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Preschoolers' parent-rated health disparities are strongly associated with measures of adiposity in the Lifeways cohort study children

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ABSTRACT

Objective: To examine the relationship between lifecourse factors from preschoolers' microecosystem and their parent-reported (mother-reported) health (PRH), following them prospectively from preconception to age 5 years. To investigate if preschoolers' body mass index (BMI) and waist circumference were associated with preschoolers' PRH when controlled for lifecourse predictors.

Design: Lifeways cross-generation cohort study.

Setting: Ireland.

Participants: Of 1082 families, 62% mothers responded on a health and lifestyle questionnaire at follow-up. Food frequency, BMI and waist circumference were measured. There were 547 family data sets available for analysis of children's PRH.

Main outcome measure: Mother-reported children's PRH at age 5. Associations with child's individual and familial exposures from preconception to age 5 years examined using logistic regression.

Results: In univariate analysis, relatively positive rating of children's PRH were associated with children's lower intake of fats (OR (95% CI) 2.2 (1.1 to 4.3)), higher intake of fruits/vegetables (OR (95% CI) 2.2 (1.1 to 4.3)); as well as familial socioeconomic characteristics {higher household income (OR (95% CI) 3.0 (1.6 to 5.9)), non-entitlement to means-tested healthcare (OR (95% CI) 2.1 (1.0 to 4.3)), mothers' higher education (OR (95% CI) 1.9 (1.0 to 3.6))}, psychosocial characteristics {father's participation in study (OR (95% CI) 2.1 (1.0 to 4.3)), mothers' perceiving better support from partner (OR (95% CI) 2.3 (1.2 to 4.3)), children (OR (95% CI) 1.9 (1.0 to 3.7)) or relatives (OR (95% CI) 2.2 (1.1 to 4.1))}, parents' lifestyle {mothers' lower intake of energy (OR (95% CI) 2.2 (1.1 to 4.3)), fathers' non-smoking status (OR (95% CI) 2.2 (1.1 to 4.4))} and parents' health {mothers' self-rated health relatively positive (OR (95% CI) 5.1 (2.6 to 9.9)), fathers' self-rated health relatively positive (OR (95% CI) 3.0 (1.5 to 6.0))}.

In multivariable analysis (χ^2=34.2, df=21, N=303, R^2 = 0.26, $p<0.05$), one of the two strong predictors of children's relatively positive PRH was child not being obese by International Obesity Task Force classification (OR (95% CI) 5.5 (1.4 to 21.0)), observed also using BMI (kg/m^2; OR (95% CI) 0.73 (0.58 to 0.93)) or waist circumference (cm; OR (95% CI) 0.89 (0.81 to 0.98)) as continuous variables. The other significant predictor was mothers' self-rated health relatively positive (OR (95% CI) 4.2 (1.5 to 12.2)).

Conclusions: Preschoolers' health is adversely associated with obesity and this is independent of lifecourse and social and environmental inequalities. The findings suggest that reducing childhood obesity and improving maternal health may be useful ways to improve child's global health.

Strengths and limitations of this study

- Nationally representative sample of preschool-age children.
- Examines the influence of lifecourse adversities, prospectively measured from preconception to age 5 on children's general health at age 5. The study analyses demographic, anthropometric, lifestyle, food and nutrients intake, psychosocial, socioeconomic and health-related exposures from children's individual as well as parental experiences.
- Demonstrates a significant and independent association between preschoolers' measured BMI as well as waist circumference and their general health status.
- The study is limited by a relatively small sample and use of parent-reported health status.

INTRODUCTION

The development of children is critical to their well-being as adults,[1 2] and across the lifecourse even subjective estimates may be useful to reflect objectively measured health.[3 4] Bronfenbrenner[5] emphasised the importance of children's microecosystem in their development. Recently, the WHO's Commission on Social Determinants of Health (CSDH) presented a Total Environment Assessment Model for Early Child Development (TEAM-ECD),[6] which again illustrates the importance of individual and family spheres of influence on children's health. The relevance of socioeconomic, psychosocial and lifestyle environment in child development and health is widely acknowledged.[6–8]

According to the lifecourse hypothesis, risk transmission is characterised by critical periods and accumulation of risk models.[9] Life Course Health Development (LCHD) framework[10] suggests that health is a consequence of multiple determinants that change in context of time and circumstances as an individual develops; these experiences are programmed into bio-behavioural regulatory systems during certain critical and sensitive periods of an individual's lifetime to decide their health trajectory. The lifecourse framework on childhood disadvantage and adult health[11] suggests that parental and childhood circumstances from the point of conception influence an individual's health in later life, and the individual's childhood health and later life circumstances may further add to this foundation. Based on this, Hertzman *et al*[12] examined self-rated health in adulthood using an integrated lifecourse framework. There are a few other studies which have also examined lifecourse determinants of adult global[13 14] or specific health status.[15] On the contrary, the literature on the determinants of child global health status is sparse,[16 17] particularly for the preschool-age children.[18] Even rarer are studies whose examination includes early lifecourse determinants of child global health status.

