Appendix 1. Multiple imputation

Table 1 shows the amount of missing data for each variable of interest in each cohort. Multiple imputation was used to account for these missing data, under a missing at random (MAR) assumption, following the guidelines of Sterne et al.[1] Evidence to support the MAR assumption is provided in Supplementary Tables 1 & 2, where we examined differences between individuals with or without missing data on key variables in each cohort. In all instances, missingness was significantly ($p < 0.05$) related to at least one other observed variable.

Imputation of 20 datasets was performed for each cohort separately using chained equations in Stata 14 (command: mi impute chained). Briefly, this approach fills in missing values iteratively by using a sequence of univariate imputation methods with fully conditional specification of prediction equations.[2] Variables included in the imputation process included 1) birth weight and birth weight Z-score, 2) weight at age three years (two and four years in the 1946 NSHD), as well as exact ages of assessment, 3) infant weight Z-score change (parameterised as a linear spline, as in the analytical models), 4) BMI and BMI Z-scores at ages 11 and 14 years, as well as exact ages of assessment, 5) and father's occupational class at age 11 years, maternal BMI, and sex. The number of participants with complete data on all these variables was greater than 50% in both cohorts (2,368 / 4,199 = 56% in the 1946 NSHD; 4,937 / 9,417 = 52% in the 2001 MCS). General linear regression was used as the univariate imputation method for all variables, except father occupational class, which was imputed using ordered logistic regression.

Following imputation, distributions of the observed and imputed data for key variables were compared and found to be similar (data not shown). Analytical models were applied to the multiple-imputed data, using Rubin's rules to combine estimates across the 20 datasets (command: mi estimate).[3]

1. Sterne JA, White IR, Carlin JB, et al. Multiple imputation for missing data in epidemiological and clinical research: potential and pitfalls. BMJ 2009;338:b2393.
2. White IR, Royston P, Wood AM. Multiple imputation using chained equations: Issues and guidance for practice. Stat Med 2011;30(4):377-99.
3. Rubin DB. Multiple imputation for nonresponse in surveys. New York, NY: Wiley 1987.

Supplementary Table 1. Differences between individuals with or without missing data on key variables in the 1946 NSHD

		Infant weight Z-score change			Adolescent BMI at age 14 years		
		Not missing (*n* = 3,345)	Missing (*n* = 854)	*P-value*	Not missing (*n* = 3,580)	Missing (*n* = 619)	*P-value*
Sex				0.180			0.996
Male	*%*	53.0	50.5		52.5	52.5	
Female	*%*	47.0	49.5		47.5	47.5	
Birth weight (kg)	*Mean*	3.40	3.39	0.444	3.40	3.40	0.833
Birth weight Z-score	*Mean*	0.18	0.17	0.773	0.18	0.17	0.781
Weight at age 2 years	*Mean*	12.89	13.05	0.135	12.92	12.78	0.054
Weight Z-score at age 2 years	*Mean*	0.65	0.77	0.082	0.68	0.57	0.021
Age at 4 years	*Mean*	4.28	4.31	<0.001	4.29	4.29	0.951
Weight at age 4 years	*Mean*	17.19	17.22	0.704	17.21	17.05	0.100
Weight Z-score at age 4 years	*Mean*	0.10	0.09	0.906	0.11	0.03	0.060
Infant weight Z-score change	*Mean*	--	--		0.20	0.16	0.421
Adolescent age at 11 years	*Mean*	10.86	10.86	0.207	10.86	10.87	0.012
Adolescent BMI (kg/m^2) at age 11 years	*Median*	16.91	16.96	0.708	16.96	16.78	0.681
Adolescent BMI Z-score at age 11 years	*Mean*	0.00	0.00	0.964	0.00	-0.01	0.772
Adolescent age at 14 years	*Mean*	14.54	14.54	0.938	--	--	
Adolescent BMI (kg/m^2) at age 14 years	*Median*	19.66	19.70	0.263	--	--	
Adolescent BMI Z-score at age 14 years	*Mean*	0.00	0.04	0.323	--	--	
Maternal BMI (kg/m^2)	*Median*	22.67	23.03	0.237	22.85	22.14	<0.001
Father's occupational class at age 11 years				0.047			0.423
I (Professional)	*%*	5.9	6.5		6.1	5.8	
II (Managerial and technical)	*%*	19.4	19.3		19.7	18.0	
IIIN (Skilled non-manual)	*%*	15.9	13.6		15.4	15.4	

