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Parental Beliefs about Returns to Child Health Investments

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Abstract

Childhood obesity has adverse health and productivity consequences and it poses negative externalities to health services. To shed light on the role of parents, we elicit parental beliefs about the returns and the persistence of a healthy diet and exercise routine in childhood. Parents believe both types of investments to improve child and adult health outcomes. Consistent with a model of taste formation, parents believe that childhood health behaviors persist into adulthood. We show that perceived returns are predictive of health investments and outcomes, and that less educated parents view the returns to health investments to be lower. Our descriptive evidence suggests that beliefs contribute to the socioeconomic inequality in health outcomes and the intergenerational transmission of obesity.

Keywords: Parental Investments, Health, Beliefs, Inequality, Equality of Opportunity, Obesity

JEL classifications: D19, I10, I12, I14

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1 Introduction

Childhood obesity is increasingly prevalent and poses a public health concern. In the UK, more than 20% of all five-year-old children are overweight or obese (RCPCH 2017). Being overweight or obese poses health and economic costs to the individual: on one side, obesity is a major cause of preventable death as it significantly increases the likelihood of suffering from type 2 diabetes, heart disease, and mental illnesses such as depression; on the other side, it is associated with lower skill acquisition and wages, less attachment to the labor force and declining productivity.[1] The costs to the economy are significant with the UK government spending more on the treatment of obesity and diabetes each year than on the police, fire service, and judicial system combined (HM Government 2016).

Health investments such as a balanced diet and regular exercise have been linked to a lower risk of obesity, diabetes and heart disease as well as to improved psychological well-being and academic performance.[2] Yet many children and adults do not follow a healthy diet or exercise regularly.[3] Recent evidence suggests that weight and healthy behaviors are formed early in life and persist into adulthood.[4] This draws attention to the family environment and the role of parents in shaping children's health behaviors and outcomes.

In this paper, we examine how parents perceive the returns to following a healthy diet and a regular exercise routine in childhood and how they perceive the persistence of health behaviors from childhood to adulthood. We explore how parental beliefs about the returns to early health investments are related to actual health investments and outcomes of their children. In addition, we study socioeconomic differences in parental beliefs, which may contribute to socioeconomic differences in health investments and outcomes.[5]

To study parental beliefs about the health production technology, 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 parental beliefs about the returns to health investments and the persistence of health behaviors by

[1] See, e.g., Mokdad et al. (2004); Rashad (2006); Kline and Tobias (2008); Pischon et al. (2008); Abdullah et al. (2010); Cawley (2010); Gatineau and Dent (2011); Cawley and Meyerhoefer (2012); Go et al. (2014).

[2] See, e.g., Lewis et al. (1997); Singh et al. (2008); Akbaraly et al. (2009); Hall et al. (2011); Mozaffarian et al. (2011); Colberg et al. (2016); World Health Organization (2016); Conner et al. (2017).

[3] For example, 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.

[4] See, e.g., Birch (1999); Lytle et al. (2000); Mannino et al. (2004); Singh et al. (2008); Daniels et al. (2009); World Health Organization (2016).

[5] For evidence on socioeconomic differences in health outcomes, see, amongst others, Case, Lubotsky and Paxson (2002); Currie (2009); Cutler, Lleras-Muney and Vogl (2011); Denney, Krueger and Pampel (2014); Pickett and Wilkinson (2015).

conducting a survey of parents in England. We use hypothetical investment scenarios to elicit beliefs about the returns to and persistence of (i) following a recommended-calorie diet and (ii) exercising regularly during childhood.

Several findings emerge from our study: first, for a broad range of outcomes, parents on average perceive the returns to both types of investments as positive. More specifically, following a healthy diet and exercise routine in childhood is perceived to lower the probability of being overweight and depressed at age 18, increase the probability of surviving until age 65 and decrease the probability of being overweight and suffering from a heart disease at age 65. To provide an example, parents on average believe that the probability of suffering from a heart disease at age 65 is reduced by 18 percentage points if children eat the daily recommended amount of calories rather than one-and-a-half times the daily recommended amount while they are 5-18 years old. If children exercise for 60 minutes every day rather than not at all, parents believe this reduces the probability of suffering from heart disease at age 65 by 25 percentage points. Following a healthy diet and exercise routine are perceived as substitutes rather than complements in the health production function. At the same time, we do not find that perceived returns to health investments differ systematically based on whether the hypothetical children in the scenarios are of normal weight or overweight at age 5.

Second, consistent with a model of taste formation, parents on average believe childhood health behaviors persist into adulthood. For example, parents believe that 74% and 73% of children who do not follow a healthy diet or exercise routine during childhood will continue having similarly unhealthy lifestyles as adults. Parental perceptions about the persistence of health behaviors are found to mediate the perceived relationship between early health investments and adult health outcomes. Parents who perceive the persistence of health behaviors as greater also perceive the returns to early investments on adult outcomes to be higher.

Third, parental perceptions are heterogeneous, correlated with parental socioeconomic status, and predictive of children's current health and exercise routine. For both types of investments, we document a substantial degree of heterogeneity in perceived returns. These perceptions are significantly related to the health investments and weight outcomes of the respondents' own children. More specifically, a one standard deviation increase in perceived returns to a healthy diet is associated with a reduction in the probability of the respondent's child being overweight by 7.6 percentage points. We further find that a one standard deviation increase in perceived returns to exercise is associated with children spending 12.4 percent more time exercising, but we do not find a significant relationship between perceived returns to exercise and the probability of the respondent's child being overweight. While we cannot interpret these results as causal, the results are consistent with a model in which parents invest more if they perceive the returns to health investments to be greater. We further investigate which background characteristics predict perceived returns. We find that parents with a university degree perceive the returns to a healthy diet to be 0.31 standard deviations larger. If we were to interpret our results as causal, then a naive back-of-the-envelope calculation would suggest that having a parent with a university degree translates into a 2.4 percentage point or 40% reduction in the socioeconomic gap in the probability of being overweight through differences in beliefs alone.

Fourth, a significant proportion of parents perceive the returns to health investment to be close to zero. Such low perceived returns are in contrast with a vast literature documenting better later-life outcomes for those who follow a healthy diet and exercise routine,[6] suggesting that some parents might be underestimating the returns to health investments. An important avenue for future research is to investigate whether informational interventions targeting parental beliefs have the potential of raising health investments and improving child health.

Our study relates to the growing literature which investigates the role of beliefs in a variety of different contexts (see Manski 2004 and Delavande 2014 for recent reviews). In this paper, we build on the seminal work by Cunha, Elo and Culhane (2013), who were the first to use hypothetical investment scenarios to elicit parental beliefs about the returns to educational investments made in young children. A similar methodology has subsequently been used in Attanasio, Boneva and Rauh (2018) and Boneva and Rauh (2018), who study parental beliefs about educational investments made in school children. Closest to our study is recent work by Bhalotra et al. (2017), who investigate parental beliefs about the returns to maternal breastfeeding on diarrhea. In contrast to these studies, we study parental beliefs about the returns to following a healthy diet and exercise routine during childhood.

Our study also relates to the literature documenting how perceptions about current health status influence health-related behaviors (see, e.g., Delavande and Kohler 2009, De Paula, Shapira and Todd 2014, Delavande and Kohler 2016, Delavande, Lee and Menon 2017). We also relate to the literature documenting parental misperceptions of child weight status and how such misperceptions relate to investments (see, e.g., Lundahl, Kidwell and Nelson 2014 for a recent meta-analysis). We contribute to this literature by examining how parents perceive the likelihood of certain health outcomes occurring depending on the level of health investments chosen during childhood.

[6] See for example Lewis et al. (1997); Singh et al. (2008); Akbaraly et al. (2009); Hall et al. (2011); Mozaffarian et al. (2011); Colberg et al. (2016); World Health Organization (2016); Conner et al. (2017)

Finally, our study builds on and contributes to the literature on the persistence of health behaviors. Both diet and exercise behaviors have been shown to be malleable during childhood and persistent over time. List and Samek (2015) and Loewenstein, Price and Volpp (2016) conduct field experiments with children to study the role of incentives in food choice. Providing students with incentives increases the consumption of healthy food and there is evidence that the effects persist post-treatment, which is consistent with a model of taste formation. Belot et al. (2018) conduct a field experiment with low income families in the UK and examine whether exposure to a healthy diet and regularity of food intake can shape dietary behaviors and children's BMI. At a three-year follow-up, treated children had a lower BMI than children in the control group. The adults, on the other hand, were completely unaffected, suggesting that eating behaviors are more malleable early in life. Similarly, Charness and Gneezy (2009) and Acland and Levy (2015) conduct field experiments to study the post-intervention effects of incentivizing people to go to the gym. Consistent with a model of taste formation, paying people to attend a gym increases attendance in the post-intervention period. Interestingly, Acland and Levy (2015) find that subjects are naive about their increase in gym attendance caused by the intervention, i.e. they do not seem to predict the persistence of behavior ex ante. We contribute to this literature by documenting whether parents perceive early health behaviors to persist from childhood to adulthood.

The paper is structured as follows: Section 2 provides a theoretical framework that motivates our research design, which is described in Section 3. Section 4 outlines the empirical strategy, while Section 5 provides summary statistics from our sample. Section 6 describes our findings, while Section 7 concludes.

2 Theoretical framework

In the following, we illustrate the role of beliefs in health investments and the formation of health over the life cycle with the help of a dynamic model. There are two periods, childhood $t = 1$ and adulthood $t = 2$, and two agents, the parent and their offspring. The decision maker during childhood is the parent, whose only objective is to maximize their offspring's utility, while the decision maker during adulthood is the offspring. Let there be two types of health investment, diet d_t and exercise e_t in each period t. For simplicity, let higher levels of investments correspond to 'healthier' levels, namely a lower number of calories and more hours of exercise. Let w_0 denote the initial weight endowment of the offspring at the beginning of childhood.

