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Accumulation and transmission of inequality of opportunity in the double burden of malnutrition: the case of Mexico

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Abstract: Using a life-course perspective and based on Roemer's inequality of opportunity framework, the hypothesis of an accumulation and intergenerational transmission of *ex-ante* and *ex-post* inequality of opportunity in malnutrition is tested. This paper measures the evolution of inequalities in the light of the socioeconomic changes and the evolution of circumstances and efforts experienced by people born between 1983 and 1988 in Mexico. Using a combination of matching and re-weighting methods, a pseudo-birth-cohort is constructed and the effect of circumstances and efforts on inequality of opportunity is disentangled and measured across nutrition-related health outcomes. Results indicate that inequality of opportunity in malnutrition has been a persistent issue across the life course of the birth cohort and that lack of opportunities have been transmitted from parents to children. When disentangling the contribution of circumstances and efforts to inequality in malnutrition, we find that, on average, people's circumstances explain 72% of the explained variation, whereas efforts account for only 28%. We find that circumstances are the main driver of inequality in undernutrition and no consistent evidence that efforts play a significant role in explaining variation in outcomes associated with overnutrition. The empirical results are relevant for reconsidering the classical assumptions behind the "economics of obesity".

Keywords: Double burden of malnutrition; Inequality of Opportunity; Matching and re-weighting; Mexico

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1 Introduction

Over the past few decades, several upper and middle-income countries, Mexico included, have experienced significant epidemiological changes. Concurrently, eating patterns, nutritional status and the disease burden of the population have been radically modified. Somewhat paradoxically perhaps, at the same time, obesity, stunting and anaemia have been observed in populations, households and individuals (Kroker-Lobos et al., 2014; Shrimpton and Rokx, 2012; WHO, 2017). The determinants behind the coexistence of stunting and obesity in upper and middle-income countries have already been studied. Rapid urbanisation, demographic changes, the modification of dietary patterns and lifestyles are factors closely related to the *nutritional transition* and the *double burden of malnutrition* (Batal et al., 2018; Doak et al., 2005; Popkin, 2001, 2015; Popkin et al., 2012; WHO, 2017). Nutritional transition occurs when rapid modification of traditional diets and physical activity patterns take place, usually across socioeconomic and demographic groups. One characteristic is that local traditional eating patterns change towards westernised diets, which are high in fat, salt, sugar and with low nutritional value. This transition has preceded the double burden of malnutrition, so that now stunting and obesity jointly can be observed in the same households, populations or individuals (Tzioumis and Adair, 2014).

Political, macroeconomic and social changes also shape people's health. Mexico is a clear example. The macroeconomic shocks that occurred during the 1980s contributed to the nutrition-profile of the population. In 1988, the highest-ever level of inflation (4,030%) was registered. Consequently, purchasing power plummeted by 70%. The stagflation crisis led to the adoption of market-oriented economic policies, including trade liberalisation. In 1994 Mexico subscribed to the North American Free Trade Agreement (NAFTA) with the United States of America (USA) and Canada. This agreement aimed to remove barriers to free trade by eliminating any kind of tariffs on imports and exports between the three countries. Evidence suggests that NAFTA transformed Mexico's food system (Clark et al., 2012). The flow of corn, soybeans, livestock, meat and feedgrains, as well as sugar and sweeteners from the USA to Mexico increased dramatically. NAFTA has directly (and indirectly) changed Mexico's food supply chain. American direct investment in Mexico also grew, particularly the number of fast-food companies substantially increased. Thus, the Mexican diet changed from a traditional plant-based to energy and animal-dense and processed food diet (Clark et al., 2012). A study, that evaluated the effect of food trade between Mexico and the USA on obesity in Mexico, found that exposure to food imports from the USA explained up to 20% of the rise in obesity prevalence among women between 1988 and 2012 (Giuntella et al., 2020). Another study that focused on characterising the effects of the 90s economic crisis on calorie intake in Mexican households found that, in general, the total calorie intake did not change, although the consumption of expensive calories (meat, eggs, milk and soft drinks) increased and inexpensive staples (cereals, legumes, sugars) decreased. The study concluded that high energy, but non-nourishing calorie consumption emerged (Arroyo et al., 2004).

In terms of the social and health conditions, by the end of the 1980s, the Mexican population was facing a high risk of stunting, predominantly in indigenous populations, rural municipalities, in the South and Central regions, and in households with poor conditions and where mothers had a low educational background (Rivera-Dommarco et al., 1995). A study describing the level of iron deficiency among women of reproductive age found that the prevalence of anaemia among women was higher in pregnant compared with non-pregnant women. Results from this research also showed that anaemia prevalence was higher among indigenous women and women living in urban areas (Martinez et al., 1995). Another cross-sectional analysis about feeding patterns of infants in Mexico found that, in 1988 the hazard rate for terminating breast-feeding increased by 38% for each increment in the household's category of living conditions at the national level (Long-Dunlap et al., 1995). In terms of health coverage, by 1995 only half of the population had access to healthcare coverage (Leal and Martínez, 2002).

The study of the evolution of malnutrition in the light of the socioeconomic changes and the evolution of opportunities experienced in people born between 1983 and 1988 in Mexico is of high relevance. Not only because, to the best of our knowledge, there are no studies that have focused on analysing i) malnutrition, as a spectrum that includes both under and over-nutrition, ii) the accumulation of socioeconomic-related health inequalities during a life course of 30 years and, iii) the potential transmission of inequalities across generations. But also, because studying the potential accumulation and transmission of health inequalities raises important questions, from a philosophical and practical perspective. The scarcity of studies is mainly explained by the unavailability of data. Unfortunately, the dearth of longitudinal-data is a common issue in low and middle income countries, where nutritional transitions are happening. Although in Mexico there is the panel survey: "Mexican Family Life Survey" (MxFLS), its time horizon covers only 10 years, from 2002 to 2012. Hence, the potential life span to be studied is very short and does not allow an analysis of the effect of the 80s and 90s economic policies on individual's health.

This study aims to overcome the limitations previously described. We use nationally representative surveys that span a longer time period, from 1988 to 2018, and propose an empirical strategy that relies on the use of matching and re-weighting methods to construct a pseudo birth-cohort panel. This strategy allows us to analyse the potential accumulation and transmission of inequality of opportunity (IOp, hereinafter) in malnutrition-related health outcomes over a period of 30 years. The use of these surveys is relevant since it allows us to exploit the rich data about food consumption and physical activity that would not be possible if other sources of data are used. We tackle the measurement of IOp via two different methodological and philosophical approaches, one that is only concerned about inequalities between people that share the same circumstances (*ex-ante*), and another that focuses on inequality between people that exert equal effort (*ex-post*), the former concerned with the reward and the latter with the compensation principle. Furthermore, we measure these for several outcomes that account for different expressions of malnutrition such as obesity and underweight, but also undernourishment and anaemia. We find that *ex-ante* IOp has been persistent across the life-course of all the individuals born between 1983 and 1988 and also that inequalities in undernutrition have increased as individuals age, whereas inequalities in overnutrition have decreased as the cohort got older. Results also indicate that circumstances are the main driver of inequality in undernutrition across the life-span. However, we do not find clear and consistent evidence that efforts account for most of inequalities in excess weight or adiposity measured through the BMI and WC. This evidence poses relevant questions regarding multiple aspects, for example the idea about the dominant role of people's choices on obesity outcomes or the long-lasting effect of nutrition-related programmes for children that were and are currently implemented by the Federal government.

The remainder of this paper is divided into six sections. The following section presents two conceptual frameworks. First, the double burden of malnutrition is explained and second, IOp is conceptualised. The third section describes the empirical strategy and how this pseudo-birth cohort is constructed, as well as the approaches to the measurement of IOp. The fourth section explains the sources of data and describes the main variables of the analysis. The subsequent section shows the results of the analysis and the final section closes by presenting conclusions and a discussion of the results.

2 Conceptual frameworks

2.1 Double burden of malnutrition

Even though malnutrition is the coexistence of under (*a lack of*) and over (*an excess of*) nutrition, many researchers and policy-makers have neglected this continuum and analysed these separately. Undernutrition is mostly related with the lack of micro nutrients (vitamins and minerals) and overnutrition is conceived as an excess of macro nutrients (proteins, carbohydrates and fats), that leads to an excess of weight or adiposity. Furthermore, there seems to be a tacit idea that relates the two sides of malnutrition with specific age groups. For example, that undernutrition is mostly present in children and that obesity mostly happens among adults. This has been materialised in the nutrition-related policy-making of the past three decades in Mexico. Notwithstanding, empirical evidence has highlighted that a double burden can indeed manifest within populations, households or individuals across the lifespan (WHO, 2017). It could be the case that individuals that were exposed to different types of malnutrition during their childhood might be more likely to develop some sort of malnutrition later in life, but it could also be possible that in a given point of life individuals present both under and overnutrition.

The double burden of malnutrition (DBM) is a worrying public health problem that many countries currently face. Its negative consequences are significant. First, it causes higher morbidity and mortality among populations. Second, undernutrition in the first stages of life can cause impairments to education, low capacity to resist diseases later in life and lower social and labour inclusion (Shrimpton and Rokx, 2012). Third, it is costly for society. A study estimated that undernutrition costed, on average, 4.6% of the aggregated gross domestic product (GDP) of

11 Latin-American countries in 2017 (ECLAC, 2017). DBM represents a financial burden through higher associated health-care costs and lower labour productivity and, consequently, low economic growth and social development (WHO, 2017).

The DBM is closely related to the familial context. There are at least three potential mechanisms of health transmissions across generations: 1) the latency model, when some exposure over a specific period has a lifelong and irreversible effect on health that may be modified later; 2) the pathway model, when several biological and psycho-social intermediate factors between early life and adult health may all matter for health changes (Jacob et al., 2017) and, 3) the intergenerational transmission, where parental health is related to children's health (Trannoy et al., 2010). Thus, familial circumstances, behaviours and contexts (an obesogenic environment, for instance) are key factors for the future health status of individuals (Aitsi-Selmi, 2015; Crossman et al., 2006; Kral and Rauh, 2010; McCormack et al., 2011; Reyes et al., 2004; Silveira et al., 2010). A better understanding of the origins and socioeconomic mechanisms behind the DBM is paramount to prevent and tackle the negative social and economic consequences of this phenomenon. The IOp framework offers a suitable approach to further this aim.

2.2 Inequality of opportunity

The (in)equality of opportunity framework was developed in order to distinguish between fair (legitimate) and unfair (illegitimate) sources of disparities. This implies that inequalities are not *per se* negative among societies. The vast literature on this topic has agreed upon two points. First, that there are factors that individuals cannot control or choose (circumstances) and efforts that people exert based on their free will and, in contrast to circumstances, efforts represent factors or choices that people can control, decide upon and therefore, be responsible for. Nevertheless, where to set the distinction between these two concepts has been a matter of debate, some argue that this differentiation can be made through the "responsibility-cut" (Jones, 2019; Roemer, 1998). Under this perspective, it is implicitly assumed that, to some extent, people are aware and conscious about the consequences of their acts. In the same vein, the distinction could be set according to a "legal age" (Arneson, 1989; Brunori, 2017; Jusot and Tubeuf, 2019), that reflects the age at which individuals can consciously comprehend their acts and actions, and be accountable for their potential consequences. In this context for example, the measurement of IOp in children should include only circumstances since, by definition, children do not choose or decide upon their acts, and thus cannot be held responsible for their lifestyles or eating consumption decisions. At most, children's circumstances reflect parents efforts.

Second, that there are two ethical principles reflected in the *ex-ante* and *ex-post* inequality measures: the reward and the compensation principles. The former demands that efforts exerted should be rewarded and respected when designing redistribution policies and the latter claims that inequality due to circumstances should be eliminated or compensated for (Jusot and Tubeuf, 2019). The reward principle, associated with *ex-ante* IOp implies that an inequality measure should not reflect within-type inequality, while the compensation principle, related with the *ex-post* approach, implies that the inequality measure should fully reflect within-tranche inequality (Brunori et al., 2022). The IOp framework proposed by John Roemer offers a better comprehension of the interplay between circumstances and the role of mediating factors, such as efforts and choices, that people exert across different stages of the lifecourse. The *ex ante* approach focuses on the measurement of people's opportunities *before* any effort is realised; thus, it concentrates on inequalities related to circumstances only (Davillas and Jones, 2020). In contrast, the *ex post* considers heterogeneity in the level of outcomes within people that have exerted the same level of effort (Ramos and Van de Gaer, 2016). The application of this framework in tracking the DBM allows us to identify how inequalities potentially accumulate, transmit and reproduce across the life-cycle and whether efforts play a mediating role in this process.

3 Empirical strategy

The analysis of accumulation of inequalities across the life cycle would, ideally, require either household or individual panel data to track individuals over a long period of time. Unfortunately such detailed longitudinal data for a significantly long time horizon are not available neither for Mexico nor other low and middle-income countries. Instead, this study relies on repeated cross-sections of individuals and exploits matching and weighting techniques to construct a pseudo-birth cohorts to mimic life cycle data. The approach consists of observing a cohort of people born between 1983 and 1988 and following matched individuals across 35 years as the cohort has aged. Children that were newborn and up to five years old in 1988 are compared with matched older individuals into adulthood. In this way, conditional on matching, the study simulates the ageing of the initial cohort (see Figure 1). For instance, individuals that were newborn in the 1988 survey would be 11 years old in 1999, 18 in 2006, 24 in 2012, 28 in 2016 and 30 years old in 2018. The use of matching and reweighting methods ensures that the six cross-sections can be regarded as representative samples of individuals from the same birth cohort at different points in time. This innovative way of dealing with the lack of longitudinal data, not only permits the study of the evolution of health inequalities over time, but also guarantees that cross sectional measures of inequality are comparable (in aggregate terms) over time since they represent the same underlying population represented by the birth cohort. Figure 1 illustrates the study design. It shows how individuals included in all nutrition surveys in Mexico, and that were born between 1983 and 1988 are used to construct a pseudo-cohort to follow them from childhood into adulthood.

To ensure that the samples can be regarded as representative of individuals from the same birth cohort at different points in time, matching and weighting methods proposed by Blackwell et al., 2009 are followed. This approach was originally designed for causal evaluation purposes, it is particularly useful when the identification strategy relies on observable characteristics and the treatment and control groups need to be balanced across covariates. We use the approach for group-balancing purposes. In what follows, the terms treatment and control groups refer to the different surveys. Formally, n represents a random sample taken from a population of N individuals, $n \leq N$. T_i is a variable that indicates whether individuals are present either in the treatment or control surveys. For our case, the treatment survey is the 1988 National Nutrition Survey (NNS) and all other surveys will be defined as controls, such that T_i=1 if i is in the 1988 NNS and T_i=0 if i belongs to the 1999, 2006, 2012, 2016 or 2018 surveys. Balance, defined as when covariate means across treatment and control cross-sections are statistically equivalent, is achieved by matching samples on observational data. Essentially selecting 1988 as a baseline (treated) group and separately matching observations from each of the other years to the baseline. The matching covariates, X, are time-invariant individual characteristics.

Once the matching variables have been defined, the following step is to create strata according to the matching covariates. Exact and many-to-one matching is used, such that multiple control individuals can be matched to a treated individual. Matching weights are calculated for each observation by dividing the number of treated by control observations in each strata, adjusting by a normalisation factor (Porro and Iacus, 2009), as:

$$W_{Cs} = \left(\frac{m^s_T}{m^s_C}\right) * \frac{m_{Cn}}{m_{Tn}}$$

Where m_T^s equals the number of treated observations T within strata s. Likewise, m_C^s is the number of control observations C within strata s. In the *normalisation factor*, $\frac{m_{Cn}}{m_{Tn}}$, m_{Tn} indicates the number of T in the n sample. The same applies for m_{Cn}. The individuals from the baseline will have weights of unity and the control individuals in other years will be assigned a matching positive weight.

IOp is measured under both, the *ex-ante* and *ex-post* approaches assuming an ethical point of view where an age of responsibility cutoff differentiates between circumstances and efforts. This is according to the "legal age" threshold and builds upon the IOp literature that highlights that although *ex post* compensation and liberal reward are inconsistently related to the timing of the choice to exert efforts, the *ex ante* compensation and liberal reward are consistent (Fleurbaey and Peragine, 2013). For this analysis, this cut-point is set at 18 years old. This age has been chosen based on the legal norms about the minimum age at which, in Mexico, it is permitted to buy and consume tobacco and alcoholic beverages, be able to vote, and to contract legal responsibilities such as: getting married, opening a bank account, eligibility for bank credit, etc. Furthermore, nutritional age restrictions are imposed due to paternalistic motivations to protect children who are deemed incapable of making rational decisions because they are unable to considerate the future consequences of their actions.

Table 1: IOp across the lifespan: empirical analysis design

Birth cohort						
1988	>0 yo...	11 yo...	18 yo ...	24 yo...	28 yo...	30 yo
1987	1 yo...	12 yo...	19 yo...	25 yo...	29 yo...	31 yo...
1986	2 yo...	13 yo...	20 yo...	26 yo...	30 yo...	32 yo...
1985	3 yo...	14 yo...	21 yo...	27 yo...	31 yo...	33 yo...
1984	4 yo...	15 yo...	22 yo...	28 yo...	32 yo...	34 yo...
1983	$\leq$ 5 yo...	$\leq$ 16 yo...	$\leq$ 23 yo...	$\leq$ 29 yo...	$\leq$ 33 yo...	$\leq$ 35 yo...
	Children	**Adolescents**	**Adults**			
Survey respondents:						
	Preschool children: <5	Preschool children: <5	Preschool children: <5	Preschool children: <5	Preschool children:<5	Preschool children: <5
		School children:5-11	School children:5-11	School children:5-9	-School children:5-9	School children:5-9
	Women: 12-49	Adolescents: 12-19	Adolescents: 12-19	Adolescents: 10-19	Adolescents: 10-19	Adolescents: 10-19
		Women: 12-49 >20	Adults >20	Adults >20	Adults >20	Adults >20
Survey year	**1988**	**1999**	**2006**	**2012**	**2016**	**2018**
	Estimation of *ex-ante* inequality of opportunity					
			Estimation of *ex-post* inequality of opportunity			

Note: yo= years old

3.1 Measuring inequality of opportunity

We measure *ex-ante* IOp at different points of age, following the direct, mean-based and parametric approach proposed by Ferreira and Gignoux (2011) and that has already been applied to health by Davillas and Jones (2020). We also measure *ex-post* IOp following the approach proposed originally by Trannoy et al. (2010) and recently applied to biomarkers by Carrieri et al. (2020). This latter approach is only estimated to individuals above the "responsibility-cut" age.

Roemer's benchmark model applied to health assumes that a health outcome (y_i) of an individual i is a function of their circumstances, C, their efforts, E, and other random factors, such as "luck", u_i. In this model, individuals that observe the same circumstances belong to the same *type*, whereas those that exert the same effort belong to the same *tranche*. Individuals that share same circumstances and efforts belong to the same *cell*. In a non-parametric approach, Roemer proposes to split the distribution of effort into quantiles in order to make the degree of effort exerted by individuals of different types comparable. Individuals that exerted the same degree of effort and therefore belong to the same quantile (q) within each type belong to the same cell as well. An important aspect in the model is that the distribution of effort within each type is a circumstance by itself, since it is beyond the individual's control (Rosa Dias, 2009). The model allows efforts to be dependant on individual circumstances together with factors that are beyond people's circumstances, v_i.

$$y_i = h(C_i, E(C_i, v_i), u_i)$$

Assuming additive separability and linearity in $h(.)$ and $E(.)$ a system of equations can be written in the following structural form:

$$y_i = \alpha_0 + \alpha_1 C_i + \alpha_2 E_i + u_i \tag{1}$$

$$E_i = \delta_0 + \delta_1 C_i + v_i \tag{2}$$

In equation (1), α_1 and α_2 are coefficients that respectively capture the direct effect of circumstances and efforts on the outcome y for individual $i = 1, ..., N$. In equation (2), δ_1 represents the indirect effect of circumstances on efforts. Equation (2) can be rearranged such that,

$$v_i = E_i - \delta_0 - \delta_1 C_i$$

which is equivalent to

$$v_i = E_i - \mathbb{E}(E_i | C_i)$$

Thus, the estimator of v_i is

$$\hat{v}_i = E_i - \hat{E}_i$$

The model also assumes that $h(.)$ is continuous and strictly increasing in C and E.