IIIM (Skilled manual)	%	34.9	31.4	33.9	36.1
IV (Partly-skilled)	%	18.2	21.9	19.2	17.2
V (Unskilled)	%	5.7	7.3	5.8	7.5

[a] Differences were tested using t-tests or Mann-Whitney U tests for continuous variables and chi-squared for categorical variables.

Supplementary Table 2. Differences between individuals with or without missing data on key variables in the 2001 MCS

		Infant weight Z-score change			Adolescent BMI at age 14 years		
		Not missing (*n* = 8,160)	Missing (*n* = 1,257)	*P-value*	Not missing (*n* = 7,578)	Missing (*n* = 1,839)	*P-value*
Sex				0.024			0.835
Male	*%*	50.4	53.9		51.0	50.7	
Female	*%*	49.6	46.1		49.0	49.3	
Birth weight (kg)	*Mean*	3.42	3.27	<0.001	3.40	3.39	0.396
Birth weight Z-score	*Mean*	0.22	0.10	<0.001	0.20	0.19	0.682
Age at 3 years	*Mean*	3.12	3.09	0.262	3.12	3.15	<0.001
Weight at age 3 years	*Mean*	15.45	14.55	0.001	15.39	15.64	<0.001
Weight Z-score at age 3 years	*Mean*	0.51	-0.50	<0.001	0.49	0.57	0.005
Infant weight Z-score change	*Mean*	--	--		0.27	0.37	0.006
Adolescent age at 11 years	*Mean*	11.18	11.20	0.066	11.17	11.22	<0.001
Adolescent BMI (kg/m^2) at age 11 years	*Median*	18.36	18.43	0.156	18.26	18.91	<0.001
Adolescent BMI Z-score at age 11 years	*Mean*	0.55	0.61	0.089	0.51	0.75	<0.001
Adolescent age at 14 years	*Mean*	14.27	14.28	0.578	--	--	
Adolescent BMI (kg/m^2) at age 14 years	*Median*	20.47	20.61	0.397	--	--	
Adolescent BMI Z-score at age 14 years	*Mean*	0.42	0.47	0.226	--	--	
Maternal BMI (kg/m^2)	*Median*	22.80	22.68	0.015	22.71	22.82	0.617
Father's occupational class at age 11 years				<0.001			<0.001
I (Professional)	*%*	5.9	2.9		6.0	3.8	
II (Managerial and technical)	*%*	44.5	37.7		45.5	35.3	
IIIN (Skilled non-manual)	*%*	12.6	12.8		12.3	14.5	
IIIM (Skilled manual)	*%*	21.6	24.4		21.1	25.5	
IV (Partly-skilled)	*%*	12.7	18.0		12.6	16.8	

V (Unskilled)	%	2.7	4.1		2.6	4.1

[a] Differences were tested using t-tests or Mann-Whitney U tests for continuous variables and chi-squared for categorical variables.

Supplementary Table 3. Unadjusted associations of infant weight change with adolescent BMI, estimated using general linear regression models applied to multiple-imputed data[a]

	1946 NSHD (*n* = 4,199)			2001 MCS (*n* = 9,417)			Between-cohort difference		
	B	*95% CI*	*P*	*B*	*95% CI*	*P*	*B*	*95% CI*	*P*
BMI Z-score at age 11 years									
Infant weight Z-score change									
If ≤ -1 Z-score	0.093	-0.049, 0.236	0.198	0.128	0.026, 0.229	0.013	0.035	-0.142, 0.211	0.701
If > -1 Z-score	0.128	0.093, 0.162	<0.001	0.220	0.197, 0.243	<0.001	0.093	0.050, 0.135	<0.001
BMI Z-score at age 14 years									
Infant weight Z-score change									
If ≤ -1 Z-score	0.069	-0.066, 0.204	0.314	0.090	-0.021, 0.201	0.111	0.021	-0.148, 0.190	0.807
If > -1 Z-score	0.106	0.073, 0.139	<0.001	0.200	0.176, 0.223	<0.001	0.094	0.053, 0.135	<0.001

[a] A separate model for each cohort and each outcome time point was applied to multiple-imputed data. To account for non-linearity, infant weight Z-score change was parameterised using linear splines (i.e., one term for values ≤ -1 Z-score and one term for values > -1 Z-score). Between-cohort differences in exposure estimates were tested using t-tests.

