 2009; Swinburn, Sacks and Ravussin 2009; Lakdawalla, Philipson and Bhattacharya 2005; Lakdawalla and Philipson 2009; Griffith, Lluberas and Lührmann 2016).[2] Indeed, health investments such as a balanced diet and regular exercise have been linked to a lower risk of obesity, diabetes, and heart disease (Lewis et al. 1997; Singh et al. 2008*b*; Mozaffarian et al. 2011; Colberg et al. 2016; World Health Organization 2016; Hall et al. 2011), but also to improved psychological well-being (Akbaraly et al. 2009; Conner et al. 2017) and academic performance (World Health Organization 2016). In spite of these benefits, only 22% of children aged 5-15 surveyed as part of the 2015 Health Survey for England satisfied the guideline of being moderately active for at least 60 minutes per day. This pattern seems to persist into adulthood with 39% of UK adults failing to meet the government's recommendation of 150 minutes of moderate exercise and strength activities twice per week (British Heart Foundation 2017). Additionally, the UK

[1]The World Health Organization concludes that "most of the world's population live in countries where overweight and obesity kills more people than underweight" (World Health Organization January 2015).

[2]Looking at the UK from 1980 to 2013, Griffith, Lluberas and Lührmann (2016) actually find an overall *decrease* in calorie consumption, albeit punctuated by a shift towards restaurants, fast foods, soft drinks, and confectionary, and an increase in sedentary work and daily lifestyles.

government's National Diet and Nutrition Survey showed that the mean intake of saturated fatty acids, which increase the risk of heart disease, is above the recommendation of 11% of total food energy for both children and adults of all ages.

Such low prevalence of health behaviors raises the important question: what motivates diet and exercise choices during childhood? Weight and habits formed early in life persist into adulthood (World Health Organization 2016; Lytle et al. 2000; Mannino et al. 2004; Daniels et al. 2009; Singh et al. 2008*a*), which is why it is crucial to understand what drives health investments early in life.

In this paper, we explore the role of parental beliefs about the returns to health investments in children's diet and exercise choices, and we investigate whether parental beliefs differ across socioeconomic groups, thereby contributing to socioeconomic differences in health outcomes (Case, Lubotsky and Paxson 2002; Pickett and Wilkinson 2015; Cutler, Lleras-Muney and Vogl 2011; Denney, Krueger and Pampel 2014; Currie 2009). To investigate the role of beliefs in health investment decisions, it is not possible to rely on choice data alone as observed choices are consistent with many different combinations of beliefs and preferences (Manski 2004). To overcome this identification problem we obtain direct measures of individual beliefs about the returns to health investments by conducting a survey of parents in England. More specifically, we elicit parental beliefs about the returns to (i) following a recommended-calorie diet and (ii) exercising regularly, using hypothetical investment scenarios, a method which has been frequently used to elicit individual beliefs about the returns to educational or parental investments (e.g. Dominitz and Manski 1996; Jensen 2010; Cunha, Elo and Culhane 2013; Attanasio and Kaufmann 2014; Kaufmann 2014; Delavande and Zafar 2014; Boneva and Rauh forthcoming; Bhalotra et al. 2017). To the best of our knowledge, our study is the first to use this methodology to systematically measure individual beliefs about the returns to child health investments and to investigate how these beliefs relate to reported investment choices and health outcomes.[3]

Our analyses reveal three main findings which contribute to our understanding of what drives child health investments and socioeconomic differences in investments and outcomes. First, we document that parents on average perceive the returns to both types of health investments to be positive when it comes to a wide range of outcomes. For example, parents believe that the probability of being overweight at age 18 is reduced by 29 percentage points if children eat the daily recommended amount of calories rather than one-and-a-half times the daily recommended amount, and by 28 percentage points if children exercise for 60 minutes every day rather than not exercising at all. Interestingly,

[3] In a related paper, Bhalotra et al. 2017 investigate parental beliefs about the returns to maternal breastfeeding, but do not focus on child health investments or health outcomes.

parents on average believe that the exercise and diet routines of children aged 5-18 do not only affect outcomes at age 18 but also outcomes later in life (at age 65). Moreover, diet and exercise are perceived as substitutes rather than complements. Second, we document a substantial amount of heterogeneity in perceived returns and show that perceived returns are predictive of health investments and outcomes. Children of parents who perceive the returns to a low-calorie diet to be greater are 6.4 percentage points less likely to be overweight or obese; children whose parents perceive the returns to exercise to be higher report spending 28 more minutes on average in intensive exercise. Third, we find a strong socioeconomic gradient in perceived returns: more educated parents perceive the returns to health investments to be significantly greater. Given the socioeconomic gradient in perceived returns and the fact that they predict investments and outcomes, these results suggest that differences in perceived returns are likely to contribute to the inequality in health outcomes across socioeconomic groups.

Our work relates to three strands of the literature: first, it relates to the growing literature investigating the role of parental beliefs about the returns to *educational* investments in their children (e.g. Cunha, Elo and Culhane 2013, Boneva and Rauh forthcoming). In this paper we use a similar methodology but applied to parental beliefs about the return to health investments. Our study also elicits perceptions about how investments made during childhood influence outcomes later in life, i.e. at ages 18 and 65, rather than only during childhood or early adulthood. Second, our study relates to work which documents that health knowledge is positively associated with health outcomes (e.g. Kenkel 1991; Nayga 2000). In contrast to these studies which document individual knowledge about certain facts, we investigate how individuals perceive the *returns* to health investments, and how those beliefs are related to socioeconomic status and actual health investments and outcomes. Other related studies investigate how individual expectations about the impact of certain diseases such as HIV/AIDS on survival and perceptions about current health status influence health-related behaviors (e.g. Delavande and Kohler 2016). Third, our paper contributes to the literature which documents the intergenerational persistence of being overweight (e.g. Crossman, Sullivan and Benin 2006) by providing evidence for a potential channel through which overweight is transmitted across generations within families. We do so by specifically eliciting perceived returns and linking these to investments.

2 Eliciting parental beliefs

To elicit parental beliefs about the different partial and cross derivatives of the health production technology that are likely to be key in determining the levels of child health investments (see Appendix B), we elicit parental beliefs using hypothetical investment scenarios.[4] We build on the seminal work by Cunha, Elo and Culhane (2013), who propose the use of hypothetical investment scenarios to elicit parental beliefs about the returns to educational investments made in children.