Health production technology: Weight w_1 and health h_1 at the end of childhood are modeled as a function of initial weight w_0, and the two health investments made during period 1:

$$w_1 = f_1^w(w_0, d_1, e_1)$$

$$h_1 = f_1^h(w_0, d_1, e_1)$$

Similarly, weight w_2 and health h_2 at the end of adulthood are modelled as a function of weight at the end of childhood w_1, and the two health investments made during period 2:

$$w_2 = f_2^w(w_1, d_2, e_2) = g_2^w(w_0, d_1, e_1, d_2, e_2)$$

$$h_2 = f_2^h(w_1, d_2, e_2) = g_2^h(w_0, d_1, e_1, d_2, e_2)$$

Given that w_1 is a function of w_0, d_1 and e_1, weight and health at the end of adulthood can be written as a function of the child's initial weight and the investments made during both time periods. We assume that the weight and health production functions are increasing and concave in d_t and e_t, and decreasing and convex in w_t.

Utility function: The offspring values being in good health but dislikes following a healthy diet and exercising. Let $\Omega(h_t)$ denote the direct utility the offspring derives from their health, which we assume to be increasing and concave in h_t, and $c_t^d > 0$ and $c_t^e > 0$ denote the utility cost for each unit of healthy diet and exercise in period t respectively. The instantaneous utility the offspring derives in period t can be written as:

$$U_t(h_t, d_t, e_t) = \Omega(h_t) - c_t^d d_t - c_t^e e_t.$$

Taste formation: Following the rational addiction model of Stigler and Becker (1977) and Becker and Murphy (1988), we allow the costs of health investments in period 2 to be a function of investments made in period 1, $c_2^d(d_1)$ and $c_2^e(e_1)$. This gives rise to the formation of tastes. We assume that the cost functions are decreasing in their arguments. Intuitively, this assumption means that following a healthy diet and exercising in adulthood is less costly if the offspring has followed a healthy diet and exercised during childhood. Put differently, the marginal utility of period 2 investments is increasing in period 1 investments. Consistent with Dragone and Ziebarth (2017), we define the formation of taste in diet as $\frac{\partial U_2^2(.)}{\partial d_2 d_1} > 0$ and the formation of taste in exercising as $\frac{\partial U_2^2(.)}{\partial e_2 e_1} > 0$.[7]

Solving the model: We solve the model through backward induction, starting in the second period. In $t = 2$, the offspring chooses d_2 and e_2 so as to maximize $U_2(h_2, d_2, e_2)$ taking the vector (w_0, d_1, e_1) as given. The costs of health investments, $c_2^d(d_1)$ and $c_2^e(e_1)$, are determined by the levels of investments in the previous period and are also treated as fixed. The offspring optimization problem is:

$$\max_{d_2, e_2} [\Omega(h_2(w_0, d_1, e_1, d_2, e_2)) - c_2^d(d_1)d_2 - c_2^e(e_1)e_2]$$

The first-order conditions for this maximization problem are:

$$\frac{\partial U_2}{\partial d_2} = \frac{\partial \Omega}{\partial h_2}\frac{\partial h_2}{\partial d_2} - c_2^d(d_1) = 0$$

$$\frac{\partial U_2}{\partial e_2} = \frac{\partial \Omega}{\partial h_2}\frac{\partial h_2}{\partial e_2} - c_2^e(e_1) = 0$$

The solution to this problem defines the optimal level of investments (d_2^*, e_2^*). Let the maximum utility the offspring can attain in adulthood be denoted as $V_2(w_0, e_1, d_1)$. In period 1, the parent chooses d_1 and e_1 so as to maximize the offspring's utility from both periods. Let the discount rate be denoted as β. The parent optimization problem is:

$$\max_{d_1, e_1} [\Omega(h_1(w_0, d_1, e_1)) - c_1^d d_1 - c_1^e e_1 + \beta V_2(w_0, e_1, d_1)]$$

The first-order conditions which define the optimal level of investments (d_1^*, e_1^*) are:

$$\frac{\partial \Omega(.)}{\partial h_1}\frac{\partial h_1}{\partial d_1} - c_1^d + \beta\frac{\partial V_2(.)}{\partial d_1} = 0$$

$$\frac{\partial \Omega(.)}{\partial h_1}\frac{\partial h_1}{\partial e_1} - c_1^e + \beta\frac{\partial V_2(.)}{\partial e_1} = 0$$

As can be seen from the first-order conditions, the returns to early investments are not confined to the benefits accrued in terms of health during childhood. A rise in early investments also changes the continuation value of the optimization problem.

[7] Another possibility is that the cost functions $c_2^d(d_1)$ and $c_2^e(e_1)$ are *increasing* in their arguments. The marginal utility of period 2 investments would then be decreasing in period 1 investments. Intuitively, this assumption means that following a healthy diet and exercising during childhood leads the offspring to be bored and fed-up with healthy behaviors, and therefore chooses to do the exact opposite in adulthood. See the discussion in Dragone and Ziebarth (2017) on how to empirically estimate this second derivative. Our elicitation method allows for both positive or negative second derivatives.

Returns to early investments: There are two main channels through which early investments (d_1, e_1) affect child health. First, following a healthy diet and exercising during childhood leads to better health at the end of childhood. Second, health investments during childhood influence adult health investments by changing their marginal cost. Therefore, early health investments improve adult health through their effect on weight at the end of childhood (channel 1) as well as through their effect on the costs of investments in the second time period (channel 2). An increase in period 1 investments lowers the costs of period 2 investments, which leads to higher period 2 investments. This follows directly from the first-order conditions of the optimization problem in $t = 2$. These increases in period 2 investments translate into improved health outcomes at the end of adulthood over and above the improvements in health that result from a lower weight at the beginning of adulthood. The returns to early investments, which operate through these different channels, are allowed to differ with the initial endowment level, w_0. Intuitively, the returns to diet and exercise as well as taste formation can be different depending on the weight of the offspring at baseline.

Parental beliefs: When choosing the levels of early investments d_1 and e_1, parents face a complex decision problem. They are unlikely to have perfect information about the properties of the health production function and the rate at which healthy behaviors persist into adulthood through the formation of tastes. Instead, parents are likely to form beliefs about the properties of the health production technology and the persistence of behaviors, and make investment decisions based on these beliefs.

There are various ways in which we allow parents to differ in their beliefs: first, we allow parents to differ in their perceptions about the marginal returns to early investments on offspring weight and health $(\frac{\partial w_1}{\partial d_1}, \frac{\partial w_1}{\partial e_1}, \frac{\partial h_1}{\partial d_1}, \frac{\partial h_1}{\partial e_1})$ as well as on adult weight and health $(\frac{\partial w_2}{\partial d_1}, \frac{\partial w_2}{\partial e_1}, \frac{\partial h_2}{\partial d_1}, \frac{\partial h_2}{\partial e_1})$. According to our model, we expect parents who perceive these returns as greater to choose higher levels of d_1 and e_1, and to have children of lower weight and better health. Second, we allow parents to differ in their perceptions about the complementarity/substitutability of a healthy diet and exercise $(\frac{\partial w_1^2}{\partial d_1 e_1}, \frac{\partial h_1^2}{\partial d_1 e_1}, \frac{\partial w_2^2}{\partial d_1 e_1}, \frac{\partial h_2^2}{\partial d_1 e_1})$, which will also play a role in their decision. Third, parents may perceive the returns to investments and the persistence of behaviors as different depending on the initial weight of the offspring, w_0. These differences might be important in explaining varying levels of investments across children of different weight at baseline. Finally, to shed more light on the channels through which early investments are perceived to affect adult weight and health, we allow parents to differ in their beliefs about the persistence of behaviors.[8] According to our model, we expect parents who

[8]Note that we allow parents to believe that behaviors in childhood will have a negative effect on adult behaviors, i.e. a negative cross-partial $\frac{\partial U_2^2(.)}{\partial d_2 d_1} < 0$ and $\frac{\partial U_2^2(.)}{\partial e_2 e_1} < 0$.

perceive the persistence of behaviors through the formation of tastes to be higher to also perceive the returns to early investments on adult weight and health as greater. Put differently, our model predicts that we can explain at least part of the perceived effect of early investments on adult outcomes by perceptions about the persistence of behaviors.

3 Eliciting parental beliefs

To gain a better understanding of how parents differ in their beliefs and how parental beliefs and health investments are related, we elicit parental beliefs using a novel survey design. More specifically, we use hypothetical investment scenarios to elicit parental beliefs about the different properties of the health production technology. Hypothetical investment scenarios have been used in a variety of different contexts and have been employed to elicit subjective expectations about the costs and benefits of a range of different behaviors (see, e.g., Manski 2004 and Delavande 2014 for recent reviews). In this paper, we build on the seminal work by Cunha, Elo and Culhane (2013), who were the first to propose the use of hypothetical investment scenarios to elicit parental beliefs about the returns to educational investments made in young children. A similar methodology has subsequently been employed by Attanasio, Boneva and Rauh (2018) and Boneva and Rauh (2018), who elicit parental beliefs about the returns to different educational investments made in school children. We advance the measurement of parental beliefs by adapting this methodology to the elicitation of beliefs about the returns to health investments (diet and exercise) and the persistence of health investment behaviors from childhood to adulthood.