3.1.1 *Ex-ante* IOp

This type of IOp focuses on measuring the role of circumstances on people's outcomes, before efforts are exerted. Thus, in the *ex-ante* approach effort is unobservable. In practice, we have the mean-based, parametric and reduced form to measure *ex-ante* IOp by inserting equation (2) into (1) and arranging the terms, such that:

$$y_i = \beta_0 + \beta_1 C_i + \epsilon_i \tag{3}$$

Where y_i are the health outcomes for individual i. β_0 =$(\alpha_0 + \alpha_2\delta_0)$ is the intercept, β_1= $(\alpha_1 + \alpha_2\delta_1)$ captures the total contribution of circumstances, reflecting the direct effects of circumstances on the outcomes and the indirect effect of circumstances through efforts. ϵ_i=$(\alpha_2 v_i + u_i)$ depicts the error term that captures random factors not captured by circumstances nor efforts such as luck, lack of talent, motivation, physical impediments, etc. Hence, from equation (3) the total effect of circumstances, which comprises the direct and indirect effect of circumstances through effort, is estimated.

The mean-based approach assumes inequality neutrality. Given that effort is not observed and that the stock of health monotonically increases with effort, the *ex-ante approach* also assumes that once types are fixed, effort is the only determinant of health. Thus, within each type, those individuals at the q^{th} quantile of the outcome distribution, on average, also belong to the q^{th} quantile of the effort distribution (Rosa Dias, 2009).

Measuring *ex-ante* IOp is a two-step procedure. The first is to estimate Equation (3) to obtain a counterfactual distribution of the outcome *if* no differences in outcomes arise as consequence of having different circumstances (Davillas and Jones, 2020). In practical terms, this corresponds to the predicted values. The second step is to plug the predicted values into an inequality measure (Ferreira and Gignoux, 2011). The way to estimate equation (3) and the inequality measure to use, depends not only on the desired properties of the measure, but also on the type of outcome variable. Chávez -Juárez and Soloaga, 2014 argue that when the outcome variable is continuous on an inherent scale, the best choice is to use the mean-logarithmic deviation (MLD). For binary variables that are scale invariant, the dissimilarity index (D-index) is preferred. We use the D-index as an inequality measure when estimating IOp at specific clinical thresholds for under and overnutrition using the dicothomised version of our outcomes and the MLD when estimating IOp across the continuous distribution of our outcomes. Thus, we use logit and linear models to estimate Equation (3) for binary and continuous outcomes, respectively. The MLD measures the deviation of the expected level of health outcome from the group's expected average. Smaller values reflect lower levels of IOp and it is defined as:

$$MLD(\hat{y}) = \frac{1}{N}\sum_{i=1}^{N} ln\frac{\bar{\hat{y}}}{\hat{y}_i}$$

where $\hat{y}_i = \mathbb{E}(y|C_i)$. Absolute inequality is obtained when the counterfactual distribution of health outcomes conditioned on circumstances is plugged into the MLD, such that:

$$\theta_a = I_0(\hat{y}_i) \tag{4}$$

and relative IOp is the ratio of the absolute level of inequality with respect to the overall inequality, as:

$$\theta_r = \frac{I_0(\hat{y}_i)}{I_0(y_i)} \tag{5}$$

Relative inequality is zero when equality is observed, and positive values depict an unequal distribution of the outcomes.

The D-index is an absolute measure that focuses on the dissimilarity of the level of health for groups defined by their circumstances compared with the average level of health of the population. Another way to interpret the index is as a weighted mean of the absolute differences of the estimated outcome, from the overall outcome average. If equality exists, D=0 (Paes de Barros et al., 2008). The D-index is defined as:

$$\theta_a = D(\hat{y}) = \frac{1}{2N\bar{\hat{y}}}\sum_{i=1}^{N} |\hat{y}_i - \bar{\hat{y}}|$$

where $\hat{y}_i = \mathbb{E}(y|C_i)$. In this case, y is a binary variable. Thus,

$$Prob\{y_i = 1\} = (e^{\beta_0+\beta+\epsilon_i}) \cdot (1 + e^{\beta_0+\beta_1 C_i+\epsilon_i})^{-1}$$

and

$$Prob\{y_i = 0\} = (1 + e^{\beta_0 + \beta_1 C_i + \epsilon_i})^{-1}$$

with $\bar{\hat{y}} = \frac{1}{N} \sum_{i=1}^{N} \hat{y}_i$.

3.1.2 *Ex-post* IOp

For individuals above the "age of responsibility" threshold, it is assumed that health outcomes are explained by circumstances, efforts and other random factors. In this approach efforts are assumed to be mediating factors that lie in the pathway between circumstances and outcomes. Since efforts are observable, it is possible to disentangle two different effects: i) the total effect of circumstances, which can be further decomposed into a direct and indirect effect and, ii) the indirect effect of efforts on outcomes.

Since the efforts exerted depend on people's circumstances, the former and the latter are correlated. To deal with this issue, *ex-post* IOp is calculated via a two-stage model. First, Equation (2) is estimated to remove the influence of circumstances on efforts, we estimate this equation using OLS models. By doing this, we can obtain $\hat{v}_i$, which represents the *true* level of effort. In the second stage, the outcome variable is regressed against the vector of circumstances and the isolated-level of effort (Trannoy et al., 2010).

Since $E_i = \hat{v}_i + \hat{E}_i$, we can re-write $h(.)$ as:

$$y_i = \alpha_0 + \alpha_1 C_i + \alpha_2(\hat{v}_i + \hat{E}_i) + u_i \tag{6}$$

and by separating terms, we obtain the total effect of circumstances, that can be further decompose into a direct and an indirect effect, and the direct effect of efforts.

$$y_i = \alpha_0 + \underbrace{\underbrace{\alpha_1 C_i}_{\text{direct effect of } C} + \overbrace{\alpha_2 \hat{E}_i}^{\text{indirect effect of } C}}_{\text{total effect of } C} + \underbrace{\alpha_2 \hat{v}_i}_{\text{direct effect of } E} + u_i \tag{7}$$

A simplified form of equation (7) can be written as:

$$y_i = \gamma_0 + \gamma_1 C_i + \gamma_2 \hat{v}_i + u_i \tag{8}$$

Where $\gamma_0 = (\alpha_0 + \alpha_2 \hat{\delta}_0)$, $\gamma_1 = (\alpha_1 + \alpha_2 \hat{\delta}_1)$ and $\gamma_2 = \alpha_2$. In equation (8), y_i represents the health outcomes for individual i that is above the legal cut-off of 18 years old (undernutrition and overnutrition outcomes defined at clinical cut-off points, as well as a binary outcome that explicitly measures malnutrition by combining under and overnutrition outcomes defined by clinical thresholds). γ_0 is the constant term; C is the vector of circumstances and γ_1 captures the total contribution of circumstances on outcome y and γ_2 is a vector that captures the direct contribution of efforts. The link between the *ex-ante* and *ex-post* approaches is the equivalence of the estimator β_1 in Equation (3) and γ_1 in Equation (8), both represent the total effect of circumstances on the outcome y. The former in the *ex-ante*, the latter under the *ex-post* approach.

For the *ex-post* case the variance is used as inequality measure. To ease the interpretation of the results, the level of inequality is disentangled between the total effect of circumstances and the direct effect of efforts. For this, we rely on previous work developed by Deutsch et al. (2018) who used a Shapley-inspired approach to decompose the variance, in our case the McFadden's R-squared[1]. y could be binary and take the value of 1 if the individual has some sort of malnutrition and 0

[1] $McR^2 = 1 - \frac{LL_M}{LL_0}$ where LL_M corresponds to the model value of the log-likelihood and LL_0 the log-likelihood when only the constant term is introduced (Deutsch et al., 2018).

otherwise. When estimating Equation (8) via a logit model,

$$Prob\{y_i = 1\} = (e^{\gamma_0+\gamma_1 C_i+\gamma_1 \hat{v}_i+u_i}) \cdot (1 + e^{\gamma_0+\gamma_1 C_i+\gamma_1 \hat{v}_i+u_i})^{-1} \tag{9}$$

and

$$Prob\{y_i = 0\} = (1 + e^{\gamma_0+\gamma_1 C_i+\gamma_1 \hat{v}_i+u_i})^{-1} \tag{10}$$

Thus, the shapley-inspired decomposition is based on the idea of comparing the indicator of goodness-of-fit (McR^2) when including all vector of circumstances and efforts versus another model in which only efforts are included, for example. The likelihood ratio that corresponds to the logit model is:

$$LL_M = LL(C_i \neq 0, \hat{v}_i \neq 0)$$

where $\neq 0$ means that all coefficients in the model are unrestricted. C_i denotes the vector of circumstance for individual i. $\hat{v}_i$ represents the vector of efforts for individuals i. If the vector of efforts $\hat{v}_i$ is not included in the model:

$$LL_C = LL(C_i \neq 0, \hat{v}_i = 0)$$

And similarly, if the vector of circumstances C_i is not included, the LL can be written as:

$$LL_v = LL(C_i = 0, \hat{v}_i \neq 0)$$

Using the Shapley decomposition approach, the marginal contribution of circumstances to the actual likelihood ratio is calculated as:

$$TCC = 0.5(LL_C) + 0.5(LL_M - LL_v)$$

and the contribution of efforts as:

$$DCE = 0.5(LL_M - LL_C) + 0.5(LL_v)$$

We can then check that, $TCC + DCE = LL_M$. Even though Deutsch et al. (2018) proposed this decomposition for the McFadden R-squared for logit models, the approach can also be used to decomposed the R squared in OLS models. Important is to note that such decomposition should not be understood as causality, but only to show the relative importance of the circumstances and efforts.

4 Data

4.1 Sources of data

Data from the 1988 and 1999 NNS and the National Health and Nutrition Surveys (ENSANUTs) from 2006, 2012, 2016 and 2018 are used. These are cross-sectional, and represent all the health and nutrition surveys carried out in Mexico. The 1988 survey was the first-ever national nutrition survey conducted in Mexico. This survey collected data from more than 13,000 households. The study population were children under five years and women between 12 and 49 years of age. The resulting sample was representative at the national level (CONEVAL, 2010; Resano-Pérez et al., 2003). The second survey, the 1999 national nutrition survey, collected data between October 1998 and March 1999. The sample consists of almost 18,000 households, that nationally represented areas with less than 2,500 inhabitants, with 2,500 to 14,999 inhabitants and areas with more than 15,000 inhabitants. The study populations were children under 5 years of age, school-age individuals between 5 and 19 years of age and women aged 12 to 49 (Resano-Pérez et al., 2003).

Ensanut 2006 collected data from around 44,500 households. It is representative at the national level, as well as urban (> 2,500 people) and rural areas (<2,500 people). The survey respondents were children under five years of age; children of school age 5-11; adolescents (12 to 19 years of age) and adults, men and women over 20 years of age (Gustavo et al., 2006). Ensanut 2012 is as well a national representative survey. The sampling design was probabilistic, multi-stage and stratified. Data collected held information from 50,528 Mexican households. The survey respondents were children less than five years old, school children (5 and 9 years old), adolescents (age between 10 and 19 years old) and adults older than 20 years old (Romero-Martínez, Shamah-Levy, Franco-Núñez, et al., 2013). Ensanut 2016 is a mid-way survey, but also nationally representative, that allows inferences on the urban and rural areas. This survey collected data from 9,479 households (Romero-Martínez, Shamah-Levy, Cuevas-Nasu, et al., 2017). Finally, Ensanut 2018 is a national representative survey. The sampling design was probabilistic, multi-stage and stratified by rural and urban areas. Data from 50,654 households were collected and the survey respondents were the same as in Ensanut 2012 (Romero-Martínez, Shamah-Levy, Vielma-Orozco, et al., 2019).

The sample units across all the surveys were households. A household is defined as a group of people, related by kinship or not, who usually sleep in a house under the same roof, benefiting from a common income, from either one or more of the household members. The key respondents were those individuals that resided in households at the time of the study. This impacts the analysis in two ways: 1) in some cases, it is not be possible to identify the familial link and given that, 2) the set of circumstances included in each model is different in each cross-section according to the availability of data.

4.2 Key variables

4.3 Matching variables

The matching covariates, X, are time-invariant individual characteristics, such as: year of birth, sex and geographical region where individuals lived. The choice of matching variables is data-availability driven. The selection of region, instead of geographical state where people live, as a time-invariant characteristic, is based on the evidence that the internal migration in Mexico occurs mainly between regions (Rangel Garrocho et al., 2014; Sobrino, 2010). This assumes that even though individuals could migrate, this migration mainly occurs within the geographical region and not across them. Even though this assumption is not testable in all surveys, in Ensanut 2018 people were asked about the State where they were born and the State where they lived when the survey took place. Results show that 82% of the respondents said they were born in the same State where they were living at the moment of the survey. 17% said they were born in another State, but 97% were born in another State of the same geographical region. Thus, these results give confidence for the assumption to hold.

4.3.1 Outcomes

Malnutrition is a spectrum that can comprise under and overnutrition. The concept of DBM, which appeared at the beginning of the 1990s, refers to the coexistence of over and undernutrition that can occur within populations, households and individuals. Then, it is possible to have a DBM at the individual-level, for instance a person overweight and that also presents a lack of nutrients. Through the life course, the way to measure nutrition-related outcomes cannot be consistently the same. It is well known that weight and height vary with age, and this is particularly important during childhood. Classically, z-scores of height-for-age (HAZ), weight-for-height (WHZ), and weight-for-age (WAZ) are used in the public health literature to assess the nutritional status of children. The Z-scores benchmark height and weight differences for all children of the same age to allow comparability. Thus, given the lifespan approach adopted, it is not possible to use the same outcomes across all age groups.

We use low HAZ as a proxy of stunting, low WHZ for wasting, low WAZ as a proxy of undernutrition and BMI-for-age for overnutrition outcomes when analysing child data, this is the 1988 survey, where individuals were children under five years old. For the rest of the cross-sections, the level of haemoglobin (HB) in the blood is used to account for undernutrition since low levels of haemoglobin in the blood is closely related to anaemia, defined as a deficiency of iron, folate and vitamin B (WHO, 2012). The body mass index and waist circumference (WC) are used as outcome variables that capture overnutrition in the form of excess weight or excess body fat and excess or central adiposity in adolescents and adults.

Undernutrition is operationalised in the following ways. For the child-level analysis (1988 cross-section), HAZ, WHZ and WAZ are used as outcome variables. We discretised the variables such that 1 depicts if the outcome is lower than -2 z-scores and 0 otherwise [2]. For the adolescent and adult-level analysis (1999 to 2018 cross-sections), the level of haemoglobin is used as a measure of undernutrition. The outcome is used both in a binary and continuous way. This aims to measure IOp using the clinical cut-off points, but also to allow IOp measurement across the whole distribution. For the binary case, the variable takes the value of 1 if hb<12g/dl[3] for females and <13 g/dl for males, and 0 otherwise (WHO, 2012). Overnutrition is defined when a child has a BMI z-score above 2 and when an adult observes a BMI above 25 kg/m^2 or WC above 80cm and 90cm (for women and men, respectively).

[2]The WHO defines moderate to severe undernutrition when height-for-age is <-2 z scores (WHO, 2020)

[3]g/dl means grams per decilitre

Furthermore, an outcome that explicitly accounts for malnutrition (under and over-nutrition) is constructed and defined as a binary variable that takes the value of 1 when a child has a z score for HAZ or WHZ or WAZ below -2 *and* BMI above +2. Likewise for adolescents and adults, malnutrition is defined when they present a BMI above 25 kg/m^2 or WC>80 cm *and* HB<13 g/dl.

Data on height, weight and blood samples were taken and measured by specialised and trained staff by the National Institute of Public Health (INSP), in Mexico. Haemoglobin (g/dl) was adjusted for altitude and smoking behaviours[4]. For the analysis, implausible biological values for z-scores are excluded, as follows: <-5 and >+3; for WHZ <-4 and >+5 and <-5 and >+5 for WAZ and BMIZ (O'Donnell et al., 2007). For BMI values below 10 kg/m^2 and above 59 kg/m^2 are excluded. For WC, measurements below 51cm and above 190 cm are excluded. Information from pregnant women is not used in the analysis. We also exclude implausible values for adjusted haemoglobin such as those below 4g/dl and above 20 g/dl (Sullivan et al., 2008).

4.3.2 Circumstances

Framed within the social, political and economic context previously described, we define circumstances as those factors beyond an individual's control and that are potential sources of illegitimate inequalities. These factors are categorised as those related to individual factors; family-related characteristics; household-level factors and geographical characteristics. The set of circumstances used have been chosen based on normative criteria according to those factors that have been socially defined as illegitimate sources of disparities. We next set out the rationale for the inclusion

[4] Raw values of haemoglobin were adjusted in the following way. For altitude: no change if altitude<1,000m; -0.2 if $\geq 1,000$m but <1,500m; -0.5 if $\geq 1,500$m but <2,000m; -0.8 if $\geq 2,000$m but <2,500m; -1.3 if $\geq 2,500$m but <3,000m and -1.9 if altitude $\geq 3,000$m but <3,500m. For smoking behaviours: -0.03 if the the individual smokes up to one pack of cigarettes per day (20 cigars per package); -0.05 if ≥ 1 but <2 packs and -0.07 if ≥ 2 packs of cigarettes (WHO, 2012).

of specific circumstances as variables. A succinct list of outcomes, circumstances and efforts used in the analysis is found in Table B.1 in the Appendix.

Ethnicity, which refers to the ethnic background of the person. We used the official definition of ethnicity according to whether a person declares to speak an indigenous language. **Mother's health insurance**, this circumstance was chosen for two reasons. First, it is a proxy of preventive healthcare utilisation. Second, even though access to health is a fundamental right stated in the Mexican Constitution, specifically in Article fourth, accessibility to the health system in Mexico is heavily conditioned on accessing the labour market. **Mother's BMI (kg/m^2)**, this circumstance is a proxy indicator of nutrition at the household (taking into account that women have traditionally taken care of the preparation of food in the household). This circumstance is framed into the literature related to the relationship between parental health and children's health outcomes. Given that in 1988 and 1999 the surveys focused on women, only the BMI of mothers is obtained. Another circumstance included is **mother's anaemia**, this circumstance is also a proxy indicator of nutritional status of the mother along with **parental diabetes**, this variable accounts for the health situation of the parents and aims to reflect some indirect transmission of health conditions and eating behaviours, since 90% of the cases of diabetes type II in Mexico are closely related to overweight and obesity (Dávila-Torres et al., 2015; Salud, 2010). We also include **parent's education**, when the information was available.

To account for household conditions, we include **running water available in the household** as a circumstance. Even though, this public service was established as a constitutional right, as part of the right to a healthy environment (Article fourth, 1999), there are still evident gaps. According to the 2015 National Household Census, 94.4% of the Mexican population had running water in their houses.

Nevertheless, there are marked differences across the States. In Southern States the percentage of households with availability of running water is, on average, 85% (INEGI, 2015). Hence, to have running water in a household cannot be taken for granted and represents a potential source of illegitimate health disparities. We also include **household living standards**, this circumstance is estimated using principal components techniques. The household asset index took into account information reported by the head of the household about the physical characteristics of the house, for instance material from which the floors, walls and roofs are made; number of rooms, whether the house has latrines or toilets, etc. The index also included data about the ownership of durable assets in the house, such as: radio, television, fridge, telephone, car, computers, washing machine, microwave, air conditioner, etc. Using the polychoric principal-component analysis method and following Basto-Abreu et al., 2018, asset indices are estimated. A single component, that in all cross-sections explained more than 50% of the variation, was extracted. The index was then categorised into quartiles.

To account for potential geographic factors driving inequalities, we include the **State deprivation level**, this is a weighted index that measures social deprivation at the State level and takes into account characteristics such as the percentage of the population older than 15 years old and deemed illiterate, population aged 6 to 14 who do not attend school, households with individuals aged 15 to 29 that have less than 9 years of education; population older than 15 years with incomplete basic education; population without health insurance; household with no floor; average occupants per bedroom; households without a toilet; piped water from the public network; sewage; electricity; washing machine or fridge. This index is estimated by the National Council for the Evaluation of Social Development Policy (CONEVAL) and the data come from the National Count of Population and Housing censuses (CONAPO), we used the 1990, 1995, 2005, 2010 and 2015 indices. The State deprivation index aims to capture the *geography of opportunity*, a concept that describes how the area and geographical space where people live condition access to opportunities (Rosenbaum, 1995).

We also include the variables used in the matching exercise **sex** and **geographic region** where individuals lived when the survey was undertaken, since these are also circumstances[5].

