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published in
Obesity
2017

DOI (link to publisher)
10.1002/oby.22022

document version
Peer reviewed version

Body mass index trajectories from adolescence to early young adulthood: Do adverse life events play a role?

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Keywords: Body mass index (BMI), life events, adolescence, young adulthood, Growth Mixture Modeling (GMM)

Running title: BMI trajectories from adolescence to adulthood

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Word count: 3470

Funding: This work was supported by a grant from the Graduate School of Medical Sciences of the University Medical Center Groningen awarded to LK Elsenburg and by the multidisciplinary research programme Healthy Ageing, Population & Society (HAPS). HAPS is supported by the University of Groningen. This research is part of the TRacking Adolescents' Individual Lives Survey (TRAILS). Participating centers of TRAILS include the University Medical Center and University of Groningen, the Erasmus University Medical Center Rotterdam, the University of Utrecht, the Radboud Medical Center Nijmegen, and the Parnassia Bavo group, all in the Netherlands. TRAILS has been financially supported by various grants from the Netherlands Organization for Scientific Research NWO (Medical Research Council program grant GB-MW 940-38-011; ZonMW Brainpower grant 100-001-004; ZonMw Risk Behavior and Dependence grants 60-60600-97-118; ZonMw Culture and Health grant 261-98-710; Social Sciences Council medium-sized investment grants GB-

MaGW 480-01-006 and GB-MaGW 480-07-001; Social Sciences Council project grants GB-MaGW 452-04-314 and GB-MaGW 452-06-004; NWO large-sized investment grant 175.010.2003.005; NWO Longitudinal Survey and Panel Funding 481-08-013 and 481-11-001), the Dutch Ministry of Justice (WODC), the European Science Foundation (EuroSTRESS project FP-006), Biobanking and Biomolecular Resources Research Infrastructure BBMRI-NL (CP 32), and the participating universities.

Disclosure: The authors declared no conflict of interest.

Study importance questions:

- Classes of body mass index (BMI) trajectories in children and adolescents have been identified in previous studies, but only few studies identified classes of BMI development from early adolescence to young adulthood.
- Knowledge about classes of BMI trajectories is important in order to identify adolescents at risk at a young age and develop tailor made prevention strategies.
- No previous studies examined the relation between accumulation of adverse life events and BMI trajectories in adolescence.
- Adverse life events could be associated with BMI via behavioral and biological mechanisms.
- Using objective measures, this study identified 3 distinct classes of BMI development from early adolescence to young adulthood.
- Accumulation of adverse life events was not related to a specific BMI trajectory class.

Abstract

Objective: To investigate whether there are different classes of body mass index (BMI) development from early adolescence to young adulthood and whether these classes are related to the number of adverse life events children experienced.

Methods: Data are from the TRAILS (TRacking Adolescents' Individual Lives Survey) cohort (n=2218). Height and weight were objectively measured five times between participants' ages 10-12 and 21-23 years. Parents reported on the occurrence of adverse life events in their child's life in an interview when children were 10-12 years old. Unconditional and conditional Growth Mixture Modeling was used for statistical analysis.

Results: A 'normal weight' (75.1%), 'late onset overweight' (20.1%) and 'early onset overweight' class (4.8%) were identified. In analyses unadjusted for additional covariates, children who experienced a higher number of adverse events had higher odds to be in the 'late onset overweight' (OR (95% CI) = 1.08 (1.00-1.17)) than the 'normal weight' class, but the association was attenuated in analyses adjusted for additional covariates (OR (95% CI) = 1.07 (0.98-1.16)).

Conclusions: Three BMI trajectory classes can be distinguished from early adolescence to young adulthood. Accumulation of adverse life events is not related to BMI trajectory class.

Introduction

Children with overweight or obesity are at increased risk for diseases in adulthood, such as cardiovascular disease, diabetes type 2 and certain types of cancer[1–3]. Overweight and obesity are conditions characterized by an excess amount of body fat and are often defined by high body mass index (BMI), which is calculated by dividing weight by height squared (kg/m^2). For most diseases in adulthood, the association with childhood obesity is at least partly mediated by adulthood obesity[2]. Overweight and obesity track from childhood to adulthood, meaning that children with overweight or obesity are likely to have overweight or obesity as adults[4,5]. However, little is known about whether different trajectories of weight development from childhood to adulthood can be distinguished. Knowledge about heterogeneity in weight trajectories in childhood is important both in order to recognize unhealthy trajectories at an early stage and to diversify and tailor potential intervention strategies.

As a consequence, what differentiates children with different trajectories of BMI development also received little attention. One factor that could influence the development of BMI from childhood to adulthood is the experience of psychosocial stressors[6]. Psychosocial stressors have been defined as external events and conditions that threaten an individuals' well-being[6]. Psychosocial stressors are suggested to influence the development of BMI by having a negative impact on children's health behaviors, e.g. lowering their engagement in physical activity and healthy eating, or by causing biological changes in the body[7–9]. Adverse life events in childhood are a particular type of psychosocial stressors. Adverse life events are events such as illness or death of a family member, parental divorce and out-of-home placement. In this study, we are interested in accumulation of adverse events, as adverse events often do not occur in isolation[10–12].