Hypothetical Scenarios: We present parents with different hypothetical scenarios based on 100 hypothetical boys living in England, all of whom are 5 years old and of the same height and weight. These scenarios vary along two key dimensions: (i) the calorie intake of the children from ages 5-18, and (ii) the amount of exercise undertaken by the children per week from ages 5-18. For calorie intake, we consider two levels: a low-calorie 'healthy' amount (described as eating the "daily recommended amount of calories") and a high-calorie 'unhealthy' amount ("one-and-a-half times the daily recommended amount of calories").[5] Similarly for exercise, our 'healthy' level is 60 minutes of exercise every day, which corresponds to the daily amount of time recommended to children in this age group, while the 'unhealthy' level is 0 minutes of exercise.[6] In total, parents are thus presented with four hypothetical investment scenarios varying in calorie intake and exercise levels. These four scenarios are (1) unhealthy exercise and unhealthy diet, (2) unhealthy exercise and healthy diet, (3) healthy exercise and unhealthy diet, and (4) healthy exercise and healthy diet. For each scenario j, we are interested in five different outcomes (y_j^k), namely being overweight at age 18, suffering from depression at age 18, being alive at age 65, being overweight at age 65 (conditional on being alive), and having a heart disease at age 65 (conditional on being alive). To elicit perceived likelihoods, we ask parents to report how many of the 100 hypothetical boys presented in the scenarios they think will experience each outcome.[7] By comparing individual responses across different scenarios, we are able to obtain measures of parental beliefs about the returns to child health investments and the complementarity/substitutability of different inputs.

Initial health status: While all parents are presented with the four aforementioned scenarios, the initial health status of the child (indexed by weight at age 5) is randomized into two groups. The first group of parents are told that the 100 boys are of average height and weight for their age, while the second group are told that the 100 boys are overweight (but of average height) for their age. A

[4]The questionnaire can be found in the Appendix.

[5]The recommended number of calories for children varies by gender and age of the child. For further details, see Scientific Advisory Committee on Nutrition (2011). Ideally, we would have varied hypothetical investment intensities (e.g. "double the daily recommend amount of calories") across and within parents, but given the relatively small sample size and our intention to keep the survey short, we decided to limit the scenarios to two values for each investment.

[6]According to the World Health Organization, children aged 5-17 should do at least one hour of physical activity every day.

[7]As common in the literature (see for instance Bellemare, Kroger and van Soest 2008), we use this elicitation method based on 100 boys rather than asking for the probability directly, since Hoffrage et al. 2000 found that individuals are prone to think using natural frequencies rather than percent probabilities.

comparison between the two groups thus allows us to identify whether parents perceive the returns to health investments to differ based on the weight of the child at age 5.

3 Empirical strategy

Our research design allows us to directly estimate the partial and cross derivatives of the perceived health production technology. Comparing parental responses about the likelihood of a given outcome in later life when there is a healthy level of a given investment versus an unhealthy level allows us to infer the perceived return to a specific health investment (i.e. it gives us estimates of the perceived partial derivatives). Additionally, by allowing for interactions between the two inputs, we are able to investigate how parents perceive the complementarity/substitutability between different investments. More formally, we estimate the following ordinary least squares regression:[8]

$$\tilde{y}_{ji} = \alpha + \beta_1 D_j + \beta_2 E_j + \beta_3 D_j \times E_j + \gamma_i + \epsilon_{ji}$$

where j denotes the scenario, y_{ji} is the outcome parent i expects in scenario j, α denotes the intercept, D_j is a dummy variable equal to 1 if scenario j involves a healthy diet investment (and zero otherwise), E_j is a dummy variable equal to 1 if scenario j involves a healthy exercise investment (and zero otherwise), and γ_i are parental fixed effects. Taking $\tilde{y}_{ji}$ to be a desirable outcome, if parents perceive returns (in terms of a given outcome variable) of a healthy diet and regular exercise to be positive, then we would expect β_1 and β_2 to be positive. If parents perceive the two inputs to be substitutes (complements), then we would expect β_3 to be negative (positive).

4 Data

To collect information on parental beliefs about health investments as well as actual health investments and outcomes for their children, we administered a survey among nearly 400 parents in England. The survey data was collected online in June-July 2017.[9] Parents were incentivized to participate in the survey through a prize draw for a voucher worth £100. To recruit parents to participate in the study, invitations were sent via a mailing list of parents who had agreed to participate in survey research.

[8] In Appendix B we sketch a theoretical framework underlying the regression equation.

[9] The survey was set up using the online survey software Qualtrics. The invitation to participate asks the primary caregiver (referred to as the “parent” throughout the paper) to complete the survey. The survey was advertised to take about 15 minutes. The actual median time to complete the survey was 18 minutes.

The parents were first contacted via parental mailing lists of different schools in England.[10]

Table A.1 presents descriptive statistics for our sample, including the height and weight of the responding parents and their children.[11] On average, responding parents are 1.66m tall and weigh 69 kg, while the children are 1.60m tall and weigh 52 kg. The BMI is computed as the ratio of weight (in kg) and height (in meters) squared. Using the standard definition of the World Health Organization, overweight is defined by a BMI above 25 and obesity above 30 for adults. For children the cutoffs are defined in relative terms using the UK 1990 reference curves based on the LMS (L = skewness, M = median and S = coefficient of variation) following Cole, Freeman and Preece (1995). A child is considered overweight if his/her BMI is greater than the 85th percentile of the LMS curve corresponding to children of the same age and gender, and obese if his/her BMI is greater than the 95th percentile. Based on this definition, 42% of the responding parents are overweight and 13% are obese. Among the children, 23% are overweight and 12% are obese.

In Table A.2 we document four facts concerning the intergenerational persistence of being overweight for our full sample (left), and when the parent does not have (middle) or has a university degree (right). First, we see that children with parents who are overweight are much more likely to be overweight than children whose parents are not overweight (32% vs. 18%, p-value < 0.01). Second, we see that the intergenerational persistence of being overweight is larger for parents without a university degree compared to parents with a university degree (36% vs. 30%, p-value $= 0.51$). Third, the likelihood of becoming overweight when the parent is not is also larger for parents without a university degree (22% vs. 16%, p-value $= 0.39$). Fourth, less educated parents are more likely to be overweight (43% vs. 40%, p-value $= 0.60$) to begin with. In summary, though most differences are far from statistical significance due to the small sample sizes, they indicate that being overweight is persistent across generations and that children from less educated parents are particularly likely to be overweight.

To investigate how parental beliefs about the returns to health investments relate to actual health investments, we ask parents to provide information on their children's exercise routines. In Table A.3

[10] To sample schools for our study we did not use any specific selection criteria. The Department for Education provides lists of all primary and secondary schools in England. We used these lists and contacted the headteachers of a random subset of these schools in no specific order. The schools were included in our sample if the headteacher agreed to distribute the invitation to participate in our studies via the parental mailing list. Given that we sent the survey out to approximately 1,700 parents, we received a response from nearly one in four parents.