Thus, the first objective of our analysis was to prospectively examine the relationship between demographic, anthropometric, lifestyle, nutritional, psychosocial, socioeconomic and health-related lifecourse exposures taken from the children's individual and family spheres of influence starting from preconception up to age 5 years and their global health status at preschool age.

In social epidemiology, the construct of 'embodiment' refers to the biological expression of an individual's materio-social world.[19 20] Similarly in lifecourse epidemiology, it is hypothesised that early life experiences get 'biologically embedded' during critical or sensitive periods of child development leading to gradients in health.[21 22]

The Foresight report identifies a large array of environmental determinants of obesity, a number of which are again related to early child development.[23] This suggests obesity as pivotal risk factor for subsequent health conditions.[24]

The negative relationship between obesity and self-rated health is now increasingly reported in adult populations,[25 26] some indicating a temporal relationship[27 28] and suggesting that obesity increases health inequalities over time.[28] However, evidence on the relationship between obesity and health is relatively limited in child population studies and those available have reported health-related-quality-of-life (HR-QoL)[29] instead of a generic measure such as global self-rated health. Moreover, this association is yet to be established for preschool-age children. To the best of our knowledge, just two population-based studies have examined this association in preschool age-group children[30 31] and neither had nutritional information.

In the Longitudinal Study of Australian Children, Wake *et al*[30] did not find a significant difference in global health status of overweight/obese and normal weight 4–5-year-old children. Skinner *et al*,[31] using data on 3–5-year-olds from the US National Health and Nutrition Examination Survey, reported a poorer global health status in obese and severely obese preschoolers. Neither of these studies accounted for a number of possibly relevant confounders, including parental body mass index (BMI), parental health and nutritional variables.

We thus hypothesised that similar to findings from studies on older age groups, anthropometric markers of child obesity in our preschool-age children study would also demonstrate a negative association with their global health status. The next objective of our analysis was to examine whether anthropometric markers of child obesity would emerge as strong predictors of global health status when accounted for other socioeconomic, psychosocial and lifestyle environmental factors in a multivariable model.

METHODS

The Lifeways cross-generation cohort study comprises three generations of 1082 Irish families and was established in 2001–2003; the recruitment procedure of this nationally representative cohort has been described previously.[32–34] The a priori purpose was to examine familial and cross-generation influences on early childhood development over the first 5 years of children's lives. Briefly, would-be mothers were at random recruited from the two regional maternity hospitals in the Republic of Ireland to get a representative sample. A comparison between the Lifeways mothers and a nationally representative sample of women of the same age group from the SLÁN (Survey of Lifestyle, Attitudes and Nutrition) surveys of Republic of Ireland[35] confirmed that the Lifeways mothers were satisfactorily representative of the Irish general women on sociodemographic characteristics.[33]

At this early pregnancy stage, mothers completed a health and lifestyle status questionnaire adapted from a validated instrument developed for Irish national SLÁN surveys.[35] Mothers reported their pre-pregnancy height (cm) and weight (kg) and their smoking status during pregnancy. Mothers' and partners' socioeconomic status was recorded. Subsequently at birth, the live infants were added to the cohort along with maternity and birth-related hospital information.

In 2007–2008, when these children averaged 5 years of age, the cohort follow-up recorded a 62% response rate.[34 36] Though mothers who responded to the follow-up were more likely to be of higher socioeconomic status, these mothers did not significantly differ in their baseline anthropometric characteristics (including BMI) from non-responders.[34 36] At this 5-year follow-up, mothers repeated the health and lifestyle assessment questionnaire, with additional questions related to her family, including a five-level Likert item question "In general, would you say your/your partner's/your Lifeways child's current health is Excellent, Very Good, Good, Fair or Poor." Mothers provided information on family's socioeconomic, psychosocial and lifestyle status. Mothers reported their habitual dietary intake for the previous year on a semiquantitative food frequency (SQFFQ) instrument developed from the EPIC study (European Prospective Investigation into Cancer and Nutrition) and validated for Irish adult population.[37] Mothers also gave details for the Lifeways child's habitual diet for the previous year using a different SQFFQ instrument adapted from the UK National Diet and Nutrition Survey of 4.5-year-old children.[38] The mothers' and children's SQFFQ was validated in the Lifeways study using a 7-day weighed food diary in a subsample.[36] Food items were aggregated by defined shelves (food groups) of the Irish food pyramid, and assessment was made for average servings per day of standard food item portions consumed from the 'top' and 'fruit and vegetable' food groups (shelves of Irish food pyramid). The 'top' food group comprises of high-calorie fat and sugar-rich foods. Total energy (kcal) and total fats (g) intake was computed using conversion values from McCance and Widdowson's food composition tables[39] with a specially developed FFQ software V.1.0.[40]

Mothers and children, and if available fathers, were offered at 5-year follow-up an anthropometric assessment at their home for height (cm), weight (kg) and waist circumference (WC;cm) using a standardised protocol,[34 36] with 80–85% mothers and children participating. BMI was calculated from weight and height information (kg/m^2).