Few previous studies investigated BMI trajectories from early adolescence to young adulthood and none of these looked at the relation of these trajectories with accumulation of adverse life events in childhood[13–16]. Evidence of prior, mostly cross-sectional, studies on accumulation of adverse life events and BMI, overweight or obesity in this age group is inconclusive with some identifying a relation[17–20] and others not[21,22]. In this study, we will examine (1) whether classes of children with different BMI trajectories from early adolescence until young adulthood can be distinguished using objectively measured BMI and (2) whether these classes can be differentiated based on the number of adverse life events children experienced. Data from the Netherlands will be used. Compared to other developed countries, overweight and obesity prevalence in the Netherlands is relatively low[23,24]. However, as in other developed countries, prevalence has increased substantially in the last couple of decades and overweight and obesity are considered a major health problem[23].

Methods

Data are from 2230 children participating in the TRacking Adolescents' Individual Lives Survey (TRAILS), a five-wave prospective cohort study conducted between participant's ages 10-12 years and 21-23 years[25,26]. Data collection took place between March 2001 and July 2002 (T1), September 2003 and December 2004 (T2), September 2005 and December 2007 (T3), October 2008 and September 2010 (T4) and April 2012 and November 2013 (T5). From two municipalities in the North of the Netherlands children born between 1 October 1989 and 30 September 1990 were identified and from three municipalities children born between 1 October 1990 and 30 September 1991 were identified (n=3483). Participation of the child's primary school was a prerequisite for children to be included in TRAILS. Children were further excluded when there was no parental or child consent, when they had a severe physical illness, handicap or mental retardation and when the available parent or parent surrogate could not speak Dutch, Turkish or Moroccan (n=548). Finally, 2230 children took part in the first wave of data collection (76.0% of eligible children in participating schools).

Body mass index

Trained research assistants measured weight and height of the children. Calibrated scales were used to measure weight (Seca 770, Hamburg, Germany at T1, T2 and T3 and Seca 876 and Besthome EB813-SL at T4 and T5) and stadiometers/measuring tapes to measure height (Seca 214 at T1, T2 and T3 and Seca 201/222 at T4 and T5). Children's BMI was determined by dividing their weight by the square of their height (kg/m^2).

Adverse events

Parents reported on the adverse events experienced by the child since birth in an interview at T1. An adverse events score was calculated by counting the number of reported adverse events. The same event (e.g. hospitalization of the child) was included in the sum score 3 times at maximum in case of multiple occurrences. To account for heterogeneity in the assessed events, sum scores of different types of events were also determined. These types of events were adverse health events and adverse relationship events. The adverse events assessed per type can be found in Supporting Information Table S1.

Covariates

The children's ages were recorded at every measurement occasion. The children's gender, socio-economic status (SES) and ethnicity were reported by parents at T1. As a measure of SES, the mean of the standardized scores for (1) maternal education, (2) paternal education (both divided into five categories from elementary to University education), (3) maternal occupation, (4) paternal occupation (both according to the International Standard Classification of Occupations (ISCO)[27]) and (5) household income was used[28]. Ethnic background was divided into Dutch and non-Dutch, depending on whether both parents were born in the Netherlands or not. No further distinction was made since only a small percentage of participants was non-Dutch.

Statistical analysis

The growth curve analysis proceeded in three steps. In a first step, we fitted a Latent Growth Model (LGM) to see whether the general development of BMI was best estimated by a linear or a quadratic model. This model was fit with individually-varying time points because of strong variation at every wave of data collection in the timing of BMI measurement in the different children. Children's age at every measurement occasion minus 10 years was used as individually-varying time point.

In a second step, we applied Growth Mixture Modeling (GMM) to determine the number of latent classes (trajectories) that could be distinguished. We estimated models with (1) equal variances across classes and (2) unequal variances across classes. Based on previous research, we fitted GMM with one to five classes[13–15]. At each stage model fit was evaluated. The best fitting model was stratified according to gender to see whether results for boys and girls differed.

Model fit was evaluated using the Loglikelihood, Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and Adjusted BIC values. Since the values of these four fit indices sometimes indicate better model fit even when large and unlikely numbers of classes are estimated, the entropy (a measure of classification quality), the shapes of the different trajectories and the percentage of participants per class were additionally used to determine the optimal number of classes. Models with an entropy near 1 and >1% of individuals per class were considered good[29]. With regard to the shapes of the different trajectories, when an added class had a trajectory shape very similar to a class already included in the model, the more parsimonious model was preferred[30].

In a third and final step, the relationship between adverse life events and the BMI trajectory classes identified in the second step was examined by performing a multinomial logistic regression analysis using conditional Growth Mixture Modeling. Initially, only the adverse events score was included as covariate. Subsequently, gender, SES and ethnicity were added to the model. Finally, the adverse events score was replaced by adverse health events and adverse relationship events to test whether these different types of adverse events were related to the BMI trajectory classes. MPlus version 7.3 was used for the analyses. Full Information Maximum Likelihood (FIML) was used to handle missing data.

RESULTS

The characteristics of the study sample (n=2218) are described in Table 1. From the main analyses, 12 children were excluded because they had not participated in any BMI measurement or because information on their age at measurement was missing. An additional 39 participants were excluded from the analyses involving GMM conditional on the adverse events score, gender, SES and ethnicity due to missing data on one or more of these covariates. The majority of the remaining 2179 participants was female (51%) and was of Dutch ethnicity (87%). On average, the children had experienced 2.4 adverse events.