Supplementary Table 4. Unadjusted associations of rapid infant weight gain with adolescent BMI, estimated using general linear regression models applied to multiple-imputed data[a]

	1946 NSHD (*n* = 4,199)			2001 MCS (*n* = 9,417)			Between-cohort difference		
	B	*95% CI*	*P*	*B*	*95% CI*	*P*	*B*	*95% CI*	*P*
BMI Z-score at age 11 years									
Infant weight Z-score change									
< -0.67 (slow)	-0.138	-0.221, -0.054	0.001	-0.365	-0.427, -0.302	<0.001	-0.227	-0.332, -0.122	<0.001
-0.67 to +0.67 (normal) [referent]	--	--	--	--	--	--	--	--	--
+0.67 to +1.34 (rapid)	0.195	0.104, 0.286	<0.001	0.197	0.128, 0.265	<0.001	0.001	-0.112, 0.115	0.980
> +1.34 (very rapid)	0.233	0.132, 0.334	<0.001	0.483	0.412, 0.554	<0.001	0.250	0.127, 0.373	<0.001
BMI Z-score at age 14 years									
Infant weight Z-score change									
< -0.67 (slow)	-0.125	-0.206, -0.043	0.003	-0.289	-0.353, -0.226	<0.001	-0.165	-0.268, -0.061	0.002
-0.67 to +0.67 (normal) [referent]	--	--	--	--	--	--	--	--	--
+0.67 to +1.34 (rapid)	0.131	0.042, 0.220	0.004	0.172	0.104, 0.241	<0.001	0.041	-0.070, 0.153	0.466
> +1.34 (very rapid)	0.216	0.123, 0.310	<0.001	0.464	0.392, 0.536	<0.001	0.248	0.130, 0.366	<0.001

[a] A separate model for each cohort and each outcome time point was applied to multiple-imputed data. Between-cohort differences in exposure estimates were tested using t-tests.

Supplementary Table 5. Unadjusted associations of rapid infant weight gain with adolescent overweight/ obesity and thinness (compared to normal weight), estimated using multinomial logistic regression models applied to multiple-imputed data[a]

	1946 NSHD (*n* = 4,199)			2001 MCS (*n* = 9,417)			Between-cohort difference[b]
	RRR	*95% CI*	*P*	*RRR*	*95% CI*	*P*	*P*
Overweight/ obesity at age 11 years							
Infant weight Z-score change							
< -0.67 (slow)	0.893	0.639, 1.247	0.505	0.613	0.530, 0.709	<0.001	0.043
-0.67 to +0.67 (normal) [referent]	--	--	--	--	--	--	
+0.67 to +1.34 (rapid)	1.530	1.141, 2.051	0.005	1.260	1.100, 1.442	0.001	0.241
> +1.34 (very rapid)	1.600	1.155, 2.216	0.005	1.989	1.750, 2.260	<0.001	0.223
Thinness at age 11 years							
Infant weight Z-score change							
< -0.67 (slow)	1.221	0.947, 1.576	0.124	1.672	1.365, 2.046	<0.001	0.060
-0.67 to +0.67 (normal) [referent]	--	--	--	--	--	--	
+0.67 to +1.34 (rapid)	0.863	0.635, 1.172	0.345	0.717	0.526, 0.976	0.035	0.404
> +1.34 (very rapid)	0.565	0.372, 0.856	0.007	0.689	0.493, 0.963	0.029	0.462
Overweight/ obesity at age 14 years							
Infant weight Z-score change							
< -0.67 (slow)	0.955	0.705, 1.293	0.764	0.689	0.596, 0.797	<0.001	0.061
-0.67 to +0.67 (normal) [referent]	--	--	--	--	--	--	
+0.67 to +1.34 (rapid)	1.343	1.016, 1.776	0.038	1.237	1.076, 1.422	0.003	0.602
> +1.34 (very rapid)	1.293	0.941, 1.777	0.113	1.904	1.670, 2.171	<0.001	0.026
Thinness at age 14 years							