Thus, variables from discrete stages (pre-pregnancy, early pregnancy, at birth, early infancy and 5-year follow-up) of child's early development representing lifecourse exposures from distinct domains (demographic, anthropometric, socioeconomic, psychosocial, lifestyle, nutritional and health) of child's individual and family spheres of influence[6–8] were considered to analyse determinants of child's health status at age 5. The selection of variables, domains and spheres of influence are based on the CSDH constructed TEAM-ECD, a model of early child development.[6–8] These lifecourse variables have been summarised as per time frame in table 1. This lifecourse time frame highlights the stages and transition points relevant from perspective of child's health development.[10] Additional details on these variables are provided in etable 1 available in the web-only supplement. The independent variables have been arranged as child-related, family-related, mother-related, father-related groups for ease of presentation.

Children's global health status rated in proxy by their mothers, hereafter referred to as parent-rated health (PRH), was the outcome variable of interest. The 5-graded scale response was dichotomised as relatively positive health (excellent or very good) and relatively negative health (poor or fair or good), based on similar dichotomisation in other studies on preschool and school children.[17 18 30] It is reasonable to take a higher cut-off when dichotomising this age dependent variable in this very young age group as there would be very limited numbers of poor or fair health children.[17 18 41]

Initially, univariate associations were established between the independent predictors and children's PRH using independent Student t tests or χ^2 tests. Independent categorical variables were dichotomised in a manner that allowed contrasting extreme levels against the others. Thus, using International Obesity Task Force (IOTF) cut-offs, children's BMI was dichotomised as obese versus overweight or normal weight. Similarly, nutrition variables ordered in quintiles were dichotomised as the extreme quintile (1st or 5th) versus the rest.

Table 1 Independent variables examined from lifecourse of 5-year-old children

Lifecourse	Independent variables
Pre-pregnancy	Maternal pre-pregnancy BMI
Early pregnancy	Family stability
	Maternal smoking in pregnancy, maternal education level
	Paternal education level
Birth	Child's birth weight, gestational age, gender
	Maternal parity
Infancy	Child's breastfeeding status
When children averaged 5 years age	Child's age, height, BMI, waist circumference, food intake: top and fruits and vegetables food groups, nutrient intake: energy and fats intake
	Family household weekly income, entitlement to means tested healthcare benefits scheme, family structure (marital status), support from partner, parents, children and relatives
	Maternal age, height, BMI, waist circumference, smoking, employment status, food intake: top and fruits and vegetables food groups, nutrient intake: energy and fats intake, self-rated health status
	Paternal height, BMI, waist circumference, smoking, employment status, self-rated health status

BMI, body mass index.

From these independent variables, principally chosen on the basis of their relevance to the child's development,[6–8] all those that qualified at significance level 20% ($p<0.2$)[42] in univariate analyses were force entered into a multivariable logistic regression model. BMI (kg/m^2) and WC (cm), the anthropometric markers of obesity, were tested separately in independent multivariable models. They were not analysed together within a model as results of possible interactions among body composition variables would have been difficult to interpret.[43 44] Initially, BMI was tested as a categorical variable in a model, followed by two additional models substituting it with BMI and then WC as continuous variables. Other independent variables were tested as categorical variables. Written informed consent was obtained from study participants.

RESULTS

There were 547 family data sets available for analysis of children's PRH. Table 2 presents the univariate associations between children's lifecourse variables and PRH. Within the individual spheres of influences, children's lifestyle behaviours (lower intake of fatty/sugary foods and total fats, and higher intake of fruits/vegetables) and their anthropometric measures at age 5 (not being obese, lower BMI and lower WC) are qualified as determinants of children's relatively positive PRH for further examination in the multivariable model.

In other words, retaining $p<0.2$ as the criterion for significance, the children's healthy food and nutrient intake habits—such as lower intake of unhealthy fat-rich and sugar-rich foods (servings/day; OR (95% CI) 1.7 (0.8 to 3.4)) or total fats (g) in their meals (OR (95% CI) 2.2 (1.1 to 4.3)) and higher intake of healthy fruits and vegetables (servings/day; OR (95% CI) 2.2 (1.1 to 4.3))—were positively associated with their favourable rating for health by their mothers. Conversely, children's higher BMI (kg/m^2; OR (95% CI) 0.85 (0.71 to 1.03)) and WC (cm; OR (95% CI) 0.95 (0.88 to 1.02)) were inversely associated with a positive parental-rated health status.