4.3.3 Efforts

Efforts are those factors that lie within the sphere of individual responsibility and subject to choice, such as: lifestyles (Jusot and Tubeuf, 2019), eating patterns and human capital investments that individuals above the age of responsibility decide to adopt/acquire. Rich data about dietary intake was collected using a food frequency questionnaire in Ensanut 2006, 2012 and 2018. This questionnaire included 101 different foods and beverages. For each food item, data about intake according to number of days in the week, daily frequency of consumption, portion size and number of portions consumed were collected[6]. With this rich data, we use factor analysis to identify dietary patterns for each individual (Denova-Gutiérrez et al., 2016). Three factors that accounted for approximately 35-50% of the total variance were extracted. We check also for the adequacy of using factor analysis using the Kaiser-Meyer-Olkin(kmo) test. The KMO coefficient was, on average, 0.85 which indicates that the sample is adequate for using the method. We characterise the three factors by looking at the loading of a given food to each factor and their correlations. The first pattern was characterised by grouping low-nutritious and high-energy food

[5]The 32 Federal States of Mexico were grouped in six regions: Northwest: Baja California, Baja California Sur, Sinaloa and Sonora. Northeast: Coahuila, Nuevo León, Tamaulipas, Chihuahua, Durango, Zacatecas and San Luis Potosí. West: Aguascalientes, Colima, Guanajuato, Jalisco, Michoacán, Nayarit and Queretaro. Centre: Mexico City, State of Mexico, Hidalgo, Morelos, Puebla and Tlaxcala. South: Guerrero, Oaxaca, Chiapas and Veracruz. Southeast: Campeche, Quintana Roo, Tabasco and Yucatán.

[6]We classified the 101 food items into five different groups. See the Appendix for further information about the items and food groups.

[7], the second pattern included high-nutritious food[8], and the third factor food items such as legumes and maize-based products[9]. To aid the interpretation of the dietary patterns, we re-scale them to range between 0 and 100.

For our analysis, efforts comprise: **dietary patterns** that includes three food groups, **nutritional supplements consumption**, this is a binary variable that takes the value of 1 if individuals reported that they consumed nutritional supplements, as part of their diet. We also include **daily hours of vigorous and moderate physical activity**, this variable is the sum of the self-reported daily hours doing vigorous physical activity, defined as those activities that take more than 6 metabolic equivalents (METs), such as: aerobics, cycling fast, lifting heavy things, digging, doing farm work, etc. And moderate physical activity, defined as activities that uses 3 to 6 METs, for example: carrying light things from one place to another, cleaning heavily, cycling at a regular pace, playing sports in a recreational way, etc. The number of hours were bounded from 0 to 16 hours in a day.

As risky health behaviours, we include **alcohol consumption**, this binary variable depicts if individuals consume alcohol above the number of daily units recommended, that is more than three units for women and more than four units for men[10]. Another risky behaviour included is **smoking**, this binary variable depicts whether an individual smokes tobacco frequently, meaning daily or on a regular basis.

4.4 Additional analyses

As illustrated in Figure 1, both *ex-ante* and *ex-post* IOp is calculated for each year. This is achieved by estimating models depicted in equations (3) and (8) and us-

[7]Whole-fat diary, fast food, sweetened beverages, sweets and red meat

[8]Fruits, vegetables, poultry, fish, cereals

[9]Beans and maize-based products are the staples of the pre-hispanic diet

[10]Examples of one unit are: one standard glass of 13%-level-of-alcohol wine; 25 millilitres (ml) of 40°-spirit; 250 ml of 4%-level-of-alcohol beer. One unit is also equivalent to 10ml or 8 grams of pure alcohol

ing the weights calculated in the matching and re-weighting exercise. The main outcomes are binary indicators of specific health outcomes, for example, under and overnutrition and a measure of malnutrition, defined according to clinical thresholds. The main approach is mean-based and assumes inequality neutrality. However, this approach is limited given that malnutrition can be found at the bottom, as well as at the upper parts of some of the outcome distributions, such as BMI and WC.

By relaxing inequality neutrality and allowing for inequality aversion, we explore the role of circumstances alone and circumstances and efforts in *ex-ante* and *ex-post* IOp, respectively. Thus, we measure IOp at the 10^{th}, 25^{th}, 50^{th}, 75^{th}, 90^{th}, 95^{th}, 99^{th} percentiles of the BMI and WC distributions. Table B.2, in the Appendix, summarises the outcomes used in each approach. To ease the flow of the paper, in the main text we present the mean-based estimations of IOp using the D-index as the inequality measure for the *ex-ante* approach and the variance for the *ex-post*. The beyond-the-mean IOp results are shown in the Appendix.

Given the structure of the data, the set of circumstances included in each model differs according to the year of analysis. Thus, we present results of IOp using a vector of common circumstances across all the six survey years (sex, ethnicity, running water inside the house, household living standards and geographic region).

Ex-post IOp was not estimated in the 2012 and 2016 survey years due to sample sizes being to small to run the models and the lack of effort variables. Specifically, the number of potential observations in the 2012 survey were: n=34 for the DBM outcome, n=35 for the HB, n=89 for the BMI, and n=85 for the WC models, respectively. Taking into account the number of circumstances and effort variables, there was likely to be insufficient degrees-of-freedom for estimation. Furthermore, we did not estimate IOp using the 2016 survey because the 2016-survey was a mid-way survey and rich data on food consumption and physical activity were not collected. Thus, there were no effort variables available.

5 Results

5.1 Description of the sample and balancing weights

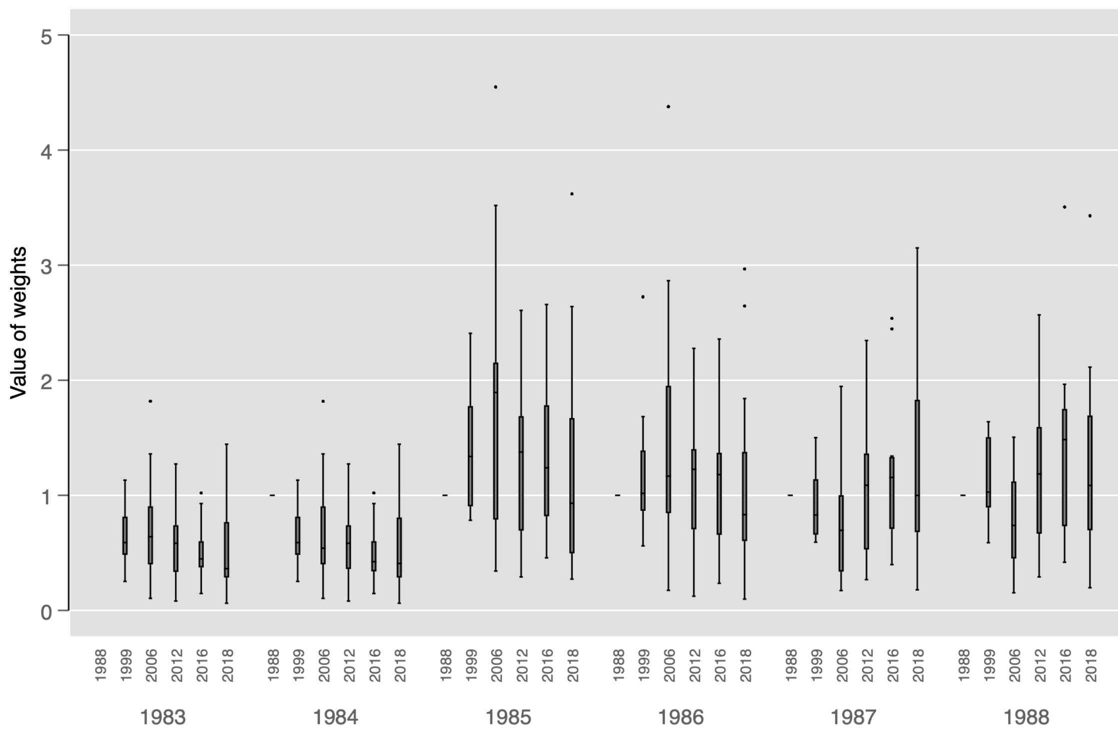
Figure 1 shows the distribution of the matching weights across the different surveys by year of birth. The empty space for those born in 1983 and surveyed in 1988 reflects the assumption that the 1988 survey collected information after December 1988, thus there were no children born in 1983 in this survey. As the treatment group are those individuals in the 1988 survey, their weights are equal to one. The highest range is found in the 2006 cross-section. Note that men living in the Northwest region of Mexico were not surveyed in the 2006 dataset, and hence were excluded from the analysis. See Appendix for more details about the results of the matching exercise.

5.2 Description of key variables

5.2.1 Outcomes

Table 2 shows the description of the dichotomised outcomes according to the clinical cut-off points for malnutrition in terms of stunning, wasting and underweight, as well as overweight and obesity. Specifically, in 1988 23% of children below five years old were stunted, 6% wasted, and 10% underweight. For overnutrition, 8% were overweight and 3% suffered a double burden of malnutrition. The table also shows the evolution of the cohort across time for undernutrition proxied by the presence of anaemia, overnutrition proxied by excess weight and adiposity, as well as malnutrition. In terms of undernutrition, the proportion of individuals with anaemia decreased from adolescence (1999 survey) to young adulthood (2012 survey). But,

Figure 1: Distribution of matching weights by cohort's year of birth



as the cohort get older, the proportion of anaemia among individuals in the 2016 and 2018 surveys doubled.

Contrary to the non-linear trend in the proportion of individuals with anaemia, the proportions of individuals with an excess of weight and adiposity have been continuously increasing across time. Table 2 shows that in 1999, the proportion of adolescents categorised as having an excessive weight was 11%, while in 2018, it was 75%. When looking at the proxy for central adiposity (WC), the proportion increased from 10% during the cohort's adolescence, to 77% during adulthood. The evolution of malnutrition is striking, the proportion of individuals with an excess of body fat or central adiposity and that also had anaemia increased from 3%, when individuals were aged 11 to 16 years old, to 41% when they were in their 30 to 35 years of age.

While Table 2 describes the outcome variables given the clinical cut-off points,

Table 2: Description of the binary outcomes across the lifespan

	Expected age of the Cohort					
	0-5	11-16	18-23	24-29	28-33	30-35
Survey year	1988	1999	2006	2012	2016	2018
Stunting						
Proportion	0.23					
N	6,003					
Wasting						
Proportion	0.06					
N	6,077					
Underweight						
Proportion	0.10					
N	6,228					
Anaemia (HB)						
Proportion		0.23	0.11	0.09	0.17	0.21
N		1,375	5,386	1,121	488	2,078
Overweight children						
Proportion	0.08					
N	6,101					
Excess weight (BMI)						
Proportion		0.11	0.39	0.58	0.70	0.75
N		3,256	5,636	1,198	1,059	2,112
Excess adiposity (WC)						
Proportion		0.10	0.51	0.59	0.73	0.77
N		2,101	2,701	1,118	984	2,019
Malnutrition children						
Proportion	0.03					
N	5,701					
Malnutrition*						
Proportion		0.03	0.08	0.10	0.29	0.41
N		978	3,354	530	175	827

Notes: Matching weights used. Stunting=Height-for-age (HAZ) below -2 Z scores. Wasting=Weight-for-height (WHZ) below -2 Z scores. Underweight=Weight-for-age (WAZ) below -2 Z scores. Anaemia: HB= 1 if Haemoglobin<13(g/dl) for men and <12 for women. Overweight children=Body mass index (BMI) Z score above 2. Excess weight: 1 if BMI>25kg/m2. Excess adiposity= 1 if WC>80cm for women and >90 for men. Malnutrition children=those that observe HAZ or WHZ or WAZ below -2 Z scores and BMI above 2 Z scores. Malnutrition*=those individuals that observe BMI above 25kg/m2 or WC>80cm (women) or WC>90cm (men) and HB<12g/dl(women) or <13 (men)

Figure E.1, in the Appendix, shows a more detailed description of the distributions of the outcomes. Overall both graphs shows a similar story. Over the whole period, undernutrition (HB) increased from an average of 13.2 to 13.8 g/dl, with the trend being non-linear. For overnutrition (BMI and WC), Figure E.1 shows an increasing trend. On average, BMI and WC rose as people aged. Furthermore, BMI increased considerably from 20 kg/m2 (clinically considered as *normal*) to 28.2 kg/m2, which lies in the cut-off of *overweight*. The same applies for the WC, that rose from 67 cm in 1999 to 93.4 cm in 2018.

5.2.2 Circumstances and efforts

Table 3 shows the description of the sample in terms of individuals' circumstances and efforts. In all survey years, 51% of the individuals are males, and in general, the proportion of non-indigenous people is between 94% and 89%. In 1988, BMI of children's mothers was on average 23.84 kg/mts^2 and 12% of the mother's cohort were anaemic. This table also shows that around half of the sample's mother had health insurance when individuals were children. Regarding the mother's education, in 1988, 12% did not have any level of education, 59% had achieved primary school as the highest level of education, and approximately 10% had education above high school. For 1999, the proportion of mothers with no education, as well as the proportion of mothers with education above high school slightly increased. The majority of mothers had a level of education up to primary school. Table 3 also shows the proportion of parents that had not been clinically diagnosed with type II diabetes. Here, parental diabetes means that at least one of the parents did not had the condition. In 1988, the proportion was high (98%). Nevertheless, this proportion has been diminishing, reflecting the rapid increase in the prevalence of type II diabetes in the Mexican population.

Table 3 also depicts the household and municipal characteristics. The proportion of households with running water varies from a low of 21% in 2006 to a high of 62% in 2012. In 1988 the majority of households were considered to have either low or medium-low (53%) living standards, but in 2018 the majority of the household were classify as medium-high and high (60%). Across all years the majority of the sample lived in States with a low or medium level of deprivation. Nevertheless, individuals that live in States with high levels of deprivation increased throughout the years (16% in 1988 vs 24% in 2018), and the proportion of people living in States considered as having very low levels of deprivation decreased (23% in 1988 vs 8% in 2018). Another geographical variable is the region where individuals lived at the time in which the information was collected. The proportions shown in Table 3 across years are the same, as this circumstance was also used as a matching variable. Thus, the figures are fixed to the 1988 baseline year, where 38% of the individuals lived in the Central region of Mexico.

Table 3 shows the description of the sample according to their *efforts*. Data about the adult's diet show that overall, as individuals aged, the consumption of low nutritious and high-energy food decreased, as well as highly nutritious food. The consumption of maize products and tortillas increased. It is relevant to note that around 6% of the individuals reported the consumption of food supplements in 2006, and the figure increased slightly to 8% in 2018. In terms of physical activity, the table shows that as individuals get older, the average number of hours dedicated to vigorous and moderate physical activities overall decreased. The same pattern follows alcohol-drinking behaviours, when the cohort were between 18 to 23 years old, the portion of people who drank above the recommendations was 31%, but as those adults aged, this portion diminished to 19% in survey year 2018, when people were between 30 and 35 years old. Finally, it shows that the portion of individuals reported to be regular smokers decreased, in general, 25% in 2006 and 22% in 2018.

Table 3: Description of Circumstances and Efforts across time

Expected age cohort	**0-5**		**11-16**		**18-23**		**24-29**		**28-33**		**30-35**	
Survey year	**1988**		**1999**		**2006**		**2012**		**2016**		**2018**	
	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean	N	Mean
Circumstances												
Men	6,491	0.51	7,095	0.51	5,660	0.51	9,988	0.51	2,223	0.51	2,208	0.51
Non-Ind	6,491	0.94	4,704	0.92	5,659	0.96	9,988	0.93	2,223	0.89	2,208	0.91
Mother's circumstances												
PNonD	5,683	0.99					1,176	0.73	1,032	0.66	2,018	0.62
BMI_M	5,532	23.85										
M.Anae	3,166	0.12										
HI	6,469	0.49	6,946	0.44								
No Edu	5,669	0.12	6,159	0.16								
Pri.	5,669	0.59	6,159	0.55								
Sec.	5,669	0.21	6,159	0.14								
HS	5,669	0.04	6,159	0.06								
HE	5,669	0.05	6,159	0.00								
Household standards												
WIH	6,471	0.51	5,945	0.41	5,281	0.21	9,988	0.62	2,223	0.55	2,208	0.61
HLS: Low	6,236	0.29	5,208	0.26	5,122	0.22	9,501	0.24	2,216	0.25	2,208	0.18
HLS: MLow	6,236	0.22	5,208	0.26	5,122	0.26	9,501	0.25	2,216	0.24	2,208	0.23
HLS: MHigh	6,236	0.27	5,208	0.26	5,122	0.26	9,501	0.26	2,216	0.24	2,208	0.26
HLS: High	6,236	0.22	5,208	0.22	5,122	0.26	9,501	0.24	2,216	0.26	2,208	0.33
State deprivation												
SDL: V.High	6,491	0.21	7,095	0.15	5,660	0.11	9,988	0.12	2,223	0.09	2,208	0.12
SDL: High	6,491	0.16	7,095	0.22	5,660	0.24	9,988	0.23	2,223	0.25	2,208	0.24
SDL: Med	6,491	0.04	7,095	0.11	5,660	0.21	9,988	0.27	2,223	0.21	2,208	0.32
SDL: Low	6,491	0.35	7,095	0.33	5,660	0.30	9,988	0.23	2,223	0.30	2,208	0.24
SDL: V.Low	6,491	0.23	7,095	0.18	5,660	0.14	9,988	0.16	2,223	0.15	2,208	0.08
Geographic regions												
NW	6,491	0.07	7,095	0.07	5,660	0.07	9,988	0.07	2,223	0.07	2,208	0.07
NE	6,491	0.24	7,095	0.24	5,660	0.24	9,988	0.24	2,223	0.24	2,208	0.24
W	6,491	0.14	7,095	0.14	5,660	0.14	9,988	0.14	2,223	0.14	2,208	0.14
C	6,491	0.37	7,095	0.37	5,660	0.37	9,988	0.37	2,223	0.37	2,208	0.37
S	6,491	0.15	7,095	0.15	5,660	0.15	9,988	0.15	2,223	0.15	2,208	0.15
SE	6,491	0.03	7,095	0.03	5,660	0.03	9,988	0.03	2,223	0.03	2,208	0.03
Efforts												
DP1					2,398	23.13	239	19.65			1,651	18.03
DP2					2,398	20.97	239	18.72			1,651	17.37
DP3					2,398	32.03	239	30.57			1,651	39.07
FS					2,398	0.07	239	0.07			1,651	0.09
PA					5,660	4.26	1,300	6.49			2,197	2.99
Alc					5,660	0.31	289	0.19			2,150	0.19
Tob					5,659	0.25	563	0.48			2,192	0.22

Notes: Matching weights used. Non-Ind=Non-Indigenous; BMI_M=BMI of the mother
M.Anae=Mother anaemic; HI=health insurance; Pri.=Eduaction up to primary school
Sec.=Education up to secondary school; HS=Education up to high school; HE=higher education
PNonD=parents non-diabetic; WIH=water inside the household; HLS=Household living standards,
MLow=Medium-low V.High=Vey high; SDL=State deprivation level, V.Low=Very low; NW=Northwest;
NE=Northeast; W=West; C=Centre; S=South; SE=Southeast
DP1=Low-nutritious, high-energy food (whole diary, fast food, sweetened beverages, candy)
DP2 High-nutritious food (Fruits, vegetables, poultry, fish, cereals)
DP3=Legumes and maize-based products; FS=1 if the individual consumes food supplements
PA=Daily hours dedicated to vigorous and moderate physical activity
Alc=1 if the person consumes alcohol above recommendation; Tob=1 if the individual smokes tobacco frequently
Variables in blue were used for matching

5.3 Regression models

By estimating Equation (3), under the *ex-ante* approach, we find that the vector of common circumstances explain most of the variation for stunting and for the double burden. Overall, non-indigenous individuals have a lower probability of experiencing undernutrition, but higher likelihood of excess weight. Living in the South or Southern regions, as well as in households in deprived conditions increases the probability of under nutritional health problems and developing over nutritional issues.

There are differences in the direction of coefficients over time and we could not identify a clear and consistent pattern in the results. When the cohort is between 18 and 23 years of age, living in households with poor conditions and in Northern States increases the probability to be malnourished (e.g to have anaemia and excess adiposity or weight). However, when the cohort is in their middle twenties, deprivation and living in Northern States exhibits a negative relationship with malnutrition and having anaemia. Looking at ages between 28 to 33 years old, the results show that the set of circumstances are relevant in explaining variation in malnutrition and excess adiposity. Men are less likely to experience nutrition-related health issues than women and non-indigenous populations higher likelihood, compared with indigenous people.

The two-step estimation for *ex-post* IOp shows that the total variance explained by our set of circumstances is greater in dietary patterns and smoking frequency. The most statistically relevant circumstances are individual's sex and household living conditions. The second stage shows the inclusion of circumstances as well as true levels of effort. Taken together, these variables explain no more than 18% of the explained variance of the outcomes, with greater relevance in explaining variation in DBM and HB outcomes.