[11] Parents are asked to provide detailed information about only one of their children aged 5-20. If parents have more than one child in this age group, they are instructed to answer the questions thinking of their youngest child in this age range. Compared to a nationally representative sample, the parents in our sample on average have higher household income (£71,472 vs £38,002), are less likely to be single parents (0.14 vs 0.31), more likely to have a university degree (0.71 vs 0.40), more likely to work (0.85 vs 0.75) and less likely to work full-time conditional on working (0.54 vs 0.70). The comparison statistics were computed by drawing 1,000 random samples with the same gender composition using the Family Resource Survey 2013-2014.

we present the average weekly number of minutes the children of our respondents engage in moderate exercise (e.g. walking, cycling) and intensive exercise (e.g. running, swimming). On average, parents report that their children engage in 285 and 187 minutes of moderate and intensive exercise per week respectively.

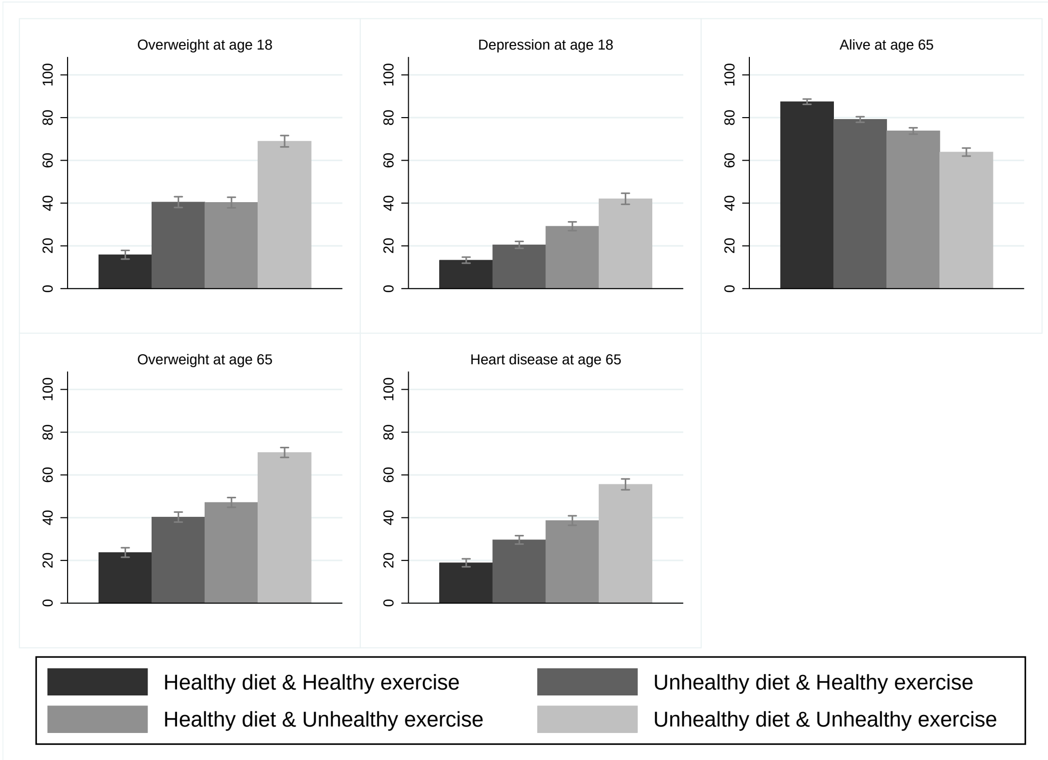
5 Results

5.1 Parental beliefs about the health technology

For each of the four different hypothetical scenarios described in Section 2, all parents are asked to state how many of the 100 boys presented as part of the scenario are likely to experience a certain outcome at a given age (18 or 65). In Figure 1 we present average responses separately for each outcome in each of the four scenarios (with 95% confidence intervals). For both health investments, parents believe that if the investment is lower, significantly more children are going to be overweight and depressed at age 18. Regarding the outcomes at age 65, parents believe that lower health investments are related to a significantly lower rate of survival until that age and a higher prevalence of overweight and heart disease (conditional on being alive at age 65). The differences in mean responses are sizeable, indicating that parents on average perceive the returns to health investments to be high.[12]

[12] While a direct comparison to the actual population statistics is not possible as we only elicit the probability of certain outcomes for four specific investment types in the population, we note that average parental beliefs across the four scenarios are close to actual population data. E.g. 35% of boys aged 13-15 are either overweight or obese (NatCen Social Research and Health 2015), and 19% of 16-24 year olds show evidence of mild to moderate mental illness such as anxiety or depression (ONS 2017).

Figure 1: Average responses for each outcome by scenario



Note: The bars show how many of the 100 hypothetical boys are expected to face each outcome separately for the four scenarios and averaged across all parents. 95% confidence intervals are provided.

To investigate the perceived returns to the two different health investments in more detail, we pool the parents' responses to the four different hypothetical scenarios and estimate the empirical specification presented in Section 3. In Table 1, we present the results of an ordinary least squares regression in which we regress parents' responses on dummy variables which indicate whether or not the children's diets and exercise routines are at a 'healthy' level, the interaction of these two dummy variables as well as parental fixed effects. The results convey that parents on average believe that eating the daily recommended number of calories (instead of eating one-and-a-half times the daily recommended amount) reduces the probability of being overweight at age 18 by 28.6 percentage points (p.p.) and the probability of being depressed at age 18 by 12.5 p.p. Interestingly, parents also believe that the children's eating habits at ages 5-18 affect health outcomes much later in life. Children following a healthy diet when they are 5-18 years old are perceived to have a higher likelihood of surviving until age 65 (+9.6 p.p.) and have a smaller likelihood of being overweight (-23.3 p.p.) and suffering from a heart disease (-17.0 p.p.) at age 65 (conditional on being alive at that age). The results suggest that on average parents believe that eating habits in childhood have long-lasting effects, possibly due to the fact that habits formed early in life also persist into adulthood; a question which we investigate in more detail in Section 5.2.

Regarding parents' perceptions about the returns to exercising for 60 minutes every day (relative to not exercising at all), we find that parents on average believe that this health investment reduces the probability of being overweight at age 18 by 28.3 p.p. and the probability of being depressed at age 18 by 21.3 p.p. Consistent with the results for following a healthy diet, following a 'healthy' exercise routine during ages 5-18 is perceived to have a positive impact on the probability of surviving until age 65 (+14.8 p.p.), and a negative effect on the probability of being overweight (-30.3 p.p.) and suffering from a heart disease (-25.8 p.p.) at that age, indicating that parents believe that exercise routines followed during the childhood period have substantial impacts on health outcomes well into adulthood.