Within the family sphere of influences, socioeconomic status (higher household income, non-entitlement to subsidised healthcare, both parents' higher education status and father's employment status), psychosocial status (father's study participation, mother's perceived social support), mother's lifestyle behaviours (lower intake of fatty/sugary foods, total energy and total fats), father's lifestyle behaviours (non-smoker) and both parents' health status (relatively positive self-rated health) are qualified as determinants of children's relatively positive PRH for further examination in the multivariable model.

In other words, by maintaining $p<0.2$ as the criterion for significance, several indicators of a family's better socioeconomic status—such as higher household income (Euros/week; OR (95% CI) 3.0 (1.6 to 5.9)), not requiring subsidised healthcare (OR (95% CI) 2.1 (1.0 to 4.3)), mother having a third-level education (OR (95% CI) 1.9 (1.0 to 3.6)), father having a third-level education (OR (95% CI) 1.9 (1.0 to 3.6)), father being self-employed (OR (95% CI) 2.5 (0.8 to 7.9)); family's better psychosocial status—such as father's involvement in family affairs (OR (95% CI) 2.1 (1.0 to 4.3)), mothers perceiving a positive social support from spouse (OR (95% CI) 2.3 (1.2 to 4.3)), parents (OR (95% CI) 2.0 (1.0 to 4.1)), children (OR (95% CI) 1.9 (1.0 to 3.7)) or relatives (OR (95% CI) 2.2 (1.1 to 4.1)); family's better lifestyle and food and nutrient intake habits—such as mother's lower intake of unhealthy fat-rich and sugar-rich foods (servings/day; OR (95% CI) 1.7 (0.8 to 3.4)), total energy (kcal; OR (95% CI) 2.2 (1.1 to 4.3)) and total fats (g; OR (95% CI) 1.7 (0.8 to 3.4)) in her meals, fathers not being a smoker (OR (95% CI) 2.2 (1.1 to 4.4)); and family's better health status—such as mother (OR (95% CI) 5.1 (2.6 to 9.9)) and father (OR (95% CI) 3.0 (1.5 to 6.0)) having a positively rated health status were positively associated with children's favourable rating for health by their mothers.

Table 3 presents the multivariable model for association between qualifying lifecourse variables and children's relatively positive PRH at age 5. A significantly strong predictor of children's relatively positive PRH was child's not being obese by IOTF classification (OR (95% CI) 5.5 (1.4 to 21.0)). When BMI was tested as a continuous variable, there was 0.73 (95% CI 0.58 to 0.93) times lower odds of the child being positively rated on health status for every 1 kg/m^2 increase in their BMI. Similarly, in the WC model, for every 1 cm increase there was 0.89 (95%CI 0.81 to 0.98) times lower odds of the child getting a relatively positive rating on health status. Thus, the association between children's BMI or WC and their PRH only strengthened following adjustments in this multivariate model, irrespective of being analysed as a categorical or continuous variable. Another significant predictor of children's relatively positive PRH was mother's having rated her own health as relatively positive. These predictors maintained the highest strength of association with children's health status when independent variables were standardised (not reported here). None of the other variables reached the level of statistical significance. The models explained over 25% of variance for children's PRH.

DISCUSSION

This analysis showed that determinants from both child's individual and family spheres have an influence on child's health at preschool age. The factors from all three material, psychosocial and lifestyle domains, the major explanations for child health inequalities,[8] were associated at univariate levels. However, in the final model, this analysis clearly demonstrated a negative association between child's obesity and health status. Child's not being obese was one of the significantly strong

Table 2 Univariate lifecourse associates of children's relatively positive PRH (N=547)