Table 1. Descriptive statistics of the study sample.

	n	Mean (SD)	%
Gender			
Girls	1128	-	50.9
Boys	1090	-	49.1
SES[a]	2179	-0.05 (0.80)	-
Ethnicity			
Dutch	1919	-	86.5
Non-Dutch	299	-	13.5
Adverse event score	2179	2.37 (1.81)	-
0 adverse events	299	-	13.7
1 adverse event	478	-	21.9
2 adverse events	516	-	23.7
3 adverse events	393	-	18.0
≥4 adverse events	493	-	22.7

SES = socio-economic status. [a]Mean of the standardized scores for maternal education, paternal education (both divided into five categories from elementary to University education), maternal occupation, paternal occupation (both according to the International Standard Classification of Occupations (ISCO))[27] and household income[28].

Growth models

The Latent Growth Models (LGM) fitted in the first step of our analyses, indicated that a LGM with an intercept, linear slope and a quadratic slope provided the best fit to our data. In the second step, Growth Mixture Models (GMM) indicated that a GMM with four classes in which variances were allowed to vary across classes had the best model fit. However, the entropy of this solution was very low (0.639) and two of the included trajectories were very similar in shape (Supporting Information Table S2). The entropy of the second-best fitting GMM: the 3-class trajectory solution in which variances were allowed to vary across classes, was acceptable (0.749) and alxl trajectories in this model were distinct. This was therefore considered the best solution (Table 2). Performing the 3-class GMM with variances allowed to vary across classes for boys and girls separately provided similar results. The analyses were therefore performed for boys and girls combined.

The 3-class trajectory solution is characterized by an 'early onset overweight' trajectory class (n=106, 4.8%), a 'late onset overweight' trajectory class (n=447, 20.1%) and a 'normal weight' trajectory class (n=1666, 75.1%) (Table 2). The development of the three trajectories across adolescence and young adulthood is shown in Figure 1. The 'early onset overweight' trajectory class starts off being normal weight, but has a strong upward slope, resulting in early onset overweight. This trajectory crosses the obesity cut-off of the International Obesity Task Force (IOTF) at the end of adolescence after which the increase levels off[31]. The 'late onset overweight' trajectory class runs nearly parallel to the overweight cut-off in adolescence and crosses the cut-off at the beginning of young adulthood[31]. The 'normal weight' trajectory class is in the area of normal weight across the entire age span. It is characterized by a steady slow increase in BMI and a slight leveling off at older ages.

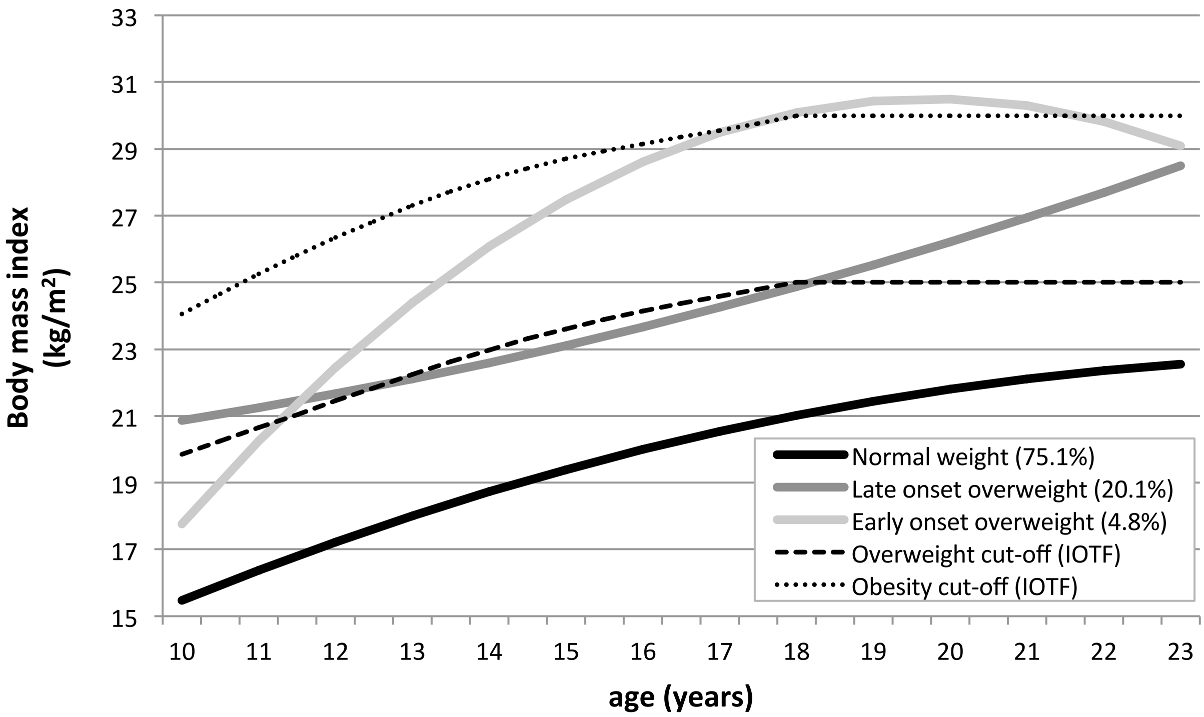

Figure 1. Estimated body mass index (BMI) trajectories of 10-23 year old participants of the TRAILS (TRacking Adolescents' Individual Lives Survey) cohort study (n=2218). Lines are plotted using the latent growth factors from Table 2. The International Obesity Task Force (IOTF) cut-offs for overweight and obesity (averaged for boys and girls) across this age span are also shown in the figure[31].