A further question that arises is whether parents perceive the two investments to be substitutes or complements. As indicated by the positive interaction coefficients in the regressions in which the outcomes are negatively coded (overweight/depression/heart disease) and the negative interaction coefficient in the regression with a positive outcome (alive), we find that parents perceive healthy diet and exercise routines to be substitutes, i.e. the returns to one investment is perceived to be significantly lower (in absolute terms) if the other investment is at the 'healthy' level.

Table 1: Perceived returns (complementarity/substitutability)

	At age 18		At age 65		
	Overweight (1)	Depression (2)	Alive (3)	Overweight (4)	Heart disease (5)
Healthy diet	-28.570***	-12.516***	9.547***	-23.304***	-16.972***
	(1.119)	(0.736)	(0.548)	(0.918)	(0.724)
Healthy exercise	-28.281***	-21.259***	14.774***	-30.249***	-25.790***
	(1.202)	(1.019)	(0.745)	(1.134)	(0.980)
Healthy diet * Healthy exercise	3.851***	5.531***	-1.376**	6.651***	6.126***
	(1.278)	(0.753)	(0.546)	(1.034)	(0.731)
Parent fixed effects	Yes	Yes	Yes	Yes	Yes
Sample mean	40.96	25.99	75.91	45.18	35.49
Observations	1562	1529	1520	1459	1428
R-squared	0.61	0.51	0.52	0.65	0.65

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses. The dependent variable is the expected number of the 100 hypothetical boys expected to experience the relevant outcome. 'Sample mean' gives the arithmetic mean of the corresponding dependent variable. 'Healthy diet' is a dummy variable equal to one if the diet is at the healthy level (i.e. the recommended number of calories), and zero otherwise. 'Healthy exercise' is a dummy variable equal to one if the children undertake the recommended amount of exercise, and zero otherwise. Parent fixed effects are included.

As explained in Section 2, we present all parents with the same four scenarios but randomize the initial weight of the child in the scenarios across participants. We investigate whether health investments are perceived as more or less productive depending on the initial weight of the child and present the results in Appendix Table A.4. Other than a greater perceived impact of a healthy diet on the reduction in the probability of depression at age 18 when the initial weight of the child is high, there are no significant interactions.

5.2 Habit persistence

A potential reason why parents may perceive that investments during the childhood period affect health outcomes well into adulthood is that they may believe that there is a persistence in diet and exercise choices. Therefore, we additionally ask parents to imagine 100 boys who follow a certain diet or exercise routine during ages 5-18 and to state how many of those boys are likely to have similar eating and exercise habits as adults.

Interestingly, parents believe that there is a high persistence of diet and exercise habits. They believe that 74% of the children who eat one-and-a-half times the daily recommended amount of calories during ages 5-18 will continue having similarly unhealthy eating habits as adults. Similarly, 73% of children who do not exercise regularly are expected to have a similarly unhealthy lifestyle later in life. Conversely, parents believe that among children who eat the daily recommended amount of calories, 72% will continue doing so as adults, while among children who exercise for at least 60 minutes every day, 57% will keep up the good habit of exercising regularly when they become adults.

To investigate whether the perceived effects of a healthy diet and exercise routine during ages 5-18 on expected later-life outcomes at age 65 are mediated by parents' beliefs about the child's weight at age 18 and the persistence of the child's habits into adulthood, we estimate the same specification as in Table 1, additionally controlling for the perceived probability of being overweight at age 18 in the scenario, as well as the parents' perceptions about how likely it is that the child will follow a healthy diet and a healthy exercise routine during adulthood.[13] The results presented in columns (1)-(3) of Table 2 are consistent with the hypothesis that early health and exercise choices are perceived to affect later-life outcomes at least in part through their effects on weight at age 18 and habits later in life. Both weight at age 18 and the perceived likelihood of following a healthy exercise routine during adulthood are significant predictors of expected later-life outcomes, and the estimated coefficients on

[13] We construct the habit variables in the following way: As can be seen in the questionnaire in Appendix C.2, we ask parents how likely it is that children will continue an (un)healthy diet after age 18 if their diet is (un)healthy before age 18. For the healthy diet scenario, we simply take the reported likelihood of continuing the habit as an explanatory variable, while for the unhealthy diet scenario, we use 100 minus the reported number as explanatory variable. In this manner, the variable "Likelihood healthy diet age 18-65" can be interpreted as the likelihood of a healthy diet after age 18. We do the analog for the exercise habit variable.

early healthy diet and exercise are now substantially reduced (in absolute value) compared to the coefficients estimated in Table 1. We would also like to note that albeit being muted, the direct effects of both an early healthy diet and exercise routine are perceived to persist until age 65 above and beyond their effects on weight at age 18 and the likelihood of following a healthy diet and exercise routine during adulthood. This result is consistent with the literature which documents that weight early in life predicts expected later-life outcomes beyond its effects through weight later in life (e.g. Tirosh et al. 2011).

Table 2: Perceived returns on outcomes at age 65 (persistence)

	(1) Alive	(2) Overweight	(3) Heart	(4) Alive	(5) Overweight	(6) Heart
Healthy diet	6.573***	-12.385***	-10.878***	4.731***	-10.617***	-8.285***
	(0.999)	(1.557)	(1.131)	(0.900)	(1.513)	(1.005)
Healthy exercise	10.365***	-17.328***	-17.150***	6.708***	-13.780***	-11.961***
	(0.923)	(1.621)	(1.241)	(0.802)	(1.547)	(1.075)
Healthy diet * Healthy exercise	-1.276**	5.509***	5.372***	0.252	4.086***	3.195***
	(0.550)	(1.048)	(0.767)	(0.564)	(1.035)	(0.794)
Likelihood healthy diet age 18-65	0.005	-0.029	-0.018	0.002	-0.026	-0.015
	(0.017)	(0.020)	(0.016)	(0.016)	(0.020)	(0.015)
Likelihood healthy exercise age 18-65	0.057***	-0.116***	-0.111***	0.027	-0.086***	-0.066***
	(0.018)	(0.027)	(0.025)	(0.018)	(0.026)	(0.021)
Overweight at age 18	-0.099***	0.326***	0.178***	-0.036**	0.264***	0.085***
	(0.020)	(0.038)	(0.026)	(0.017)	(0.038)	(0.021)
Depression at age 18				-0.297***	0.291***	0.425***
				(0.041)	(0.047)	(0.035)
Parent fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Sample mean	75.91	45.18	35.49	75.91	45.18	35.49
Observations	1402	1401	1402	1398	1397	1398
R-squared	0.56	0.72	0.69	0.63	0.73	0.75

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses. The dependent variable is the expected number of the 100 hypothetical boys expected to experience the relevant outcome at age 65. 'Sample mean' gives the arithmetic mean of the corresponding dependent variable. 'Healthy diet' is a dummy variable equal to one if the diet is at the healthy level (i.e. the recommended number of calories), and zero otherwise. 'Healthy exercise' is a dummy variable equal to one if the children undertake the recommended amount of exercise, and zero otherwise. 'Likelihood healthy diet (exercise) age 18-65' is the likelihood of following the healthy diet (exercise) routine at age 65. 'Overweight (Depression) at age 18' is the probability of being overweight (depressed) at age 18 under the particular scenario. Parent fixed effects are included.

