Patterns of BMI development between 10-42 years of age and their determinants in the 1970 British Cohort Study

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Conflicts of interest

All authors declare no conflict of interest.

What is already known about this subject

Most individuals gain weight gradually across the life-course although some gain weight more rapidly or not at all. Models of the average growth of BMI in the population obscure the fact that different people have different patterns or trajectories towards overweight or obesity

Studies of BMI trajectories in childhood using latent class models suggest there are distinct patterns in the way children increase BMI across childhood.

Little is known about trajectories of BMI change from childhood through adolescence to adulthood.

What this study adds

We identified three credible BMI trajectories in a large British birth cohort. The majority (92%) gained weight gradually across the lifecourse. There were two rapid onset obesity trajectories.

Higher parental BMI and early puberty increased the probability of being in either the childhood persistent obesity or the adolescent/young adult-onset obesity groups

Abstract

Background

Mixture modelling is a useful approach to identify sub-groups in a population who share similar trajectories. We aimed to identify distinct BMI trajectories between 10-42 years and investigate how known early-life risk factors are related to trajectories.

Methods

Sample: 9,187 participants in the 1970 British Birth Cohort Study, with BMI observations between 10-42 years and data on birth-weight, parental BMI, socioeconomic status (SES), breastfeeding and puberty. Latent growth mixture modelling in Mplus was used to model age-related BMI trajectories and test associations of risk factors with trajectory membership.

Results

A three latent class model was most credible; 1) Normative: 92%: started normal weight but gradually increased BMI to become overweight in adulthood; 2) Childhood onset persistent obesity (COP): 4%: persistently high BMI from childhood; 3) Adolescent and young adulthood onset obesity (AYAO): 4%: normal weight in childhood but had a steep ascending trajectory. Higher maternal and paternal BMI and early puberty increased the probability of being in either the COP or the AYAO classes compared with the normative class.

Conclusion

Most individuals gradually increased BMI and became overweight in mid-adulthood. Only 8% demonstrated more severe BMI trajectories. Further research is needed to understand the underlying body composition changes and health risks in the COP and AYAO classes.

Introduction

Understanding the patterns of accumulation of adiposity within populations and factors which increase risk of or protect against the development of overweight are important to the development of effective prevention strategies across the life-course. Models of the average growth of BMI in the population obscure the fact that individuals are likely to differ in trajectories towards obesity, and these may represent discrete sub-populations in the greater population.[1]

Analytic methods such as mixture models are newer statistical techniques which aim to identify likely different sub-populations within a population, probabilistically assigning individuals into latent classes representing a subpopulation or a trajectory based upon similar patterns of observed longitudinal data.[1, 2]

Studies of BMI trajectories using these methods have become increasingly common and there is growing acceptance that there are distinct BMI distinct sub-groups or latent classes across childhood.[3-5] Other studies have examined trajectories across adolescence[6, 7] and young adulthood[8] or in the elderly.[9, 10] However there has been little study of BMI trajectories from childhood into adult life, nor of childhood risk or protective factors linked with membership of these latent classes or trajectories.

We have previously used simple manual methods to identify four main patterns for the evolution of overweight and obesity from 10 to 42 years in the 1970 British Cohort Study (BCS). The most common were those who were never overweight or obese (29.5%) and those with early-adult onset obesity (44.3%), followed by mid-adult onset obesity (8.0%), childhood onset obesity (6.2%) and with 12.0% with a range of other patterns.[11] The disadvantages of manual methods however are that the number of trajectories increase exponentially with the number of waves of data, there are no objective criteria for selecting trajectories for study other than frequency, trajectories cannot be identified for continuous variables (e.g. for BMI) and they cannot account for patterns of missing data across waves. In contrast, analytic techniques such as mixture models allow the identification of a parsimonious number of classes using probabilistic assessments of trajectory independence and fit, are suitable for continuous or binary variables, account for missing data across waves and allow assessment of risk factors within the latent class analysis for identifying trajectories.