Results from the first and second stages bring evidence about the potential health inequalities transmission channels of direct and indirect effects. For example, if circumstances are statistically significant in the first stage, but not on the second, as with geographical region, suggests that those circumstances have an indirect effect on malnutrition that operates only through the effort channel, dietary-patterns in our case Fajardo-Gonzalez (2016). All regression models are displayed in the Appendix.

5.4 Inequality of opportunity: *Ex-ante* approach

Table 4 shows the results from the mean-based *ex-ante* analysis for different outcomes when using a set of common circumstances. It is worth noting that results from 1988 are not strictly comparable to the rest of the years, given the different outcomes used. The table depicts the level of IOp in children's outcomes and in haemoglobin, BMI and WC for adolescents and adults at the clinical cut-off points for anaemia, excess weight and excess adiposity. For all cross-sections, IOp was also estimated for an outcome that explicitly accounts for the double burden of malnutrition at the individual level.

These results show inequality measured through the dissimilarity index, that depicts the fraction of all opportunity sets that should be re-allocated from better to worse-off groups to reach an inequality-free situation (Paes de Barros et al., 2008). When the cohort were below five years of age, the level of inequality related to circumstances in stunning, wasting and underweight was 28.4%, 18.0% and 26.4%, respectively, while IOp in overweight was 15.6%. Inequality in child malnutrition was the highest, at 28.7%. Table 4 also depicts the level of inequality in anaemia excess weight and central adiposity, these inequality measurements are comparable across years. Overall, the level of IOp in anaemia has increased as the cohort gets older. During adolescence, IOp was 21.2% and when the cohort reached the thirties, inequality reached 28.7%. These results differ for the overnutrition outcomes, where

Table 4: Absolute *Ex-Ante* IOp in outcomes defined according to clinical thresholds

Survey year	**1988**		**1999**	**2006**	**2012**	**2016**	**2018**
Expected age of cohort	0-5		11-16	18-23	24-29	28-33	30-35
Stunting	0.284***						
N	5,766						
Wasting	0.180***						
N	5,839						
UWeight	0.264***						
N	5,984						
		Anaem.	0.212***	0.263***	0.274***	0.206***	0.287***
		N	794	4,898	986	436	2,060
Over weight (BMI)	0.156***	**Excess weight (BMI)**	0.225***	0.053***	0.059**	0.041	0.026
N	5,827	**N**	1,946	5,103	1,045	989	2,109
		Excess adiposity (WC)	0.246***	0.121***	0.098***	0.097***	0.057***
		N	1,510	2,647	976	922	2,046
DBMc	0.287***	**DBMa**	0.313***	0.324***	0.336***	0.368***	0.260***
N	5,478	**N**	589	3,075	483	178	835

Notes: *p≤ 0.1, **p≤ 0.05, ***p≤ 0.01

Stunting=Height-for-Age below -2 Z-scores; OW(BMIZ)=Body mass index above 2 Z-scores

Wasting=Weight-for-Height below -2 Z-scores

DBM_c defined as HAZ or WHZ below -2 Z-scores and BMI above +2 Z-scores

Anaem.=Anaemia=Haemoglobin <13 g/dl; Excess weight (BMI)=Body mass index>25 kg/m^2

Excess adiposity (WC)=Waist circumference> 80cm

DBM_a defined as BMI above 25 kg/m^2 or WC>80 cm and HB<13 g/dl the level of IOp decreased as people aged, from 22.5% to 2.6% in excess weight and from 24.6% to 5.7% in excess adiposity. Thus, in general, inequalities related to circumstances are higher for under compared to overnutrition outcomes. Inequality related to circumstances in malnutrition for adolescents and adults slightly decreased with age, from 31.3% during the cohort's adolescence to 26% in their early adulthood.

Figures J.1 and J.2, in the Appendix, show the level of *ex-ante* IOp across different points of the BMI and WC distributions. The y-axis depicts the level of relative IOp and the x-axis the ageing of the cohort. Each line is the trajectory of IOp over age for each percentile. The relevance of circumstances in explaining IOp is greater for under than for overnutrition outcomes. For BMI, circumstances matter more for people at the 25^{th} percentile, than for those at the 99^{th} percentile. Inequality related to circumstances across the life course follows a non-linear pattern, in which IOp is higher during adolescence, decreases during emerging adulthood as starts increasing again in early adulthood[11]. Above 18 years of age, circumstances matter more for people at the 10^{th} percentile. Regarding WC, Figure J.2 shows no clear patterns across percentiles. Overall, the importance of circumstances decreases in emerging adulthood, but increase as adulthood develops up to the early adulthood when their importance drops again.

5.5 Inequality of opportunity: *Ex-post* approach

In the *ex-post* approach, the total contribution of circumstances and the direct contribution of effort are estimated. Table 5 shows the results when estimating Equation (8) and computing the relative contribution of circumstances and efforts. To ease the interpretation of the results, circumstances and effort variables were grouped. The table shows the absolute and relative (%) contributions of circumstances and

[11]Emerging adulthood covers the period between 18 and 29 years of life, while middle adulthood spans from 30 to 45

efforts to inequality in anaemia, overweight (either via a proxy of excess weight and excess adiposity) and malnutrition. For anaemia, there is a clear pattern. Across time, circumstances play the most relevant role, 74% and 90% of the total HB variance is explained by circumstances. We did not find concluding evidence about efforts accounting for most of the explained variance in the overnutrition outcomes. On average, efforts are the most important determinant in the variation of excess weight, particularly 56% during emerging adulthood and 68% in early adulthood. However, circumstances account for most of the variation, 71% and 67% of excess adiposity during the emerging and early adulthood, respectively. Systematically, circumstances are the main driver of inequality in malnutrition and as people age, the relative importance of circumstances increases, while that of efforts declines.

Table 5: *Ex-post* IOp in outcomes defined according to clinical thresholds

Survey year		**2006**		**2012**		**2016**		**2018**	
Expected age cohort		18-23		24-29		28-33		30-35	
		Abs	**%**	**Abs**	**%**	**Abs**	**%**	**Abs**	**%**
Anaem.	Circum.	0.07	74	-	-	-	-	0.10	90
	Efforts	0.03	26	-	-	-	-	0.01	10
	N	1,938		-		-		1,571	
Excess weight (BMI)	Circum.	0.01	44	-		-	-	0.01	32
	Efforts	0.02	56	-	-	-	-	0.02	68
	N	2,034		-		-		1,591	
Excess adiposity) (WC)	Circum.	0.06	71	-	-	-	-	0.05	67
	Efforts	0.02	29	-	-	-	-	0.02	33
	N	993		-		-		1,508	
DBMa	Circum.	0.10	66	-	-	-	-	0.14	78
	Efforts	0.05	34	-	-	-	-	0.04	22
	N	1,223		-		-		631	

Notes: - unable to estimate IOp due to small sample size (n<80).

Circum.=Total contribution of circumstances

Efforts=Direct contribution of efforts.

Anaem.=Anaemia (HB <13 g/dl)

Excess weight (BMI> 25 kg/m^2); Excess adiposity (WC> 80cm)

DBM_a defined as BMI above 25 kg/m^2 or WC>80 cm and HB<13 g/dl

Figures J.3 and J.4 show the results of estimating *ex-post* IOp when the outcome is continuous and the contribution of circumstances and efforts is measured at different points of the distributions. The distributional analysis shows mixed results as well regarding the contribution of circumstances and efforts and there are no clear patterns across the percentiles lifespan. For both outcome distributions, the only point in common is that circumstances are more relevant for people at the bottom and top parts of the distributions (percentiles 10^{th} and 99^{th}) and when the cohort is between 18-23 years of age, but efforts are of greater importance only for individuals at the lower point of the distribution and when they are 30 to 35 years old. For BMI, efforts are more relevant at the 25^{th} and 50^{th} percentiles, and circumstances become predominantly more relevant than efforts in the 90^{th}, 95^{th} and 99^{th} percentiles. Conversely, for WC, efforts are more relevant at the 90^{th} and 95^{th} percentiles and circumstances have a higher relevance at the 25^{th}, 75^{th} and 99^{th} percentiles.

6 Discussion

This study is a first attempt to deal with the lack of birth cohort data to analyse the evolution of IOp in nutrition-related health outcomes from childhood to adulthood. The study contributes to the ongoing literature by constructing a pseudo-birth cohort for people born between 1983 and 1988. This is as well the first paper to measure IOp in outcomes related to the emerging double burden of malnutrition. The main results of these analyses are the following. First, inequalities that mainly look at the role of circumstances, and therefore are considered unfair, have been persistent across the life-course of all individuals born between 1983 and 1988. Second, *ex-ante* IOp is higher in undernutrition-related outcomes than in overnutrition. Third, inequalities in anaemia increased as individuals age, whereas inequalities in excess weight and central adiposity decreased as the cohort got older. Fourth, inequalities related to circumstances in malnutrition have been persistent across 30 years for individuals born between 1983 and 1988. Fifth, when looking at *ex-post* IOp and disentangling the role of circumstances and efforts results indicate that circumstances are the main driver of inequality in anaemia and malnutrition during adulthood. We did not find sufficient and conclusive evidence that efforts are the main driver of variation in outcomes such as excess weight or adiposity.

Despite differences in magnitude, across all outcomes, circumstances drive inequalities. For anaemia, across the life-span that covers adolescence to early adulthood, between 21% to 28% of the total share of opportunities would need to be reallocated from individuals without anaemia to anaemic individuals to reach equality of opportunity. These numbers are lower for BMI and WC which are 22% during the adolescence to 2.6% during emerging adulthood and 24% to 5.7%, respectively. This contrasts with recent evidence from China, where circumstances explained more of the variation of BMI and WC as people aged. Nevertheless, that study was focused on middle-aged and older individuals (Nie et al., 2020). Moreover, the role of circumstances is particularly relevant when looking at the double burden of malnutrition, around 26% to 31% of the share of circumstances would need to be reassigned across the life-span to reach equality. These results are similar to those of Fernald and Neufeld (2007) who documented that the prevalence of concurrent overweight or obesity and stunting was approximately 5% in non-indigenous children, and over 10% in indigenous children of two to five years old. This study also found that the factors associated with this double burden were socioeconomic status, maternal age, education, maternal height and household size (Fernald and Neufeld, 2007).

Noticeable differences between the relative importance of circumstances and efforts to the mean-based level of *ex-post* IOp in excess weights and adiposity outcomes are worthy of discussion. It seems conflicting that while, on average, efforts contribute more to the total variation of excess weight, circumstances are the main driver of *ex-post* inequality in central adiposity and that these patterns are consistent across both points in time. However, beyond-the-mean results (Figures J.3 and J.4 in the Appendix) show inconclusive evidence. Although we find consistency at the bottom and upper parts of the distributions, there are mixed results regarding the relevance of circumstances and efforts to IOp in other points of the distribution. For example, although inequality results are similar for people at the 10^{th} and 99^{th} percentiles of both outcome distributions: circumstances contribute more than efforts to the total variation when individuals are 18 to 23 years old. But, when the cohort is older, at 30 to 35 years old, efforts matter the most. At the 90^{th} and 95^{th} percentiles of the BMI distribution, circumstances matter more than efforts, but at the 90^{th} percentile of the WC, efforts are more relevant and at the 99^{th} percentile, circumstances are slightly more important than effort when the cohort is between 18-23 years of age, although efforts play the most relevant role when the cohort is 30 to 35 years old. Thus, this indicates the lack of clear and consistent evidence that efforts are the most relevant factor for inequities in over nutritional outcomes. At most, we believe that further research is needed to be able to claim that inequality in obesity in Mexico is boosted by people's eating and life-styles patterns. This is an important point to make since there is an implicit belief that most of the variation in over nutritional outcomes is driven by free will choices. Current policies aiming to tackle the obesity acute crisis in Mexico have framed the roots of obesity and overweight as an individual-decision matter. To be obese is, according to a tacit and collective definition, a deliberate action. Notwithstanding, we did not find enough and conclusive evidence to support this claim.

Our results also indicate that inequalities related to circumstances in anaemia display an overall growing trend. Since the role of public programmes is not evaluated in this study, it would be not only interesting, but also relevant to explore the effect of the different nutrition-related programmes on the context of IOp under a life-cycle approach. This is pertinent since there is little evidence about the effect of early-life nutritional programmes on later-life outcomes for the case of Mexico. It is of further relevance because over the last 30 years, there have been a considerable amount of programmes implemented by the Mexican government that have had the clear objective to tackle poverty and undernutrition, the most outstanding example is that of PROGRESA-OPORTUNIDADES-PROSPERA[12], a well known case study in the policy evaluation literature. As people born between 1983 and 1988 aged, circumstances play a much more relevant role in the level of inequalities related to under-nutritional, and less for over nutritional outcomes. Paradoxically, most of the nutrition-related programmes in place between 1988 and 2000 aimed to tackled undernutrition in vulnerable people. For instance, the objectives of programmes such as: *Liconsa-conasupo*, *tortibonos* or *school breakfasts* were to ameliorate the diet of most-at-risk people. Impact evaluations of the Liconsa programme found that the fortified milk reduced the risk of anaemia among preschool and school-aged children between 1999 and 2006 (Rivera et al., 2010; Villalpando et al., 2006). Nevertheless, there is as yet no evidence regarding whether this effect hold over time, as a lasting protective factor for developing malnutrition later in life. All in all, our analyses show that equality of opportunity in nutrition-related health outcomes is far from being achieved in Mexico. Circumstances are a key source of health disparities for all health outcomes. Therefore, to be effective policy interventions aimed to enhance people's health should focus more on compensating, rather than on rewarding aspects.

In a more theoretical view, the empirical results of this analysis are also relevant for reconsidering the *economics of obesity* framework. Taking an economic perspective, some studies have claimed that supply-side factors or individual behaviours are at the core of the overweight/obesity epidemic. For example, that innovations

[12] This is the same programme, although different federal administrations have changed its name

in food production have resulted in more availability of high calorie food, and in energy dense food cheaper than fresh produce (Finkelstein and Strombotne, 2010). Others have argued that since medical advances have lowered the perceptions of the ill-health effects of obesity, individuals are more likely to be unafraid of being obese (Lakdawalla and Philipson, 2002). Others studies have looked at the role of time preference and obesity, pointing out that people with a high time preference are more willing to enjoy the utility that overeating represents than the future benefits of not doing so (Cavaliere et al., 2013; Zhang and Rashad, 2008). It is as well important to discuss the extent to which these visions are closely related to the idea of a *pure* free will. The IOp framework claims that free will is not entirely orthogonal to circumstances and instead, it inherently depends on individual circumstances. People's decisions are bounded by their structural conditions and available resources, but structural conditions are not given as endowments to individuals, sometimes they are inherited. People do not decide their initial conditions. In this context, the role of government it is not only to cope with market failures, but also to guarantee the fundamental initial conditions for a healthy start to life.

Grossman's *demand for health* model, which assumes that individuals *inherit* an initial amount of *health* that depreciates with age and increases with investments (Grossman, 1972) is also a case for reflection. The IOp framework highlights that the amount of the initial stock of health is endogenous to parent's health and their structural conditions. One of the main results of this study is that circumstances explain between 18% to 28% of the variation in nutrition-health outcomes (HAZ, WHZ, WAZ, BMI-Z and DBM) in children. Conceptually, children's circumstances reflect parents circumstances, but also their efforts. Mother's health insurance, education, health condition, as well as geographical factors play a non-trivial role in the development of stunning, wasting, a low weight for their age and also a higher BMI. Moreover, these results show that the rate of health depreciation varies according to the initial amount of inherited health.

It should be emphasised that this is not a causal analysis. We are not interested in measuring the causal effect of circumstances and efforts on nutrition-related health outcomes, but rather to establish the pathways from circumstances to health outcomes and evaluating mediator factors such as individual efforts. As with any analysis, there are some limitations worthy of discussion. One is that we are restricted to the characteristics of the 1988 survey design. For instance, the 1988 survey collected data only about women between 12 and 49 years old, implying that family characteristics (education, BMI, Anaemia) from both parents are missing. Another important point about the data is that the sample units in all of the six surveys was the household and hence respondents were those individuals residing in households at the time of the study. This impacted in small sample sizes that did not allow us to measure *ex-post* IOp in 2012. We did not estimate inequality under this approach using the 2016 survey because data on food consumption were collected differently with respect to previous waves, and therefore effort variables were not available. Despite these limitations, the study contributes in different aspects. In terms of the methods, we proposed an innovative way to deal with the lack of panel data when performing life course analysis. With regards to the literature on IOp, this paper is a first attempt to measure the importance of circumstances and efforts to explain a relatively new and certainly worrying public health problem: the double burden of malnutrition. Also, this piece of work contributes to a better understanding of the relevance of studying malnutrition as a two-dimension and interconnected public health problem, instead of assuming that under and overnutrition are independent and exclusive to certain age groups. Future analyses should be undertaken in other settings and using different data to test whether the same results hold.

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A Appendix

B Variable definitions

Table B.1: Key variables definition

Outcomes		
Variable	**Definition**	**Focus**
Stunting	HAZ <-2 z scores	Under nutrition
Wasting	WHZ <-2 z scores	Under nutrition
Underweight	WAZ <-2 z scores	Under nutrition
Overweight	BMIZ >2 z scores	Over nutrition
Double burden in children	HAZ or WHZ or WAZ <-2 z scores AND BMI >2 z scores	Malnutrition
Anaemia*	HB<13 gl/dl	Under nutrition
Excess weight*	BMI>25 kg/mts2	Over nutrition
Excess adiposity*	WC >80 cm	Over nutrition
Double burden in people older than 11 years old	BMI >25 kg/mts2 or WC>80cm AND HB<13 gl/dl	Malnutrition
Circumstances		
Variable	**Definition**	
Sex	1 if man, 0 woman	
Ethnicity	1 if non-indigenous, 0 if indigenous	
Mother's health insurance	1 if mother insuranced, 0 otherwise	
Mother's BMI	In kg/mts2	
Mother's anaemia	1 if mother anaemic, 0 otherwise	
Parental diabetes	1 if mother or father was diagnosed with diabetes, 0 otherwise	
Parent's education	Five categories: No education, up to primary school up to secondary school, up to high school and higher education	
Running water available in the household	1 if water available, 0 otherwise	
Household living standards	Five levels: low, medium low, medium high and high	
State deprivation level	Five levels: very high,high,medium,low and very low	
Geographic region	Six regions: Northwest, Northeast, West, Centre, South and Southeast	
Efforts		
Dietary patterns	Three patterns: Low-nutritious and highly-caloric, high-nutritious food and legume and maize-based products. Food supplements consumption	
Physical activity	Daily hours dedicated to do vigorous and moderate physical activities	
Alcohol consumption	1 if the alcohol consumption is above recommendation, 0 otherwise	
Smoking frequency	1 if smoking tobacco occurs daily or regularly, 0 otherwise	

Note: *Outcomes measured in individuals older than 11 years old

Table B.2: Outcomes analysed in the *Ex-ante* and *Ex-post* approaches

	Ex-ante approach					Ex-post approach				
		Mean-based		Beyond-the-mean			Mean-based		Beyond-the-mean	
Age group	**Outcome**	**Proxy**	**Focus**	**Outcome**	**Focus**	**Outcome**	**Proxy**	**Focus**	**Outcome**	**Focus**
0 to 5 years old	Stunting	HAZ <-2 z scores	Under nutrition							
	Wasting	WHZ <-2 z scores								
	Underweight	WAZ <-2 z scores								
	Overweight	BMIZ >2 z scores	Over nutrition							
	Double burden	HAZ or WHZ or WAZ <-2 z scores AND BMI >2 z scores	Malnutrition							
11 to 35 years old	Anaemia	HB<13 gl/dl	Under nutrition	HB		Anaemia	HB<13 gl/dl	Under nutrition	HB	
	Excess weight	BMI>25 kg/mts2	Over nutrition	BMI	Percentiles: 10^{th} 25^{th} 50^{th} 75^{th} 90^{th} 95^{th} and 99^{th}	Excess weight	BMI>25 kg/mts2	Over nutrition	BMI	Percentiles: 10^{th} 25^{th} 50^{th} 75^{th} 90^{th} 95^{th} and 99^{th}
	Excess adiposity	WC >80 cm		WC		Excess adiposity	WC >80 cm		WC	
	Double burden	BMI >25 kg/mts2 or WC>80cm AND HB<13 gl/dl	Malnutrition			Double burden	BMI >25 kg/mts2 or WC>80cm AND HB<13 gl/dl	Malnutrition		

C Matching results

Table C.1: Matching summary

		Control	Treatment	Strata
1988-1999	All	6,471	6,510	60
	Matched	6,471	6,510	60
	Unmatched	0	0	0
1988-2006	All	6,517	6,510	65
	Matched	2,201	6,455	59
	Unmatched	4,316	55	6
1988-2012	All	14,559	6,510	60
	Matched	14,559	6,510	60
	Unmatched	0	0	0
1988-2016	All	2,223	6,510	60
	Matched	2,223	6,510	60
	Unmatched	0	0	0
1988-2018	All	2,208	6,510	60
	Matched	2,208	6,510	60
	Unmatched	0	0	0

The 55 treatment observations unmatched across the 1988 and 2006 surveys correspond to men that lived in the Northwest region and were born in 1985.