There are different ways to elicit subjective expectations using hypothetical scenarios: first, a choice needs to be made about whether parents are asked about their own children or hypothetical children. There are several advantages and disadvantages to both methods, which are discussed in Delavande (2014). We chose to ask parents about hypothetical children rather than their own child because this allows us to hold the information about the hypothetical children constant. While we cannot fully rule out that parents use private information about their own child to inform their judgement about the hypothetical children, we chose this survey design to make parental responses as comparable as possible.[9] An additional advantage of this design is that we can vary the characteristics of the hypothetical children across respondents, which allows us to investigate whether parents perceive the

[9] While we tried to minimize the role of private information based on the respondent's own child, we cannot rule out that parents use this to inform their judgement about the hypothetical children.

returns to health investments to be different depending on the characteristics of the child. Second, subjective expectations about probabilities can be elicited in different ways. One possibility is to use a chance scale (0-100%), which has been used in a variety of different contexts (see, e.g. Manski 2004 and Hurd 2009 for a review). Alternatively, one can ask respondents about natural frequencies rather than probabilities. This method has been used in a variety of different studies that elicit subjective probabilities about different outcomes such as survival or HIV status and transmission rates (e.g., Delavande and Kohler 2009, De Paula, Shapira and Todd 2014, Delavande and Kohler 2016, Delavande, Lee and Menon 2017). The method has the advantage that natural frequencies are less abstract and easier to understand (Hoffrage et al. 2000), and that the questions allow for the visual representation of replies (see Delavande 2014 for a discussion of this method). We chose to use this method and to elicit perceptions about natural frequencies using sliders, which we provide more detail on below. All questions can be found in Appendix B.

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. The scenarios vary in the diet (d_1) and exercise (e_1) the children follow in the childhood period ($t = 1$). More specifically, we vary (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").[10] 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.[11] In total, parents are thus presented with four hypothetical investment scenarios varying in diet (d_1) and exercise (e_1). These four scenarios are (i) unhealthy exercise and unhealthy diet, (ii) unhealthy exercise and healthy diet, (iii) healthy exercise and unhealthy diet, and (iv) healthy exercise and healthy diet.

For each scenario j, we are interested in five different outcomes, namely being overweight (w_1) and depressed (h_1) at the end of childhood (age 18), and being alive, overweight (w_2) and suffering from

[10] The recommended number of calories for children varies by gender and age of the child. For example, a 12 year old boy is estimated to require 2247 kilocalories per day, while an 18 year old boy requires 3155 kilocalories. For further details, see Table 15 in 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.

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

a heart disease (h_2) at the end of adulthood (age 65), conditional on being alive at age 65. 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. By comparing individual responses across different scenarios, we are able to obtain measures of parental beliefs about the returns to early investments and the complementarity/substitutability of diet and exercise.

Taste formation: To elicit parental beliefs about the persistence of health investments from childhood to adulthood which could arise through the formation of tastes, we ask respondents to think about whether the children in the hypothetical scenarios are likely to keep or change their diet and exercise routines when they become adults. More specifically, we present parents with four scenarios in which we specify the diet (d_1) or exercise routine (e_1) of 100 boys aged 5-18 and ask parents to guess how many of those boys will still follow similar diets or exercise routines as adults. The boys in the four scenarios are described as (i) eating the daily recommended amount of calories, (ii) eating one-and-a-half times the daily recommended amount of calories, (iii) exercising for 60 minutes every day, or (iv) not exercising.

Initial endowment: While all parents are presented with scenarios that vary in d_1 and e_1 in the same way, the initial weight of the children in the scenarios w_0 is randomized across respondents. 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 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.

4 Empirical strategy

Our research design allows us to explore several important research questions: first, we examine parental beliefs about the shape of the health production technology. Second, we explore parental beliefs about the persistence of health behaviors and whether these beliefs can be represented by our model of taste formation outlined in Section 2. Third, we examine the extent to which parental beliefs are related to actual health investments and outcomes. We use different empirical specifications to study the different questions of interest.

Parental beliefs about the health technology: To study parents' perceptions about the properties of the production technology, we estimate the following empirical specification using least squares regressions:

$$y_{jik} = \alpha_k + \beta_{1k} d_{1j} + \beta_{2k} e_{1j} + \beta_{3k} d_{1j} \times e_{1j} + \gamma_{ik} + \epsilon_{jik} \quad \forall k \tag{1}$$

where y_{jik} is the outcome k parent i expects in scenario j, α_k denotes the intercept, d_{1j} is a dummy variable equal to 1 if scenario j involves a healthy diet in childhood (and zero otherwise), e_{1j} is a dummy variable equal to 1 if scenario j involves a healthy exercise investment (and zero otherwise), and γ_{ik} are parental fixed effects. As explained above, we study five different outcomes and estimate this specification separately for each outcome. The estimates of β_{1k} and β_{2k} allow us to explore how parents on average perceive the marginal return to early diet and exercise investments on the given outcome ($\frac{\partial y_k}{\partial d_1}, \frac{\partial y_k}{\partial e_1}$), holding the other type of investment constant at the 'unhealthy' level of investment. The estimate of β_{3k} allows us to examine whether parents on average perceive the two investments as complements or substitutes ($\frac{\partial y_k^2}{\partial d_1 \partial e_1}$). Taking y_k 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, we expect β_{1k} and β_{2k} to be positive. If parents perceive the two inputs to be substitutes (complements), we expect β_{3k} to be negative (positive). These estimates are a local linear approximation of the derivatives of the perceived functions $f_1(\cdot)$ and $g_2(\cdot)$ presented in the theoretical model outlined in Section 2.

As explained in Section 3, we randomize the initial weight of the children in the scenarios across respondents. We present all results separately for the two groups. A comparison of the estimated coefficients across the different groups allows us to investigate whether parents perceive the marginal returns as different depending on the initial weight of the child. If parents on average perceive the returns to investments to be higher (lower) if the child is initially overweight, then we would expect β_{1k} and β_{2k} to be larger (smaller) in absolute magnitude for parents confronted with this scenario. We can also examine whether the degree to which the inputs are perceived as substitutable varies with the initial weight of the child. Results are described in Section 6.1.

Persistence of behaviors: The theoretical model outlined in Section 2 allows for different channels through which early investments can affect adult outcomes. Early investments can improve adult health through their effect on weight at the end of childhood (channel 1) as well as through their effect on the costs of investments in the second period (channel 2). In the presence of taste formation, our model predicts that we can explain at least part of the perceived effect of early investments on adult outcomes by perceptions about the persistence of behaviors. To study the importance of the different channels, we estimate the following empirical specification using least squares regressions:

$$y_{jik} = \alpha_k + \beta_{1k}d_{1j} + \beta_{2k}e_{1j} + \beta_{3k}d_{1j} \times e_{1j} + \beta_{4k}d_{2j} + \beta_{5k}e_{2j} + \beta_{6k}w_{1j} + \gamma_{ik} + \epsilon_{jik} \quad \forall k \tag{2}$$

where y_{jik} is outcome k parent i expects in scenario j, d_{2j} and e_{2j} capture the (perceived) probability that a healthy diet and exercise are followed in adulthood in scenario j, and w_{1j} is the (perceived) probability that the child is overweight at the end of childhood in scenario j. We estimate this specification separately for each of the three adult outcomes we measure. We also perform the analyses separately for the two groups who were presented with different initial weight endowments (w_0). We test several different hypotheses: first, we test whether perceptions about adult investments, d_{2j} and e_{2j}, as well as weight at the end of childhood, w_{1j}, predict parents' beliefs about adult outcomes. Second, we investigate whether the coefficients on early diet and exercise investments (β_{1k} and β_{2k}) are estimated to be smaller (in absolute value) once we control for d_{2j}, e_{2j} and w_{1j}, which would be consistent with the dynamic model featuring taste formation derived in Section 2. Results are described in Section 6.2.

Prediction of health investments and outcomes: To understand whether parental beliefs are predictive of actual health investments and outcomes, we calculate the perceived returns to investments separately for each parent, and relate parental beliefs about returns to their children's current time spent exercising and overweight status. We first compute individual perceived returns to a healthy diet, r^d_{ik}, and a healthy exercise routine, r^e_{ik}, for each parent i and outcome k. This is possible given that each parent i is presented with four different scenarios j for each outcome k. More specifically, we calculate the perceived returns for each outcome k as:

$$r^d_{ik} = \frac{(y_{2ik} - y_{1ik}) + (y_{4ik} - y_{3ik})}{2} \quad \forall k \tag{3}$$

$$r^e_{ik} = \frac{(y_{3ik} - y_{1ik}) + (y_{4ik} - y_{2ik})}{2} \quad \forall k \tag{4}$$

where 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. The different outcomes are being overweight and depressed at age 18, and being alive, overweight and suffering from a heart disease at age 65.

Taken together, for each parent and type of investment, we now have five different measures of perceived returns. For the purpose of this analysis, it is useful to aggregate these five measures into one composite measure. One possibility would be to average over the returns we calculate for the five different outcomes. If all measures were equally informative, this would allow us to minimize the role of measurement error in the analysis. Instead, we follow a similar approach as Cunha, Elo and Culhane (2013) and allow for a richer specification that better captures measurement error when not all items are equally informative. In particular, let the measurement model be written as:

$$\begin{cases} r^d_{ik} = \alpha^d_{0,k} + \alpha^d_{1,k}\rho^d_i + \varepsilon^d_{ik} \text{ for } k \in \{1,...,5\} \\ r^e_{ik} = \alpha^e_{0,k} + \alpha^e_{1,k}\rho^e_i + \varepsilon^e_{ik} \text{ for } k \in \{1,...,5\} \end{cases} \tag{5}$$

where the latent constructs ρ^d_i and ρ^e_i represent parental beliefs about the returns to diet and exercise investments respectively, and ε^d_{ik} and ε^e_{ik} are the measurement errors associated with outcome k. We further relate these latent constructs to observed child outcomes, namely the child's overweight status and the number of hours the child spends exercising, by specifying the following equations:

$$\begin{cases} weight_i = \beta^w_0 + \beta^w_1\rho^d_i + \beta^w_2\rho^e_i + \beta^w_3 X_i + \varepsilon^w_i \\ exercise_i = \beta^e_0 + \beta^e_1\rho^d_i + \beta^e_2\rho^e_i + \beta^e_3 X_i + \varepsilon^e_i \end{cases} \tag{6}$$

We estimate the system of equations specified in (5) and (6) using maximum likelihood and the implicit subjective expectations about the returns to diet and exercise investments, ρ^d_i and ρ^e_i, via the Bartlett method. The latent constructs ρ^d_i and ρ^e_i are assumed to be normally distributed with mean zero and variance 1, while the error terms ε^d_{ik} and ε^e_{ik} are assumed to be jointly normally distributed and orthogonal to the latent constructs and the individual-level controls X_i.[12] This Structural Equation Modelling (SEM) approach has the advantage that it estimates the interrelated dependence of the different variables in a single analysis. Our estimation approach gives higher weight to perceived returns with a greater factor loading $\alpha^\delta_{1,k}$ and lower variance of measurement error ε^δ_{ik} for $\delta \in \{d, e\}$. The coefficients of interest are $\beta^w_1, \beta^w_2, \beta^e_1$ and β^e_2, namely whether the perceived returns to diet ρ^d_i and exercise ρ^e_i are predictive of the child being overweight or spending time exercising. We further use the Bartlett scores to investigate heterogeneity in perceived returns. Results are described in Section 6.3.