5.3 Do perceived returns predict outcomes and investments?

On average parents believe that diet and exercise choices made during childhood have a positive impact on health outcomes later in life. But to what extent do parents differ in their beliefs about the returns to health investments, and are parental beliefs predictive of actual investment decisions? Given that for each outcome each parent is presented with four different scenarios, we can compute individual perceived returns to a healthy diet, r_{ik}^D, and a healthy exercise routine, r_{ik}^E, for each parent i and outcome k. More specifically, for each outcome k, we calculate the perceived returns as:

$$r_{ik}^{D} = \frac{(\tilde{y}_{2ik} - \tilde{y}_{1ik}) + (\tilde{y}_{4ik} - \tilde{y}_{3ik})}{2} \quad \forall k \tag{1}$$

$$r_{ik}^{E} = \frac{(\tilde{y}_{3ik} - \tilde{y}_{1ik}) + (\tilde{y}_{4ik} - \tilde{y}_{2ik})}{2} \quad \forall k \tag{2}$$

where $\tilde{y}_{jik}$ denotes parent i's belief of the number of hypothetical boys facing the health outcome k under scenario j. $j = 1$ and $j = 2$ denote scenarios with an unhealthy exercise investment, but with unhealthy and healthy diet investments respectively. Similarly, $j = 3$ and $j = 4$ denote scenarios with a healthy exercise investment, but with unhealthy and healthy diet investments respectively.

In Appendix Figure A.1 we plot the cumulative density of perceived returns separately for each outcome, and Appendix Figures A.2 and A.3 provide contour plots of the joint distributions. While for both types of investments most parents believe that there are positive health returns, we see a substantial degree of heterogeneity and a positive correlation between perceived returns to diet and exercise.

To investigate whether perceived returns are predictive of actual health investments and outcomes, we summarize perceived returns to, e.g., a healthy diet, by extracting a factor from the individual perceived returns as computed in equation (1) to a healthy diet in terms of its effect on depression at age 18, being alive at age 65, having heart disease at age 65, and being overweight at age 18 and 65. We repeat the same exercise for perceived returns to exercise as computed using equation (2). We thus create one single measure of perceived returns for each health investment (i.e. diet and exercise) with mean zero and a standard deviation of 1. We then examine whether perceived returns to diet choices and perceived returns to exercise routines are predictive of whether or not the parent's own child is overweight or obese using a linear probability model. The results are presented in columns (1) and (2) of Table 3. Consistent with a model in which parents encourage their children to follow a healthier lifestyle if they perceive the returns to be higher, we find that children are significantly less likely to be overweight and obese if their parents believe in the positive effects of a healthy diet. More specifically, a one standard deviation increase in perceived returns reduces the probability of their child being overweight (obese) by 6.4 (4.3) percentage points. For perceived returns to exercise we do not find a significant effect.

Table 3: Predictors of children's weight outcomes and exercise habits

	(1)	(2)	(3)	(4)
	Weight outcomes		Exercise	
	Overweight	Obese	Moderate	Intensive
Perceived return to healthy food	-0.064**	-0.043*	4.269	-11.195
	(0.029)	(0.023)	(20.131)	(13.840)
Perceived return to exercise	0.039	0.028	14.115	28.463**
	(0.030)	(0.025)	(26.548)	(12.872)
Controls	Yes	Yes	Yes	Yes
Sample mean	0.23	0.12	285.00	187.12
Observations	286	286	257	257
R-squared	0.13	0.17	0.05	0.05

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses. 'Overweight' is a dummy variable equalling one if the individual is either overweight or obese, and zero otherwise. 'Obese' is a dummy variable equal to one if the individual is are dummy variables equalling one if the individual is obese, and zero otherwise. 'Moderate' refers to time in minutes spent by the child on moderate exercise activities such as walking and cycling, while 'Intensive' exercise includes running and swimming. 'Perceived return to healthy diet' is the extracted first principal component from the perceived returns to a healthy diet corresponding to the five health outcomes (as calculated in Equation 1). 'Perceived return to exercise' is the extracted first principal component from the perceived returns to regular exercise. Controls include age and gender of parent and child, parental BMI, whether parent is single, parental employment, number of children, whether mainly speak English at home, whether the parent has an undergraduate degree, and the initial weight of the child in the scenario.

When relating the extracted factor of the five perceived returns to exercise to reported exercise times, we find that children of parents perceiving higher returns engage in more intensive exercise as presented in column (4) of Table 3. A one standard deviation increase in perceived returns is associated with children spending 28 minutes more on intensive exercise per week.

5.4 Heterogeneity by SES

Given the large and growing socioeconomic gap in health outcomes, which has been documented in the UK and many other countries (Pickett and Wilkinson, 2015; Hauser and Kitagawa, 1973; Rogers, Hummer and Nam, 2000; Case, Lubotsky and Paxson, 2002; Adler et al., 1994; Condliffe and Link, 2008; Cutler, Lleras-Muney and Vogl, 2011; Denney, Krueger and Pampel, 2014; Conti, Heckman and Urzua, 2010), a natural question which emerges is whether parents from different socioeconomic groups differ in their beliefs about the returns to health investments.[14]

To investigate this question, we separately estimate our main specification but splitting the sample by whether or not the responding parent has a university degree. The evidence presented in Table 4 suggests that parents with a degree perceive the returns to health investments to be significantly

[14]For perceived returns to educational investments, many findings point to a positive correlation between parents' socioeconomic status and perceived returns, which are also related to higher investments (e.g. Cunha, Elo and Culhane 2013; Boneva and Rauh forthcoming).

greater. In particular, parents perceive the positive health effects of a healthy diet on the probability of being overweight at ages 18 and 65 as well as the probability of suffering from a heart disease at age 65 to be significantly greater. They also believe that the returns to a healthy exercise routine on the probability of being overweight at age 65 are significantly higher. Given that parental beliefs are related to the actual health outcomes and investments of their children, these socioeconomic gaps in beliefs about returns are likely to manifest themselves in socioeconomic gaps in health outcomes.

