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ABSTRACT

Introduction: Obesity is associated with chronic pain, but the contribution of body mass index (BMI) trajectories over the life course to the onset of pain problems remains unclear. We retrospectively analyzed how BMI trajectories during the transition to adulthood were associated with a measure of pain interference obtained at age 29 in a longitudinal birth cohort study.

Methods: Data from the National Longitudinal Survey of Youth, 1997 Cohort (follow-up from 1997 to 2015) were used to determine BMI trajectories from age 14 to 29 via group trajectory modeling. At age 29, respondents described whether pain interfered with their work inside and outside the home over the past 4 weeks (not at all, a little, or a lot). Multivariable ordinal logistic regression was used to evaluate pain interference according to BMI trajectory and study covariates.

Results: Among 7,875 respondents, 11% reported “a little” and 4% reported “a lot” of pain interference at age 29. Four BMI trajectory group were identified, varying in starting BMI and rate of weight gain. The “obese” group (8% of respondents) had a starting BMI of 30 kg/m^2, and gained an average of 0.7 kg/m^2/year. On multivariable analysis, this group was most likely to have greater pain interference, compared to “high normal weight” (OR=1.47; 95% CI: 1.15, 1.89), “low normal weight” (OR=1.44; 95% CI: 1.12, 1.85), and “overweight” trajectories (OR=1.33; 95% CI: 1.02, 1.73).

Conclusions: Obesity and rapid weight gain during the transition to adulthood were associated with higher risk of pain interference among young adults.

INTRODUCTION

Pain is increasingly recognized as a common health problem in adolescents and young adults.[1-3] In cross-sectional studies, obesity has been found to be a common comorbidity of chronic pain, and this association has been ascribed to several mechanisms by which obesity may influence the development of pain problems.[4-7] First, excess weight may contribute to the development of musculoskeletal pain, including back pain, joint pain, and chronic regional pain.[8-10] Chronic systemic inflammation due to obesity may also contribute to new and sustained chronic pain, including both musculoskeletal pain and pain at other sites, such as chronic migraine.[10-12] These physiological mechanisms may also be intertwined with the experience of weight stigma,[13] which can contribute to mental health comorbidities known to increase the likelihood of developing chronic pain. While these explanations offer multiple reasons for the observation that pain and obesity tend to co-occur, they also point to a need for understanding how trajectories of weight gain (or maintenance of excess weight) culminate in an elevated risk or severity of pain problems.

Most evidence on the co-occurrence of obesity and pain has focused on middle-aged and older adults.[4,5] In light of the increasing prevalence of pediatric obesity,[14] it is especially important to understand how early-life trajectories of weight gain may contribute to pain problems emerging in late adolescence and young adulthood. Some existing data suggest that higher body mass index (BMI) at age 7 is correlated with persistent back pain in adulthood,[15] and that higher BMI at age 20 predicts knee pain in later life.[9] However, these studies were limited by a lack of repeated BMI measures that could differentiate between trajectories of weight change. We hypothesized that trajectories involving more rapid weight gain during the transition to adulthood would be associated with increased risk of pain problems in young adulthood. Focusing on a measure of pain interference with school or work participation, we tested this hypothesis using available data from a longitudinal birth cohort study in the United States (US).

METHODS

This study was deemed exempt from review by the Institutional Review Board at Nationwide Children's Hospital. We used publicly available, de-identified data from the National Longitudinal Survey of Youth, 1997 cohort (NLSY97).[16] This survey, sponsored by the Bureau of Labor Statistics of the US Department of Labor, enrolled a nationally representative sample of nearly 9,000 adolescents ages 12-16 years as of December 31, 1996.[17] Participants were followed up annually from 1997 through 2011, and biennially through 2015. Interviews were conducted primarily in-person, although telephone interviews were conducted when in-person interviewing was not feasible. In the 2015 round, the total retention rate was 79% of the original sample, and 73% of completed interviews were conducted in-person.[16] Data from this survey have been previously used to characterize determinants of weight gain and obesity in adolescence and young adulthood.[18,19] We included all available data for each respondent until they reached age 29, when the outcome measure of pain interference was assessed (as part of a broader set of questions about health at age 29). We excluded respondents missing data on the outcome measure, and missing data on study covariates.