Here we use mixture models to examine whether there are likely credible sub-populations with differing BMI trajectories across the life-course in this national birth cohort. We then examined which previously identified early life risk factors for obesity influences BMI trajectory from childhood to middle age. Factors investigated were sex, birthweight,[3, 12, 13] parental BMI,[3, 4] socioeconomic status,[3, 12-14] breastfeeding,[15] and timing of puberty.[16]

Methods

1970 British Cohort Study (BCS70)

The BCS70 recruited just under 17,200 people born in Great Britain in one week in April 1970 and has followed them to date (at ages five (1975), 10 (1980), 16 (1986), 26 (1996), 30 (2000), 34 (2004) and 38 (2008) years, with the last follow-up in 2012 at age 42.

Data and variables

Participants were eligible for this study if they provided valid BMI data at any age and had available data for all predictors. BMI data were available at 10, 16, 26, 30, 34 and 42 years. Predictor data were taken from the birth (birthweight), 5 year (breastfeeding) and 10 year (socioeconomic status, maternal education, parental BMI and child signs of puberty). BMI was calculated (weight (kg)/ height (m)^2) from weight and height at each age, measured at 10 and 16 years of age according to standard protocols, and self-reported in questionnaires at 26 years and face-to-face interviews at 30, 34, and 42 years. The analysis sample for this study was 9187 (51.2% males).

Maternal and paternal BMI were calculated from self-reported weight and height from the 10 year survey and transformed by centring data on the cohort mean for mothers and fathers.

Birth weight (kg) was recorded by the midwife who had undertaken the delivery or the senior midwife. Breastfeeding duration data were reported by mothers in the 5 year survey, and classified by us as "<3 months" or "≥3 months". Any signs of puberty at age 10 years was recorded during the medical examination by a Community Medical Officer, shown here as 'early puberty'. Maternal and paternal occupation was reported by the mother at the 10-year follow-up. We created a binary variable for socioeconomic status, defined as high if father, mother or both belonged to a professional or managerial social class, or medium-low if they did not. The mother's highest educational achievement was obtained from the 10 year survey, dichotomised as attaining "A-levels or above" (A-levels are the requirement for university access) or below A-levels.

Analyses

Mixture modeling was undertaken using the *mixture* commands in MPlus 8.0 (www.statmodel.com). We used a free-loading model that fitted a smoothing spline to model BMI change over time. Models used maximum likelihood estimation which account for missing data, with 1500 random starts used in each model for maxiumum likelihood optimization; this was sufficient in all models to replicate the best log-likelihood ratio. We examined the effects of our hypothesized predictors on an individual's likelihood of belonging to one of the trajectory classes within each model. We began with a trajectory model with two BMI classes and sequentially increased trajectory number. All predictors were included together in each model. We assessed model fit at each step using the AIC, sample adjusted BIC together with entropy (a measure of separation of identified trajectories) and the Vuong-Lo-Mendell-Rubin test. The latter was used to test fit with k classes compared to a model with k-1 classes.[17] We judged the best model on the basis of clinical plausibility, model fit and entropy criteria.[1, 18] Model outputs for each predictor included a) multinomial regression coefficients indicating between-class variation, i.e. showing risk of belonging to one BMI trajectory class compared with another; and b) coefficients from the mixture regression indicating within-class variation, indicating the effect of the predictor on BMI within each trajectory class.[18]

Ethics: No ethics permissions required for these secondary analyses of an anonymised dataset.

Results

Mean BMI at each wave in the overall cohort and in the sample for these trajectory analyses is shown in Table 1, together with means/proportions for each predictor variable. Note that the sample for BMI at each wave in the analysis sample represents the sample in that wave with BMI data and full data on all predictor variables. There were minimal differences in mean BMI at any wave between the full BCS70 sample and the analysis sample, with means within 0.03kg/m^2 for each wave. Similarly for predictors, there were minimal differences between the whole and analysis samples.

Mixture models for BMI trajectories from 10 to 42 years are shown in Table 2. The 4- and 5 class models were discounted as containing a number of very tiny classes and not offering any notable advantage in terms of entropy or model fit. The 3 class model was judged to be the model providing the most parsimonious fit to the data, offering the best separation of classes (high entropy) and the likelihood ratio test suggesting it was superior to the 2 class model. The average class probabilities by latent class for the 3 class model are shown in the supplementary Appendix.