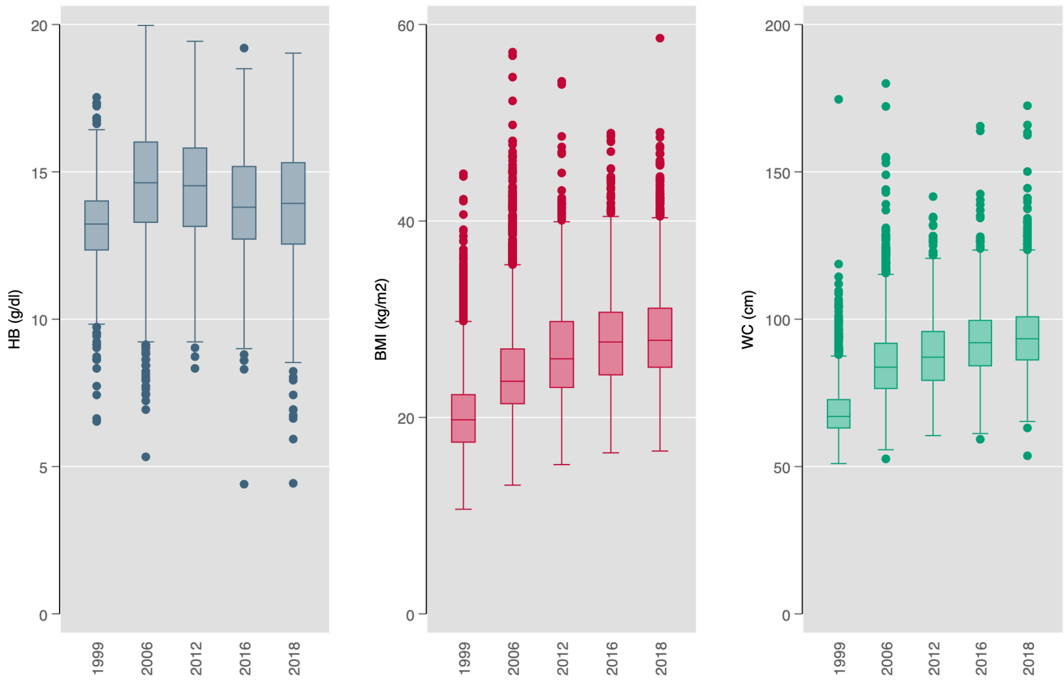
D Distribution of samples by year of birth

Table D.1: Distribution of the matched samples across cohorts

	Survey year						
Year of birth	1988	1999	2006	2012	2016	2018	**Total**
1983		949	694	1,565	406	372	3,986
1984	1,212	1,063	706	1,589	400	384	5,354
1985	1,373	1,071	677	1,661	334	363	5,479
1986	1,295	1,161	716	1,704	377	382	5,635
1987	1,258	1,514	1,336	1,750	364	331	6,553
1988	1,353	1,337	1,531	1,719	342	376	6,658
Total	6,491	7,095	5,660	9,988	2,223	2,208	33,665

E Description of continuous outcomes

Figure E.1: Distribution of HB, BMI and WC across survey years



F Construction of effort variables

Eating pattern 1: low-nutritious and high-energy food, such as whole-fat diary, fast food, sweetened beverages, sweets and red meat. **Eating pattern 2:** high-nutritious food, such as fruits, vegetables, poultry, fish, and cereals. **Eating pattern 3:** Legumes and maize-based products.

Figure F.1: Distribution of eating-patterns across survey years

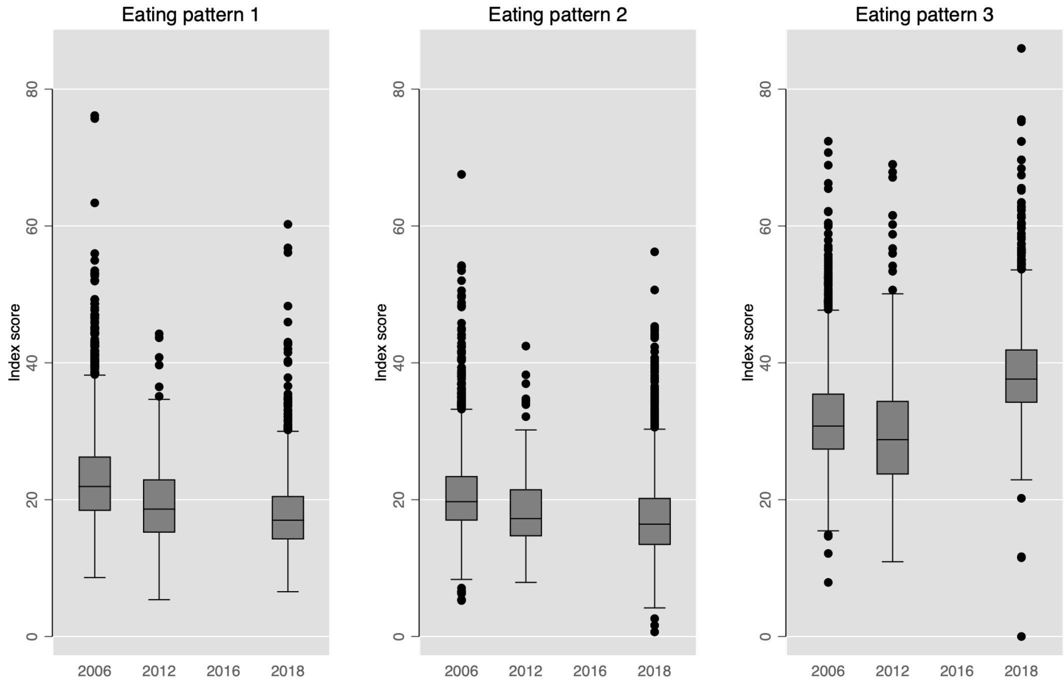


Table F.1: Food items included in the 2006, 2012 and 2018 surveys (I)

Animal protein	**One portion is:**
Milk (whole, skim, lactose-free, powder, LICONSA, etc)	1 cup (240 ml)
Panela or cottage-type cheese	1 slice or 2 tablespoons (30 g)
Chihuahua-type, manchego, gouda cheese	1 slice (30 g)
Yogurt	1 typical cup yogurt (150 g)
Liquid yoghurt	One typical jar (230 g)
Petite suisse yogurt	1 pot (45 g)
Sweetened probiotic milk beverage	1 bottle (80 ml)
Pork or beef meat	1 medium steak (90 g)
Dried beef	1 plate (80 g)
Sausage	1/2 piece (30 g)
Pork sausage, ham, turkey, mortadella	1 sausage or slice (30 g)
Chicken (leg, thigh or breast)	1 piece (leg, thigh) (90 g)
Chicken wing	One wing
Chiken liver or gizzard	1 piece (30 g)
Egg (boiled or cooked)	1 piece (62 g)
Fish	1 piece (90 g)
Tuna and sardines (Tomato, water or oil)	1/4 tin (40 g)
Other seafood (shrimp, oysters, etc.)	1 plate (100 g)
Fruits, vegetables and legumes	**One portion is:**
Banana	1 medium piece (176 g)
Jicama	1/2 medium piece (163 g)
Orange or tangerine	1 large piece (206 g)
Apple or pear	1 medium piece (140 g)
Melon or watermelon	1 slice or 3/4 cup (115 g)
Guava	1 medium piece (75 g)
Mango	1 medium piece (185 g)
Papaya	1 medium slice (100 g) or 1/2 cup
Pineapple	1 medium slice (150 g)
Grapefruit	1 piece small (270 g)
Strawberry	1 cup or 9 medium pieces (140 g)
Grapes	10 pieces (60 g)
Peach	1 medium piece (50 g)
Red tomatoes	Half piece (30 g)
Green leaves (spinach, quelites)	1/2 plate (85 g)
Squash	1/4 piece(50 g) or 1/3 cup
Carrot	1 small piece or 1/2 cup (50 g)
Zucchini	1/2 medium part (50 g)
Broccoli, cauliflower or cabbage	1/4 cup (35 g)
Green beans	1/4 cup or 5 pieces (30 g)
Corn cob	Half small piece (50 g)
Lettuce	1/2 cup (30 g)
Nopales	1 large piece (100 g)
Cucumber	1/2 large piece (150 g)
Avocado	1 slice or 1 small piece (33 g)
Poblano chile	A medium piece or 1/3 cup (80 g)
Canned vegetables such as peas, carrots, mushrooms and green beans	1/3 cup or 1 small can
Frozen vegetables such as peas, carrots, broccoli, cauliflower, green beans	1/3 cup
Beans	50 g
Lentils and chick peas	1 plate or 1 cup (100 g)

Table F.2: Food items included in the 2006, 2012 and 2018 surveys (II)

Energy-dense food	**One portion is:**
Cake or sandwich	1 medium piece (130 g)
Burger	Medium 1 piece (240 g)
Pizza	1 slice small (92 g)
Hot dog	1 medium piece (110 g)
Soda	1 cup (240 ml)
Tea or coffee	1 cup (240 ml)
Natural juices	1 cup (240 ml)
Fruit-favoured water	1 cup (240 ml)
Sweetened beverages	1 cup (240 ml)
Chocolate	1 piece or 1 tablespoon (10 g)
Candy (Candies, lollipops)	1 piece (30 g)
Spicy and sweet candy	1 piece (30 g)
Snacks (like peanuts, crisps)	1 single package or small bag (35 g)
Gelatin, flan	1 piece or slice (125 g)
Cake or pie	1 medium slice (125 g)
Ice cream	1 scoop (80 g)
Peanuts, beans or seeds	1 fist (han (35 g)
Microwavable popcorn (All types)	1 medium bag (100 g)
Donuts	1 piece (70g)
Biscuits (All types)	2 units (32 g)
Cereal bars	1 piece (25g)
Margarine	1 tablespoon (10 g)
Butter	1 tablespoon (10 g)
Mayonnaise	1 tablespoon (10 g)
Fresh sour cream	1 tablespoon (10 g)
Vegetable lard	1 tablespoon (10 g)
Animal lard	1 tablespoon (10 g)
Pasta, cereals and white bread	**One portion is:**
Cooked rice	1 cup or 1 plate (100 g)
White bread	2 slices or one roll(70g)
Wholemeal bread	2 slices or one roll (70g)
Sweet bread (Except donuts and fritters)	1 piece (70g)
Bakery donuts and churros	1 piece (70g)
Pretzels	4 pieces (20 g)
Potatoes cooked	1/2 medium cooked piece (40g)
Fried potatos	1/2 medium piece (40 g)
Box cereals (chocolate, light, corn flakes, fruit-flavoured, fiber)	1 cup (30 g dry)
Broth	1 cup (240 ml)
Soups	1 plate (240 mL)
Instant soup	1 pot (64 g)
Maize products and tortillas	**One portion is:**
Meatless snacks like sopes, quesadillas, tlacoyos, gorditas and enchiladas	100 g
Antojitos with beef, pork, poultry, organ meats, such as tacos, quesadillas, tlacoyos, enchiladas, gorditas	100 g
Pozole (All types)	1 plate (100 g)
Tamale (All types)	1 piece (200 g)
Atole (all types)	1 cup (240 ml)
Maize tortillas	1 unit
Wheat flour tortilla	1 unit

G Linear regression models. *Ex-ante* approach

Table G.1: Logit regression results: *Ex-Ante* analysis, 1988. Clinical cut-off points.

	HAZ	**WHZ**	**WAZ**	**BMIz**	**DBM**
Individual Characteristics					
Individual's sex	0.078	-0.004	-0.002	0.295**	0.265+
	(0.068)	(0.110)	(0.088)	(0.100)	(0.156)
Individual's ethnicity	-0.616***	-0.155	-0.768***	0.561*	0.392
	(0.135)	(0.274)	(0.148)	(0.282)	(0.331)
Household living standards					
Running water HH	0.183+	0.419**	0.363**	-0.088	0.224
	(0.100)	(0.159)	(0.132)	(0.151)	(0.243)
LS:Low	2.460***	0.357	2.011***	0.129	1.551***
	(0.161)	(0.229)	(0.216)	(0.200)	(0.339)
LS:Med-Low	1.326***	0.407*	1.317***	-0.422*	0.160
	(0.149)	(0.189)	(0.200)	(0.182)	(0.332)
LS:Med-High	0.876***	0.396*	0.900***	-0.192	0.191
	(0.137)	(0.163)	(0.187)	(0.146)	(0.287)
State Deprivation					
Dep:V.High	0.129	0.146	0.160	0.259	-0.167
	(0.155)	(0.307)	(0.205)	(0.245)	(0.404)
Dep:High	0.198	-0.050	-0.199	-0.143	0.190
	(0.148)	(0.210)	(0.192)	(0.204)	(0.330)
Dep:Med	0.312	-0.568	0.049	-0.354	-0.130
	(0.204)	(0.368)	(0.275)	(0.280)	(0.481)
Dep:Low	0.099	-0.103	-0.042	0.003	0.106
	(0.105)	(0.158)	(0.143)	(0.142)	(0.255)
Geographical Region					
Northwest	-0.689**	0.930+	-1.027**	0.780*	0.496
	(0.264)	(0.518)	(0.346)	(0.362)	(0.603)
Northeast	-0.172	1.079*	-0.229	0.148	0.493
	(0.206)	(0.478)	(0.259)	(0.336)	(0.509)
West	0.217	1.069*	-0.111	0.615+	0.988*
	(0.202)	(0.477)	(0.256)	(0.327)	(0.494)
Centre	0.264	0.168	-0.489+	-0.166	0.364
	(0.217)	(0.497)	(0.278)	(0.351)	(0.539)
South	0.157	0.385	-0.268	-0.475	0.639
	(0.258)	(0.581)	(0.325)	(0.427)	(0.645)
Constant	-2.412***	-3.751***	-2.597***	-3.146***	-5.305***
	(0.302)	(0.604)	(0.378)	(0.490)	(0.720)
N	5,764	5,837	5,981	5,861	5,475
r2_p	.129	.0251	.0748	.0224	.052

Notes: standard errors in parenthesis + $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$
r2_p=pseudo R squared. HAZ=1 if stunting. WHZ=1 if wasting. WAZ=1 if underweight
BMIz=1 if overweight. DBM=1 if stunting or wasting or underweight and overweight

H Nonlinear regression models. *Ex-ante* approach

Table G.2: Logit regression results: *Ex-Ante* analysis, 1999. Clinical cut-off points.

	DBM	**HB**	**BMI**	**WC**
Individual Characteristics				
Individual's sex	0.000	1.323***	-1.711***	0.000
	(.)	(0.253)	(0.443)	(.)
Individual's ethnicity	-0.415	-0.256	0.912+	0.894
	(1.167)	(0.345)	(0.469)	(0.688)
Household living standards				
Running water HH	-0.102	0.238	-0.121	-0.346
	(0.903)	(0.293)	(0.210)	(0.250)
LS:Low	-2.280+	0.394	-0.804**	-1.156**
	(1.259)	(0.427)	(0.297)	(0.364)
LS:Med-Low	-1.007	0.590	-0.756**	-0.904**
	(0.959)	(0.367)	(0.249)	(0.294)
LS:Med-High	-2.070*	-0.287	-0.351+	-0.592**
	(0.978)	(0.336)	(0.188)	(0.227)
State Deprivation				
Dep:V.High	0.487	-0.314	-0.569	-1.243
	(2.438)	(0.701)	(0.576)	(0.770)
Dep:High	0.813	0.485	0.011	-0.482
	(1.104)	(0.411)	(0.274)	(0.339)
Dep:Med	0.035	0.636	-0.061	-0.094
	(1.101)	(0.460)	(0.295)	(0.338)
Dep:Low	0.010	0.694*	0.053	-0.191
	(0.968)	(0.353)	(0.215)	(0.250)
Geographical Region				
Northwest	1.836	-0.159	0.652	0.234
	(2.214)	(0.639)	(0.520)	(0.697)
Northeast	-0.064	-0.344	0.338	0.176
	(2.260)	(0.597)	(0.506)	(0.678)
West	0.961	-0.822	0.124	0.238
	(2.148)	(0.588)	(0.503)	(0.670)
Centre	0.069	-0.903	-0.386	-0.459
	(2.111)	(0.555)	(0.484)	(0.655)
South	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)
Constant	-2.677	-1.594+	-2.132**	-1.785+
	(2.730)	(0.822)	(0.731)	(1.003)
N	518	775	1,905	1,519
r2_p	.107	.0583	.0676	.0647

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
r2_p=pseudo R squared. HB=1 if anaemia. BMI=1 if excess weight
WC=1 if excess adiposity. DBM=1 if excess weight or adiposity and anaemia
Sex and South omitted because of collinearity.

Table G.3: Logit regression results: *Ex-Ante* analysis, 2006. Clinical cut-off points.

	DBM	**HB**	**BMI**	**WC**
Individual Characteristics				
Individual's sex	-1.534***	-1.245***	0.082	-0.918***
	(0.161)	(0.107)	(0.058)	(0.084)
Individual's ethnicity	0.170	0.370	0.414*	0.637**
	(0.361)	(0.283)	(0.185)	(0.234)
Household living standards				
Running water HH	0.016	0.056	-0.030	0.029
	(0.185)	(0.130)	(0.082)	(0.112)
LS:Low	0.479*	0.253	-0.061	0.162
	(0.223)	(0.158)	(0.098)	(0.136)
LS:Med-Low	0.344+	0.073	0.130	0.195+
	(0.200)	(0.142)	(0.083)	(0.118)
LS:Med-High	-0.062	0.021	-0.081	0.017
	(0.206)	(0.141)	(0.080)	(0.115)
State Deprivation				
Dep:V.High	-0.421	0.291	-0.720***	-0.712*
	(0.483)	(0.333)	(0.216)	(0.311)
Dep:High	-0.075	0.558**	-0.309**	-0.300*
	(0.258)	(0.185)	(0.108)	(0.147)
Dep:Med	-0.164	0.113	-0.134	-0.030
	(0.234)	(0.177)	(0.100)	(0.139)
Dep:Low	-0.057	0.190	0.057	0.138
	(0.227)	(0.170)	(0.093)	(0.128)
Geographical Region				
Northwest	0.292	0.636+	-0.526**	-0.133
	(0.477)	(0.337)	(0.202)	(0.298)
Northeast	0.082	0.338	-0.507**	-0.038
	(0.436)	(0.305)	(0.182)	(0.277)
West	0.049	0.295	-0.524**	-0.304
	(0.446)	(0.312)	(0.187)	(0.284)
Centre	-0.558	-0.132	-0.464**	-0.369
	(0.421)	(0.293)	(0.174)	(0.266)
South	-0.005	0.185	-0.208	0.140
	(0.524)	(0.361)	(0.227)	(0.350)
Constant	-1.978***	-2.534***	-0.304	-0.051
	(0.580)	(0.432)	(0.264)	(0.362)
N	3,005	4,863	5,100	2,430
r2_p	.0815	.0596	.00881	.0471

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
r2_p=pseudo R squared. HB=1 if anaemia. BMI=1 if excess weight
WC=1 if excess adiposity. DBM=1 if excess weight or adiposity and anaemia

Table G.4: Logit regression results: *Ex-Ante* analysis, 2012. Clinical cut-off points.