Table 2. Latent growth factor estimates for the 3-class Growth Mixture Model with growth factor variances allowed to vary across classes (n=2218).

Class	n (%) [a]	Latent growth factor	Estimate	95% CI	p-value
1	1665.6	Intercept	15.47	15.26 – 15.68	<0.01
	(75.1)	Linear slope	0.93	0.89 – 0.98	<0.01
		Quadratic slope	-0.03	-0.03 – -0.03	<0.01
2	446.5	Intercept	20.86	19.86 – 21.87	<0.01
	(20.1)	Linear slope	0.37	0.11 – 0.63	<0.01
		Quadratic slope	0.02	0.00 – 0.04	0.06
3	105.9	Intercept	17.76	16.01 – 19.52	<0.01
	(4.8)	Linear slope	2.61	1.83 – 3.40	<0.01
		Quadratic slope	-0.13	-0.18 – -0.09	<0.01

Class 1 = ‘normal weight’ trajectory class, class 2 = ‘late onset overweight’ trajectory class, class 3 = ‘early onset overweight’ trajectory class. CI = confidence interval, [a] Sample sizes are not integers, because participants can be partially assigned to one trajectory and partially to another trajectory.

Adverse life events and BMI trajectory classes

In the final step of the analysis, the association of adverse life events with the three BMI trajectories was examined. In analyses unadjusted for additional covariates (Supporting Information Table S3), a higher adverse event score was associated with higher odds of being in the ‘late onset overweight’ class compared to the ‘normal weight’ class (OR (95% CI) = 1.08 (1.00-1.17)). The confidence interval around the estimate for being in the ‘early onset overweight’ class instead of the ‘normal weight’ class was too wide to state that an effect was present (OR (95% CI) = 1.12 (0.96-1.30)). When gender, SES and ethnicity were additionally included as covariates (Table 3), the confidence intervals around both estimates included 1 (OR (95% CI) = 1.07 (0.98-1.16) and 1.08 (0.93-1.24), respectively).

In the analyses adjusted for additional covariates, boys had lower odds than girls to be in the ‘late onset overweight’ trajectory class (OR (95% CI) = 0.53 (0.36 – 0.76)) and the ‘early onset overweight’ trajectory class (OR (95% CI) = 0.47 (0.28-0.81)) than the ‘normal weight’ trajectory class. Further, the higher the SES of children, the lower the odds they were in both the ‘late onset overweight’ (OR (95% CI) = 0.52 (0.43-0.63)) and ‘early onset overweight’ (OR (95% CI) = 0.44 (0.32-0.61)) than the ‘normal weight’ class.

The adverse health events score showed similar associations with the BMI trajectory classes as the overall adverse events score (Supporting Information Table S4 & S5). The confidence intervals around the estimates of the association between the adverse relationship events score with the BMI trajectory classes included 1 in both analyses unadjusted and analyses adjusted for additional covariates (Supporting Information Table S6 & S7).

Table 3. Model fit statistics, latent growth factors, sample sizes and odds ratios for being in the ‘late onset overweight’ and ‘early onset overweight’ class in comparison to the ‘normal

weight' class of the 3-class conditional Growth Mixture Model (GMM) with variances allowed to vary across classes. The model is conditional on adverse events, gender, SES and ethnicity.

	Model information	95% CI	p-value
Sample size	2179	n/a	n/a
No. of free parameters	36	n/a	n/a
Model fit			
Loglikelihood	-18265.480	n/a	n/a
AIC	36602.960	n/a	n/a
BIC	36807.679	n/a	n/a
Adjusted BIC	36693.302	n/a	n/a
Classification accuracy			
Entropy	0.764	n/a	n/a
Class 1 'normal weight'			
Sample size (%)[a]	1667.9 (76.5)	n/a	n/a
Intercept	15.54	15.35 – 15.73	<0.01
Slope	0.92	0.87 – 0.96	<0.01
Quadratic slope	-0.03	-0.03 – -0.03	<0.01
Class 2 'late onset overweight'			
Sample size (%)[a]	386.2 (17.7)	n/a	n/a
Intercept	21.20	20.07 – 22.34	<0.01
Slope	0.31	-0.01 – 0.63	0.06
Quadratic slope	0.02	0.00 – 0.05	0.06
Adverse events score, OR[b]	1.07	0.98 – 1.16	0.14
Covariates, OR			
Gender[b, c]	0.53	0.36 – 0.76	<0.01
SES[b]	0.52	0.43 – 0.63	<0.01
Ethnicity[b, d]	0.90	0.56 – 1.45	0.67
Class 3 'early onset overweight'			
Sample size (%)[a]	125.0 (5.7)	n/a	n/a
Intercept	17.70	16.06 – 19.33	<0.01
Slope	2.50	1.71 – 3.29	<0.01
Quadratic slope	-0.13	-0.18 – -0.08	<0.01
Adverse events score, OR[b]	1.08	0.93 – 1.24	0.31
Covariates, OR			
Gender[b, c]	0.47	0.28 – 0.81	<0.01
SES[b]	0.44	0.32 – 0.61	<0.01
Ethnicity[b, d]	0.97	0.43 – 2.20	0.95