Infant weight Z-score change							
< -0.67 (slow)	1.387	1.043, 1.843	0.024	1.589	1.287, 1.962	<0.001	0.451
-0.67 to +0.67 (normal) [referent]	--	--	--	--	--	--	
+0.67 to +1.34 (rapid)	0.923	0.654, 1.302	0.647	0.814	0.606, 1.094	0.173	0.587
> +1.34 (very rapid)	0.675	0.435, 1.049	0.080	0.621	0.438, 0.879	0.007	0.771

RRR, relative risk ratio

[a] A separate model for each cohort and each outcome time point was applied to multiple-imputed data. Between-cohort differences in exposure estimates were tested using t-tests.

[b] Between-cohort differences for the *RRR* are not shown as they are not intuitive as they are not equal to the estimate for the 2001 MCS minus the estimate for the 1946 NSHD.

Supplementary Table 6. Estimates for the potential confounders included in the models shown in Table 2

	1946 NSHD (*n* = 4,199)			2001 MCS (*n* = 9,417)		
	B	*95% CI*	*P*	*B*	*95% CI*	*P*
BMI Z-score at age 11 years						
Sex						
Male [referent]	--	--	--	--	--	--
Female	-0.055	-0.113, 0.003	0.063	0.043	0.000, 0.085	0.048
Birth weight Z-score	0.406	0.365, 0.446	<0.001	0.450	0.423, 0.478	<0.001
Maternal BMI	0.048	0.041, 0.056	<0.001	0.064	0.059, 0.070	<0.001
Father's occupational class (ridit scores)	0.083	-0.024, 0.190	0.129	0.334	0.239, 0.426	<0.001
BMI Z-score at age 14 years						
Sex						
Male [referent]	--	--	--	--	--	--
Female	0.192	0.136, 0.249	<0.001	0.237	0.193, 0.281	<0.001
Birth weight Z-score	0.342	0.299, 0.384	<0.001	0.386	0.357, 0.415	<0.001
Maternal BMI	0.049	0.041, 0.056	<0.001	0.068	0.062, 0.074	<0.001
Father's occupational class (ridit scores)	0.122	0.012, 0.231	0.029	0.348	0.236, 0.460	<0.001

Supplementary Table 7. Estimates for the potential confounders included in the models shown in Table 3

	1946 NSHD (*n* = 4,199)			2001 MCS (*n* = 9,417)		
	B	*95% CI*	*P*	*B*	*95% CI*	*P*
BMI Z-score at age 11 years						
Sex						
Male [referent]	--	--	--	--	--	--
Female	-0.067	-0.126, -0.008	0.027	0.004	-0.040, 0.047	0.875
Birth weight Z-score	0.246	0.210, 0.281	<0.001	0.243	0.219, 0.268	<0.001
Maternal BMI	0.051	0.044, 0.059	<0.001	0.070	0.065, 0.076	<0.001
Father's occupational class (ridit scores)	0.007	-0.102, 0.117	0.895	0.326	0.228, 0.423	<0.001
BMI Z-score at age 14 years						
Sex						
Male [referent]	--	--	--	--	--	--
Female	0.183	0.125, 0.240	<0.001	0.202	0.157, 0.247	<0.001
Birth weight Z-score	0.211	0.176, 0.246	<0.001	0.203	0.179, 0.228	<0.001
Maternal BMI	0.051	0.043, 0.059	<0.001	0.073	0.067, 0.079	<0.001
Father's occupational class (ridit scores)	0.060	-0.049, 0.169	0.282	0.342	0.229, 0.454	<0.001

Supplementary Table 8. Estimates for the potential confounders included in the models shown in Table 4