[12] Controls include age and gender of parent and child, parental BMI, whether the parent is single, parental employment, number of children, whether the parent has an undergraduate degree, the log of household income, whether the language spoken at home is mainly English, and the initial weight of the child in the scenario.

5 Data

To collect information on parental beliefs about the returns to health investments as well as actual health investments and outcomes for their children, we administered a survey among 391 parents in England. The survey data was collected online over June-July 2017 and 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 median time to complete the survey was 18 minutes. 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 to approximately 1,700 parents. These parents had participated in a previous study (Boneva and Rauh 2018) and had provided consent to be contacted again for future studies. The response rate for this study was about 23%.[13]

Table 1 presents descriptive statistics for our sample, including the height and weight of the responding parents and their children.[14] On average, responding parents are 1.66m tall and weigh 69kg, while the children are 1.60m tall and weigh 52kg. The body-mass index (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.

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. We present the average weekly number of minutes the children of our respondents engage in moderate exercise (e.g.

[13] To recruit participants for Boneva and Rauh (2018), parents were contacted via the parental mailing lists of 45 schools in England. To recruit the schools, the headteachers of schools listed on the Department for Education website were contacted in no specific order. Among the schools with which an initial contact was established, about half distributed the survey. More information on the sampling of schools and the characteristics of schools that participated can be found in Boneva and Rauh (2018).

[14] 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.

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. The distribution of moderate and intensive exercise as well as (log) total exercise can be seen in Appendix Figure A.4.

Table 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
Weekly moderate exercise (minutes)	285	270.942	0	1785
Weekly intensive exercise (minutes)	187.115	167.284	0	900
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 over 25, and as obese if they have a BMI 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.

In our data, 22% of children whose parents have a university degree are overweight compared to 28% of children whose parents do not have a university degree (p-value = 0.02). In Table A.1 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 slightly 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 suggest that being overweight is persistent across generations and that children from less educated parents are particularly likely to be overweight.

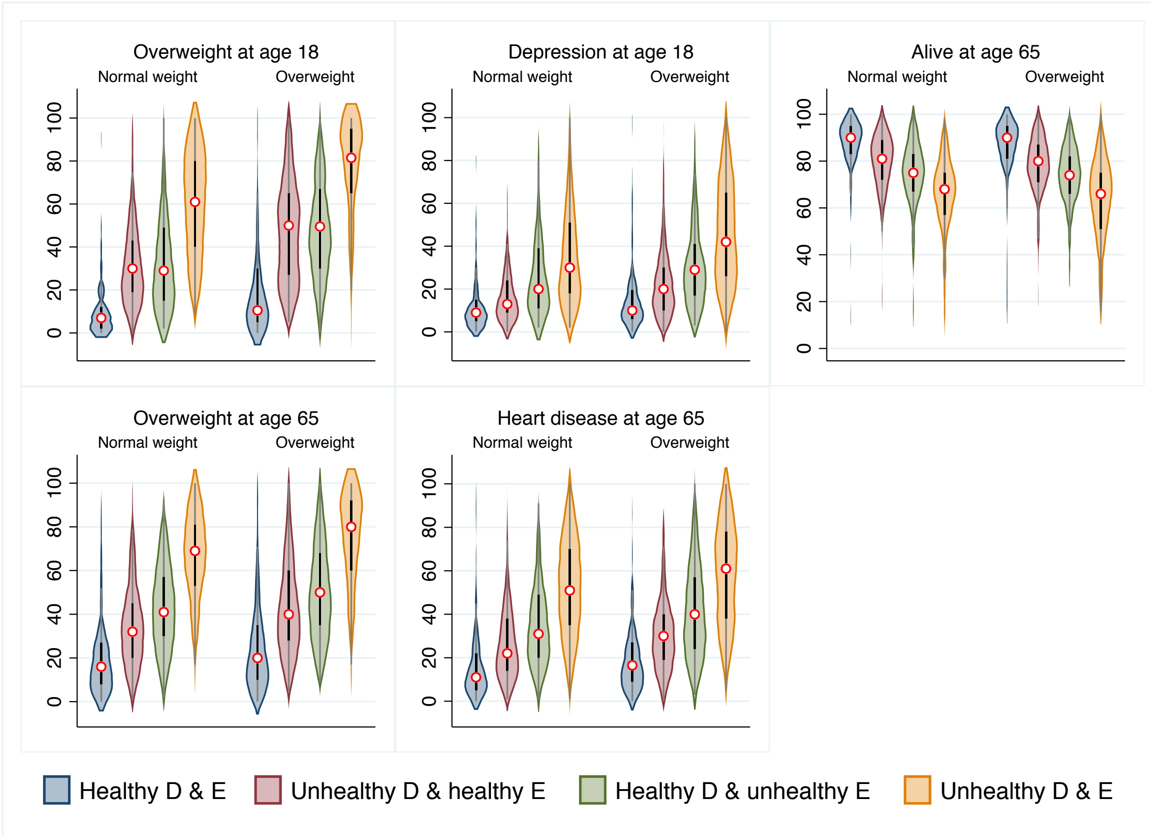
6 Results

6.1 Parental beliefs about the health technology

For each of the four hypothetical scenarios described in Section 3, all parents are asked to state how many of the 100 boys presented as part of the scenario are likely to experience a certain health outcome at a given age (18 or 65). Figure 1 presents the distribution of responses for each outcome in each scenario separately by whether the hypothetical boys were initially of normal weight (left) or overweight (right). For both health investments (diet and exercise), parents believe that if the investment is at the 'unhealthy' level, significantly more children are going to be overweight and depressed at age 18. Regarding the outcomes at age 65, parents believe that an unhealthy level of investments is related to a significantly lower survival rate and a higher prevalence of overweight and heart disease (conditional on being alive at age 65). The differences in median responses are large, indicating that parents perceive the returns to health investments to be high.[15] Parents perceive worse outcomes for boys who are described as being overweight at baseline. This level effect is larger for outcomes at age 18 than at age 65.

[15] 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. For example, 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 violin plots show how many of the 100 hypothetical boys are expected to face each outcome separately for the four scenarios and split by whether the hypothetical children were initially of normal weight (left) or overweight (right). "D" stands for diet and "E" for exercise. The circle represents the median, while the black bar covers 50% of the responses and the thin line 95% of responses. The width of the violin represents the density.

To estimate the perceived returns to a healthy diet and exercise routine, we pool parents' responses to the four scenarios and estimate the empirical specification presented in equation (1). Table 2 presents the results of ordinary least squares regressions in which we regress parents' responses on dummy variables which indicate whether 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. As explained in Section 3, we present all parents with the same four scenarios but randomize the initial weight of the hypothetical children across respondents. We investigate whether health investments are perceived as more or less productive and whether they are perceived as more or less substitutable depending on the initial weight of the children. Panel A of Table 2 presents the results for hypothetical boys who are initially of normal weight, while Panel B shows the results for boys who are overweight at baseline.

Table 2: Perceived returns by initial weight

	At age 18		At age 65		
	Overweight (1)	Depression (2)	Alive (3)	Overweight (4)	Heart disease (5)
Panel A: Hypothetical boys with initial normal weight					
Healthy diet	-28.162***	-10.215***	9.366***	-23.188***	-17.530***
	(1.439)	(0.872)	(0.662)	(1.245)	(1.044)
Healthy exercise	-28.173***	-19.867***	14.696***	-30.758***	-25.410***
	(1.508)	(1.355)	(0.911)	(1.490)	(1.340)
Healthy food * Healthy exercise	6.039***	4.856***	-0.959	8.015***	7.443***
	(1.533)	(0.807)	(0.694)	(1.324)	(0.989)
Sample mean	33.84	22.81	76.58	41.62	33.09
Parent fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	786	780	776	743	732
R-squared	0.66	0.48	0.59	0.67	0.65
Panel B: Hypothetical boys with initial overweight					
Healthy diet	-28.985***	-14.914***	9.737***	-23.425***	-16.385***
	(1.723)	(1.176)	(0.883)	(1.360)	(1.004)
Healthy exercise	-28.392***	-22.711***	14.855***	-29.721***	-26.190***
	(1.884)	(1.529)	(1.192)	(1.723)	(1.440)
Healthy food * Healthy exercise	1.655	6.235***	-1.812**	5.240***	4.741***
	(2.046)	(1.290)	(0.852)	(1.597)	(1.077)
Sample mean	48.17	29.30	75.21	48.88	38.01
Parent fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	776	749	744	716	696
R-squared	0.59	0.54	0.47	0.64	0.65

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses. The dependent variable is the number of 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.