	DBM	**HB**	**BMI**	**WC**
Individual Characteristics				
Individual's sex	-1.777***	-1.476***	0.015	-0.993***
	(0.433)	(0.313)	(0.130)	(0.138)
Individual's ethnicity	1.306	0.932+	0.076	0.104
	(0.840)	(0.505)	(0.251)	(0.269)
Household living standards				
Running water HH	-0.765	-0.584+	0.134	0.185
	(0.466)	(0.318)	(0.182)	(0.195)
LS:Low	-0.716	-0.263	0.092	-0.245
	(0.581)	(0.442)	(0.244)	(0.260)
LS:Med-Low	-0.349	-0.197	0.614**	0.517*
	(0.540)	(0.400)	(0.217)	(0.232)
LS:Med-High	-0.458	-0.232	0.257	-0.020
	(0.496)	(0.376)	(0.194)	(0.204)
State Deprivation				
Dep:V.High	1.928	2.661*	0.726	1.128*
	(1.484)	(1.325)	(0.452)	(0.476)
Dep:High	0.672	0.774+	-0.375	0.027
	(0.648)	(0.466)	(0.244)	(0.254)
Dep:Med	0.461	0.335	-0.179	0.122
	(0.581)	(0.421)	(0.215)	(0.228)
Dep:Low	0.820	0.719+	-0.012	0.344
	(0.588)	(0.408)	(0.217)	(0.228)
Geographical Region				
Northwest	-1.214	-0.589	-0.481	-0.022
	(0.956)	(0.679)	(0.460)	(0.472)
Northeast	-1.351+	-0.789	-0.885*	-0.258
	(0.801)	(0.584)	(0.407)	(0.419)
West	-1.657+	-1.077+	-0.932*	-0.411
	(0.860)	(0.632)	(0.424)	(0.435)
Centre	-1.543*	-1.133*	-0.501	-0.135
	(0.784)	(0.567)	(0.395)	(0.405)
South	-2.577+	-2.676*	-1.079*	-0.616
	(1.412)	(1.298)	(0.491)	(0.508)
Constant	-1.155	-1.849*	0.697	0.594
	(1.331)	(0.919)	(0.549)	(0.574)
N	498	1,049	1,122	1,051
r2_p	.125	.0873	.0241	.0652

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
r2_p=pseudo R squared. HB=1 if anaemia. BMI=1 if excess weight
WC=1 if excess adiposity. DBM=1 if excess weight or adiposity and anaemia

Table G.5: Logit regression results: *Ex-Ante* analysis, 2016. Clinical cut-off points.

	DBM	**HB**	**BMI**	**WC**
Individual Characteristics				
Individual's sex	-2.105***	-0.707*	-0.391**	-1.644***
	(0.464)	(0.300)	(0.143)	(0.168)
Individual's ethnicity	0.957	0.489	0.511*	0.610*
	(0.726)	(0.508)	(0.235)	(0.266)
Household living standards				
Running water HH	1.071*	0.603+	0.079	-0.434*
	(0.540)	(0.336)	(0.183)	(0.211)
LS:Low	0.827	0.627	0.078	-0.396
	(0.840)	(0.523)	(0.273)	(0.314)
LS:Med-Low	0.940	0.570	0.060	-0.429
	(0.758)	(0.467)	(0.237)	(0.271)
LS:Med-High	0.859	0.417	0.193	-0.044
	(0.737)	(0.452)	(0.225)	(0.260)
State Deprivation				
Dep:V.High	1.486	0.826	-0.089	-0.040
	(1.372)	(0.946)	(0.458)	(0.521)
Dep:High	1.210	1.107+	-0.026	0.093
	(0.889)	(0.628)	(0.261)	(0.300)
Dep:Med	-0.007	0.718	0.163	-0.010
	(0.996)	(0.672)	(0.266)	(0.301)
Dep:Low	-0.891	0.257	-0.263	-0.175
	(0.873)	(0.641)	(0.236)	(0.272)
Geographical Region				
Northwest	-0.686	-0.205	0.639	0.371
	(1.265)	(0.800)	(0.514)	(0.598)
Northeast	-1.762+	-0.811	-0.073	-0.275
	(1.022)	(0.656)	(0.425)	(0.502)
West	-1.808	-1.190+	0.175	0.086
	(1.150)	(0.714)	(0.443)	(0.517)
Centre	-0.958	-0.139	0.188	-0.211
	(1.043)	(0.669)	(0.432)	(0.507)
South	-2.781*	-0.870	-0.087	-0.407
	(1.223)	(0.788)	(0.506)	(0.592)
Constant	-1.037	-2.697*	0.399	2.031**
	(1.566)	(1.091)	(0.578)	(0.686)
N	174	485	1,055	980
r2_p	.264	.0707	.0242	.123

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
r2_p=pseudo R squared. HB=1 if anaemia. BMI=1 if excess weight
WC=1 if excess adiposity. DBM=1 if excess weight or adiposity and anaemia

Table G.6: Logit regression results: *Ex-Ante* analysis, 2018. Clinical cut-off points.

	DBM	**HB**	**BMI**	**WC**
Individual Characteristics				
Individual's sex	-1.974***	-1.648***	0.034	-0.998***
	(0.170)	(0.130)	(0.102)	(0.114)
Individual's ethnicity	-0.340	-0.330	0.079	0.091
	(0.310)	(0.218)	(0.198)	(0.194)
Household living standards				
Running water HH	-0.068	-0.027	-0.144	-0.404*
	(0.233)	(0.168)	(0.150)	(0.159)
LS:Low	0.139	-0.293	0.490*	0.795***
	(0.322)	(0.235)	(0.200)	(0.213)
LS:Med-Low	0.293	0.088	0.433*	0.772***
	(0.286)	(0.206)	(0.186)	(0.200)
LS:Med-High	0.194	-0.092	0.372*	0.514**
	(0.248)	(0.179)	(0.159)	(0.168)
State Deprivation				
Dep:V.High	0.163	-0.018	0.670+	0.073
	(0.596)	(0.453)	(0.401)	(0.406)
Dep:High	0.630+	0.509+	0.461*	0.308
	(0.354)	(0.273)	(0.212)	(0.225)
Dep:Med	0.591+	0.396	0.472*	0.684**
	(0.323)	(0.253)	(0.195)	(0.212)
Dep:Low	0.979**	0.791**	0.267	0.506*
	(0.341)	(0.263)	(0.204)	(0.220)
Geographical Region				
Northwest	-0.506	0.164	-0.903*	-0.339
	(0.573)	(0.393)	(0.424)	(0.386)
Northeast	-0.320	0.030	-0.715+	-0.082
	(0.527)	(0.348)	(0.391)	(0.340)
West	-1.140*	-0.555	-0.914*	-0.373
	(0.551)	(0.374)	(0.402)	(0.353)
Centre	-0.565	-0.107	-0.924*	-0.255
	(0.501)	(0.334)	(0.379)	(0.322)
South	-0.118	0.164	-0.720	-0.087
	(0.636)	(0.450)	(0.477)	(0.434)
Constant	0.565	-0.716	1.258**	1.306**
	(0.645)	(0.455)	(0.458)	(0.420)
N	827	2,078	2,112	2,019
r2_p	.161	.104	.0123	.0564

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
r2_p=pseudo R squared. HB=1 if anaemia. BMI=1 if excess weight
WC=1 if excess adiposity. DBM=1 if excess weight or adiposity and anaemia

Table H.1: Linear regression: *Ex-Ante* IOp in BMI across different percentiles. 1999

	p10	**p25**	**p50**	**p75**	**p90**	**p95**	**p99**
Individual Characteristics							
Individual's sex	-1.040***	-2.838***	-3.191***	-2.512***	-2.913***	-3.487**	-4.744
	(0.238)	(0.285)	(0.340)	(0.476)	(0.747)	(1.200)	(3.169)
Individual's ethnicity	0.451	0.520	0.493	1.155*	0.743	0.980	-1.695
	(0.287)	(0.344)	(0.411)	(0.574)	(0.902)	(1.450)	(3.827)
Household living standards							
Running water HH	0.425+	0.051	-0.476	0.265	-0.217	-0.926	-3.814
	(0.220)	(0.264)	(0.315)	(0.440)	(0.691)	(1.111)	(2.933)
LS:Low	-0.109	-1.101**	-2.313***	-2.423***	-3.134**	-4.309**	-9.420*
	(0.309)	(0.370)	(0.442)	(0.618)	(0.970)	(1.558)	(4.115)
LS:Med-Low	0.048	-0.742*	-1.673***	-2.215***	-2.897***	-4.379**	-7.021*
	(0.267)	(0.320)	(0.382)	(0.534)	(0.839)	(1.348)	(3.560)
LS:Med-High	-0.235	-0.418	-1.252***	-1.398**	-1.886**	-2.466*	-7.893**
	(0.219)	(0.262)	(0.313)	(0.438)	(0.687)	(1.104)	(2.916)
State Deprivation							
Dep:V.High	-0.761	-0.765	-0.903	0.005	-2.325	-2.210	-2.344
	(0.569)	(0.682)	(0.815)	(1.139)	(1.789)	(2.874)	(7.588)
Dep:High	-0.547+	-0.526	-0.500	0.190	-0.622	-0.359	-5.186
	(0.307)	(0.367)	(0.439)	(0.614)	(0.964)	(1.548)	(4.088)
Dep:Med	-0.409	-0.709+	-0.199	-0.052	-0.543	-0.860	-1.334
	(0.338)	(0.405)	(0.484)	(0.676)	(1.062)	(1.706)	(4.505)
Dep:Low	-0.287	-0.598+	-0.185	-0.044	-0.041	-0.815	-2.388
	(0.259)	(0.310)	(0.371)	(0.519)	(0.815)	(1.309)	(3.456)
Geographical Region							
Northwest	-0.561	0.057	0.539	1.655	1.764	1.175	2.298
	(0.533)	(0.639)	(0.764)	(1.067)	(1.676)	(2.694)	(7.112)
Northeast	-0.847+	-0.523	-0.551	0.589	0.799	0.027	7.461
	(0.512)	(0.613)	(0.734)	(1.025)	(1.610)	(2.586)	(6.829)
West	-0.775	-0.545	-0.169	0.213	-0.205	0.041	4.233
	(0.503)	(0.602)	(0.720)	(1.006)	(1.580)	(2.538)	(6.702)
Centre	-0.652	-0.559	-0.409	-0.498	-1.692	-2.243	0.350
	(0.472)	(0.566)	(0.676)	(0.945)	(1.484)	(2.384)	(6.296)
South	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Constant	17.052***	19.356***	22.293***	23.448***	28.768***	32.884***	45.797***
	(0.654)	(0.783)	(0.936)	(1.308)	(2.054)	(3.301)	(8.716)
N	1,931	1,931	1,931	1,931	1,931	1,931	1,931
r2	.0226	.0732	.0799	.0591	.0497	.0223	.0153

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
r2=R squared. South region omitted because of collinearity.

Table H.2: Linear regression: *Ex-Ante* IOp in WC across different percentiles. 1999

	p10	**p25**	**p50**	**p75**	**p90**	**p95**	**p99**
Individual Characteristics							
Individual's sex	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Individual's ethnicity	0.778	-0.638	0.121	2.940+	2.192	-1.576	-0.235
	(0.989)	(0.951)	(0.990)	(1.564)	(2.394)	(4.527)	(8.428)
Household living standards							
Running water HH	0.723	0.192	0.468	-0.474	-1.791	-6.338+	-7.626
	(0.712)	(0.685)	(0.713)	(1.126)	(1.723)	(3.258)	(6.066)
LS:Low	-1.454	-2.704**	-2.868**	-6.519***	-8.051***	-16.313***	-12.221
	(0.997)	(0.959)	(0.998)	(1.577)	(2.414)	(4.564)	(8.497)
LS:Med-Low	-0.167	-2.062*	-2.785**	-5.334***	-6.971***	-11.505**	-8.092
	(0.856)	(0.823)	(0.857)	(1.354)	(2.073)	(3.920)	(7.297)
LS:Med-High	-0.798	-1.496*	-2.579***	-4.656***	-4.943**	-8.371*	-3.648
	(0.713)	(0.685)	(0.713)	(1.127)	(1.725)	(3.261)	(6.071)
State Deprivation							
Dep:V.High	0.221	0.507	1.222	0.294	-4.897	-19.518*	-10.954
	(1.895)	(1.822)	(1.897)	(2.996)	(4.586)	(8.672)	(16.144)
Dep:High	0.214	0.485	0.568	-1.491	-2.338	-12.422**	-12.805
	(0.988)	(0.950)	(0.990)	(1.563)	(2.393)	(4.524)	(8.423)
Dep:Med	1.756	1.797+	0.670	-0.731	-0.664	-9.236+	-0.641
	(1.100)	(1.058)	(1.102)	(1.740)	(2.663)	(5.037)	(9.376)
Dep:Low	0.537	1.237	0.931	0.093	-1.581	-8.228*	-0.350
	(0.825)	(0.793)	(0.826)	(1.304)	(1.996)	(3.775)	(7.027)
Geographical Region							
Northwest	0.820	0.684	3.271+	6.067*	3.454	2.357	2.188
	(1.806)	(1.737)	(1.808)	(2.856)	(4.372)	(8.267)	(15.389)
Northeast	1.148	1.592	3.938*	4.757+	3.180	-1.891	1.292
	(1.721)	(1.655)	(1.723)	(2.722)	(4.167)	(7.879)	(14.668)
West	-0.655	-0.684	1.719	3.597	3.091	-0.361	3.389
	(1.706)	(1.640)	(1.708)	(2.697)	(4.129)	(7.808)	(14.535)
Centre	0.086	0.643	2.277	2.320	-1.453	-7.575	-0.839
	(1.603)	(1.541)	(1.604)	(2.534)	(3.879)	(7.335)	(13.655)
South	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(.)	(.)	(.)	(.)	(.)	(.)	(.)
Constant	58.522***	64.010***	66.683***	72.712***	86.099***	113.813***	115.856***
	(2.189)	(2.105)	(2.192)	(3.462)	(5.300)	(10.022)	(18.657)
N	1,505	1,505	1,505	1,505	1,505	1,505	1,505
r2	.0181	.0247	.0407	.0589	.0413	.0392	.00991

Notes: standard errors in parenthesis + $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$
r2=R squared. South region omitted because of collinearity.

Table H.3: Linear regression: *Ex-Ante* IOp in BMI across different percentiles. 2006

	p10	**p25**	**p50**	**p75**	**p90**	**p95**	**p99**
Individual Characteristics							
Individual's sex	0.266+	0.278*	0.256+	0.121	-0.320	-1.025*	-1.247
	(0.137)	(0.128)	(0.149)	(0.209)	(0.371)	(0.436)	(1.143)
Individual's ethnicity	-0.546	0.367	0.825+	1.447*	3.132**	1.790	2.162
	(0.396)	(0.370)	(0.431)	(0.605)	(1.075)	(1.264)	(3.312)
Household living standards							
Running water HH	0.015	-0.153	-0.020	0.029	-0.451	-1.402*	-2.220
	(0.192)	(0.180)	(0.209)	(0.294)	(0.521)	(0.613)	(1.606)
LS:Low	0.221	0.035	0.099	-0.523	0.091	-0.042	1.924
	(0.229)	(0.214)	(0.249)	(0.350)	(0.622)	(0.731)	(1.917)
LS:Med-Low	0.203	0.363*	0.443*	0.245	-0.056	0.514	3.184+
	(0.196)	(0.183)	(0.213)	(0.300)	(0.532)	(0.626)	(1.640)
LS:Med-High	0.125	0.191	-0.007	-0.509+	-1.077*	-1.148+	1.205
	(0.190)	(0.177)	(0.206)	(0.290)	(0.515)	(0.606)	(1.587)
State Deprivation							
Dep:V.High	0.029	-0.741	-2.465***	-1.879*	-2.215	-1.041	-2.672
	(0.503)	(0.471)	(0.547)	(0.769)	(1.366)	(1.606)	(4.209)
Dep:High	0.438+	0.046	-0.845**	-1.141**	-2.121**	-1.802*	-4.319*
	(0.252)	(0.236)	(0.274)	(0.386)	(0.685)	(0.806)	(2.111)
Dep:Med	0.106	0.061	-0.271	-0.824*	-1.545*	-1.750*	-3.597+
	(0.238)	(0.222)	(0.258)	(0.363)	(0.645)	(0.759)	(1.988)
Dep:Low	0.018	0.074	-0.169	-0.178	-0.627	-0.571	-1.178
	(0.221)	(0.207)	(0.241)	(0.339)	(0.601)	(0.707)	(1.853)
Geographical Region							
Northwest	-0.556	-0.744	-1.049*	-1.299+	-2.485+	-2.118	1.836
	(0.483)	(0.452)	(0.526)	(0.739)	(1.313)	(1.544)	(4.045)
Northeast	-0.889*	-1.096**	-1.364**	-1.597*	-2.892*	-2.069	1.057
	(0.435)	(0.407)	(0.473)	(0.665)	(1.181)	(1.388)	(3.637)
West	-0.550	-0.961*	-1.084*	-1.473*	-3.240**	-2.705+	-0.948
	(0.447)	(0.419)	(0.487)	(0.684)	(1.215)	(1.429)	(3.744)
Centre	-0.314	-0.695+	-1.216**	-1.522*	-4.073***	-4.028**	-2.847
	(0.416)	(0.389)	(0.452)	(0.636)	(1.129)	(1.327)	(3.477)
South	-0.169	0.109	0.042	-0.954	-3.370*	-3.705*	-0.911
	(0.542)	(0.507)	(0.590)	(0.829)	(1.472)	(1.731)	(4.535)
Constant	20.075***	21.449***	24.212***	27.848***	33.016***	37.114***	40.923***
	(0.604)	(0.565)	(0.657)	(0.923)	(1.640)	(1.928)	(5.051)
N	5,103	5,103	5,103	5,103	5,103	5,103	5,103
r2	.00796	.00616	.00992	.00953	.0113	.0113	.00504

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
r2=R squared

Table H.4: Linear regression: *Ex-Ante* IOp in WC across different percentiles. 2006

	p10	**p25**	**p50**	**p75**	**p90**	**p95**	**p99**
Individual Characteristics							
Individual's sex	2.724***	3.395***	2.766***	3.728***	3.121**	5.130**	4.669+
	(0.547)	(0.537)	(0.587)	(0.754)	(1.131)	(1.840)	(2.772)
Individual's ethnicity	0.233	4.619**	2.922+	7.159***	5.627+	4.041	-10.165
	(1.492)	(1.462)	(1.600)	(2.054)	(3.081)	(5.014)	(7.555)
Household living standards							
Running water HH	0.759	0.686	-0.117	0.316	-2.235	-2.404	-4.729
	(0.738)	(0.724)	(0.792)	(1.017)	(1.525)	(2.482)	(3.739)
LS:Low	0.483	0.898	1.429	1.330	2.900	-0.393	10.377*
	(0.896)	(0.878)	(0.961)	(1.234)	(1.851)	(3.011)	(4.537)
LS:Med-Low	1.163	0.985	1.847*	2.203*	-0.167	-2.167	6.373
	(0.770)	(0.755)	(0.826)	(1.060)	(1.590)	(2.588)	(3.899)
LS:Med-High	-0.829	0.338	0.460	1.125	0.405	-0.836	4.954
	(0.757)	(0.742)	(0.811)	(1.042)	(1.563)	(2.543)	(3.831)
State Deprivation							
Dep:V.High	-0.918	-5.896**	-6.165**	-3.952	-4.752	-4.160	-8.142
	(2.031)	(1.990)	(2.178)	(2.796)	(4.194)	(6.824)	(10.282)
Dep:High	1.004	-0.531	-1.150	-1.417	-4.008*	-5.072	-9.722*
	(0.966)	(0.946)	(1.036)	(1.330)	(1.994)	(3.245)	(4.889)
Dep:Med	-1.183	-0.809	-1.100	-1.802	-4.744*	-6.457*	-10.138*
	(0.914)	(0.895)	(0.980)	(1.258)	(1.887)	(3.070)	(4.626)
Dep:Low	0.119	-0.309	0.454	0.501	-2.080	-2.821	-3.618
	(0.843)	(0.826)	(0.904)	(1.161)	(1.741)	(2.833)	(4.268)
Geographical Region							
Northwest	1.829	1.486	0.147	-0.753	1.696	1.853	2.972
	(1.956)	(1.917)	(2.098)	(2.694)	(4.040)	(6.574)	(9.906)
Northeast	0.550	1.052	1.521	-0.445	-0.101	5.998	1.161
	(1.814)	(1.778)	(1.946)	(2.498)	(3.747)	(6.098)	(9.187)
West	1.446	1.323	-0.288	-3.566	-2.689	-0.671	-0.539
	(1.862)	(1.824)	(1.996)	(2.563)	(3.845)	(6.256)	(9.426)
Centre	-0.158	-0.739	-1.624	-4.027+	-4.678	-5.043	-6.235
	(1.747)	(1.712)	(1.874)	(2.406)	(3.609)	(5.872)	(8.847)
South	1.165	4.402*	1.561	-0.285	-1.504	1.302	-0.574
	(2.288)	(2.242)	(2.453)	(3.150)	(4.725)	(7.688)	(11.583)
Constant	69.298***	70.019***	80.082***	85.511***	100.085***	109.488***	135.107***
	(2.360)	(2.313)	(2.531)	(3.250)	(4.875)	(7.932)	(11.951)
N	2,674	2,674	2,674	2,674	2,674	2,674	2,674
r2	.0168	.0281	.0264	.0259	.0167	.0179	.00868