	1946 NSHD (*n* = 4,199)			2001 MCS (*n* = 9,417)		
	RRR	*95% CI*	*P*	*RRR*	*95% CI*	*P*
Overweight/ obesity at age 11 years						
Sex						
Male [referent]	--	--	--	--	--	--
Female	1.537	1.225, 1.927	<0.001	1.411	1.277, 1.559	<0.001
Birth weight Z-score	1.532	1.321, 1.777	<0.001	1.346	1.266, 1.432	<0.001
Maternal BMI	1.097	1.068, 1.126	<0.001	1.128	1.114, 1.141	<0.001
Father's occupational class (ridit scores)	0.932	0.615, 1.413	0.741	1.799	1.479, 2.190	<0.001
Thinness at age 11 years						
Sex						
Male [referent]	--	--	--	--	--	--
Female	1.415	1.141, 1.755	0.002	1.311	1.092, 1.574	0.004
Birth weight Z-score	0.598	0.530, 0.674	<0.001	0.615	0.575, 0.658	<0.001
Maternal BMI	0.910	0.879, 0.942	<0.001	0.908	0.880, 0.937	<0.001
Father's occupational class (ridit scores)	0.817	0.549, 1.214	0.318	0.672	0.458, 0.984	0.041
Overweight/ obesity at age 14 years						
Sex						
Male [referent]	--	--	--	--	--	--
Female	1.594	1.284, 1.978	<0.001	1.294	1.168, 1.433	<0.001
Birth weight Z-score	1.522	1.326, 1.746	<0.001	1.331	1.254, 1.413	<0.001
Maternal BMI	1.111	1.083, 1.140	<0.001	1.125	1.111, 1.138	<0.001
Father's occupational class (ridit scores)	1.606	1.074, 2.402	0.021	1.926	1.522, 2.437	<0.001
Thinness at age 14 years						

Sex						
Male [referent]	--	--		--	--	--
Female	1.004	0.797, 1.264	0.976	0.748	0.623, 0.898	0.002
Birth weight Z-score	0.662	0.582, 0.753	<0.001	0.718	0.667, 0.773	<0.001
Maternal BMI	0.900	0.863, 0.940	<0.001	0.900	0.873, 0.928	<0.001
Father's occupational class (ridit scores)	1.231	0.794, 1.908	0.351	0.740	0.520, 1.052	0.093

RRR, relative risk ratio

Supplementary Table 9. Adjusted associations of rapid infant weight gain with adolescent thinness (compared to normal weight), estimated using multinomial logistic regression models applied to multiple-imputed data[a]

	1946 NSHD (*n* = 4,199)			2001 MCS (*n* = 9,417)			Between-cohort difference[b]
	RRR	*95% CI*	*P*	*RRR*	*95% CI*	*P*	*P*
Thinness at age 11 years							
Infant weight Z-score change							
< -0.67 (slow)	2.047	1.537, 2.726	<0.001	2.830	2.258, 3.546	<0.001	0.083
-0.67 to +0.67 (normal) [referent]	--	--	--	--	--	--	
+0.67 to +1.34 (rapid)	0.623	0.458, 0.848	0.003	0.601	0.440, 0.821	0.001	0.870
> +1.34 (very rapid)	0.261	0.163, 0.419	<0.001	0.321	0.224, 0.460	<0.001	0.494
Thinness at age 14 years							
Infant weight Z-score change							
< -0.67 (slow)	2.138	1.560, 2.928	<0.001	2.335	1.851, 2.945	<0.001	0.657
-0.67 to +0.67 (normal) [referent]	--	--	--	--	--	--	
+0.67 to +1.34 (rapid)	0.711	0.501, 1.010	0.057	0.699	0.521, 0.937	0.017	0.940
> +1.34 (very rapid)	0.368	0.222, 0.610	<0.001	0.359	0.249, 0.518	<0.001	0.939

RRR, relative risk ratio

[a] A separate model for each cohort and each outcome time point was applied to multiple-imputed data. Between-cohort differences in exposure estimates were tested using t-tests. Adjustment was made for birth weight Z-score, father's occupational class at age 11 years (transformed to ridit scores), maternal BMI, sex, and exact age of outcome assessment.

[b] Between-cohort differences for the *RRR* are not shown as they are not intuitive as they are not equal to the estimate for the 2001 MCS minus the estimate for the 1946 NSHD.