The outcome in this analysis was a one-item pain interference scale, administered after each respondent turned 29 years old. Respondents were asked the question, "During the past 4 weeks, how much did pain interfere with your normal work (including both work outside of the home and housework)?" Response options were originally coded as (1) a lot, (2) a little, or (3) not at all. We reverse-coded this scale so that higher-numbered responses indicated greater pain interference. BMI data in the NLSY97 were based on self-reported height and weight in each interview.[19] For each year, we calculated BMI (kg/m^2) using the current weight and the current or most recently reported height. BMI data were excluded if collected after age 29 or while the respondent was pregnant, and values <15 kg/m^2 or >50 kg/m^2 were excluded as biologically implausible. Following prior studies, BMI trajectories were analyzed using group-based developmental trajectory modeling.[20,21] The Bayesian Information Criterion was used to identify the trajectory shape that best fit the data and the optimal number of trajectories, under the constraint that each trajectory represent at least 5% of respondents. Based on previous studies using this approach, we considered groupings of 2-6 trajectories and linear, quadratic, or cubic trajectory shapes.[21-25] Models used all available BMI data up to age 29 to predict respondents' likelihood of being in each trajectory group. Respondents were assigned to their most likely trajectory group based on the best fitting model, and the average posterior probability (APP) of group membership was used as a measure of internal validity, with values closer to 1 meaning that members of each group were similar to one another and not to members of other groups.

Pain interference outcomes and respondent characteristics were compared among BMI trajectory groups in descriptive analysis. Further analysis included multivariable ordinal logistic regression, where odds ratios (ORs) indicated the association between each covariate and the likelihood of experiencing greater pain interference at age 29. Apart from BMI trajectory, we controlled for birth year, gender, race/ethnicity, highest degree completed by age 29, marital status and number of biological children, and current health insurance coverage. We also controlled for early-life characteristics, which may have influenced the trajectory of BMI and health behaviors throughout adolescence and young adulthood.[26] These characteristics included mother's educational attainment, whether the respondent lived with both biological parents at the time of the 1997 interview, and whether the respondent had early-life health problems, as reported by a parent at the 1997 interview ("any physical, emotional, or mental condition that has limited [the child's] ability to attend school regularly, do regular school work, or work at a job for pay?").

Because the pain interference outcome was not assessed until age 29, we considered whether its association with weight trajectory was mediated by development of physical or mental health problems earlier in the life course. First, we added a control variable for whether a respondent had experienced any health-related limitations on the type of work or amount of work they could do. This measure included data collected from 2007 until the interview before each respondent turned 29. Second, we controlled for a recent history of mental health problems as of age 29. This was measured using 2 questions asking whether, in the past 12 months, an "emotional, mental, or psychiatric problem" led the respondent to seek treatment by a mental health professional, or miss at least 1 full day of usual activities. We fit the regression model with and without these additional controls to understand how development of health-related work limitations and mental health problems may have explained the association between BMI trajectory and pain interference. Following other recent analysis of NLSY97, we adjusted the standard errors in the regression model for the clustering of respondents (siblings) within households.[27] Stata/IC 14.2 was used for data analysis (College Station, TX: StataCorp, LP), and two-tailed $P<0.05$ was considered statistically significant.