Focusing on the results in Panel A, we find that parents on average believe that eating the daily recommended number of calories (rather than eating one-and-a-half times the recommended amount) reduces the probability of being overweight at age 18 by 28 percentage points (p.p.) and the probability of being depressed at age 18 by 10 p.p.[16] Interestingly, parents also believe that children's eating routine at ages 5-18 affect health outcomes much later in life. Children following a healthy diet when they are 5-18 years old are believed to have a 9 p.p. higher likelihood of surviving until age 65 and they are perceived as having a smaller likelihood of being overweight (-23 p.p.) and suffering from a heart disease (-18 p.p.) at age 65 (conditional on being alive). On average, parents believe that following a healthy diet in childhood has long-lasting effects, possibly due to the fact that tastes are formed early in life and persist into adulthood; a question which we investigate in more detail in Section 6.2.

[16] We are presenting the effects for boys who are not engaging in a healthy level of exercise.

Regarding parents' perceptions about the returns to exercising for 60 minutes every day (relative to not exercising), we find that parents on average believe that this health investment reduces the probability of being overweight at age 18 by 28 p.p. and the probability of being depressed at age 18 by 20 p.p.[17] 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 (+15 p.p.), and a negative effect on the probability of being overweight (-31 p.p.) and suffering from a heart disease (-25 p.p.), indicating that parents expect the positive impacts of following a healthy exercise routine in childhood to last 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 negative (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. Put differently, the returns to one investment are perceived as lower (in absolute terms) if the other investment is at the 'healthy' level.

Turning to the results in Panel B, we find that parents' beliefs about the returns to following a healthy diet and exercise routine are perceived as remarkably similar if the children in the hypothetical scenarios are described as overweight rather than having a normal weight. To test whether there are significant differences in the estimated coefficients by initial weight status, we estimate a fully interacted model that includes interactions between initial overweight status and diet and exercise (see Appendix Table A.2). With the exception of the perceived impact of a healthy diet on depression at age 18, which is perceived as greater if the children are initially overweight, we cannot reject the null hypothesis that the perceived returns are the same across the different initial endowment levels, indicating that parents perceive the returns as similar.

While we do not find much evidence that parents perceive the returns to a healthy diet or exercise routine to depend on the children's initial weight, we do find substantial level effects. In Table 3 we present the results from regressing the parental fixed effects estimated from the regressions presented in Table A.2 on a dummy indicating whether respondents were presented with the scenario in which the children were overweight at baseline as well as a range of parental background characteristics. Parents confronted with scenarios in which the boys were overweight at age 5 believe that at age 18 these boys are 16 p.p. more likely to be overweight and 9 p.p. more likely to be depressed. Even at age 65 they

[17] We are presenting the effects for boys who are not following a healthy diet.

still perceive these boys to be 8 p.p. more likely to be overweight and 5 p.p. more likely to suffer from heart disease. Parents of overweight children are more pessimistic about the health outcomes of the hypothetical children at age 18 (but not age 65). Concerning parental characteristics, we find that parents with higher income or education are slightly more optimistic about certain health outcomes.

Table 3: Explaining parental fixed effects

	At age 18		At age 65		
	Overweight (1)	Depression (2)	Alive (3)	Overweight (4)	Heart disease (5)
Initial overweight scenario	16.049***	9.476***	-1.871	8.393***	5.437**
	(1.917)	(1.842)	(1.420)	(2.067)	(2.126)
Log(Household income)	-0.378	-3.043	3.399**	-1.329	-2.712
	(1.915)	(2.221)	(1.396)	(1.993)	(2.596)
Parent has a university degree	1.717	-4.416**	0.502	-2.574	-1.267
	(2.243)	(2.223)	(1.692)	(2.670)	(2.472)
Male parent	-2.502	1.304	-2.849	4.000	3.391
	(2.700)	(2.663)	(2.265)	(2.876)	(2.660)
Parent age	-0.028	-0.117	0.206	0.086	-0.211
	(0.178)	(0.176)	(0.158)	(0.201)	(0.200)
Single parent	0.774	2.108	-1.479	-0.113	4.242
	(3.100)	(3.185)	(2.565)	(3.550)	(4.581)
Parent employed	3.312	5.156*	-2.876	2.434	0.647
	(3.001)	(2.763)	(2.271)	(3.293)	(3.741)
Number of children	-0.312	-0.373	0.116	-1.090	-1.580
	(1.414)	(1.474)	(0.929)	(1.491)	(1.437)
Child age	0.058	-0.202	-0.286	0.097	0.150
	(0.336)	(0.329)	(0.243)	(0.334)	(0.328)
Male child	-2.228	-1.147	2.043	-3.234	-2.374
	(2.042)	(1.885)	(1.487)	(2.224)	(2.193)
Parent overweight	0.182	2.332	-1.040	1.495	0.451
	(1.904)	(1.880)	(1.440)	(2.064)	(2.226)
Child overweight	6.077***	3.465	-2.377	1.828	3.302
	(2.302)	(2.177)	(1.498)	(2.677)	(2.580)
Constant	-5.857	37.041	-41.050**	7.641	38.947
	(22.437)	(24.984)	(16.395)	(24.422)	(29.838)
Observations	288	288	288	288	288
R-squared	0.24	0.16	0.08	0.09	0.07

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Bootstrapped standard errors in parentheses. The dependent variable is the number of boys expected to experience the relevant outcome. 'Initial overweight scenario' is a dummy variable equal to one if the parent faced hypothetical children who were overweight, and zero if they saw children of normal weight. 'Parent has a university degree' is a dummy variable equal to one if the responding parent has an undergraduate degree or higher, and zero otherwise. 'Parent employed' equals 1 if the responding parent works full-time, 0.5 if the parent works part-time and zero otherwise. 'Parent overweight' and 'Child overweight' are dummy variables indicating whether the responding parent and their child are overweight, respectively.

Overall, we conclude that parents perceive the initial level of endowment as well as health investments made during childhood to matter for later-life outcomes. Next we explore how parents perceive the persistence of behaviors and whether parents' perceptions about this persistence can explain why parents expect early endowments and investments to impact outcomes well into adulthood.

6.2 Persistence of behaviors

We measure parental beliefs about the persistence of behaviors by presenting parents with different scenarios that vary in their levels of investments (see Section 3). For each scenario, we ask parents how many of the 100 hypothetical boys in the scenarios are likely to have a similar eating or exercise routine as adults.

Parents believe that there is a high persistence of diet and exercise behaviors. 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 routine 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 behaviors into adulthood, we estimate the specification presented in equation (2), in which we additionally control 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.[18] The results presented in Table 4 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 behaviors later in life. The results are presented separately for parents who were presented with normal weight (columns 1-3) and overweight children (columns 4-6). While the results differ in magnitude across the samples, qualitatively they point in the same direction. 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 early healthy diet and exercise are now substantially reduced (in absolute value) compared to the coefficients estimated in Table 2.

We note that, albeit being muted, the direct effects of early diet and exercise are perceived to persist until age 65 above and beyond their effects on weight at age 18 and the likelihood of following

[18] We construct the variables in the following way: As can be seen in the questionnaire in Appendix B.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 behavior 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 analogue for the exercise variable.

a healthy diet and exercise routine during adulthood. Our stylized model would predict that e_1 and d_1 should no longer matter for outcomes at age 65 once we control for the probability of being overweight at age 18 and health investments in adulthood. It is easy, however, to imagine why this might not be the case. Health is multi-dimensional and being overweight at age 18 may not be a sufficient statistic for health. Exercise and diet early in life might be perceived as having an impact on other health outcomes or be perceived as having a cumulative effect, which is why parents might perceive e_1 and d_1 to still play a role for later-life outcomes. This result is consistent with the finding 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 4: Perceived returns on outcomes at age 65 (persistence)

	Normal weight at age 5			Overweight at age 5		
	(1) Alive	(2) Overweight	(3) Heart	(4) Alive	(5) Overweight	(6) Heart
Healthy food	5.732***	-11.689***	-9.821***	7.302***	-12.308***	-11.559***
	(1.034)	(2.202)	(1.626)	(1.770)	(2.136)	(1.508)
Healthy exercise	9.980***	-17.229***	-15.669***	10.662***	-17.092***	-18.274***
	(1.045)	(2.115)	(1.720)	(1.510)	(2.351)	(1.789)
Healthy food * Healthy exercise	-0.543	5.402***	5.889***	-1.949**	5.298***	4.557***
	(0.706)	(1.495)	(1.101)	(0.861)	(1.498)	(1.099)
Prob. healthy diet age 18-65	0.008	-0.008	-0.022	0.001	-0.052*	-0.013
	(0.018)	(0.027)	(0.023)	(0.030)	(0.029)	(0.022)
Prob. healthy exercise age 18-65	0.042**	-0.075**	-0.090***	0.071**	-0.154***	-0.134***
	(0.021)	(0.038)	(0.032)	(0.030)	(0.039)	(0.038)
Overweight at age 18	-0.111***	0.381***	0.226***	-0.093***	0.294***	0.145***
	(0.031)	(0.053)	(0.040)	(0.026)	(0.050)	(0.032)
Parent fixed effect	Yes	Yes	Yes	Yes	Yes	Yes
Sample mean	76.58	41.62	33.09	75.21	48.88	38.01
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 number of 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. 'Prob. healthy diet (exercise) age 18-65' is the likelihood of following the healthy diet (exercise) routine during adulthood. 'Overweight at age 18' is the probability of being overweight at age 18 under the particular scenario. Parent fixed effects are included.

Finally, we examine whether beliefs about behavior persistence differ systematically across respondents with different characteristics by regressing perceived behavior persistence variables on covariates. The dependent variables in Table 5 are the perceived persistence of a healthy routine (columns 1 and 4) and an unhealthy routine (columns 2 and 5), as well as the mean of the perceived persistence of a healthy and unhealthy routine (columns 3 and 6), i.e. perceived persistence in general.