There are two important questions which emerge from our study. First, a natural question which arises is whether parental beliefs about the returns to health investments are on average correct. Given that credible causal estimates of the effects of a healthy diet and a healthy exercise routine followed during childhood are not readily available, we cannot provide a definite answer to this question. We do note, however, that in light of the literature documenting the positive effects of these health investments on later-life outcomes (e.g. Lewis et al. 1997; Singh et al. 2008*b*; Akbaraly et al. 2009; Mozaffarian et al. 2011; Hall et al. 2011; Colberg et al. 2016; World Health Organization 2016; Conner et al. 2017), a significant proportion of parents are likely to underestimate the returns as they perceive the returns to be close to zero (see Appendix Figure A.1). Secondly, a question which emerges is how parental beliefs about the returns to health investments are formed and whether these beliefs are malleable. An important avenue for future research is to investigate whether informational interventions, which target parental beliefs about the returns to health investments, may be effective in raising health investments and improving child health outcomes.[15]

[15] Previous studies have shown that beliefs about the returns to educational investments are malleable and can be targeted through interventions (see Jensen 2010, Alan, Boneva and Ertac 2015).

Table 4: Perceived returns by parental education

Panel A – Outcomes at age 18:						
	Overweight			Depression		
	(1)	(2)	p-	(3)	(4)	p-
Parent has degree	No	Yes	value	No	Yes	value
Healthy diet	-22.675***	-27.382***	0.04	-9.133***	-9.744***	0.65
	(2.420)	(1.504)		(2.250)	(1.188)	
Healthy exercise	-24.156***	-27.904***	0.13	-20.057***	-18.763***	0.60
	(2.420)	(1.504)		(2.250)	(1.188)	
Initial overweight	16.830***	13.430***	0.41	10.522***	4.132***	0.12
	(2.606)	(1.533)		(2.425)	(1.211)	
Controls	Yes	Yes		Yes	Yes	
Sample mean	39.27	41.66		28.36	25.01	
Observations	315	835		316	836	
R-squared	0.47	0.48		0.35	0.31	

Panel B – Outcomes at age 65:									
	Alive			Overweight			Heart disease		
	(1)	(2)	p-	(3)	(4)	p-	(5)	(6)	p-
Parent has degree	No	Yes	value	No	Yes	value	No	Yes	value
Healthy diet	8.500***	9.282***	0.38	-15.253***	-20.818***	0.00	-12.114***	-14.407***	0.03
	(1.540)	(0.941)		(2.581)	(1.406)		(2.406)	(1.323)	
Healthy exercise	15.766***	14.349***	0.39	-22.177***	-27.311***	0.04	-22.886***	-23.024***	0.95
	(1.540)	(0.941)		(2.581)	(1.406)		(2.406)	(1.323)	
Initial overweight	-1.180	-2.215**	0.72	14.139***	5.331***	0.05	12.306***	2.832**	0.05
	(1.660)	(0.959)		(2.782)	(1.433)		(2.593)	(1.349)	
Controls	Yes	Yes		Yes	Yes		Yes	Yes	
Sample mean	76.07	75.84		46.71	44.55		36.60	35.03	
Observations	316	836		316	836		316	836	
R-squared	0.39	0.33		0.34	0.44		0.34	0.36	

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors in parentheses. Panel A shows regressions using age 18 health outcomes as dependent variables, while Panel B gives the regression results for age 65 health outcomes. Within each block of three columns, the first column gives regression results using only those parents without an undergraduate degree, while the second column uses only parents with an undergraduate degree. The third column gives the p-value testing the equality of coefficients for the two subgroups. 'Healthy diet' is a dummy variable equal to one if the diet is at the healthy level (i.e. the recommended number of calories), and zero otherwise. 'Healthy exercise' is a dummy variable equal to one if the children undertake the recommended amount of exercise, and zero otherwise. Controls include age, BMI, and gender of parent and child, whether parent is single, parental employment, number of children, whether mainly speak English at home, whether the parent has an undergraduate degree, and the initial weight of the child in the scenario. 'Sample mean' gives the arithmetic mean of the corresponding dependent variable.

6 Conclusion

Obesity amongst children is a growing problem. It is associated with a range of poor health and psychological outcomes, thereby not only increasing the future burden on individuals but also adding costs and putting pressure on public health services. Given the crucial role parents play in the diet and daily routines of their child, we investigate the role of parental beliefs about the returns to health investments in children's health investment choices and health outcomes.

We find that parents on average perceive the returns to a healthy diet and a regular exercise routine to be positive, and that perceived returns are predictive of the weight and exercise routines of their own children. We also document that the heterogeneity in perceived returns is systematic with more educated parents perceiving the returns to both types of health investments to be significantly greater. Given the large and rising socioeconomic gaps in health outcomes reported in many countries around the world, our study contributes to our understanding of what might be driving those differences.

Our findings suggest that informational campaigns which make parents aware of the positive returns to early health investments have the potential of improving children's health and narrowing the socioeconomic gap in health investments and outcomes. Future work should also explore how traditional economic explanations such as time and budget constraints interact with beliefs and quantify the relative importance of the different factors in order to gain a better understanding of the most cost-effective ways for policies to be successful.

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A Tables and figures

Table A.1: Descriptive statistics of sample

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Parent				
Male	0.156	0.363	0	1
Age (in years)	49.831	6.633	17	70
Height (in meters)	1.661	0.095	1.39	2.11
Weight (in kg)	69.017	14.516	35	113.852
BMI	25.009	4.713	12.856	41.322
Overweight	0.422	0.494	0	1
Obese	0.132	0.339	0	1
Single parent	0.136	0.343	0	1
Works part time	0.391	0.489	0	1
Works full time	0.458	0.499	0	1
Has a degree	0.706	0.456	0	1
Number of children	1.898	0.823	1	6
Mainly speak English at home	0.929	0.255	0	1
Household income (in £s)	71472.930	29380.587	5000	102500
Child				
Male	0.598	0.491	0	1
Age (in years)	14.423	3.659	5	23
Height (in meters)	1.599	0.207	0.97	1.99
Weight (in kg)	52.321	17.67	12.701	110
BMI	19.928	4.515	4.155	46.997
Overweight	0.234	0.424	0	1
Obese	0.123	0.329	0	1
Observations	391			

Note: 'Male' is a dummy variable equalling one if the individual is male, and zero otherwise. 'Overweight' is a dummy variable equalling one if the individual is either overweight or obese, and zero otherwise. 'Obese' is a dummy variable equal to one if the individual is are dummy variables equalling one if the individual is obese, and zero otherwise. BMI is calculated as weight (in kg) divided by height (in meters) squared. Adults are classified as overweight if they have a BMI between 25-30, and obese if they have a BMI of over 30. For children, classification is based on the UK 1990 reference curves following Cole, Freeman and Preece (1995). 'Has a degree' is a dummy variable equalling one if the parent has an undergraduate degree or higher, and zero otherwise.