The 3 class model for trajectories of BMI is illustrated in Figure 1, with mean and 95% CI shown for BMI in each trajectory from 10 to 42 years. The Figure also shows the thresholds for overweight and obesity at ages 10 and 16 years according to the International Obesity Taskforce thresholds,[19] and World Health Organisation (WHO) thresholds for adult overweight and obesity thereafter. The most common trajectory (91.6%) was one where mean BMI began in the normal weight range at age 10 and increased slowly across the lifecourse, finishing with mean BMI just above the overweight threshold. We termed this the Normative weight gain trajectory (Class 2 in Table 2). While the mean BMI in this group was within the overweight range by age 42 years, there is assumed to be a normal distribution around that mean and, of course, some individuals were normal weight according to their observed BMI values. There were then two much smaller trajectory classes. The first of these we termed Childhood onset persistent obesity (COP: 4.0% of the sample; Class 1)) where mean BMI in this group began on the border of overweight and obesity at age 10 and climbed into the obese range at age 16 and continued relatively stable within the obese range thereafter. The third trajectory we named Adolescent & young adult onset obesity (AYAO: 4.3% of sample; Class 3 in Table 2), as this had mean BMI in the normal range in childhood and in the overweight range in adolescence but in the obese range by young adulthood (age 26 years). This last trajectory had the highest mean BMI in adulthood, being in the morbidly obese range by age 42 years.

Table 3 shows the multinomial regression odds ratios (OR) for the associations of predictors with trajectory class membership in the 3 class model. Compared with being in the Normative weight gain trajectory, higher maternal and paternal BMI and early puberty increased risk of being in either COP or Adolescent and AYAO trajectory classes, with similar effect sizes for each predictor for both trajectories. A higher birthweight was protective against being in the COP trajectory, whilst male sex and higher socioeconomic status were protective against being in the AYAO trajectory, compared with the Normative weight trajectory. Alternative parameterization for the categorical latent variable regression using the COP class as the reference group showed that risk of being in the AYAO trajectory compared to the COP class was reduced amongst males (OR 0.42, p<0.0001) with a borderline significant finding that risk was increased by higher birthweight (OR 1.42, p=0.05).We found no role for breastfeeding for 3 months or more or maternal education on trajectory class membership.

Table 4 shows results of the within-class mixture regression, with coefficients shown for the independent effect of each predictor on the baseline intercept (i.e. BMI at age 10 years) and subsequent slope of BMI change (from 10 to 42 years) within each trajectory class. Note that effects for predictors are shown adjusted for all other factors. In both the AYAO and normative trajectories, males had a lower BMI at 10 years but then a higher slope indicating higher rate of BMI acceleration thereafter. In contrast, in the COP trajectory males had a higher BMI at 10 years but then a slower rise in BMI thereafter. Birthweight was only significant in the normative trajectory, with a higher birthweight leading to a higher BMI at 10 years although a lower slope of BMI change. Breastfeeding was not associated with BMI in any trajectory class. Early puberty was associated with higher early BMI in the COP and normative trajectories but with a lower early BMI in the AYAO trajectory. Maternal educational status had little influence in any trajectory class, whilst higher father's social class was important only in the normative weight gain trajectory, associated with a slightly higher

BMI at 10 years but a lower rate of change thereafter. Parental BMIs were not associated with BMI within the AYAO trajectory and within the COP trajectory the only association was for maternal obesity with a higher BMI at the 10 year baseline. However in the normative weight gain trajectory both maternal and paternal BMI were associated with higher baseline BMI at 10 years and a steeper rise in BMI over the study period.

Discussion

We identified three plausible and discrete trajectories by which a nationally representative sample of Britons gain weight across the early and mid life-course. We found that the great majority of the population (91.6%, Normative weight gain trajectory) form a relatively homogenous group, with mean BMI beginning in the normal range in childhood and gradually increasing to mean BMI within the overweight range by age 42 years, consistent with gradual adiposity accumulation across life. We identified only two other discrete BMI trajectories, both accounting for around 4% of the population. The first were those with high BMI in childhood whose BMI remained in the obese range across the study (Childhood onset persistent obesity, COP). The second (Adolescent and young adult onset obesity, AYAO) were those whose BMI increased rapidly from adolescence onwards, transitioning from normal mean BMI in childhood to mean BMI in the obese range in adolescence and early adulthood and ending in the morbidly obese range. This latter class may be at higher risk for cardiovascular disease and other obesity co-morbidities than other classes.