CI = confidence interval, SES = socio-economic status, GMM = Growth Mixture Model, AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, OR = odds ratio, [a] Sample sizes are not integers, because participants can be partially assigned to one trajectory and partially to another trajectory, [b] 'normal weight' trajectory class = reference category, [c] boys vs. girls (girls = reference category), [d] non-Dutch vs. Dutch (Dutch = reference category).

Discussion

In an earlier study using the same data, we showed that accumulation of adverse life events before adolescence was associated with a higher BMI in young adulthood[32]. In this study we wanted to examine whether the difference identified in young adulthood was actually set in motion earlier in life by identifying different BMI trajectories from adolescence to young adulthood and studying whether accumulation of adverse life events was related to the different BMI trajectories. This study indicated 3 distinct BMI developmental trajectories could be distinguished from early adolescence until early young adulthood. The majority of adolescents and young adults was in the 'normal weight' trajectory class, characterized by an overall normal weight from age 10-12 to age 21-23 years. About 1 in 5 adolescents and young adults was in the 'late onset overweight' trajectory class, being near the overweight cut-off during adolescence and crossing it at the beginning of young adulthood. About 1 in 20 was in the 'early onset overweight' trajectory class, crossing the overweight cut-off at the beginning of adolescence. The number of adverse events children experienced was not associated with being in a specific class of BMI development.

Comparison to previous research

In line with previous research, our study found that children who were in the upper range of normal weight at the beginning of adolescence were likely to end up with overweight or obesity in young adulthood[4,5]. We also identified a small group of children that was not at risk for overweight in early adolescence, but ended up with overweight or obesity in adolescence or young adulthood. This is in line with the finding that while children with overweight are likely to have overweight or obesity in adulthood, many adults with overweight or obesity do not yet have overweight or obesity in childhood[4,5]. A finding that could be attributed to increased autonomy of adolescents and young adults over their health behaviors, such as physical activity and healthy eating[33,34]. Additionally, we found that children with overweight or obesity in general do not become healthy weight or underweight in the course of adolescence. A previous study did identify a trajectory characterized by obesity in childhood and healthy weight in adolescence[15].

Only a limited number of studies provided detailed insight into the developmental trajectories of BMI from early adolescence until young adulthood[13–16]. Three studies using GMM found four distinct BMI trajectories and one study identified two trajectory classes[13–16]. In this last study, the identified trajectories were similar to the 'normal weight' and the 'early onset overweight' trajectory identified in the current study[16]. In one of the other studies, that constrained the variances across classes to be equal, four parallel trajectories were identified[13]. The studies identifying four non-parallel trajectories had solutions resembling the findings of the current study[14,15].

Accumulation of adverse events was not associated with BMI trajectory class in this study. This is surprising as associations between accumulation of adverse events and BMI or overweight and obesity were identified in previous studies in adolescents[17–20]. Further, exposure to domestic violence in boys has been related to increased odds of being in an unhealthy BMI trajectory instead of in a healthy BMI trajectory[14]. There are several possible explanations for the fact that we did not observe a relation, while previous studies did. Firstly, differences between the studies could result in different associations. Previous studies were often cross-sectional, using a single BMI or overweight and obesity measurement instead of repeated BMI measurements[17–19]. Therefore, in the current study reverse causality is better controlled for than in the previous studies. Further, the associations in the Netherlands could be different from the associations in countries such as the United States and Canada, where previous studies were performed. The Netherlands has a relatively good healthcare and social support system and this could result in weaker associations between adverse events and health as people are more likely to seek and receive help when they encounter adverse life events or when their health deteriorates. Additionally, our adverse event measure did not include events regarding the experience of witnessing violence at home or in the neighborhood, the experience of bullying or the experience of abuse, whereas adverse events measures in previous studies did[17–20]. Secondly, the relationship between accumulation of adverse events and BMI might be moderated by the way in which adolescents cope with adverse events[35]. Some adolescents might cope well with adversity in life, while others cope with adversity by displaying unhealthy behaviors, such as unhealthy or restrained eating[36]. In part of the adolescent population there will then be a relationship between accumulation of adverse events and BMI trajectories, but this will not be detected in the overall population. Finally, if particularly adolescents in the higher weight groups respond to adversity by increasing their food intake, while adolescents in lower weight groups tend to respond to adversity by decreasing their food intake, no relationship between accumulation of adverse events and BMI trajectory class will be identified.