Table 5: Explaining beliefs about behavior persistence

	Diet			Exercise		
	(1) Healthy	(2) Unhealthy	(3) Mean	(4) Healthy	(5) Unhealthy	(6) Mean
Initial overweight scenario	1.246	2.408***	1.827**	-4.165***	3.546***	-0.310
	(1.012)	(0.917)	(0.842)	(1.129)	(1.135)	(0.926)
Log(Household income)	0.795	-2.488***	-0.847	-4.109***	-3.023***	-3.566***
	(1.140)	(0.782)	(0.738)	(0.939)	(0.931)	(0.756)
Parent has a university degree	-2.953***	-1.424	-2.188**	1.017	2.983**	2.000*
	(1.098)	(1.061)	(0.945)	(1.313)	(1.377)	(1.156)
Male parent	2.283	0.611	1.447	2.077	0.165	1.121
	(1.431)	(1.430)	(1.284)	(1.622)	(1.761)	(1.371)
Parent age	0.280***	0.394***	0.337***	-0.157	0.052	-0.053
	(0.087)	(0.091)	(0.078)	(0.106)	(0.100)	(0.085)
Single parent	0.921	1.475	1.198	1.339	-2.579	-0.620
	(1.346)	(1.205)	(1.071)	(1.863)	(1.900)	(1.471)
Parent employed	-1.977	-1.711	-1.844	-2.226	-0.377	-1.301
	(1.416)	(1.487)	(1.249)	(1.815)	(1.752)	(1.462)
Number of children	0.662	-1.113*	-0.225	-1.094	-1.820**	-1.457**
	(0.725)	(0.613)	(0.520)	(0.815)	(0.785)	(0.631)
Child age	0.044	-0.526***	-0.241*	0.185	0.165	0.175
	(0.150)	(0.154)	(0.130)	(0.216)	(0.182)	(0.171)
Male child	1.433	0.543	0.988	3.388***	-0.260	1.564*
	(1.101)	(0.946)	(0.892)	(1.132)	(1.146)	(0.938)
Parent overweight	-3.171***	-1.111	-2.141**	1.275	-0.608	0.334
	(1.058)	(0.981)	(0.894)	(1.194)	(1.270)	(1.020)
Child overweight	-6.412***	-6.686***	-6.549***	0.202	-3.331**	-1.564
	(1.288)	(1.182)	(1.098)	(1.336)	(1.378)	(1.173)
Constant	52.603***	93.980***	73.291***	109.816***	102.549***	106.183***
	(12.379)	(8.543)	(7.999)	(10.445)	(10.362)	(8.475)
Sample mean	71.98	73.82	72.90	57.10	73.29	65.20
Parent fixed effects	No	No	No	No	No	No
Observations	1148	1148	1148	1148	1148	1148
R-squared	0.06	0.07	0.07	0.05	0.03	0.03

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses. Columns (1)-(3) refer to regressions involving the persistence of dietary behaviors, while Columns (4)-(6) look at the persistence of exercise routines. Within each block of three, the first column uses as the dependent variable the expected number of boys continuing with their healthy childhood diet/exercise routine, the second with their unhealthy routine, and the third with the mean of the two. 'Initial overweight scenario' is a dummy variable equal to one if the parent faced hypothetical children who were overweight, and zero if they saw children of normal weight. 'Parent has a university degree' is a dummy variable equal to one if the responding parent has an undergraduate degree or higher, and zero otherwise. 'Parent employed' equals 1 if the responding parent works full-time, 0.5 if the parent works part-time and zero otherwise. 'Parent overweight' and 'Child overweight' are dummy variables indicating whether the responding parent and their child are overweight respectively.

Parents with higher household income believe that unhealthy eating behaviors during childhood are less likely to persist into adulthood. Parents with a university degree believe that healthy eating behaviors are less likely to persist and also believe in less persistence of a dietary routine in general. Older parents believe that diet routines followed during childhood are more likely to persist into adulthood. Overweight parents are more pessimistic about a healthy diet followed during childhood persisting into adulthood. In general, overweight parents and parents of overweight children believe in less persistence of a dietary routine. Concerning exercise, we find that parents with overweight children are more optimistic about children abandoning their habit of not exercising when they become adults. However, parents confronted with the initially overweight children in the scenarios are more likely to believe that an unhealthy exercise routine will persist into adulthood and less likely to believe that a healthy one will persist.

6.3 Prediction of health investments and outcomes

On average, parents believe that diet and exercise choices made during childhood have a beneficial impact on health outcomes later in life. To what extent do parents differ in their beliefs about the returns to health investments, and are differences in parental beliefs predictive of children's actual health investments and outcomes? To answer these questions, we first describe the variation across parents in the perceived returns to a healthy diet, r^d_{ik}, and a healthy exercise routine, r^e_{ik}, for each outcome k, as calculated in equations (3) and (4). In Appendix Figure A.1, we plot the cumulative density of perceived returns separately for each outcome, while Appendix Figures A.2 and A.3 provide contour plots of the joint distributions. Both types of investments are believed to be beneficial on average, but we find evidence of a substantial degree of heterogeneity, as well as a positive correlation between perceived returns to diet and exercise.

Table 6: Predictors of children's weight outcomes and exercise behaviors

	(1) Overweight	(2) Log exercise
Perceived return to healthy diet	-0.076*	-0.068
	(0.040)	(0.077)
Perceived return to exercise	0.052	0.124*
	(0.038)	(0.075)
Observations	243	243

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Coefficients obtained through maximum likelihood estimation of structural equation modeling (SEM). Standard errors in parentheses. 'Overweight' is a dummy variable equalling one if the individual is overweight, and zero otherwise. 'Log exercise' is the log of the total time in minutes spent by the child on moderate and intensive exercise. 'Perceived return to healthy diet' and 'Perceived return to exercise' are the calculated Bartlett scores. Controls include age and gender of parent and child, parental BMI, whether the parent is single, parental employment, number of children, whether the parent has an undergraduate degree, the log of household income, whether the language spoken at home is mainly English, and the initial weight of the child in the scenario.

Secondly, we relate the children's current exercise routine and overweight status to a latent factor of perceived returns to diet ρ^d_i and exercise ρ^e_i, constructed by aggregating the perceived returns across the five different outcomes as described in Section 4.[19] The results are presented in Table 6.

Table 7: Correlates of Bartlett scores

	(1) Diet	(2) Exercise
Initial overweight scenario	0.085	0.122
	(0.118)	(0.123)
Log(Household income)	0.162	0.147
	(0.119)	(0.126)
Parent has a university degree	0.308**	0.033
	(0.146)	(0.153)
Male parent	-0.093	0.097
	(0.163)	(0.168)
Parent age	-0.001	-0.015
	(0.012)	(0.014)
Single parent	-0.130	0.111
	(0.211)	(0.220)
Parent employed	0.267	0.104
	(0.186)	(0.198)
Number of children	-0.026	-0.010
	(0.075)	(0.084)
Child age	0.005	0.030
	(0.020)	(0.022)
Male child	-0.104	0.035
	(0.120)	(0.130)
Parent overweight	-0.145	0.108
	(0.126)	(0.130)
Child overweight	-0.318**	-0.015
	(0.149)	(0.149)
R-squared	0.08	0.03
Observations	286	286

Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses. The dependent variables are the Bartlett scores of the combined returns to the five outcomes of a healthy diet (column 1) and exercise (column 2). 'Initial overweight scenario' is a dummy variable equal to one if the parent faced hypothetical children who were overweight, and zero if they saw children of normal weight. 'Parent has a university degree' is a dummy variable equal to one if the responding parent has an undergraduate degree or higher, and zero otherwise. 'Parent employed' equals 1 if the responding parent works full-time, 0.5 if the parent works part-time and zero otherwise. 'Parent overweight' and 'Child overweight' are dummy variables indicating whether the responding parent and their child are overweight respectively.

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 if their parents believe in the positive effects of a healthy diet.[20] More specifically, a one standard deviation increase in perceived returns to a healthy diet is associated with a reduction in

[19]The correlation between the two summary scores is 0.53. Therefore, parents who perceive the returns to a healthy diet to be high are also likely to perceive the returns to exercise to be high (and vice versa).

[20]We cannot exclude that reverse causality plays a role here as well. A parent with an overweight child might become more pessimistic about the returns to a healthy diet if those investments were deemed ineffective for their own child.

the probability of their child being overweight by 7.6 percentage points. We do not find a statistically significant relationship between perceived returns to exercise and the probability of being overweight. When relating the perceived return factors to reported exercise times, we find that children of parents perceiving higher returns to exercise spend more time exercising as presented in column (2) of Table 6. A one standard deviation increase in perceived returns to exercise is associated with children spending 12.4% more time on exercise. While we cannot interpret these results as causal, the results are consistent with a model in which parents act on their beliefs, i.e. invest more if they perceive the returns to be greater.

Given the large and growing socioeconomic gaps in health outcomes, a natural question which emerges is whether parents from different socioeconomic groups differ in their beliefs about the returns to health investments. Table 7 shows how parental characteristics relate to perceived returns to health investments, predicted using the Bartlett method. We find that parents with a university degree perceive the returns to a healthy diet to be 0.31 standard deviations higher.[21] If we were to interpret our results as causal and combine this estimate with the findings in Table 6 for a naive back-of-the-envelope calculation, then having a parent with a university degree would translate into a 2.4 p.p. reduction in the probability of being overweight. If we were to take these numbers at face value, SES differences in beliefs about returns would account for 40% of the SES gap in the probability of being overweight.

6.4 Discussion

There are several important questions which emerge from our study: first, are parental beliefs about the returns to health investments correct? Given that credible causal estimates of the effects of a healthy diet and exercise routine followed during childhood are not readily available and inherently difficult to estimate, we cannot provide a definite answer to this question. Using cross-sectional data from the UK National Nutrition and Diet Survey, we document that calorie intake is positively associated with the probability of being overweight, while time spent exercising is not (see Appendix Table A.3).[22] These

[21] We also separately estimate a variant of our main specification while splitting the sample by whether or not the responding parent has a university degree. In Appendix Figure A.5, we present the coefficients of the healthy diet (left panels) and exercise (right panels) dummies for each of the outcomes at age 18 (top panels) and 65 (bottom panels) for parents without a university degree (blue) and with a university degree (red). The evidence suggests that parents with a degree perceive the returns to health investments to be significantly 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.