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
r2=R squared

Table H.5: Linear regression: *Ex-Ante* IOp in BMI across different percentiles. 2012

	p10	**p25**	**p50**	**p75**	**p90**	**p95**	**p99**
Individual Characteristics							
Individual's sex	0.308	0.364	-0.407	-0.006	-0.878	-1.016	-1.525
	(0.375)	(0.370)	(0.422)	(0.480)	(0.683)	(1.037)	(1.156)
Individual's ethnicity	-0.742	0.579	0.037	-0.090	0.056	-0.373	0.476
	(0.722)	(0.711)	(0.812)	(0.925)	(1.315)	(1.995)	(2.225)
Household living standards							
Running water HH	-0.288	0.230	0.789	0.125	-2.234*	-1.860	1.178
	(0.521)	(0.513)	(0.585)	(0.666)	(0.948)	(1.438)	(1.603)
LS:Low	-0.945	-0.477	-0.101	-0.835	-4.089**	-4.513*	-1.765
	(0.708)	(0.697)	(0.795)	(0.906)	(1.289)	(1.955)	(2.180)
LS:Med-Low	-0.128	0.879	1.767*	0.377	-0.489	0.545	-2.817
	(0.621)	(0.611)	(0.698)	(0.795)	(1.130)	(1.715)	(1.912)
LS:Med-High	0.459	0.506	0.381	-0.773	-1.376	-3.008+	-3.983*
	(0.565)	(0.556)	(0.635)	(0.723)	(1.029)	(1.561)	(1.740)
State Deprivation							
Dep:V.High	1.601	2.817*	1.884	-0.893	-2.859	-1.801	-0.859
	(1.298)	(1.279)	(1.459)	(1.662)	(2.364)	(3.587)	(4.000)
Dep:High	-0.035	-0.752	-1.061	-1.406	-2.823*	0.749	-1.986
	(0.705)	(0.695)	(0.793)	(0.903)	(1.284)	(1.948)	(2.172)
Dep:Med	0.292	-0.679	-0.910	-1.589*	-1.977+	1.926	-0.616
	(0.622)	(0.612)	(0.699)	(0.796)	(1.132)	(1.717)	(1.915)
Dep:Low	0.643	-0.112	-0.297	-1.343+	-0.908	-0.087	-3.267+
	(0.624)	(0.615)	(0.701)	(0.799)	(1.136)	(1.724)	(1.923)
Geographical Region							
Northwest	-1.162	-2.637*	-0.995	0.681	0.024	2.367	-2.283
	(1.270)	(1.250)	(1.427)	(1.625)	(2.312)	(3.507)	(3.911)
Northeast	-1.623	-2.995**	-2.208+	-1.360	-2.215	-2.622	-6.605+
	(1.122)	(1.105)	(1.261)	(1.437)	(2.044)	(3.100)	(3.457)
West	-0.593	-3.271**	-1.923	-0.672	-2.405	-2.464	-6.018+
	(1.172)	(1.154)	(1.317)	(1.501)	(2.134)	(3.238)	(3.611)
Centre	0.307	-1.680	-1.227	-0.726	-2.434	-1.075	-6.199+
	(1.085)	(1.068)	(1.219)	(1.388)	(1.975)	(2.996)	(3.341)
South	-0.248	-3.363*	-3.048*	-1.726	-1.602	0.143	-6.471
	(1.374)	(1.353)	(1.544)	(1.759)	(2.502)	(3.796)	(4.233)
Constant	22.124***	24.536***	27.323***	32.292***	40.195***	41.168***	50.449***
	(1.547)	(1.524)	(1.739)	(1.980)	(2.817)	(4.273)	(4.765)
N	1,045	1,045	1,045	1,045	1,045	1,045	1,045
r2	.0296	.0363	.0287	.0167	.0333	.0279	.0186

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
r2=R squared

Table H.6: Linear regression: *Ex-Ante* IOp in WC across different percentiles. 2012

	p10	**p25**	**p50**	**p75**	**p90**	**p95**	**p99**
Individual Characteristics							
Individual's sex	2.397**	3.092**	3.464**	4.794***	6.129***	5.734*	1.421
	(0.921)	(1.004)	(1.077)	(1.137)	(1.810)	(2.632)	(4.297)
Individual's ethnicity	0.101	-1.324	1.388	2.312	1.377	-2.808	-0.197
	(1.813)	(1.975)	(2.120)	(2.238)	(3.563)	(5.180)	(8.456)
Household living standards							
Running water HH	0.858	-0.070	-0.271	2.046	1.390	-2.936	-8.257
	(1.291)	(1.407)	(1.510)	(1.594)	(2.538)	(3.689)	(6.023)
LS:Low	-1.734	-0.858	-2.848	-1.731	-7.990*	-13.527**	-3.035
	(1.743)	(1.899)	(2.038)	(2.151)	(3.425)	(4.979)	(8.129)
LS:Med-Low	-0.071	2.678	2.271	1.917	-1.800	-3.340	2.625
	(1.526)	(1.663)	(1.785)	(1.884)	(3.000)	(4.361)	(7.120)
LS:Med-High	0.503	1.241	-0.180	-3.163+	-8.138**	-6.069	2.807
	(1.380)	(1.503)	(1.614)	(1.703)	(2.712)	(3.942)	(6.436)
State Deprivation							
Dep:V.High	7.508*	9.050**	3.038	-2.777	-8.279	-12.271	-18.077
	(3.186)	(3.471)	(3.726)	(3.933)	(6.261)	(9.103)	(14.861)
Dep:High	0.642	-0.058	-1.723	-3.805+	-3.456	-3.168	-3.421
	(1.728)	(1.883)	(2.022)	(2.133)	(3.397)	(4.938)	(8.062)
Dep:Med	2.225	0.255	-0.610	-3.913*	0.252	0.615	-3.364
	(1.535)	(1.673)	(1.795)	(1.895)	(3.017)	(4.386)	(7.160)
Dep:Low	2.028	1.553	0.478	-1.837	-2.182	-2.708	-7.090
	(1.533)	(1.670)	(1.793)	(1.892)	(3.012)	(4.379)	(7.149)
Geographical Region							
Northwest	-0.911	-1.142	-0.981	-0.171	3.739	1.100	3.790
	(3.125)	(3.405)	(3.655)	(3.857)	(6.141)	(8.928)	(14.576)
Northeast	-0.491	-2.704	-2.521	-3.142	-2.960	-4.282	-1.157
	(2.785)	(3.035)	(3.258)	(3.438)	(5.474)	(7.958)	(12.992)
West	-2.318	-3.747	-2.484	-1.191	-1.433	-5.493	-0.683
	(2.900)	(3.160)	(3.392)	(3.580)	(5.700)	(8.286)	(13.528)
Centre	-0.985	-1.557	-2.913	-2.345	-3.546	-4.076	-8.842
	(2.695)	(2.937)	(3.153)	(3.327)	(5.297)	(7.701)	(12.573)
South	-3.226	-7.610*	-6.476	-4.609	-0.100	-0.755	3.700
	(3.395)	(3.699)	(3.971)	(4.191)	(6.672)	(9.700)	(15.837)
Constant	71.931***	79.792***	88.064***	96.307***	108.931***	127.678***	134.706***
	(3.844)	(4.189)	(4.497)	(4.746)	(7.556)	(10.985)	(17.934)
N	980	980	980	980	980	980	980
r2	.0231	.0304	.0351	.052	.0475	.0269	.0092

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
r2=R squared

Table H.7: Linear regression: *Ex-Ante* IOp in BMI across different percentiles. 2016

	p10	**p25**	**p50**	**p75**	**p90**	**p95**	**p99**
Individual Characteristics							
Individual's sex	-0.639	-1.237**	-0.921*	-1.487**	-1.704*	-1.596	1.342
	(0.461)	(0.415)	(0.418)	(0.513)	(0.755)	(0.973)	(1.673)
Individual's ethnicity	1.280	1.516*	1.215+	1.322	2.051	2.410	3.890
	(0.793)	(0.714)	(0.719)	(0.883)	(1.300)	(1.675)	(2.879)
Household living standards							
Running water HH	0.236	0.242	0.114	0.788	0.007	1.448	0.891
	(0.581)	(0.522)	(0.526)	(0.646)	(0.951)	(1.226)	(2.107)
LS:Low	0.126	0.338	0.293	-0.496	-0.905	0.019	0.172
	(0.862)	(0.776)	(0.782)	(0.960)	(1.413)	(1.821)	(3.129)
LS:Med-Low	0.952	0.434	-0.667	-0.460	-0.496	1.043	1.540
	(0.748)	(0.673)	(0.678)	(0.833)	(1.226)	(1.580)	(2.715)
LS:Med-High	0.963	0.661	-0.679	-1.517+	-1.903+	-2.141	-3.654
	(0.700)	(0.630)	(0.634)	(0.779)	(1.147)	(1.478)	(2.539)
State Deprivation							
Dep:V.High	-0.392	0.134	-0.002	-2.015	-1.513	-2.089	8.310
	(1.487)	(1.338)	(1.348)	(1.655)	(2.436)	(3.139)	(5.394)
Dep:High	1.222	0.047	-0.062	-1.233	-2.370+	-1.965	6.663*
	(0.821)	(0.739)	(0.744)	(0.914)	(1.345)	(1.733)	(2.978)
Dep:Med	0.050	-0.037	0.265	-1.377	-3.801**	-3.246+	3.713
	(0.820)	(0.738)	(0.743)	(0.912)	(1.343)	(1.731)	(2.974)
Dep:Low	0.063	-1.086	-1.052	-1.681*	-2.062+	-2.184	0.397
	(0.744)	(0.670)	(0.675)	(0.828)	(1.219)	(1.571)	(2.700)
Geographical Region							
Northwest	0.340	1.494	0.274	-0.505	3.631	2.815	5.437
	(1.543)	(1.389)	(1.400)	(1.718)	(2.529)	(3.259)	(5.601)
Northeast	-0.995	-0.587	-1.261	-2.563+	-0.379	1.366	8.132+
	(1.338)	(1.204)	(1.213)	(1.489)	(2.192)	(2.825)	(4.855)
West	0.222	0.543	-0.719	-2.146	0.631	0.890	9.634+
	(1.386)	(1.247)	(1.256)	(1.542)	(2.270)	(2.926)	(5.028)
Centre	0.574	0.160	-0.146	-3.135*	-3.509	-3.664	3.125
	(1.353)	(1.218)	(1.227)	(1.506)	(2.217)	(2.857)	(4.909)
South	0.324	-0.895	-1.477	-2.388	-2.534	-1.902	-1.956
	(1.615)	(1.454)	(1.465)	(1.798)	(2.647)	(3.411)	(5.861)
Constant	20.097***	23.331***	28.156***	34.195***	38.091***	38.527***	32.191***
	(1.834)	(1.650)	(1.663)	(2.041)	(3.004)	(3.872)	(6.653)
N	988	988	988	988	988	988	988
r2	.0265	.031	.024	.036	.0474	.0385	.0275

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
r2=R squared

Table H.8: Linear regression: *Ex-Ante* IOp in WC across different percentiles. 2016

	p10	**p25**	**p50**	**p75**	**p90**	**p95**	**p99**
Individual Characteristics							
Individual's sex	0.299	-0.749	0.413	0.673	-1.377	1.451	9.470+
	(1.133)	(1.018)	(1.056)	(1.198)	(1.882)	(2.147)	(5.602)
Individual's ethnicity	7.339***	4.286*	2.655	4.918*	7.096*	3.915	11.235
	(1.997)	(1.794)	(1.861)	(2.111)	(3.318)	(3.784)	(9.873)
Household living standards							
Running water HH	-2.140	-3.060*	-1.364	0.144	-0.498	0.585	-0.431
	(1.428)	(1.282)	(1.330)	(1.509)	(2.372)	(2.705)	(7.059)
LS:Low	-0.371	-1.185	-0.431	-1.398	-4.642	-6.945+	-2.366
	(2.135)	(1.918)	(1.989)	(2.256)	(3.547)	(4.045)	(10.555)
LS:Med-Low	-0.398	-0.869	-1.853	0.234	-1.590	0.373	15.646+
	(1.850)	(1.662)	(1.724)	(1.955)	(3.073)	(3.505)	(9.145)
LS:Med-High	3.228+	0.883	-2.133	-2.686	-6.489*	-5.856+	-5.036
	(1.728)	(1.552)	(1.610)	(1.827)	(2.871)	(3.274)	(8.544)
State Deprivation							
Dep:V.High	3.408	1.305	-2.249	-0.359	-4.345	-2.493	30.729+
	(3.628)	(3.258)	(3.380)	(3.834)	(6.025)	(6.872)	(17.932)
Dep:High	1.691	1.005	0.097	-2.630	-9.056**	-3.837	24.734*
	(2.029)	(1.823)	(1.891)	(2.145)	(3.371)	(3.844)	(10.032)
Dep:Med	-0.768	0.037	-0.520	-2.445	-11.995***	-7.405+	-0.224
	(2.009)	(1.804)	(1.872)	(2.123)	(3.337)	(3.805)	(9.931)
Dep:Low	-1.116	-0.598	-2.654	-4.252*	-11.904***	-6.156+	-7.067
	(1.834)	(1.647)	(1.708)	(1.938)	(3.046)	(3.474)	(9.065)
Geographical Region							
Northwest	4.150	4.629	5.105	2.327	8.390	13.878+	8.054
	(3.840)	(3.449)	(3.578)	(4.058)	(6.378)	(7.274)	(18.982)
Northeast	1.094	1.055	1.379	-4.353	-2.750	4.277	6.412
	(3.355)	(3.013)	(3.126)	(3.546)	(5.573)	(6.356)	(16.586)
West	0.831	2.232	2.721	-2.281	1.018	6.663	19.784
	(3.453)	(3.101)	(3.217)	(3.649)	(5.736)	(6.541)	(17.070)
Centre	0.537	2.268	2.556	-2.581	-7.320	-4.594	-9.661
	(3.382)	(3.037)	(3.151)	(3.574)	(5.617)	(6.406)	(16.716)
South	-3.552	-1.073	-0.431	-6.442	-9.431	-3.788	-32.815+
	(3.996)	(3.588)	(3.723)	(4.223)	(6.637)	(7.569)	(19.751)
Constant	71.442***	80.653***	90.853***	101.627***	119.570***	118.381***	108.623***
	(4.616)	(4.146)	(4.301)	(4.878)	(7.667)	(8.744)	(22.817)
N	926	926	926	926	926	926	926
r2	.0313	.0211	.0201	.0317	.0582	.0472	.0431

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
r2=R squared

Table H.9: Linear regression: *Ex-Ante* IOp in BMI across different percentiles. 2018

	p10	**p25**	**p50**	**p75**	**p90**	**p95**	**p99**
Individual Characteristics							
Individual's sex	0.569+	0.016	-0.302	-0.812**	-1.579**	-2.006**	-2.478*
	(0.323)	(0.269)	(0.261)	(0.314)	(0.498)	(0.648)	(1.135)
Individual's ethnicity	-0.216	-0.002	0.547	1.633**	2.334*	1.799	0.670
	(0.633)	(0.526)	(0.512)	(0.615)	(0.976)	(1.269)	(2.224)
Household living standards							
Running water HH	-0.365	-0.344	-0.533	-1.306**	-0.858	-0.446	1.860
	(0.477)	(0.397)	(0.387)	(0.464)	(0.737)	(0.958)	(1.678)
LS:Low	1.490*	0.951+	0.441	0.853	-0.218	-1.771	-2.091
	(0.638)	(0.531)	(0.517)	(0.620)	(0.985)	(1.281)	(2.244)
LS:Med-Low	0.902	1.006*	0.711	1.526**	-0.156	-0.554	-0.799
	(0.591)	(0.492)	(0.479)	(0.575)	(0.913)	(1.187)	(2.080)
LS:Med-High	0.882+	0.950*	0.821*	0.955+	1.206	0.619	3.043+
	(0.503)	(0.419)	(0.408)	(0.489)	(0.777)	(1.010)	(1.770)
State Deprivation							
Dep:V.High	2.824*	1.764+	-0.222	-0.645	-1.745	-4.116	-11.930**
	(1.258)	(1.047)	(1.018)	(1.222)	(1.941)	(2.524)	(4.422)
Dep:High	1.724*	1.169*	0.088	-1.299+	-3.377**	-6.021***	-12.944***
	(0.701)	(0.583)	(0.568)	(0.681)	(1.082)	(1.407)	(2.465)
Dep:Med	1.322*	1.234*	0.574	-0.539	-2.720**	-4.757***	-12.435***
	(0.645)	(0.537)	(0.522)	(0.627)	(0.996)	(1.295)	(2.269)
Dep:Low	0.645	0.454	-0.076	-1.777**	-3.491***	-5.267***	-10.635***
	(0.682)	(0.567)	(0.552)	(0.662)	(1.052)	(1.368)	(2.397)
Geographical Region							
Northwest	-0.569	-1.828+	-2.789**	-2.061+	-3.677*	-3.316	-3.446
	(1.126)	(0.937)	(0.912)	(1.095)	(1.738)	(2.260)	(3.961)
Northeast	-0.692	-1.420+	-2.419**	-3.171***	-5.227***	-4.387*	-3.925
	(0.984)	(0.819)	(0.797)	(0.956)	(1.518)	(1.974)	(3.459)
West	-1.272	-1.851*	-2.476**	-2.838**	-5.212**	-4.737*	-4.440
	(1.033)	(0.860)	(0.836)	(1.004)	(1.594)	(2.073)	(3.632)
Centre	-0.969	-2.183**	-2.778***	-3.535***	-6.149***	-5.331**	-4.286
	(0.943)	(0.785)	(0.764)	(0.917)	(1.456)	(1.893)	(3.317)
South	-2.596*	-1.910+	-1.796+	-3.438**	-7.121***	-6.610*	-4.450
	(1.300)	(1.082)	(1.053)	(1.263)	(2.006)	(2.609)	(4.572)
Constant	21.673***	25.412***	29.638***	34.132***	41.991***	47.350***	57.653***
	(1.263)	(1.051)	(1.023)	(1.227)	(1.949)	(2.535)	(4.442)
N	2,109	2,109	2,109	2,109	2,109	2,109	2,109
r2	.0102	.013	.0131	.0266	.028	.0239	.0249

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
r2=R squared

Table H.10: Linear regression: *Ex-Ante* IOp in WC across different percentiles. 2018

	p10	**p25**	**p50**	**p75**	**p90**	**p95**	**p99**
Individual Characteristics							
Individual's sex	2.681***	4.111***	2.892***	2.966***	5.004***	4.033*	0.839
	(0.752)	(0.722)	(0.635)	(0.746)	(1.206)	(1.762)	(2.927)
Individual's ethnicity	-1.587	2.304	2.834*	4.563**	2.948	-1.212	-15.708**
	(1.475)	(1.417)	(1.245)	(1.463)	(2.366)	(3.456)	(5.744)
Household living standards							
Running water HH	-1.845+	-0.795	-1.071	-0.507	-0.887	2.175	17.104***
	(1.114)	(1.070)	(0.940)	(1.105)	(1.787)	(2.611)	(4.338)
LS:Low	4.321**	0.667	0.186	0.988	2.733	0.194	-17.903**
	(1.487)	(1.429)	(1.255)	(1.475)	(2.386)	(3.485)	(5.791)
LS:Med-Low	3.264*	0.830	1.249	2.516+	3.981+	0.881	-16.952**
	(1.380)	(1.326)	(1.165)	(1.369)	(2.214)	(3.234)	(5.374)
LS:Med-High	2.804*	1.127	0.923	2.362*	2.475	0.345	-5.332
	(1.172)	(1.126)	(0.990)	(1.163)	(1.881)	(2.747)	(4.565)
State Deprivation							
Dep:V.High	-3.575	-2.929	-3.266	0.061	1.421	-10.564	-36.150**
	(2.920)	(2.805)	(2.464)	(2.895)	(4.684)	(6.841)	(11.368)
Dep:High	1.908	-0.525	-1.928	-2.137	-2.858	-12.113**	-22.924***
	(1.625)	(1.561)	(1.372)	(1.612)	(2.607)	(3.809)	(6.329)
Dep:Med	3.287*	2.207	0.794	0.843	-2.411	-8.838*	-23.389***
	(1.499)	(1.440)	(1.266)	(1.487)	(2.405)	(3.513)	(5.838)
Dep:Low	2.555	2.217	-0.964	-0.393	-2.284	-11.496**	-23.844***
	(1.576)	(1.514)	(1.330)	(1.563)	(2.528)	(3.693)	(6.137)
Geographical Region							
Northwest	-0.820	-3.989	-1.226	-1.775	-2.696	-1.255	-4.470
	(2.643)	(2.539)	(2.231)	(2.621)	(4.240)	(6.193)	(10.291)
Northeast	0.650	-0.730	-1.238	-1.891	-4.778	-5.172	-4.586
	(2.297)	(2.207)	(1.939)	(2.278)	(3.685)	(5.383)	(8.944)
West	-0.517	-2.864	-1.389	0.162	-3.878	-1.629	4.428
	(2.412)	(2.317)	(2.036)	(2.392)	(3.869)	(5.651)	(9.391)
Centre	-0.077	-2.778	-2.669	-2.135	-4.267	-2.804	-0.805
	(2.200)	(2.114)	(1.857)	(2.182)	(3.530)	(5.156)	(8.568)
South	4.243	1.735	-0.127	-1.773	-6.286	-2.019	11.443
	(3.025)	(2.906)	(2.554)	(3.000)	(4.853)	(7.089)	(11.780)
Constant	75.726***	82.491***	91.790***	96.216***	109.215***	126.787***	165.706***
	(2.944)	(2.828)	(2.485)	(2.919)	(4.723)	(6.898)	(11.463)
N	2,055	2,055	2,055	2,055	2,055	2,055	2,055
r2	.0161	.0279	.0243	.0276	.0138	.00985	.0239