Strengths and limitations

A major strength of this study is that we used objectively measured BMI to estimate BMI trajectories from early adolescence to young adulthood, an important developmental period in life[33]. Only a limited number of studies estimated BMI trajectories in this age group using objective BMI measurements. In addition, few studies estimated BMI trajectories in European adolescents. Objectively measured BMI is a strength, because the identified BMI trajectories are more likely to represent true BMI trajectories from adolescence to young adulthood. Further, when BMI is subjectively reported and participants with a higher BMI are more likely to report a lower weight or a higher height, associations between adverse events and BMI could be attenuated. Another strength of this study is that variances were allowed to vary across classes. We showed that model fit improved considerably when variances across BMI trajectory classes were allowed to vary. Studies that fixed the variances across trajectories might thus have identified an oversimplified pattern of BMI development trajectories in adolescents.

A limitation of this study is that the exposure measure contained a large number of heterogeneous events that might not all have equal impact on children. To preempt this limitation, we distinguished different types of events that are expected to have a similar impact, i.e. health and relationship events, and tested whether these different types of events were related to the BMI trajectory classes. Although the size of the impact of the different events in these subgroups may still be different, we decided not to rate the severity of the events, as the same event can have a very different impact on different children. A second limitation is that the assessment of events relied on parent-reported events that occurred in the past as this could lead to both reporting and recall bias. However, we believe that the use of an interview rather than a questionnaire, covering a limited time span of approximately 10 years, minimizes the risk of bias. A final limitation is possible lack of generalizability of our results. About 2,5% of the participants had obesity and about 12% had overweight at the beginning of the study. This is in line with overweight and obesity prevalence in the Netherlands in this age group[23]. Therefore, the BMI trajectories identified in this study are expected to be generalizable to the Netherlands as well as to other countries with similar prevalence rates. Results regarding the association of adverse events with the trajectories might, however, not be generalizable to other countries. As stated earlier, associations between adverse events and health could be weaker in the Netherlands as the Netherlands has a relatively good healthcare and social support system.

Conclusion

Different developmental trajectories of BMI from early adolescence to young adulthood were distinguished in this study. A large majority of children had a healthy weight during adolescence and early young adulthood. However, about 1 in 5 children was at risk for overweight during adolescence and entered young adulthood with overweight. A small proportion of children experienced rapid increases in BMI during adolescence, with some even going from having a healthy weight in early adolescence to having obesity in early young adulthood. Children in general did not become healthy weight or underweight in the course of adolescence after having had overweight or obesity in childhood. Interventions to prevent tracking of overweight and obesity into young adulthood can therefore best be targeted at all children showing signs of overweight in early and late adolescence. A lower SES characterized children at risk for overweight and obesity in adolescence and young adulthood. Children at risk for overweight and obesity in adolescence and young adulthood did not experience a different number of adverse events in childhood.

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Supporting Information

Table S1. List of adverse events assessed per event type (health and relationship)

Health	**Relationship**
Hospitalization participant	Divorce parents
Illness mother	Divorce non-biological parents
Mental illness mother	Moved in with family
Illness father	Moved in with foster family
Mental illness father	Moved into a children's home
Illness sibling	Moved into a youth facility
Illness friend	Other out-of-home placement
Death mother	
Death father	
Death non-biological mother	
Death non-biological father	
Death sibling	
Death other family member	
Death grandparent	
Death friend	
Death other loved one	

Table S2. Model (fit) information of the various tested Growth Mixture Models (GMM)[a].

	1-class GMM	**2-class GMM equal variances**	**2-class GMM unequal variances**	**3-class GMM equal variances**	**3-class GMM unequal variances**	**4-class GMM equal variances**	**4-class GMM unequal variances**
No. of free parameters	14	18	21	22	28	26	35
Model fit							
Loglikelihood	-19204.296	-18936.823	-18690.476	-18801.105	-18591.324	-18706.330	-18522.967
AIC	38436.593	37909.647	37422.951	37646.210	37238.649	37464.661	37115.935
BIC	38516.454	38012.325	37542.743	37771.706	37398.371	37612.974	37315.588
Adjusted BIC	38471.974	37955.137	37476.023	37701.809	37309.410	37530.368	37204.387
Classification accuracy							
Entropy	n/a	0.934	0.649	0.911	0.749	0.894	0.639
Sample size							
Class 1	2218.000	136.802	1676.784	131.136	105.884	121.957	94.523
Class 2	n/a	2081.198	541.216	119.799	446.492	215.577	777.597
Class 3	n/a	n/a	n/a	1976.065	1665.624	35.108	166.684
Class 4	n/a	n/a	n/a	n/a	n/a	1845.358	1179.197

AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, GMM = Growth Mixture Model, n/a = not applicable, [a]No model fit information of the five-class models is given, as they were not identified.

Table S3. Model fit statistics, latent growth factors, sample sizes and odds ratios for being in the 'late onset overweight' and 'early onset overweight' class in comparison to the 'normal weight' class of the 3-class conditional Growth Mixture Model (GMM) with variances allowed to vary across classes. The model is conditional on adverse events.