RESULTS

The original survey enrolled 8,984 respondents in 1997, of whom 7,875 ultimately contributed data on the outcome variable in our study. We included all 7,875 respondents in BMI trajectory analysis and bivariate analysis, whereas our multivariable analysis included 6,999 respondents who had complete data on covariates. At age 29, 85.1% of respondents reported no pain interference with their activities, 10.9% reported some pain interference, and 4.0% reported a lot of pain interference. Our analysis of BMI trajectories found that 4 groups of cubic trajectories best fit the data, while preserving >5% of the sample in each group. Although all trajectories implied weight gain from age 14 to 29, initial BMI and the rate of weight gain varied (**Figure 1**). In the largest trajectory group (36.2% of respondents), BMI at age 14 was estimated to be 21.4 kg/m^2 and the average rate of weight gain up to age 29 was 0.4 $kg/m^2/yr$. In the second-largest trajectory group (35.8% of respondents), initial BMI was 19.1 kg/m^2 and the rate of weight gain averaged 0.2 $kg/m^2/year$. In the third trajectory group (20.0% of respondents), initial BMI was 24.9 kg/m^2 and the rate of weight gain averaged 0.6 $kg/m^2/year$. In the fourth trajectory group (7.9% of respondents), initial BMI was 30.3 kg/m2, and average weight gain was 0.7 $kg/m^2/year$. APPs in the 4 groups were 0.95, 0.96, 0.97, and 0.99, respectively, indicating very good internal validity of assigning respondents to these trajectories. In describing our further results, we refer to the 4 trajectories as "high normal weight," "low normal weight," "overweight," and "obese," respectively.

The characteristics of the study sample are compared by BMI trajectory in **Table 1**. Among respondents on the high normal weight trajectory, 87.0% had no pain interference at age 29, 9.2% had some pain interference, and 3.8% had significant pain interference. Among respondents on the obese trajectory, the corresponding percentages were 78.1%, 16.8%, and 5.2%, respectively. On multivariable analysis (**Table 2**), after adjusting for demographic characteristics, socioeconomic status, and early-life characteristics, the trajectory of obesity and rapid weight gain was associated with 63% higher odds of greater pain interference, as compared to the high normal weight trajectory (OR=1.63; 95% CI: 1.28, 2.07; p<0.001). Although the odds of greater pain interference were also elevated in the overweight trajectory, this difference did not reach statistical significance (OR=1.19; 95% CI: 0.99, 1.44; p=0.070). Respondents in the obese group also had greater pain interference compared to those in the low normal group (OR = 1.55; 95% CI: 1.22, 1.98; p<0.001) and compared to those in the overweight group (OR=1.36; 95% CI: 1.06, 1.76; p=0.017). When adding controls for health-related work limitation and recent history of mental health problems (**Table 3**), the greater risk of pain interference in the obese group remained both statistically and substantively significant when compared to the high normal (OR=1.47; 95% CI: 1.15, 1.89; p=0.002), low normal (OR=1.44; 95% CI: 1.12, 1.85; p=0.004), and overweight (OR=1.33; 95% CI: 1.02, 1.73; p=0.036) trajectories.

Based on the final model in **Table 3**, several additional characteristics associated with the pain interference outcome. Considering respondents' demographic characteristics, women were more likely to report pain interference than men, and non-Hispanic White respondents were more likely to report pain interference than Black or Hispanic respondents. Measures of socioeconomic status had conflicting associations with the outcome of pain interference; lower pain interference was seen among respondents who completed a college or graduate degree, but also among respondents who lacked health insurance coverage as of age 29. Considering early-life characteristics, respondents who grew up with both biological parents had lower pain interference, but pain interference at age 29 was not associated with mother's educational attainment or parent-reported presence of physical or mental health problems during adolescence. As expected, work-related health limitations and a recent history of mental health problems were positively and strongly associated with experiencing pain interference at age 29.

DISCUSSION

Cross-sectional associations between obesity and chronic pain have been reported in a variety of populations,[4-8] including several studies specifically identifying obesity as a risk factor for persistent pain during childhood.[28-31] Although a few studies have suggested that obesity in childhood or early adulthood can predispose people to pain in later life,[9,15] longitudinal evidence supporting this hypothesis has remained limited. As weight can change rapidly during the transition to adulthood, we sought to determine whether trajectories of weight gain at this developmental stage were associated with a measure of pain interference at age 29. Using data from a nationally representative longitudinal birth cohort study, we found that the highest level of pain interference at age 29 was found among respondents who gained weight rapidly during the transition from adolescence to adulthood, at a rate averaging 0.7 kg/m^2/year. These data provide evidence that the pace of weight gain, and not only BMI at a single point in time, should be considered when evaluating the risk for persistent or recurrent pain among obese adolescents and young adults.