Our findings extend previous trajectory studies of BMI across childhood and adolescence, which have largely identified a relatively consistent group of gradually increasing BMI trajectories, with differences related to the timing and rapidity of BMI increase. [3-5] Our findings are consistent with a systematic review that reported that the majority (around 70%) of obese adults become so in adulthood.[20]

We found that males were significantly less likely to be in the AYAO trajectory than either the Normative weight gain or the COP trajectories. Within trajectories, males had lower BMI than females at the 10 year baseline in the AYAO and normative classes, although a higher baseline BMI in the COP trajectory. These findings are consistent with clinical and epidemiological observations that girls gain more weight during puberty.[21] It also suggests that whilst boys are at lower risk of early onset obesity, those that are in this trajectory have a higher BMI.

We found that high maternal or paternal BMI each independently increased the risk of being in either of the two early obesity onset trajectories, despite adjustment for other potentially confounding factors. This is consistent with studies of BMI trajectories across childhood, who find that parental obesity increases risk of early onset or rapidly rising obesity in childhood,[3-5] with maternal having stronger effects than paternal BMI.[22] This is also consistent with the clear role we identified for both maternal and paternal BMI in the normative trajectory, with higher parental BMI increasing both BMI in childhood and increasing BMI gain through to adulthood. We also found early puberty to be a common risk factor for both early onset trajectories, consistent with previous findings[16] and consistent with our earlier study.[11]

In our study, a higher birthweight was protective against being in the childhood onset trajectory compared with being in the normative weight gain trajectory, with tentative evidence that higher birthweight increased risk of being in the Adolescent and young adult-onset trajectory compared with the Childhood onset trajectory. Our findings on birthweight are consistent with a large literature on the developmental origins of adult disease,[12, 13], although the nature and strength of this association is less clear in studies that account for potential confounders as here. Our findings suggest that a lower birthweight increases risk of childhood onset obesity, whilst those with a higher birthweight were equally likely to be in the normative weight gain and adolescent/young adult onset obesity trajectory.

We found that those with childhood higher socioeconomic position were less likely to be in the Adolescent / young adult onset obesity trajectory than the Normative weight gain trajectory. However higher socioeconomic position was not protective against being in the Childhood onset trajectory. Within classes, socioeconomic position was significant only within the normative trajectory, associated with lower rate of BMI gain across adult life. A protective effect for higher social position against obesity, including socioeconomic position in childhood, is well described in modern studies.[12-14] We did not find that breastfeeding or maternal education influenced trajectory membership and found little role for them in regressions within each trajectory class. Whilst both breast-feeding and greater maternal education are recognised protective factors for higher later BMI,[13, 23] our findings suggest that in this cohort at least, they did not influence trajectory class membership.

Strengths and Limitations

We used longitudinal data from a nationally representative birth cohort, with BMI data from childhood through to mid adult life. The analysis sample used in this paper was minimally different to the whole cohort (Table 1) and the analytic strategy accounted for missing data. We used best practice in mixture modelling, undertaking analyses in MPlus and using best practice criteria for determining model fit and trajectory class number.[17] Our data were subject to a number of limitations. Mixture modelling is an exploratory/ data driven technique and it is possible that chance relationships in our data may influence trajectory group findings.[24] However the trajectory groups we identified were similar to those found in other studies and were clinically plausible. Whilst we identified two smaller classes of just over 4%, these were biologically plausible and consistent with our findings from the manual analysis.[11]

The BCS70 has a small degree of excess attrition amongst lower socioeconomic individuals, in common with most longitudinal cohorts, and this may introduce bias. Whilst measured BMI were available at 10 and 16 years, surveys after these used self-report height and weight. BMI based upon self-report is accepted to be a valid proxy for BMI in epidemiological studies, however population-based data suggest that obese individuals are more likely to under-report their BMI by approximately 1.5 kg/m^2 .[25] This bias may have led our analysis to underestimate the size of the early onset classes. Finally, the BCS70 is now a historical cohort, with over 35 years elapsing since the 10 year survey, and obesity rates amongst modern children are much higher in most high income countries.[26] However the BCS70 remains one of the most contemporary longitudinal studies linking childhood with mid adult life.