Table A.2: Conditional intergenerational weight transition matrix

	Full sample			No degree			Has degree		
Child / Parent	R	O	N	R	O	N	R	O	N
Regular R	.82	.18	187	.78	.22	51	.84	.16	136
Overweight O	.68	.32	130	.64	.36	39	.70	.30	91
Observations N	242	75		65	25		178	49	

Note: The first block of three columns refer to the full sample, the middle to parents without a university degree, and the last to parents with a university degree.

Table A.3: Weekly exercise of children as reported by parents (in minutes)

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
Moderate	285	270.942	0	1785
Intensive	187.115	167.284	0	900
Total	472.115	350.204	0	2580
Observations	312			

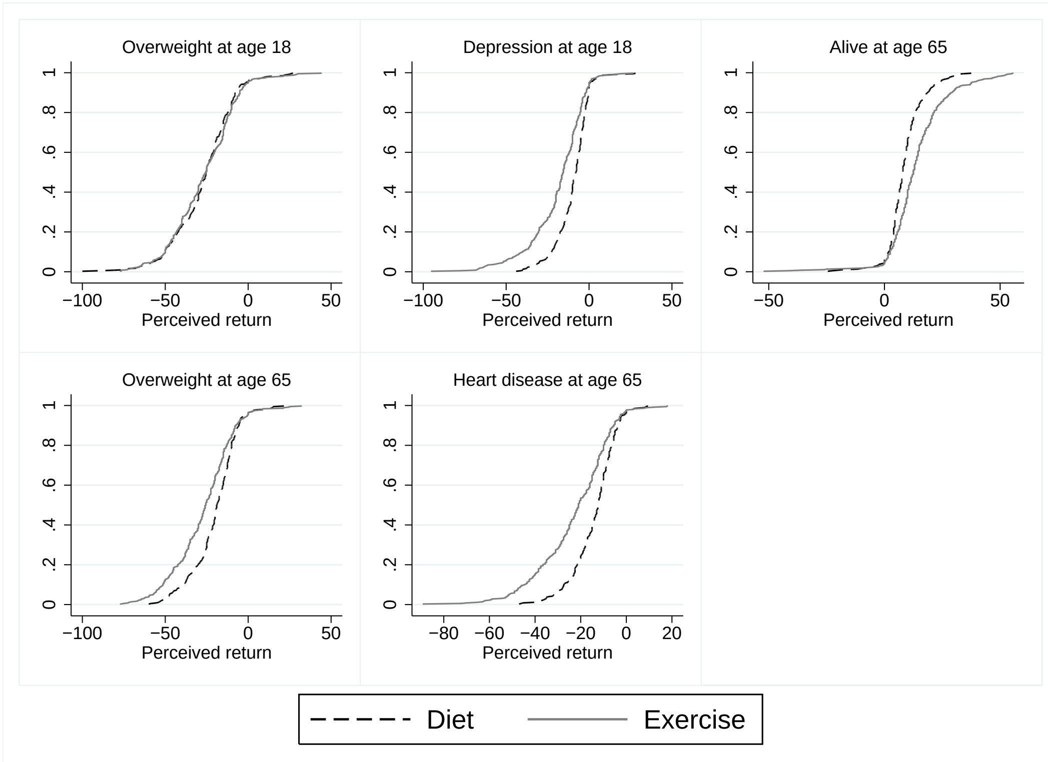
Note: ‘Moderate’ exercise is described to parents as activities such as walking and cycling, while ‘Intensive’ exercise includes running and swimming. ‘Total’ is calculated as the unweighted sum of moderate and intensive exercise times.

Table A.4: Do perceived returns differ by initial weight?

	At age 18		At age 65		
	Overweight (1)	Depression (2)	Alive (3)	Overweight (4)	Heart disease (5)
Healthy diet	-25.153***	-7.787***	8.887***	-19.188***	-13.809***
	(1.161)	(0.651)	(0.498)	(0.949)	(0.713)
Healthy exercise	-25.164***	-17.438***	14.216***	-26.758***	-21.689***
	(1.216)	(1.204)	(0.815)	(1.287)	(1.125)
Healthy diet x Initial overweight	-3.004	-4.010***	-0.056	-1.616	-0.206
	(1.858)	(1.019)	(0.807)	(1.440)	(1.005)
Healthy exercise x Initial overweight	-2.401	-2.155	-0.268	-0.343	-2.130
	(1.994)	(1.696)	(1.321)	(1.899)	(1.689)
Sample mean	40.96	25.99	75.91	45.18	35.49
Parent fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	1562	1529	1520	1459	1428
R-squared	0.61	0.51	0.52	0.64	0.64

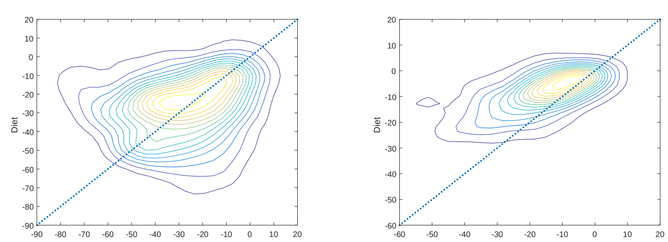
Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses. The dependent variable is the expected number of the 100 hypothetical boys expected to experience the relevant outcome. ‘Sample mean’ gives the arithmetic mean of the corresponding dependent variable. ‘Healthy diet’ is a dummy variable equal to one if the diet is at the healthy level (i.e. the recommended number of calories), and zero otherwise. ‘Healthy exercise’ is a dummy variable equal to one if the children undertake the recommended amount of exercise, and zero otherwise. ‘Initial overweight’ is a dummy variable equal to one if the parent faced hypothetical children who were overweight, and zero if they saw children of average weight. ‘Healthy diet x Initial overweight’ and ‘Healthy exercise x Initial overweight’ are interaction terms between the corresponding dummy variables. Parent fixed effects are included.