	N	Relatively negative PRH (n=42) Per cent (n)	Relatively negative PRH (n=42) Mean (SD)	Relatively positive PRH (n=505) Per cent (n)	Relatively positive PRH (n=505) Mean (SD)	OR	95% CI
Child's individual characteristics							
Birth weight adjusted for gestational age (g)	487	(34)	3564.1 (616)	(453)	3548.4 (552)	1.00	(0.999 to 1.001)
Child's age (years)	547	(42)	5.42 (0.23)	(505)	5.46 (0.25)		
Gender	547						
Male		8.0 (22)		92.0 (242)		Ref	
Female		7.1 (21)		92.9 (262)		1.14	(0.60 to 2.20)
BMI (kg/m^2)	464	(35)	17.09 (2.5)	(429)	16.59 (1.6)	0.85	(0.71 to 1.03)^
BMI (IOTF)	464						
Obese		16.7 (5)		83.3 (25)		Ref	
Overweight/normal		6.9 (30)		93.1 (404)		2.69	(0.96 to 7.54)^
Waist circumference (cm)	462	(35)	57.01 (6.8)	(427)	55.88 (4.3)	0.95	(0.88 to 1.02)†
Height (cm)	464	(35)	111.6 (5.6)	(429)	112.1 (4.8)	1.02	(0.95 to 1.10)
Breast feeding	528						
Not breast fed		6.5 (16)		93.5 (229)		Ref	
Breast fed		8.8 (25)		91.2 (258)		0.72	(0.38 to 1.38)
Energy (kcal)	547						
Quintile 5 (>1794)		10 (11)		90.0 (99)		Ref	
Quintile 1–4		7.1 (31)		92.9 (406)		1.46	(0.71 to 3.00)
Fats (g)	547						
Quintile 5 (>62.9)		12.8 (14)		87.2 (95)		Ref	
Quintile 1–4		6.4 (28)		93.6 (410)		2.16	(1.09 to 4.26)*
Top food group (servings/day)	547						
Quintile 5 (>6.47)		10.9 (12)		89.1 (98)		Ref	
Quintile 1–4		6.9 (30)		93.1 (407)		1.66	(0.82 to 3.36)†
Fruits veg food group (servings/day)	547						
Quintile 1 (<2.1)		12.8 (14)		87.2 (95)		Ref	
Quintile 2–5		6.4 (28)		93.6 (410)		2.16	(1.09 to 4.26)*
Family Characteristics							
Household weekly income	509						
Less than €760		13.3 (26)		86.7 (170)		Ref	
More than €760		4.8 (15)		95.2 (298)		3.04	(1.57 to 5.90)**
Entitlement to general medical card	532						
Entitled		13 (12)		87.0 (80)		Ref	
Not entitled		6.6 (29)		93.4 (411)		2.13	(1.04 to 4.34)*
Fathers' participation	547						
No		9.7 (31)		90.3 (290)		Ref	
Yes		4.9 (11)		95.1 (215)		2.09	(1.03 to 4.25)*
Marital status	542						
Others		11.4 (5)		88.6 (39)		Ref	
Married/cohabiting		7.2 (36)		92.8 (462)		1.65	(0.61 to 4.43)
Elder children in family (parity)	535						
Nullipara		8 (18)		92.0 (207)		Ref	
Multipara		7.7 (24)		92.3 (286)		1.04	(0.55 to 1.96)
Support from spouse/partner	538						
Lesser support		12.9 (17)		87.1 (115)		Ref	
More support		6.2 (25)		93.8 (381)		2.25	(1.18 to 4.32)*
Support from parents	487						
Lesser support		12.5 (12)		87.5 (84)		Ref	
More support		6.6 (26)		93.4 (365)		2.01	(0.97 to 4.14)^
Support from children	532						
Lesser support		10.6 (20)		89.4 (169)		Ref	
More support		5.8 (20)		94.2 (323)		1.91	(1.00 to 3.65)*
Support from close relatives	510						
Lesser support		12.4 (19)		87.6 (134)		Ref	
More support		6.2 (22)		93.8 (335)		2.16	(1.13 to 4.12)*
Maternal characteristics							
Pre-pregnancy BMI (kg/m^2)	475	(36)	23.3 (3.3)	(439)	23.8 (3.9)	1.04	(0.94 to 1.14)