The relationship between obesity and pain is complex, and entails multiple biological and psychosocial pathways.[6] These pathways may include increased mechanical loading, chronic inflammation, dysregulation of gut microbiota, sleep disturbance, depression, and other mental health or behavioral problems.[6,7] Health behaviors (e.g., sedentary lifestyle) and socioeconomic disadvantage can further contribute to the risks of weight gain and pain persistence, complicating the task of distinguishing how BMI affects pain independently of other risk factors. Importantly, the contribution of obesity to the risk of chronic pain may be mediated through the onset of specific conditions associated with pain, such as arthritis. In our analysis, we found that the association between rapid weight gain and subsequent risk of pain interference with usual activities was not explained by controlling for other health problems limiting respondents' ability to work, or controlling for respondents' recent history of mental health problems. This result suggests that in young adults, obesity, and, in particular, rapid weight gain during the transition to adulthood, could specifically influence the risk of recurrent or persistent pain, beyond any generalized association of obesity with physical or mental health problems. Further research incorporating longitudinal measures of both BMI and pain characteristics could elucidate the most relevant mechanisms explaining the association between excess weight gain and pain persistence or recurrence at this stage of the life course.

Among adolescents, Deere et al. have reported that obesity increased not only the likelihood of musculoskeletal pain, but also the severity of pain symptoms.[12] The independent effect of obesity was substantiated in an adjusted analysis of a community-based twin registry (mean age = 31 years), where overweight and obesity increased the risk of abdominal pain, back pain, headache, fibromyalgia, and chronic widespread pain.[32] These previous findings have prompted the recommendation that treatment of obesity be integrated with the treatment of chronic pain.[6] While gradual weight loss may improve pain symptoms for older patients with obesity,[33] the normative trajectory of slow weight gain in our cohort (e.g., averaging 0.4 kg/m^2/year among respondents in the largest trajectory group) suggests that weight maintenance—rather than weight loss—could be an appropriate goal for obese adolescents and young adults presenting for treatment of chronic pain. Wilson et al. have previously described possible interventions for weight management among adolescents treated at a multidisciplinary pain clinic, including counseling about nutrition and encouraging greater physical activity.[34] Some interventions, such as increasing physical activity, might improve short-term outcomes among adolescents with chronic pain,[35] as well as potentially reduce the risk of future recurrent or persistent pain, through controlling the rate of weight gain.

Apart from trajectories of weight gain, our analysis identified several characteristics associated with pain interference at age 29. There were notable racial/ethnic and gender differences in the likelihood of pain interference, with women and non-Hispanic Whites being most likely to report greater pain interference at this age. Similarly to a recent study of pain interference in adults, we found that greater educational attainment was associated with reduced risk.[5] However, comparing our study to research on pain in children in adolescents, we found that early-life characteristics had limited associations with pain interference at age 29. Studies in pediatric samples have suggested that low socioeconomic status, poor childhood health, and negative life events, such as experiencing parents' divorce, were associated with the presence of pain complaints such as headache and musculoskeletal pain.[28,29] A recent cohort study examining long-term profiles of back pain in adulthood found mixed evidence for the influence of childhood factors, noting that abdominal pain, conduct problems, and parental divorce—but not early-life serious illness, emotional problems, or mother's education—were associated with greater odds of persistent back pain in later life.[15] Similarly, we found that family structure in adolescence, but not maternal education or parent-rated adolescent health status, was associated with pain interference among young adults included in our sample. These results suggest that select health and family characteristics during childhood may influence the long-term risk or persistence of pain. While our study and the previous cohort study by Muthuri et al. included general measures of childhood health,[15] future research may also consider whether specific chronic diseases or medications used during childhood can predispose people to both weight gain and development of pain problems.