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
r2=R squared

I Linear regression models. *Ex-post* approach

Table I.1: Linear regression results: *Ex-post* approach. Stage I. 2006

	DP1	**DP2**	**DP3**	**FS**	**PA**	**Alc.**	**Tob.**
Individual Characteristics							
Individual's sex	2.145***	-1.189***	2.735***	0.013	0.450**	0.216***	0.235***
	(0.289)	(0.260)	(0.306)	(0.011)	(0.143)	(0.013)	(0.012)
Individual's ethnicity	2.850***	-0.348	0.623	0.029	-0.437	0.085*	0.012
	(0.652)	(0.587)	(0.689)	(0.026)	(0.416)	(0.036)	(0.034)
Household living standards							
Running water HH	-0.516	-0.433	0.736+	-0.004	-0.034	-0.060***	-0.013
	(0.363)	(0.327)	(0.384)	(0.014)	(0.202)	(0.018)	(0.016)
LS:Low	-4.420***	-1.065*	3.897***	-0.023	0.858***	-0.111***	-0.102***
	(0.485)	(0.437)	(0.513)	(0.019)	(0.241)	(0.021)	(0.020)
LS:Med-Low	-3.132***	-1.322**	3.445***	-0.006	0.553**	-0.112***	-0.000
	(0.458)	(0.412)	(0.484)	(0.018)	(0.206)	(0.018)	(0.017)
LS:Med-High	-2.172***	-0.876*	1.696***	-0.019	0.407*	-0.059***	0.009
	(0.458)	(0.412)	(0.484)	(0.018)	(0.199)	(0.017)	(0.016)
State Deprivation							
Dep:V.High	-1.024	2.493**	3.164**	0.064	0.401	-0.021	-0.026
	(1.032)	(0.929)	(1.090)	(0.040)	(0.529)	(0.046)	(0.043)
Dep:High	-1.662**	0.855+	2.344***	-0.014	0.402	-0.005	-0.041+
	(0.555)	(0.500)	(0.587)	(0.022)	(0.265)	(0.023)	(0.022)
Dep:Med	-1.941***	1.448**	2.300***	0.005	-0.343	-0.058**	-0.096***
	(0.534)	(0.481)	(0.565)	(0.021)	(0.249)	(0.022)	(0.020)
Dep:Low	-0.148	1.071*	0.658	0.009	-0.384+	-0.004	-0.016
	(0.504)	(0.454)	(0.533)	(0.020)	(0.233)	(0.020)	(0.019)
Geographical Region							
Northwest	-2.310*	0.839	-0.557	-0.039	0.654	0.068	0.023
	(1.018)	(0.916)	(1.076)	(0.040)	(0.507)	(0.044)	(0.041)
Northeast	-1.959*	-0.210	1.899*	0.005	0.394	0.014	0.043
	(0.893)	(0.804)	(0.943)	(0.035)	(0.455)	(0.040)	(0.037)
West	-2.716**	-0.036	0.760	-0.007	0.568	0.069+	0.065+
	(0.918)	(0.827)	(0.971)	(0.036)	(0.469)	(0.041)	(0.038)
Centre	-3.106***	1.710*	-0.062	0.005	0.086	-0.013	0.079*
	(0.845)	(0.761)	(0.894)	(0.033)	(0.435)	(0.038)	(0.035)
South	-3.877***	-1.433	-0.402	-0.042	-0.675	-0.030	-0.016
	(1.110)	(0.999)	(1.173)	(0.044)	(0.569)	(0.050)	(0.046)
Constant	26.433***	21.470***	25.100***	0.049	3.915***	0.214***	0.136**
	(1.149)	(1.035)	(1.215)	(0.045)	(0.632)	(0.055)	(0.051)
N	2,040	2,040	2,040	2,040	5,126	5,126	5,125
r2	.165	.0421	.114	.00838	.00931	.0884	.102

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
DP1= low-nutritious and high-energy food. DP2=high-nutritious food. DP3=legumes and maize-based products. FS=food supplements. PA=physical activity. Alc=Alcohol consumption.Tob.=Smoking
Phase I means that effort variables are regressed against circumstances.

Table I.2: Logit regression results: *Ex-post* approach. Stage II. 2006

	DBM	HB	BMI	WC
Individual Characteristics				
Individual's sex	-1.912***	-1.616***	-0.003	-1.224***
	(0.301)	(0.200)	(0.094)	(0.144)
Individual's ethnicity	0.763	0.991*	0.724**	0.632*
	(0.621)	(0.484)	(0.242)	(0.297)
Household living standards				
Running water HH	-0.183	-0.044	-0.022	-0.236
	(0.281)	(0.198)	(0.119)	(0.163)
LS:Low	0.855*	0.595*	-0.307*	0.056
	(0.393)	(0.282)	(0.157)	(0.229)
LS:Med-Low	0.659+	0.508+	-0.065	-0.017
	(0.389)	(0.271)	(0.146)	(0.216)
LS:Med-High	-0.010	0.219	-0.340*	-0.307
	(0.410)	(0.282)	(0.148)	(0.223)
State Deprivation				
Dep:V.High	-2.669***	-0.688	-0.960**	-1.505**
	(0.803)	(0.542)	(0.330)	(0.475)
Dep:High	-0.639	-0.103	-0.342+	-0.309
	(0.420)	(0.310)	(0.180)	(0.257)
Dep:Med	-0.655+	-0.378	-0.232	-0.135
	(0.390)	(0.293)	(0.172)	(0.242)
Dep:Low	-0.294	0.035	0.006	0.032
	(0.380)	(0.279)	(0.161)	(0.234)
Geographical Region				
Northwest	0.011	0.298	-0.776*	0.275
	(0.781)	(0.549)	(0.332)	(0.485)
Northeast	-0.111	0.199	-0.508+	-0.052
	(0.707)	(0.484)	(0.288)	(0.441)
West	-0.362	-0.186	-0.381	-0.059
	(0.733)	(0.504)	(0.296)	(0.452)
Centre	-0.576	-0.395	-0.232	-0.078
	(0.678)	(0.466)	(0.272)	(0.422)
South	0.554	0.165	0.250	0.996+
	(0.787)	(0.572)	(0.353)	(0.538)
Dietary patterns and physical activity				
DP1_hat	-0.001	-0.008	-0.007	0.011
	(0.019)	(0.014)	(0.007)	(0.010)
DP2_hat	-0.019	-0.029+	0.017*	0.020+
	(0.021)	(0.015)	(0.008)	(0.011)
DP3_hat	0.027+	0.021+	-0.009	0.005
	(0.015)	(0.011)	(0.007)	(0.010)
FS_hat	0.369	0.380	-0.444*	-0.145
	(0.404)	(0.305)	(0.193)	(0.264)
PA_hat	0.071***	0.039**	0.032***	0.007
	(0.019)	(0.015)	(0.009)	(0.012)
Risky health behaviours				
Alc_hat	0.184	-0.190	0.159	-0.272
	(0.294)	(0.220)	(0.110)	(0.168)
Tob_hat	0.244	0.055	0.264*	0.792***
	(0.329)	(0.240)	(0.117)	(0.183)
Constant	-2.257*	-2.821***	-0.444	0.114
	(0.933)	(0.708)	(0.386)	(0.541)
N	1,223	1,938	2,034	993
r2_p	.158	.102	.0311	.082

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
DP1_hat= low-nutritious and high-energy food. DP2_hat=high-nutritious food.
DP3_hat=legumes and maize-based products. FS_hat=food supplements.
PA_hat=physical activity. Alc_hat=Alcohol consumption. Tob.=Smoking
Phase II outcomes are regressed against circumstances and true levels of effort.
r2_p=pseudo R squared. HB=1 if anaemia. BMI=1 if excess weight
WC=1 if excess adiposity. DBM=1 if excess weight or adiposity and anaemia

Table I.3: Linear regression results: *Ex-post* approach. Stage I. 2018

	DP1	**DP2**	**DP3**	**FS**	**PA**	**Alc.**	**Tob.**
Individual Characteristics							
Individual's sex	2.543***	-1.185***	2.895***	-0.066***	1.577***	0.266***	0.232***
	(0.256)	(0.305)	(0.322)	(0.015)	(0.128)	(0.016)	(0.016)
Individual's ethnicity	2.363***	0.267	0.214	0.009	-0.178	0.001	0.073*
	(0.460)	(0.548)	(0.580)	(0.026)	(0.237)	(0.029)	(0.030)
Household living standards							
Running water HH	0.813*	0.206	-1.037*	0.021	-0.019	0.031	0.049*
	(0.372)	(0.443)	(0.468)	(0.021)	(0.186)	(0.023)	(0.024)
LS:Low	2.876***	2.024***	-4.640***	0.024	-1.068***	0.047	0.021
	(0.497)	(0.593)	(0.626)	(0.029)	(0.244)	(0.030)	(0.031)
LS:Med-Low	1.928***	0.773	-1.628**	0.024	-0.635**	0.017	-0.007
	(0.455)	(0.543)	(0.574)	(0.026)	(0.227)	(0.028)	(0.029)
LS:Med-High	1.005*	0.308	-0.499	0.017	-0.259	0.034	0.006
	(0.391)	(0.467)	(0.493)	(0.023)	(0.196)	(0.024)	(0.025)
Geographical Region							
Northwest	-1.784***	1.363*	-1.616*	0.009	0.669*	-0.008	0.086**
	(0.526)	(0.628)	(0.663)	(0.030)	(0.261)	(0.032)	(0.033)
Northeast	-0.844+	0.160	0.547	0.025	-0.180	-0.036	0.048+
	(0.459)	(0.548)	(0.579)	(0.026)	(0.221)	(0.027)	(0.028)
West	-1.310**	1.600**	1.164*	0.052*	0.517*	-0.025	0.022
	(0.432)	(0.515)	(0.544)	(0.025)	(0.212)	(0.026)	(0.027)
Centre	-1.336**	0.976+	0.748	0.025	0.550*	-0.080**	0.047+
	(0.456)	(0.543)	(0.574)	(0.026)	(0.224)	(0.028)	(0.028)
South	-0.243	1.811**	4.135***	0.020	0.296	-0.083**	0.017
	(0.471)	(0.562)	(0.593)	(0.027)	(0.236)	(0.029)	(0.030)
Constant	13.861***	16.040***	38.223***	0.063*	2.391***	0.073*	-0.042
	(0.534)	(0.637)	(0.674)	(0.031)	(0.268)	(0.033)	(0.034)
N	1,651	1,651	1,651	1,651	2,197	2,150	2,192
r2	.136	.0348	.187	.0213	.0901	.131	.101

Notes: standard errors in parenthesis + p<0.1, * p<0.05, ** p<0.01, *** p<0.001
DP1= low-nutritious and high-energy food. DP2=high-nutritious food. DP3=legumes and maize-based products.
FS=food supplements. PA=physical activity. Alc=Alcohol consumption.Tob.=Smoking
Phase I means that effort variables are regressed against circumstances.

Table I.4: Logit regression results: *Ex-post* approach. Stage II. 2018

	DBM	HB	BMI	WC
Individual Characteristics				
Individual's sex	-1.816***	-1.550***	0.109	-0.830***
	(0.197)	(0.146)	(0.118)	(0.129)
Individual's ethnicity	-0.215	-0.270	0.096	0.098
	(0.340)	(0.233)	(0.208)	(0.207)
Household living standards				
Running water HH	0.006	0.029	-0.051	-0.281
	(0.270)	(0.193)	(0.172)	(0.183)
LS:Low	0.179	-0.342	0.421+	0.843***
	(0.380)	(0.275)	(0.232)	(0.250)
LS:Med-Low	0.590+	0.229	0.527*	0.846***
	(0.331)	(0.236)	(0.214)	(0.230)
LS:Med-High	0.408	-0.011	0.395*	0.608**
	(0.292)	(0.206)	(0.183)	(0.195)
Geographical Region				
Northwest	-0.356	0.336	-1.123*	-0.371
	(0.666)	(0.452)	(0.489)	(0.439)
Northeast	-0.396	0.046	-0.876+	-0.073
	(0.631)	(0.416)	(0.461)	(0.400)
West	-1.086+	-0.438	-1.115*	-0.448
	(0.654)	(0.440)	(0.467)	(0.406)
Centre	-0.543	0.005	-1.027*	-0.378
	(0.608)	(0.404)	(0.450)	(0.381)
South	-0.298	-0.076	-0.555	-0.446
	(0.628)	(0.425)	(0.466)	(0.395)
Dietary patterns and physical activity				
DP1_hat	-0.012	-0.025+	0.004	-0.010
	(0.020)	(0.015)	(0.011)	(0.011)
DP2_hat	-0.006	-0.008	-0.009	-0.005
	(0.014)	(0.011)	(0.009)	(0.010)
DP3_hat	-0.063***	-0.041***	-0.033***	-0.019*
	(0.016)	(0.012)	(0.009)	(0.009)
FS	-1.152***	0.067	-0.827***	-0.928***
	(0.322)	(0.213)	(0.196)	(0.215)
PA	-0.056+	-0.006	-0.017	-0.054**
	(0.030)	(0.023)	(0.018)	(0.018)
Risky health behaviours				
Alc	-0.290	-0.081	-0.356*	-0.150
	(0.291)	(0.222)	(0.160)	(0.160)
Tob	-0.237	-0.351+	-0.046	-0.367*
	(0.268)	(0.207)	(0.154)	(0.151)
Constant	0.814	-0.503	1.622***	1.587***
	(0.651)	(0.438)	(0.476)	(0.415)
N	631	1,571	1,591	1,508
r2_p	.185	.106	.0337	.0728

Notes: standard errors in parenthesis + $p<0.1$, * $p<0.05$, ** $p<0.01$, *** $p<0.001$
DP1_hat= low-nutritious and high-energy food. DP2_hat=high-nutritious food.
DP3_hat=legumes and maize-based products. FS_hat=food supplements.
PA_hat=physical activity. Alc_hat=Alcohol consumption. Tob.=Smoking
Phase II outcomes are regressed against circumstances and true levels of effort.
r2_p=pseudo R squared. HB=1 if anaemia. BMI=1 if excess weight
WC=1 if excess adiposity. DBM=1 if excess weight or adiposity and anaemia

J Results: Beyond-the-mean IOp

Figure J.1: *Ex-ante* IOp with continuous BMI

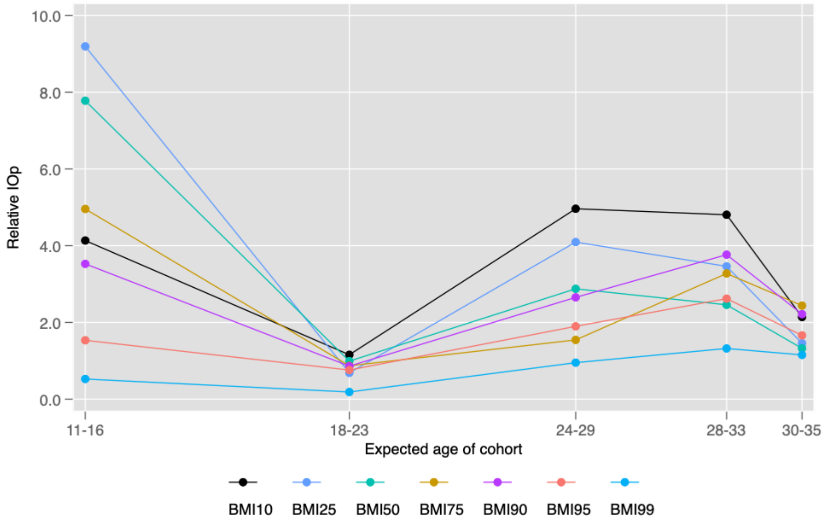


Figure J.2: *Ex-ante* IOp with continuous WC

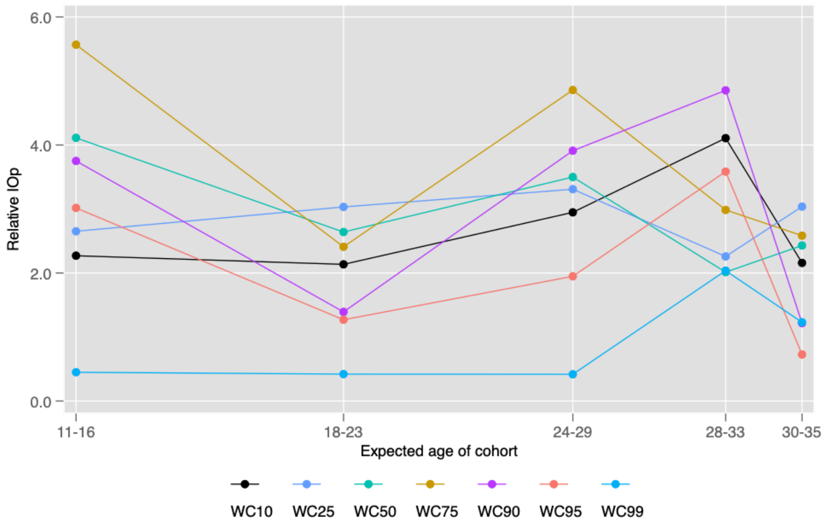


Figure J.3: *Ex-post* IOp with continuous BMI

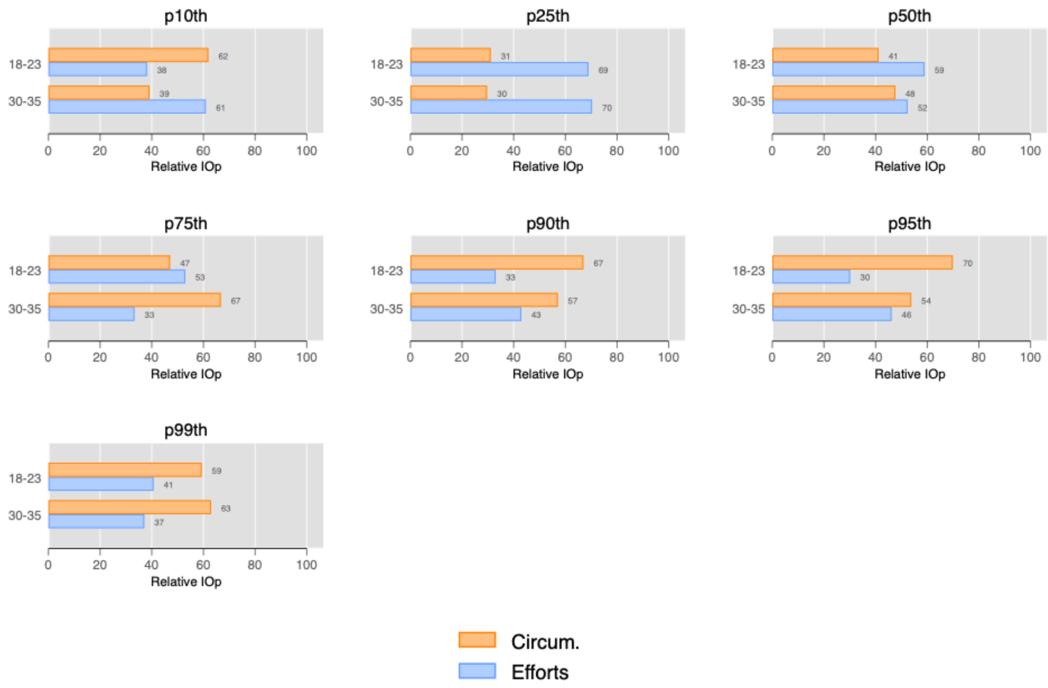


Figure J.4: *Ex-post* IOp with continuous WC