Continued

Table 2 Continued

	N	Relatively negative PRH (n=42)		Relatively positive PRH (n=505)			
		Per cent (n)	Mean (SD)	Per cent (n)	Mean (SD)	OR	95% CI
Pre-pregnancy BMI (WHO cut-offs)							
Obese		2.6 (1)		97.4 (38)		Ref	
Overweight/normal		8 (35)		92.0 (401)		0.30	(0.04 to 2.26)
Mother's age (years)	546	(42)	36.5 (6.3)	(504)	37.1 (5.3)	1.02	(0.96 to 1.08)
BMI at 5-year follow-up (kg/m^2)	432		25.6 (3.9)		26.3 (5.0)	1.03	(0.95 to 1.12)
BMI at 5-year follow-up (WHO cut-offs)	432						
Obese		7.2 (5)		92.8 (64)		Ref	
Overweight/normal		7.4 (27)		92.6 (336)		0.97	(0.36 to 2.62)
Waist circumference (cm)	434	(31)	85.3 (10.6)	(403)	87.6 (11.9)	1.02	(0.99 to 1.05)
Height (cm)	454	(33)	161.9 (6.8)	(421)	162.9 (6.0)	1.03	(0.97 to 1.09)
Smoking in pregnancy	534						
Smoker		8.1 (8)		91.9 (91)		Ref	
Non-smoker		7.6 (33)		92.4 (402)		1.07	(0.48 to 2.4)
Smoking at 5-year follow-up	541						
Smoker		7.6 (9)		92.4 (110)		Ref	
Non-smoker		7.6 (32)		92.4 (390)		1.0	(0.46 to 2.15)
Energy (kcal)	546						
Quintile 5 (>2570.9)		13 (14)		87.0 (94)		Ref	
Quintile 1–4		6.4 (28)		93.6 (410)		2.18	(1.11 to 4.30)*
Fats (g)	546						
Quintile 5 (>106)		11 (12)		89.0 (97)		Ref	
Quintile 1–4		6.9 (30)		93.1 (407)		1.68	(0.83 to 3.40)†
Top food group (servings/day)	545						
Quintile 5 (>8.35)		11 (12)		89.0 (97)		Ref	
Quintile 1–4		6.9 (30)		93.1 (406)		1.67	(0.83 to 3.39)†
Fruits veg food group (servings/day)	546						
Quintile 1 (<4.5)		9.1 (10)		90.9 (100)		Ref	
Quintile 2–5		7.3 (32)		92.7 (404)		1.26	(0.60 to 2.65)
Education level	534						
Lower		10.4 (25)		89.6 (215)		Ref	
Third level		5.8 (17)		94.2 (277)		1.90	(1.00 to 3.60)*
Employment	545						
Not earning		6.4 (15)		93.6 (221)		Ref	
Employed		9 (22)		91.0 (222)		0.69	(0.35 to 1.36)
Self-employed		7.7 (5)		92.3 (60)		0.81	(0.29 to 2.33)
Self-reported health	546						
Relatively negative		17.1 (27)		82.9 (131)		Ref	
Relatively positive		3.9 (15)		96.1 (373)		5.10	(2.64 to 9.93)**
Paternal characteristics							
BMI at 5-year follow-up (kg/m^2)	66	(4)	28.4 (5.5)	(62)	27.9 (4.1)	0.97	(0.76 to 1.23)
Waist circumference (cm)	65	(3)	94.9 (7.6)	(62)	95.9 (1.3)	1.01	(0.90 to 1.13)
Height (cm)	66	(4)	175.2 (2.0)	(62)	175.5 (8.0)	1.01	(0.88 to 1.15)
Smoking at 5-year follow-up	521						
Smoker		11.5 (16)		88.5 (123)		Ref	
Non-smoker		5.5 (21)		94.5 (361)		2.24	(1.13 to 4.42)*
Education level	514						
Lower		11.1 (16)		88.9 (128)		Ref	
Third level		6.2 (23)		93.8 (347)		1.89	(0.97 to 3.68)^
Employment	518						
Not earning		9.2 (8)		90.8 (79)		Ref	
Employed		7.9 (24)		92.1 (279)		1.18	(0.51 to 2.72)
Self-employed		3.9 (5)		96.1 (123)		2.49	(0.79 to 7.89)†
Self-reported health	510						
Relatively negative		12.6 (20)		87.4 (139)		Ref	
Relatively positive		4.6 (16)		95.4 (335)		3.01	(1.52 to 5.99)**

*p<0.05, **p<0.01, ^p<0.1, †p<0.2.
BMI, body mass index; IOTF, International Obesity Task Force; Ref, reference category (OR=1); PRH, parent-rated health.

Table 3 Multivariable logistic regression model for predictors of children's relatively positive PRH (N=303)