Figure A.1: Cumulative densities of average individual perceived returns



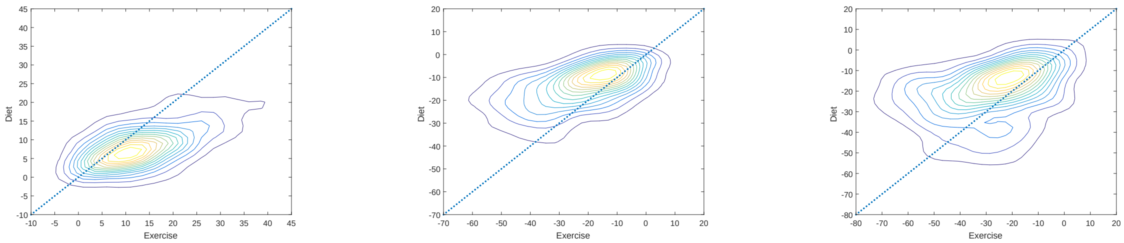
Note: The figures display the cumulative density of individual perceived returns calculated using Equations 1 and 2.

Figure A.2: Individual perceived returns (age 18)



(a) Overweight (b) Depression

Figure A.3: Individual perceived returns (age 65)



(a) Alive (b) Heart Disease (c) Overweight

Note: This figure shows 2D contour plots showing the joint distribution of perceived returns to healthy diet and exercise investments for each of the five health outcomes (as calculated in Equations 1 and 2). Figure A.2 looks at age 18 health outcomes, while Figure A.3 looks at age 65 health outcomes.

B Theoretical framework

The simple model presented here below provides a useful framework for understanding how choices about child health investments can be influenced by parental beliefs. Suppose that children are endowed with initial conditions, θ_0, which reflect the child's health status at the beginning of the childhood period. During childhood, parents can affect two types of health investments made by their child: the amount of regular exercise the child engages in (E) as well as the diet that the child follows (D). The child's health status at the end of childhood, θ_1, depends on the child's initial health status θ_0, the two investments E and D and the production function f: $\theta_1 = f(\theta_0, E, D)$. To ensure an interior solution to the model, we assume that f is monotonically increasing in its arguments, twice continuously differentiable and concave in θ_0, E and D.

Let $\mathbf{y}$ denote a vector of positive health outcomes during adulthood which relates to the child's health status, θ_1, via the function g, which we assume to be monotonically increasing in θ_1: $\mathbf{y} = g(\theta_1)$. $\mathbf{y}$ thus depends on the child's initial health status θ_0, exercise investments E, diet investments D, and the function $h = g \circ f$ which maps these inputs into the health outcome $\mathbf{y}$: $\mathbf{y} = h(\theta_0, E, D)$. Given the complexity of the health production function, parents are unlikely to know all aspects of this technology and are thus likely to make investment choices based on their *perceptions* of this technology. More specifically, parent i chooses health investments based on expected outcomes $\tilde{\mathbf{y}}$, which depend on the perceived technology h_i:

$$\tilde{\mathbf{y}} = h_i(\theta_0, E, D).$$

Various partial and cross derivatives will be key in determining parent i's optimal choices of child health investments. First, the perceived marginal returns to the two investment types are likely to be important:

$$\frac{\partial h_i(\cdot)}{\partial E}, \frac{\partial h_i(\cdot)}{\partial D}$$

Second, there may be complementarities between the child's initial health status and health investments. For example, a parent may believe that the return to regular exercise or healthy eating is higher/lower depending on the child's initial health status. As such, the following perceived cross derivatives may also be of interest:

$$\frac{\partial h_i^2(\cdot)}{\partial E \partial \theta_0}, \frac{\partial h_i^2(\cdot)}{\partial D \partial \theta_0}.$$

Third, there may be important substitutability or complementarity between the two investment types. For example, a parent may perceive the return to regular exercise to be higher/lower if the child also eats healthily. Consequently, the optimal level of health investment is likely to depend on the following cross derivative:

$$\frac{\partial h_i^2(\cdot)}{\partial E \partial D}.$$

C Questionnaires

C.1 Hypothetical Investment Scenarios

We are interested in your opinion about how different diets and exercise routines affect children's health. For this purpose, imagine 100 boys living in England who are all 5 years old and of average height but overweight.[16] *We will now ask you to state how many of these boys are likely to develop certain health conditions based on their diets and exercise routines at ages 5-18.*

More specifically, we will present you with scenarios in which these children either eat the daily recommended amount of calories (e.g. salmon with potatoes, fruit, sugar-free drinks) OR eat one-and-a-half times the daily recommended amount of calories (e.g. fish and chips, sweets, sugary drinks). Moreover, these children either exercise for 60 minutes every day (e.g. playing football) OR they do not exercise but engage in other activities instead (e.g. playing PlayStation).

We know these questions are difficult. Please think about each question carefully and tell us what you believe the answer to be.

Out of 100 boys who are of average height but overweight at age 5, how many of them do you think will be overweight at age 18 if at ages 5-18 they...[17]

(A) ...eat the daily recommended amount of calories and exercise for 60 minutes every day. [0-100 scale]

(B) ...eat one-and-a-half times the daily recommended amount of calories and exercise for 60

[16]Parents are randomly allocated into two groups - one group sees 100 boys who are of 'average height but overweight', while the other group sees 100 boys of 'average height and weight'.

[17]The four other outcomes asked are as follows: suffer from depression at age 18, alive at age 65, overweight at age 65 (conditional on all 100 boys being alive) and have a heart disease at age 65 (conditional on all 100 boys being alive). The formatting of questions is the same as for overweight at age 18.

minutes every day. [0-100 scale]

(C) ...eat the daily recommended amount of calories and do not exercise but engage in other activities instead. [0-100 scale]

(D) ...eat one-and-a-half times the daily recommended amount of calories and do not exercise but engage in other activities instead. [0-100 scale]

C.2 Habit formation

Now we would like you to think about whether children are likely to keep or change their habits when they become adults.

1. *Out of 100 overweight boys of average height who eat the daily recommended amount of calories (e.g. salmon with potatoes, fruit, sugar-free drinks) while they are 5-18 years old, how many of them do you think will have similar eating habits as adults?*[18] [0-100 scale]

2. *Out of 100 overweight boys of average height who eat the one-and-a-half times the daily recommended amount of calories (e.g. fish and chips, candy, sugary drinks) while they are 5-18 years old, how many of them do you think will have similar eating habits as adults?*

3. *Out of 100 overweight boys of average height who exercise for 60 minutes every day (e.g. playing football) while they are 5-18 years old, how many of them do you think will have similar exercise habits as adults?* [0-100 scale]

4. *Out of 100 overweight boys of average height who do not exercise but engage in other activities instead (e.g. playing PlayStation) while they are 5-18 years old, how many of them do you think will have similar exercise habits as adults?* [0-100 scale]

C.3 Child's health investments

During the past week, how much time did your child approximately spend on the following activities (in hours and minutes)?

1. *Moderate exercise (e.g. walking, cycling,...)*

2. *Intensive exercise (e.g. running, swimming,...)*

[18] Parents are shown the same weight at age 5 as was displayed in the hypothetical scenarios.