Conclusions

The majority of the population gradually accumulate adiposity across the life-course, becoming overweight or obese in mid adult life. However we identified two plausible trajectory classes with earlier onset obesity, in childhood or in adolescence/young adulthood, likely to be at higher risk for obesity comorbidities. Known risk factors for obesity appear to affect both trajectory class membership and BMI change within trajectory classes. Parental BMI appears to confer higher risk whilst higher socioeconomic position was protective against obesity across classes. Other risk factors such as early puberty appeared to have roles only within early onset trajectories. Future biomedical follow-up of this cohort will allow the examination of associations of trajectories with objective markers of cardiovascular risk.

Licence for Publication

Competing Interest

Competing Interest: None declared.

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Table & Figure Legend

Table 1. Characteristics of the total BCS70 sample and the sample for the trajectory analyses

	Total sample			**Analysis sample**		
Variable	**Sample**	**Median**	**IQR**	**Sample**	**Median**	**IQR**
BMI (kg/m^2)						
10 years	12,160	16.49	2.42	8,641	16.52	2.46
16 years	5,723	20.76	3.59	3,851	20.75	3.59
26 years	7,303	22.96	4.32	4,537	22.92	4.31
30 years	10,891	24.11	5.20	6,728	24.13	5.15
34 years	9,355	25.11	5.58	5,917	25.11	5.56
42 years	8,841	25.99	6.05	5,469	25.97	5.92
Predictor variables	**Sample**	**Mean**	**SD**	**Sample**	**Mean**	**SD**
Birthweight (kg)	17,161	3.27	0.58	9,187	3.33	0.52
Maternal BMI (kg/m^2)	13,256	23.46	3.87	9,187	23.44	3.77
Paternal BMI (kg/m^2)	12,500	24.49	3.05	9,187	24.49	3.03
	Sample	**%**	**n**	**Sample**	**%**	**n**
Sex: male	16,496	51.78%	8541	9,187	51.20%	4704
Maternal education: at least A levels	14,472	16.15%	2337	9,187	16.34%	1501
Signs of puberty at 10 years	12,981	15.49%	2011	9,187	15.35%	1410
Breastfed ≥ 3 months	12,981	10.88%	1412	9,187	11.20%	1029
Managerial/professional social class	13,311	29.10%	3869	9,187	30.02%	2758

Legend: BMI – Body mass index; SD – Standard deviation

Table 2. Mixture models and model fit criteria for 2 through to 5 class models for Body Mass Index from 10 to 42 years

		2 classes		3 classes		4 classes		5 classes	
N		9187		9187		9187		9187	
AIC		159214.9		167868.3		167309		158567.3	
AIC change from previous				5.4%		-0.3%		-5.2%	
Adjusted BIC		159400.5		167781.6		167526.8		158819.9	
BIC change from previous				5.3%		-0.2%		-5.2%	
Entropy (classification quality)		0.82		0.89		0.9		0.85	
Entropy change from previous				8.5%		1.1%		-5.6%	
Parametric bootstrapped log-likelihood ratio test				3 v. 2		4 v. 3		5 v. 4	
Luong-Vo-Mendell likelihood ratio test				0.04		p=0.3		p=0.03	
		N	%	N	%	N	%	N	%
Class membership	Class 1	1250	13.6	370	4.00%	8288	90.20%	329	3.60%
	Class 2	7937	86.4%	8418	91.60%	269	2.90%	1288	14.00%
	Class 3			399	4.30%	32	0.30%	16	0.20%
	Class 4					598	6.50%	1	0.01%
	Class 5							7533	82.20%

Legend: AIC - Akaike information criterion; BIC - Bayesian information criterion

Table 3. Associations of predictor variables with trajectory class membership in the 3 class model for BMI from 10 to 42 years

Odds ratios (OR) and 95% confidence intervals (95% CI) are shown for the multinomial regression of trajectory class on each predictor. The reference class for these analyses was the "Normative" weight gain trajectory.