	Relatively positive PRH		Relatively positive PRH		Relatively positive PRH	
	BMI categorical¶		BMI continuous‡		WC continuous§	
	OR	95% CI	OR	95% CI	OR	95% CI
Child's individual characteristics						
BMI (IOTF), obese† vs overweight/normal	5.48	(1.43 to 21.03)*				
BMI, kg/m^2 (continuous)			0.73	(0.58 to 0.93)**		
WC, cm (continuous)					0.89	(0.81 to 0.98)*
Fats, g (quintiles), Q5† vs Q1–4	1.57	(0.42 to 5.79)	1.49	(0.40 to 5.53)	1.32	(0.36 to 4.80)
Top food group servings/day (quintiles), Q5† vs Q1–4	1.23	(0.33 to 4.53)	1.30	(0.36 to 4.63)	1.29	(0.36 to 4.62)
Fruits veg food group servings/day (quintiles), Q1† vs Q2–5	2.57	(0.75 to 8.80)	2.86	(0.83 to 9.93)	2.73	(0.78 to 9.49)
Family characteristics						
Household weekly income, less† vs high	1.85	(0.63 to 5.40)	1.76	(0.59 to 5.21)	1.79	(0.61 to 5.26)
Entitlement to general medical, card yes† vs no	0.94	(0.24 to 3.71)	1.03	(0.26 to 4.07)	1.04	(0.26 to 4.10)
Fathers' participation, not† vs yes	1.88	(0.68 to 5.21)	1.86	(0.67 to 5.16)	2.06	(0.74 to 5.71)
Support from spouse/partner, less† vs more	0.70	(0.20 to 2.49)	0.67	(0.19 to 2.33)	0.74	(0.22 to 2.52)
Support from parents, less† vs more	1.92	(0.53 to 6.93)	2.33	(0.64 to 8.42)	2.37	(0.66 to 8.53)
Support from children, less† vs more	1.15	(0.38 to 3.45)	1.29	(0.42 to 3.91)	1.25	(0.41 to 3.82)
Support from close relatives, less† vs more	0.86	(0.23 to 3.13)	0.84	(0.24 to 3.02)	0.84	(0.23 to 3.01)
Maternal characteristics						
Energy, kcal (quintiles), Q5† vs Q1–4	1.89	(0.30 to 11.84)	2.00	(0.31 to 12.86)	1.57	(0.28 to 8.84)
Fats, g (quintiles), Q5† vs Q1–4	0.72	(0.09 to 5.54)	0.59	(0.07 to 4.77)	0.92	(0.13 to 6.41)
Top food group servings/day (quintiles), Q5† vs Q1–4	1.08	(0.29 to 3.94)	1.30	(0.36 to 4.65)	1.18	(0.32 to 4.34)
Education, lower† vs third level	1.34	(0.47 to 3.78)	1.35	(0.48 to 3.80)	1.48	(0.53 to 4.13)
Self-reported health status, Rel.Negative† vs Rel.Positive	4.20	(1.45 to 12.20)**	4.42	(1.53 to 12.79)**	4.17	(1.47 to 11.87)**
Paternal characteristics						
Current smoking status, yes† vs no	1.37	(0.48 to 3.93)	1.31	(0.45 to 3.83)	1.53	(0.54 to 4.35)
Education, lower† vs third level	0.69	(0.21 to 2.28)	0.79	(0.24 to 2.57)	0.83	(0.26 to 2.67)
Employment, non-earning † vs self-employed	1.60	(0.73 to 3.53)	1.52	(0.69 to 3.32)	1.57	(0.70 to 3.53)
Self-reported health status, Rel.Negative† vs Rel.Positive	1.48	(0.52 to 4.20)	1.54	(0.54 to 4.35)	1.43	(0.51 to 3.96)

*p<0.05 (2-tailed), **p<0.01 (2-tailed).
†Reference category (OR=1).
¶Child BMI as a categorical variable; model $\chi^2 = 34.2$, df = 21, p = 0.034; −2LL = 128.6, Nagelkerke $R^2 = 0.26$.
‡Child BMI as a continuous variable; model $\chi^2 = 35.9$, df = 21, p = 0.022; −2LL = 126.9, Nagelkerke $R^2 = 0.27$.
§Child WC as a continuous variable; model $\chi^2 = 33.8$, df = 21, p = 0.038; −2LL = 128.9, Nagelkerke $R^2 = 0.25$.
BMI, body mass index; PRH, parent-rated health; Rel.Negative, relatively negative; Rel.Positive, relatively positive; WC, waist circumference.

predictors of child's relatively positive health status, which was also observed with measured BMI and WC analysed as continuous variables.

This negative relationship observed between measured obesity and PRH conforms to published literature on primary school age-group children and adolescents.[45–47] Most importantly, for the first time to our knowledge, this analysis demonstrates the association having adjusted for food and nutrient intake, along with a wide range of other explanatory variables.

Self-rated health is an important and valid measure of morbidity, mortality, longevity and health status,[3 4] also in Irish adult[48 49] and children.[16] It is believed to be a more inclusive measure of health than the objective measurements, with a capacity to comprehensively evaluate health dynamics, behaviours and psychophysiological states that are not otherwise easy to measure.[3] This holistic measure better accommodates the WHO defined concept of health as opposed to a diagnosed specific disease.[3] Use of parent proxy for child self-reported health is justified for children too young to have adequate cognitive skills.[50 51] Systematic reviews report good agreement between ratings by children and their parents on child HR-QoL, particularly for physical health domain.[50–52] Parents tend to be thoughtful when responding to proxy questions and report children's usual health disposition.[53] Studies on construct validity report positively.[54–57] Maternal ratings of child's general health status were found sensitive when validated against children's illnesses and other morbidity or healthcare indicators,[41 58–60] including evidence of a gradient in strength of these associations.[41] Many national-level studies have accepted parent proxy as an appropriate measure[17 18 61 62] and successfully used it to longitudinally demonstrate risk and consequences of child health.[17 61]

Self-rated health, a composite measure, represents all domains of HR-QoL,[4] but better represents physical health than HR-QoL.[63] Studies on older age-group children have reported stronger/sole negative associations for general/physical health domain of HR-QoL and obesity,[46 64] irrespective whether children themselves or parents reported their HR-QoL,[29] and also whether BMI was analysed as a categorical[45 46] or continuous variable.[65 66]