[22] We note that a direct comparison of the estimated associations with the perceived returns we document is not possible due to potential issues of reverse causality and endogeneity that arise when estimating returns from cross-sectional data.

results are consistent with our finding that parents' perceptions about the returns to diet investments are significantly related to their children being overweight while their perceptions about the returns to exercising are not, despite the fact that these are related to the amount of time children spend exercising.

While we cannot judge whether parental beliefs are on average accurate, we note that a significant proportion of parents seem to underestimate the returns to a healthy diet and exercise routine on adult health outcomes. An extensive literature documents the beneficial effects of health investments on later-life outcomes (e.g. Lewis et al. 1997; Singh et al. 2008; Akbaraly et al. 2009; Hall et al. 2011; Mozaffarian et al. 2011; Colberg et al. 2016; World Health Organization 2016; Conner et al. 2017). In our survey, however, 5 to 10% of the parents perceive health investments to be ineffective (see Appendix Figure A.1). The possibility that some parents might be underestimating the beneficial returns to health investments resonates with existing work on parental misperceptions of child weight status. A recent meta-analysis concludes that about half of parents underestimate their children's overweight/obese status (Lundahl, Kidwell and Nelson 2014). While such misperceptions have been widely documented, recent evidence provides little hope for policy interventions targeting these misperceptions to tackle the obesity crisis. Overweight children whose parents appropriately classify them as overweight are just as likely to be overweight a few years later compared to overweight children whose parents misperceive their weight status (Parkinson et al. 2017). Correcting misperceptions about child weight through informational interventions also does not result in meaningful changes in parental behaviors or children's BMI (Prina and Royer 2014). We find that parents' perceptions about the importance of a healthy diet vary widely across the population and are predictive of children's weight status. At the same time, little is known about how beliefs are formed and whether beliefs are shaped by family or by peers. An important avenue for future research is to investigate whether informational interventions targeting parental beliefs about the returns to health investments rather than perception about child's BMI may be more effective in raising health investments and improving child health outcomes.[23]

Further open questions include the role of credit, time and knowledge constraints as well as differences in preferences. In order to gain some insights into these questions we ask parents whether they agree with a range of statements related to perceived constraints. We show the distribution of

If we were to take the estimates at face value, a back-of-the-envelope calculation would suggest that a boy with median calorie intake in this data would be nearly 10 p.p. more likely to be overweight if his calorie intake was 50% higher.

[23] 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 2019).

responses by parental background in Appendix Figure A.6. A χ^2-test for equality of distributions suggests that only for the statement 'I would cook/buy more healthy food if it was cheaper' do we find significant differences between parents with and without a university degree. This could hint at differences in perceived budget constraints. Future work should explore how traditional economic explanations such as time and budget constraints interact with beliefs and quantify the relative importance of the different factors to gain a better understanding of the most cost-effective ways for policies to be successful.

7 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 for children's 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 a healthy diet to be significantly greater. Given the large and rising socioeconomic gaps in health outcomes reported in many countries around the world, our descriptive evidence 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.

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Appendix

A Tables and figures

Table A.1: Conditional intergenerational weight transition matrix

Parent \ Child	Full sample R	Full sample O	Full sample N	No degree R	No degree O	No degree N	Has degree R	Has degree O	Has degree 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.2: 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	-28.162***	-10.215***	9.366***	-23.188***	-17.530***
	(1.437)	(0.871)	(0.661)	(1.244)	(1.043)
Healthy exercise	-28.173***	-19.867***	14.696***	-30.758***	-25.410***
	(1.506)	(1.353)	(0.910)	(1.488)	(1.339)
Healthy diet * Healthy exercise	6.039***	4.856***	-0.959	8.015***	7.443***
	(1.531)	(0.806)	(0.693)	(1.322)	(0.988)
Healthy diet * Initial overweight	-0.822	-4.699***	0.371	-0.236	1.145
	(2.242)	(1.462)	(1.102)	(1.841)	(1.446)
Healthy exercise * Initial overweight	-0.219	-2.845	0.159	1.037	-0.780
	(2.410)	(2.040)	(1.499)	(2.275)	(1.964)
Diet * Exercise * Overweight	-4.384*	1.379	-0.853	-2.774	-2.701*
	(2.553)	(1.519)	(1.097)	(2.072)	(1.460)
Constant	68.391***	41.502***	64.095***	70.281***	55.339***
	(0.813)	(0.676)	(0.527)	(0.776)	(0.675)
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	0.62	0.51	0.52	0.65	0.65

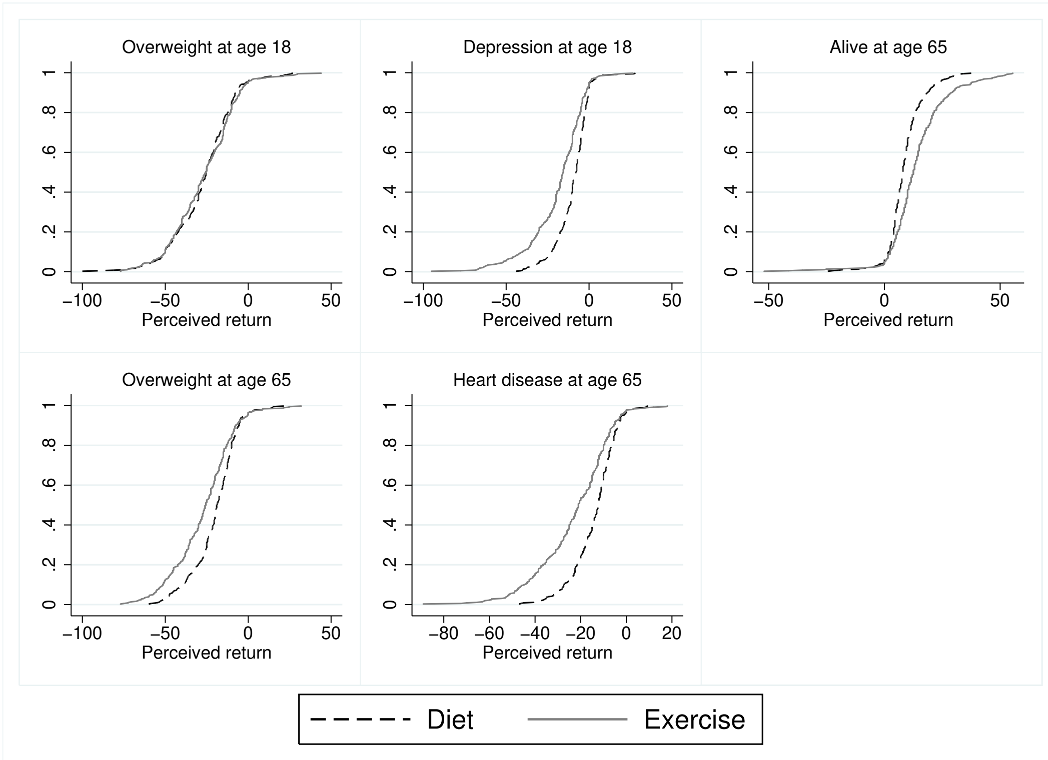
Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Robust standard errors in parentheses. The dependent variable is the expected number of the 100 hypothetical boys expected to experience the relevant outcome. 'Sample mean' gives the arithmetic mean of the corresponding dependent variable. 'Healthy diet' 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. '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.

Table A.3: Predictors of being overweight

	Overweight		
	(1)	(2)	(3)
Calories (kcal)	2.735*	2.745*	2.662*
	(1.617)	(1.612)	(1.586)
Exercise (min)	0.010	-0.015	-0.016
	(0.011)	(0.050)	(0.049)
Calories * Exercise		0.013	0.013
		(0.025)	(0.024)
Height (in meters)	1.528	1.524	1.533
	(1.849)	(1.844)	(1.809)
Height * Calories	-1.548*	-1.571*	-1.520*
	(0.915)	(0.914)	(0.899)
Parent has university degree			-0.269*
			(0.142)
Pseudo R^2	.06	.06	.09
Observations	185	185	185

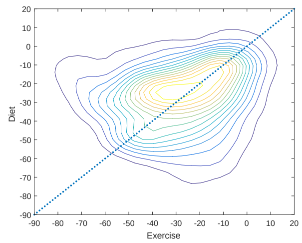
Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Standard errors are in parenthesis. All estimates are marginal effects from logit models including age dummies. The dependent variable is a dummy variable indicating whether the individual is overweight. 'Calories (kcal)' are the average energy intake in terms of kilocalories (1000 calories units) measured across four days. 'Exercise (min)' are the average time in minutes spent at moderate or vigorous physical activity measured across four days. The sample consists of adolescent boys aged 16-18. *Data source:* National Nutrition and Diet Survey.

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

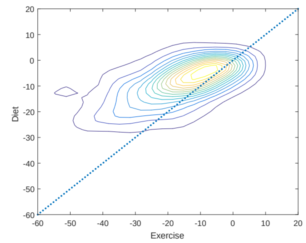


Note: The figures display the cumulative density of individual perceived returns calculated using Equations 3 and 4.