	Model information	95% CI	p-value
Sample size	2179	n/a	n/a
No. of free parameters	30	n/a	n/a
Model fit			
Loglikelihood	-18313.172	n/a	n/a
AIC	36686.343	n/a	n/a
BIC	36856.942	n/a	n/a
Adjusted BIC	36761.628	n/a	n/a
Classification accuracy			
Entropy	0.753	n/a	n/a
Class 1 'normal weight'			
Sample size (%)[a]	1644.8 (75.5)	n/a	n/a
Intercept	15.48	15.27 – 15.69	<0.01
Slope	0.93	0.89 – 0.98	<0.01
Quadratic slope	-0.03	-0.03 – -0.03	<0.01
Class 2 'late onset overweight'			
Sample size (%)[a]	429.9 (19.7)	n/a	n/a
Intercept	20.95	19.92 – 21.98	<0.01
Slope	0.35	0.09 – 0.61	<0.01
Quadratic slope	0.02	0.00 – 0.04	0.06
Adverse events score, OR[b]	1.08	1.00 – 1.17	0.04
Class 3 'early onset overweight'			
Sample size (%)[a]	104.3 (4.8)	n/a	n/a
Intercept	17.70	15.88 – 19.51	<0.01
Slope	2.63	1.85 – 3.41	<0.01
Quadratic slope	-0.14	-0.18 – -0.09	<0.01
Adverse events score, OR[b]	1.12	0.96 – 1.30	0.16

CI = confidence interval, SES = socio-economic status, GMM = Growth Mixture Model, AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, OR = odds ratio, [a] Sample sizes aren't integers, because participants can be partially assigned to one trajectory and partially to another trajectory, [b] 'normal weight' trajectory class = reference category.

Table S4. Model fit statistics, latent growth factors, sample sizes and odds ratios for being in the 'late onset overweight' and 'early onset overweight' class in comparison to the 'normal weight' class of the 3-class conditional Growth Mixture Model (GMM) with variances allowed to vary across classes. The model is conditional on adverse health events.

	Model information	95% CI	p-value
Sample size	2179	n/a	n/a
No. of free parameters	30	n/a	n/a
Model fit			
Loglikelihood	-18313.800	n/a	n/a
AIC	36687.599	n/a	n/a
BIC	36858.198	n/a	n/a
Adjusted BIC	36762.884	n/a	n/a
Classification accuracy			
Entropy	0.753	n/a	n/a
Class 1 'normal weight'			
Sample size (%)[a]	1643.9 (75.4)	n/a	n/a
Intercept	15.48	15.27 – 15.69	<0.01
Slope	0.93	0.89 – 0.98	<0.01
Quadratic slope	-0.03	-0.03 – -0.03	<0.01
Class 2 'late onset overweight'			
Sample size (%)[a]	430.7 (19.8)	n/a	n/a
Intercept	20.94	19.91 – 21.97	<0.01
Slope	0.35	0.10 – 0.61	<0.01
Quadratic slope	0.02	0.00 – 0.04	0.06
Adverse health events score, OR[b]	1.08	1.00 – 1.18	0.06
Class 3 'early onset overweight'			
Sample size (%)[a]	104.4 (4.8)	n/a	n/a
Intercept	17.70	15.90 – 19.50	<0.01
Slope	2.63	1.84 – 3.41	<0.01
Quadratic slope	-0.14	-0.18 – -0.09	<0.01
Adverse health events score, OR[b]	1.10	0.94 – 1.30	0.24

CI = confidence interval, SES = socio-economic status, GMM = Growth Mixture Model, AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, OR = odds ratio, [a] Sample sizes aren't integers, because participants can be partially assigned to one trajectory and partially to another trajectory, [b] 'normal weight' trajectory class = reference category.

Table S5. Model fit statistics, latent growth factors, sample sizes and odds ratios for being in the 'late onset overweight' and 'early onset overweight' class in comparison to the 'normal weight' class of the 3-class conditional Growth Mixture Model (GMM) with variances allowed to vary across classes. The model is conditional on adverse health events, gender, SES and ethnicity.

	Model information	95% CI	p-value
Sample size	2179	n/a	n/a
No. of free parameters	36	n/a	n/a
Model fit			
Loglikelihood	-18264.699	n/a	n/a
AIC	36601.398	n/a	n/a
BIC	36806.117	n/a	n/a
Adjusted BIC	36691.740	n/a	n/a
Classification accuracy			
Entropy	0.764	n/a	n/a
Class 1 'normal weight'			
Sample size (%)[a]	1667.9 (76.5)	n/a	n/a
Intercept	15.54	15.35 – 15.74	<0.01
Slope	0.92	0.87 – 0.96	<0.01
Quadratic slope	-0.03	-0.03 – -0.03	<0.01
Class 2 'late onset overweight'			
Sample size (%)[a]	385.3 (17.7)	n/a	n/a
Intercept	21.20	20.07 – 22.34	<0.01
Slope	0.31	-0.02 – 0.63	0.06
Quadratic slope	0.02	0.00 – 0.05	0.06
Adverse health events score, OR[b]	1.09	0.99 – 1.19	0.07
Covariates, OR			
Gender[b, c]	0.52	0.36 – 0.76	<0.01
SES[b]	0.52	0.42 – 0.63	<0.01
Ethnicity[b, d]	0.90	0.56 – 1.45	0.67
Class 3 'early onset overweight'			
Sample size (%)[a]	125.8 (5.8)	n/a	n/a
Intercept	17.70	16.09 – 19.31	<0.01
Slope	2.49	1.70 – 3.29	<0.01
Quadratic slope	-0.13	-0.18 – -0.08	<0.01
Adverse health events score, OR[b]	1.09	0.94 – 1.26	0.26
Covariates, OR			
Gender[b, c]	0.47	0.28 – 0.81	<0.01
SES[b]	0.43	0.31 – 0.60	<0.01
Ethnicity[b, d]	0.98	0.43 – 2.21	0.96

CI = confidence interval, SES = socio-economic status, GMM = Growth Mixture Model, AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, OR = odds ratio, [a] Sample sizes aren't integers, because participants can be partially assigned to one trajectory and partially to another trajectory, [b] 'normal weight' trajectory class = reference category, [c] boys vs. girls (girls = reference category), [d] non-Dutch vs. Dutch (Dutch = reference category).