	Childhood onset persistent obesity			Adolescent & young adult onset obesity		
Predictor	OR	(95% CI)	p	OR	(95% CI)	p
Birthweight (continuous) kg	0.70	(0.53, 0.91)	0.009	0.99	(0.77, 1.26)	0.9
Male sex	0.84	(0.63, 1.13)	0.2	0.36	(0.26, 0.49)	<0.0001
Maternal education of A levels or above (vs. < A levels)	0.92	(0.59, 1.42)	0.7	0.84	(0.58, 1.22)	0.4
Father's social class managerial/professional (vs. unskilled or manual)	0.76	(0.49, 1.17)	0.2	0.72	(0.53, 0.99)	0.04
Breastfed for 3 months or more (vs. <3months)	0.73	(0.44, 1.23)	0.2	1.16	(0.80, 1.69)	0.4
Maternal BMI (continuous) kg/m^2	1.10	(1.07, 1.12)	<0.0001	1.10	(1.07, 1.13)	<0.0001
Paternal BMI (continuous) kg/m^2	1.08	(1.04, 1.11)	<0.0001	1.08	(1.04, 1.13)	<0.0001
Early puberty: any signs of puberty at 10 years	2.08	(1.44, 3.00)	<0.0001	1.96	(1.47, 2.62)	<0.0001

Legend: BMI – Body mass index

Table 4. Associations of predictor variables with BMI intercept and slope within each trajectory class, estimated as part of the mixture model (n=9187).

	Intercept (baseline BMI at 10 years)			Slope (BMI change 10 to 42 years)		
	B	Se	p	B	Se	p
Childhood onset persistent obesity						p
Male sex	7.757	2.04	<0.001	-1.83	0.438	<0.001
Birthweight (continuous) kg	1.541	0.979	0.115	-0.285	0.181	0.116
Breastfed for 3 months or more (vs. <3months)	-1.05	1.004	0.296	-0.029	0.337	0.932
Early puberty: any signs of puberty at 10 years	19.138	4.203	<0.001	-4.232	1.045	<0.001
Maternal education of A levels or above (vs. < A levels)	0.868	1.07	0.417	-0.177	0.29	0.541
Father's social class managerial or professional (vs. unskilled or manual)	1.316	1.148	0.252	-0.091	0.212	0.668
Maternal BMI (continuous) kg/m^2	0.14	0.041	0.001	-0.001	0.02	0.95
Paternal BMI (continuous) kg/m^2	0.111	0.076	0.147	0.03	0.027	0.27
Adolescent/young adult onset obesity						
Male sex	-2.683	0.92	0.004	0.852	0.397	0.03
Birthweight (continuous) kg	0.169	0.356	0.635	-0.094	0.157	0.55
Breastfed for 3 months or more	0.072	0.793	0.927	0.524	0.358	0.143
Early puberty: any signs of puberty at 10 years	-1.762	0.599	0.003	0.52	0.27	0.05
Maternal education of A levels or above	-0.935	1.306	0.474	1.696	0.797	0.03
Father's social class managerial or professional	0.543	0.722	0.452	0.068	0.372	0.856
Maternal BMI (continuous) kg/m^2	0.096	0.062	0.12	-0.018	0.016	0.253
Paternal BMI (continuous) kg/m^2	0.144	0.082	0.078	0.016	0.021	0.436
Normative weight gain trajectory						
Male sex	-0.139	0.059	0.02	0.314	0.076	<0.001
Birthweight (continuous) kg	0.379	0.049	<0.001	-0.043	0.014	0.003

Breastfed for 3 months or more	0.053	0.069	0.445	-0.029	0.019	0.126
Early puberty: any signs of puberty at 10 years	0.959	0.086	<0.001	-0.017	0.02	0.396
Maternal education of A levels or above	0.03	0.062	0.627	-0.011	0.016	0.47
Father's social class managerial or professional	0.129	0.057	0.02	-0.032	0.016	0.04
Maternal BMI (continuous) kg/m^2	0.077	0.007	<0.001	0.015	0.004	<0.001
Paternal BMI (continuous) kg/m^2	0.109	0.008	<0.001	0.016	0.004	<0.001

Legend: B = coefficient; BMI – Body mass index; Se = standard error

Figure 1. BMI trajectories (95% CI) in the 3-class model and cohort mean BMI, from age 10 to 42 years