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

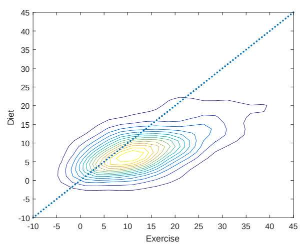


(a) Overweight

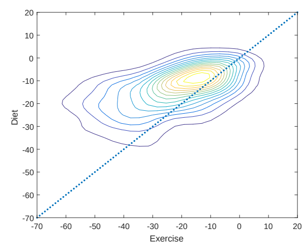


(b) Depression

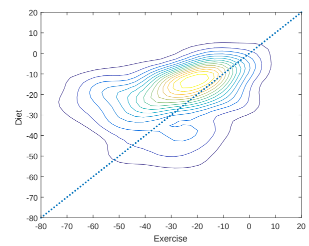
Figure A.3: Individual perceived returns (age 65)



(a) Alive



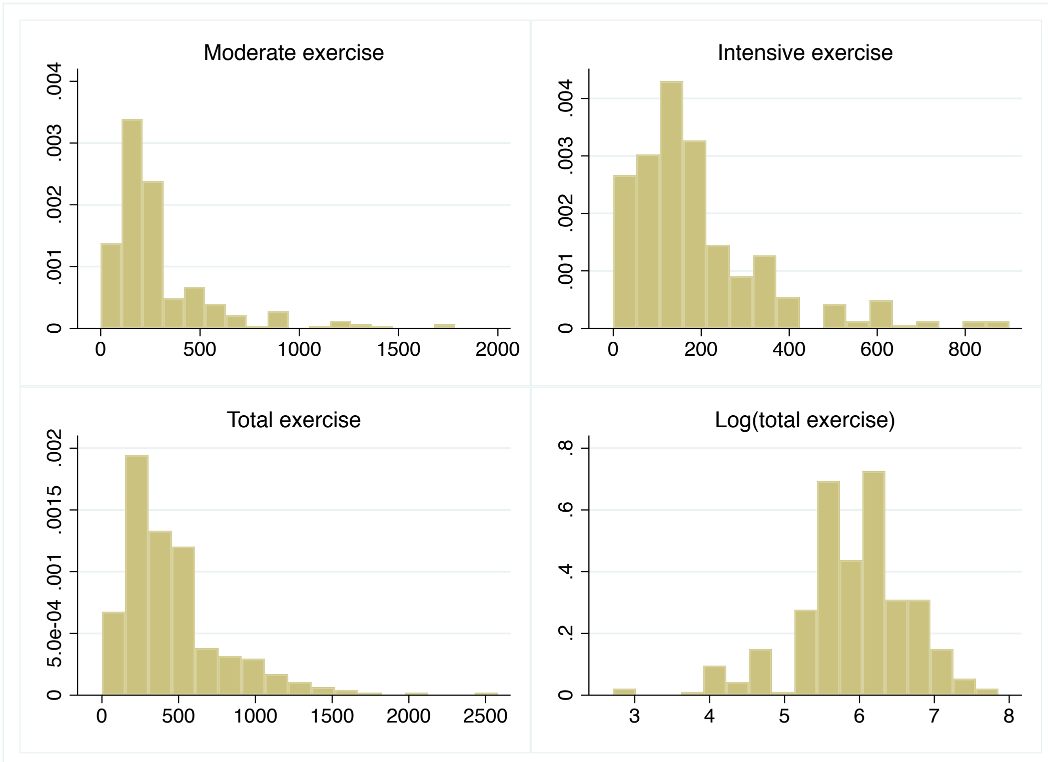
(b) Heart Disease



(c) Overweight

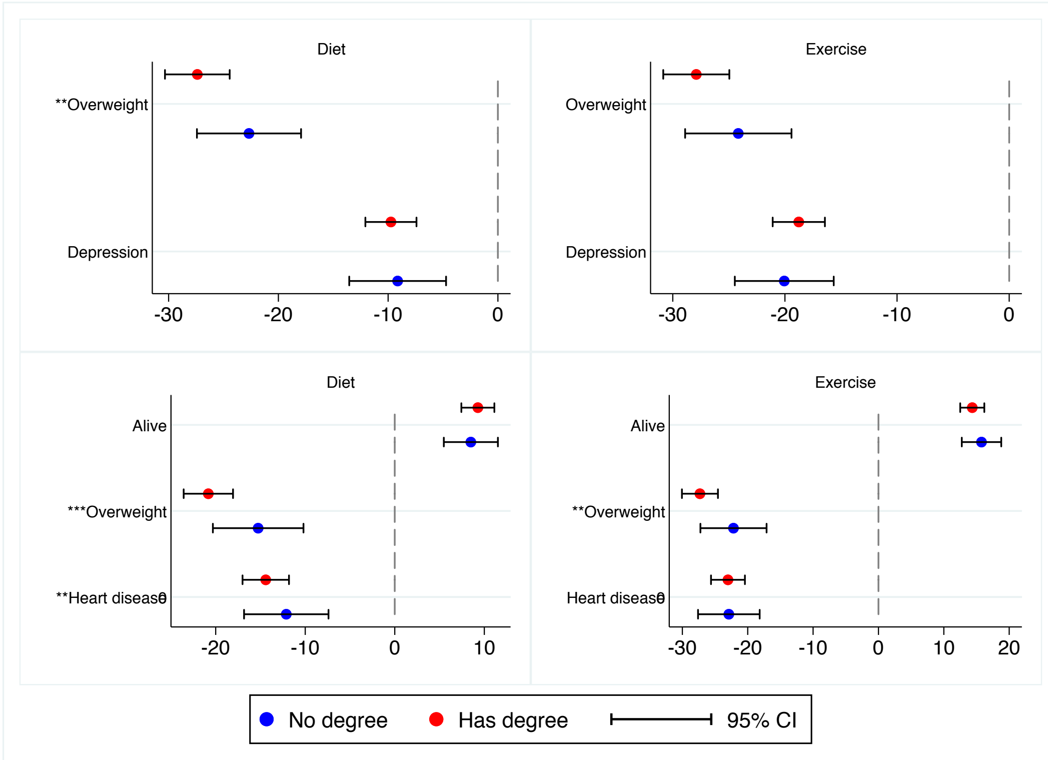
Note: These figures show 2D contour plots displaying the joint distribution of perceived returns to healthy diet and exercise investments for each of the five health outcomes (as calculated in Equations 3 and 4). Figure A.2 looks at age 18 health outcomes, while Figure A.3 looks at age 65 health outcomes.

Figure A.4: Time spent exercising (in minutes)



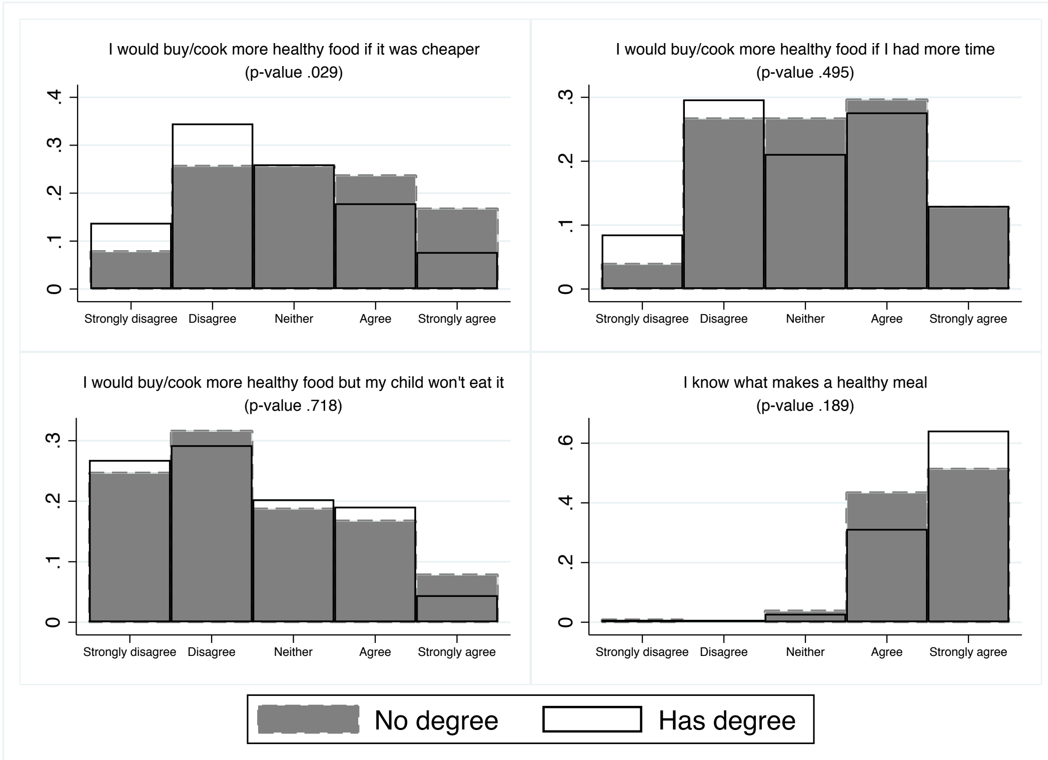
Note: The bottom left quadrant is the sum of moderate and intensive time, while the bottom right is the log of the total.

Figure A.5: Perceived returns by parental education



Note: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$ p-value of a t-test checking for equality of coefficients. 95% confidence intervals of coefficients are provided. The y-axis specifies the outcome variable of the regression and the x-axis the size of the coefficients. The top two panels show regressions using age 18 health outcomes as dependent variables, while the bottom two panels gives the regression results for age 65 health outcomes. The left panels show the coefficients of a 'healthy diet' dummy. The right panels show the coefficients of a 'healthy exercise' dummy. The blue dot gives regression results using only those parents without an undergraduate degree, while the red dot presents results from only parents with (at least) an undergraduate degree. 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, and the initial weight of the child in the scenario.

Figure A.6: Agreement with statements about healthy food by parental education



Note: The figure shows the distribution of levels of agreement to the statements in the subtitles. Responses are split by whether the responding parent has a university degree or not. We test the equality of distributions using a χ^2-test and provide corresponding p-values in brackets in each panel.

B Questionnaires

B.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.[24] *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...[25]

(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 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]

[24] 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'.

[25] 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.

B.2 Persistence of Behaviors

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?*[26] [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]

B.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,...)*

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