Table S6. Model fit statistics, latent growth factors, sample sizes and odds ratios for being in the 'late onset overweight' and 'early onset overweight' class in comparison to the 'normal weight' class of the 3-class conditional Growth Mixture Model (GMM) with variances allowed to vary across classes. The model is conditional on adverse relationship events.

	Model information	95% CI	p-value
Sample size	2179	n/a	n/a
No. of free parameters	30	n/a	n/a
Model fit			
Loglikelihood	-18315.713	n/a	n/a
AIC	36691.427	n/a	n/a
BIC	36862.025	n/a	n/a
Adjusted BIC	36766.711	n/a	n/a
Classification accuracy			
Entropy	0.753	n/a	n/a
Class 1 'normal weight'			
Sample size (%)[a]	1645.3 (75.5)	n/a	n/a
Intercept	15.48	15.27 – 15.70	<0.01
Slope	0.93	0.89 – 0.98	<0.01
Quadratic slope	-0.03	-0.03 – -0.03	<0.01
Class 2 'late onset overweight'			
Sample size (%)[a]	427.5 (19.6)	n/a	n/a
Intercept	20.97	19.92 – 22.02	<0.01
Slope	0.35	0.09 – 0.60	<0.01
Quadratic slope	0.02	0.00 – 0.04	0.05
Adverse relationship events score, OR[b]	1.11	0.87 – 1.42	0.42
Class 3 'early onset overweight'			
Sample size (%)[a]	106.2 (4.9)	n/a	n/a
Intercept	17.72	16.07 – 19.36	<0.01
Slope	2.62	1.87 – 3.36	<0.01
Quadratic slope	-0.14	-0.18 – -0.09	<0.01
Adverse relationship events score, OR[b]	1.29	0.88 – 1.89	0.19

CI = confidence interval, SES = socio-economic status, GMM = Growth Mixture Model, AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, OR = odds ratio, [a] Sample sizes aren't integers, because participants can be partially assigned to one trajectory and partially to another trajectory, [b] 'normal weight' trajectory class = reference category.

Table S7. Model fit statistics, latent growth factors, sample sizes and odds ratios for being in the 'late onset overweight' and 'early onset overweight' class in comparison to the 'normal weight' class of the 3-class conditional Growth Mixture Model (GMM) with variances allowed to vary across classes. The model is conditional on adverse relationship events, gender, SES and ethnicity.

	Model infomation	95% CI	p-value
Sample size	2179	n/a	n/a
No. of free parameters	36	n/a	n/a
Model fit			
Loglikelihood	-18266.703	n/a	n/a
AIC	36605.405	n/a	n/a
BIC	36810.123	n/a	n/a
Adjusted BIC	36695.747	n/a	n/a
Classification accuracy			
Entropy	0.763	n/a	n/a
Class 1 'normal weight'			
Sample size (%)[a]	1665.2 (76.4)	n/a	n/a
Intercept	15.54	15.34 – 15.73	<0.01
Slope	0.92	0.87 – 0.96	<0.01
Quadratic slope	-0.03	-0.03 – -0.03	<0.01
Class 2 'late onset overweight'			
Sample size (%)[a]	387.8 (17.8)	n/a	n/a
Intercept	21.20	20.05 – 22.35	<0.01
Slope	0.31	-0.01 – 0.62	0.06
Quadratic slope	0.02	0.00 – 0.04	0.06
Adverse relationship events score, OR[b]	0.86	0.64 – 1.14	0.29
Covariates, OR			
Gender[b, c]	0.54	0.37 – 0.77	<0.01
SES[b]	0.50	0.41 – 0.62	<0.01
Ethnicity[b, d]	0.91	0.57 – 1.44	0.68
Class 3 'early onset overweight'			
Sample size (%)[a]	126.0 (5.8)	n/a	n/a
Intercept	17.69	16.15 – 19.24	<0.01
Slope	2.49	1.72 – 3.27	<0.01
Quadratic slope	-0.13	-0.18 – -0.08	<0.01
Adverse relationship events score, OR[b]	0.98	0.63 – 1.51	0.92
Covariates, OR			
Gender[b, c]	0.48	0.28 – 0.82	<0.01
SES[b]	0.43	0.30 – 0.61	<0.01
Ethnicity[b, d]	0.97	0.44 – 2.14	0.94

CI = confidence interval, SES = socio-economic status, GMM = Growth Mixture Model, AIC = Akaike Information Criterion, BIC = Bayesian Information Criterion, OR = odds ratio, [a] Sample sizes aren't integers, because participants can be partially assigned to one trajectory and partially to another trajectory, [b] 'normal weight' trajectory class = reference category, [c] boys vs. girls (girls = reference category), [d] non-Dutch vs. Dutch (Dutch = reference category).