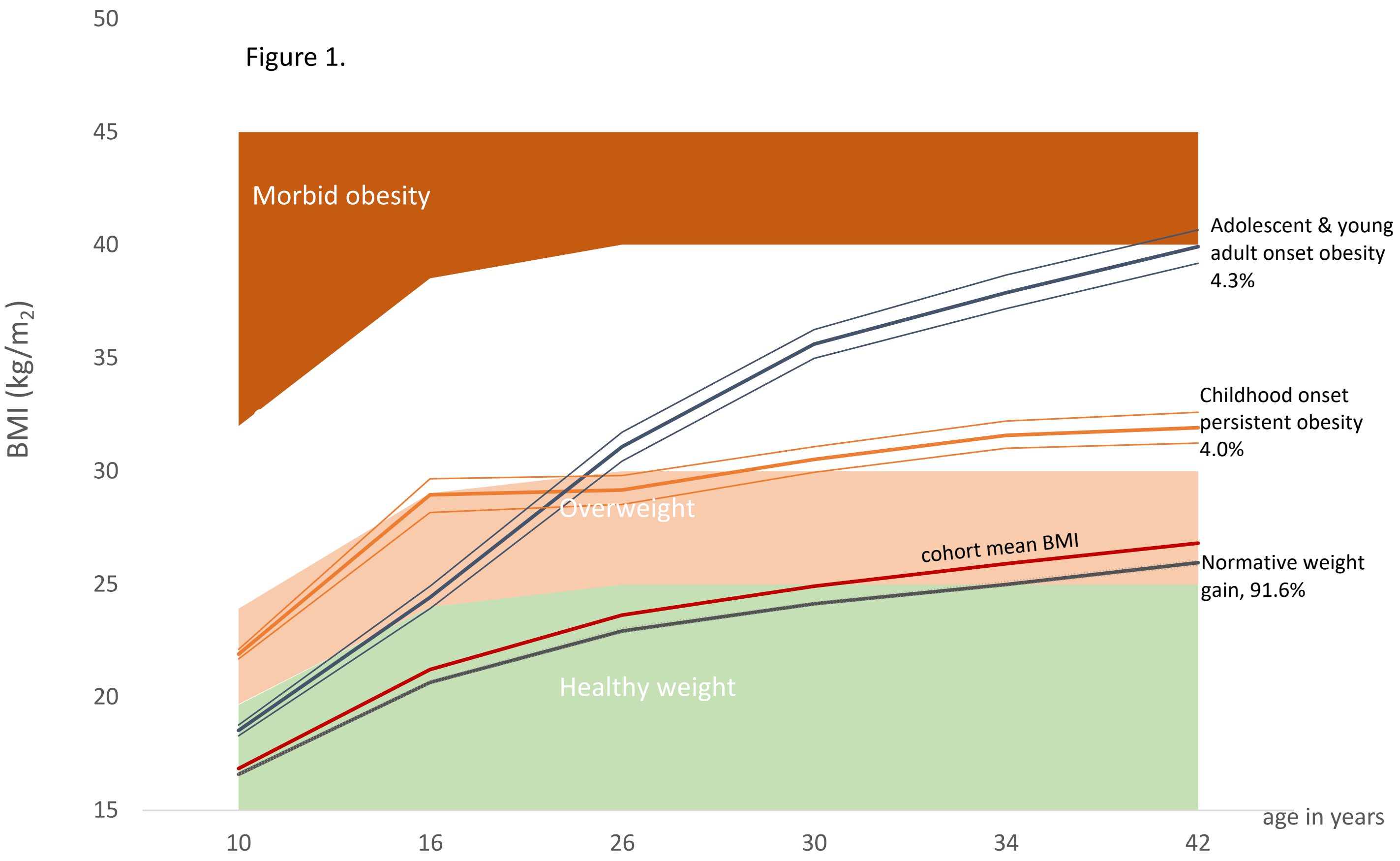

Figure shows trajectories and 95% confidence intervals (CI) for each class, with shaded areas showing healthy weight (green), overweight (orange), obese (red) and morbidly obese (dark red) BMI ranges by age. The mean BMI of the whole cohort is shown as a dotted line for reference. For defining overweight and obesity, international obesity taskforce (IOTF) thresholds by age and sex are used for 10 and 16 year olds,[19] plus a threshold for morbid obesity of >=3.5SD at these ages. Standard WHO obesity thresholds are used for adults

Appendix

Table. Average class probabilities by latent trajectory class for the 3 class model for Body Mass Index from 10 to 42 years