Another relevance of this analysis is in demonstrating this association of obesity with general health in a nationally representative sample of preschool-age children, for which literature is scant. Though, a few have shown similar association of obesity with specific paediatric conditions or admission history in this age group.[30 31 67–70] A longitudinal study speculated that preschool obesity influences a decline in early-age health, and then both obesity and poor health tracks into adolescence.[71] The WHO recommends high priority for determinants of health inequalities during early development.[72]

The Lifeways previously demonstrated longitudinal association between parental socioeconomic and lifestyle characteristics and child's BMI and WC.[36] In this analysis, when same anthropometric measures are included along with material, psychosocial and lifestyle determinants of child obesity and health, a prominent relationship emerges between children's anthropometric measures and health status. One possible explanation is that determinants of health inequalities biologically embed[21 22] in early life and child obesity is an early phenotypic expression of this inequality, though the continued influence of environmental factors is not undermined. Adult[25 26] and adolescence studies[46 47] have also shown this association to be independent of sociodemographic, lifestyle-related or health-related factors.

The observed association between BMI or WC and PRH in the present analysis may be temporal, as demonstrated in adults.[27 28] Though a number of large-scale cross-sectional studies have shown an association between anthropometric measures of obesity and self-rated health,[73] only recently a few nationally representative prospective studies have established the temporality of this association in adults.[27 28] Though this relationship maybe bidirectional to an extent,[74 75] the mounting evidence from longitudinal birth cohort studies regarding a sequential relationship between lifetime growth trajectories and adult disease, disability and deaths[2] primarily rules out reverse causality in this association and suggests that the association observed in our birth cohort is also more likely to be temporal. Moreover, the available findings from a few longitudinal studies on primary school age children suggest that at least in the childhood this inverse association found between BMI and HR-QoL is predominantly in the given direction and not the reverse.[76 77] However, this needs careful interpretation as anthropometric and health data were concurrently collected, and this limitation may be addressed with next sweep of cohort data collection.

This analysis demonstrated that maternal health was strongly predictive of her child's health. One concern is that mother's perception of her own health may bias her perception of her child's health. However, this intergenerational association has been previously reported,[41 58 59 78–81] and reporting mothers can effectively discriminate between their own and children's health.[41 58 59 79 80 82] Several mechanisms such as inherited susceptibility, uterine environment and shared environment have been suggested for this familial aggregation pattern.[58 79 80]

Maternal BMI may be related to both maternal self-rated health and child's BMI, so the observed associations in this analysis could possibly be a reflection of an association between maternal BMI and child's PRH. However, this was not observed in our analysis. Maternal BMI at pre-pregnancy and 5-year follow-up was not associated with child's PRH at univariate level. Also, when maternal BMI was forcibly added into the multivariable model (not reported here), the observed associations did not attenuate.

The study has limitations in use of reported rather than measured health status and a relatively small sample size. Though the study was able to detect the major explanatory domains for child health inequalities documented in the literature,[8] the relatively small sample size of this study may possibly have underpowered it to detect variables with lesser effect sizes. The complete case approach to analysis reduced the sample size of the final multivariate model, which may have power implications. However, these missing data were on account of an accumulation across a number of variables. On analysis, there was no evidence of selectivity in the participants for whom there were missing data (etable 2). eTable 2, available in the web-only supplement, compares children included and not included in the final model for variables belonging to explanatory domains. It suggests that there were no significant differences in the characteristics of children included and not included (due to missing data) for analysis, suggesting that the children in the final model are representative of the study participants as a whole. It may be argued that the reduced sample size possibly influenced the OR estimate for the association between children's relatively positive PRH and the child's not being obese (using a categorical IOTF classification). Nonetheless, this association between children's anthropometric measures and their PRH variable is likely to be coherent, because these associations remain statistically significant even when BMI and WC are analysed as continuous variables.

As in most birth cohort studies,[83 84] the Lifeways birth cohort also experienced the attrition of mothers belonging to lower socioeconomic status in the early stages of the study. Though this may underestimate some socioeconomic inequalities,[85] it does not negate the exposure-outcome associations detected through regression models of such longitudinal studies.[86 87]

Nevertheless, this study has advantages in use of lifecourse variables from preconception to age of 5 years, with measured BMI and WC data. It also has detailed foods and nutrient data along with other socioeconomic, psychosocial and lifestyle variables for child and both parents.

In conclusion, these analyses from the Lifeways cohort show that lifecourse adversities were associated with mother-reported health for preschoolers, suggesting an early life influence. Preschoolers' BMI and WC demonstrated strong negative associations with mother-reported health independent of socioeconomic, psychosocial, and lifestyle factors, suggesting early biological expression of lifecourse adversities. The findings have important implications in understanding how early life environment may create inequalities in developmental health.

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