Although our analysis adds new evidence on the association between weight gain trajectories and pain in young adulthood, our conclusions are subject to several limitations of the data and analytic approach. First, due to the limitations of NLSY97 data collection, we analyzed a single measure of pain that asked about interference with activities over a 4 week period. This measure of pain interference may not be comparable to measures explicitly designed to capture chronic pain persisting or recurring over at least 3 months. Although we controlled for early-life health status as well as physical and mental health problems emerging during young adulthood, we could not specifically measure longitudinal change in pain severity or symptoms using these data. As with many prior cohort studies on BMI trajectories, our results may have been limited by the use of self-reported height and weight data. Particularly, under-reporting of weight may have led us to underestimate the rate of weight gain in the obese group, or the number of respondents who should have been assigned to this group. Conversely, our use of group-based trajectory modeling allowed us to flexibly determine the best categorization of BMI trajectories, taking advantage of multiple data points obtained during adolescence and the transition to adulthood. Nevertheless, the reasons for rapid weight gain during adolescence are multifactorial, and in an observational study, confounding of the association between rapid weight gain and pain interference cannot be entirely ruled out.

In sum, our study adds novel evidence about the role of weight gain trajectories in the association between obesity and pain. We demonstrate that adolescents who experience the fastest gain in BMI during the transition to adulthood eventually have the highest risk of pain interference with activities, as reported at age 29. These data support the importance of addressing both current obesity and the rate of weight gain in adolescents and young adults presenting for treatment of chronic pain. With emerging evidence suggesting that weight status and weight gain in adolescence can have long-term consequences for persistent or recurring pain, future research may also examine long-term reduction in the risk of chronic pain as an outcome of interventions designed to address excess weight in pediatric populations.

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Table 1. Characteristics of study participants, by body mass index trajectory (N = 7,875).

Variable	N (%) or mean (SD), by BMI trajectory			
	Low normal (N = 2,821)	High normal (N = 2,853)	Overweight (N = 1,580)	Obese (N = 621)
Study outcome: Pain interferes with work at age 29 (including housework and work outside the home)				
Not at all	2,407 (85%)	2,483 (87%)	1,328 (84%)	485 (78%)
A little	307 (11%)	263 (9%)	184 (12%)	104 (17%)
A lot	107 (4%)	107 (4%)	68 (4%)	32 (5%)
Demographic characteristics:				
Female	1,600 (57%)	1,194 (42%)	729 (46%)	369 (59%)
Race/ethnicity				
Non-Hispanic White	1,556 (55%)	1,346 (47%)	634 (40%)	217 (35%)
Non-Hispanic Black	643 (23%)	768 (27%)	491 (31%)	243 (39%)
Hispanic	495 (18%)	653 (23%)	395 (25%)	147 (24%)
Other	127 (5%)	86 (3%)	60 (4%)	14 (2%)
Birth year	1982 (1)	1982 (1)	1982 (1)	1982 (1)
Characteristics at age 29:				
Educational attainment				
Did not complete high school	215 (8%)	286 (10%)	180 (11%)	69 (11%)
High school or GED	1,662 (59%)	1,866 (65%)	1,113 (70%)	464 (75%)
Four-year college degree	696 (25%)	561 (20%)	230 (15%)	76 (12%)
Graduate/professional degree	248 (9%)	140 (5%)	57 (4%)	12 (2%)
Number of children				
0	1,388 (49%)	1,132 (40%)	609 (39%)	283 (46%)
1	627 (22%)	686 (24%)	345 (22%)	143 (23%)
2	469 (17%)	585 (21%)	344 (22%)	111 (18%)
3+	337 (12%)	450 (16%)	282 (18%)	84 (14%)
Marital status[a]				
Never married	1,559 (55%)	1,536 (54%)	879 (56%)	396 (64%)
Married	1,020 (36%)	1,073 (38%)	572 (36%)	182 (29%)
Separated/divorced/widowed	234 (8%)	235 (8%)	126 (8%)	43 (7%)
Lack of health insurance[b]	822 (29%)	888 (31%)	549 (35%)	200 (32%)
Early life characteristics:				
Mother's educational attainment[c]				
<12 years	528 (20%)	629 (24%)	418 (29%)	171 (30%)
12 years (high school)	890 (34%)	996 (38%)	531 (36%)	234 (41%)
1-3 years of college	616 (24%)	595 (23%)	327 (22%)	117 (20%)
4+ years of college	573 (22%)	408 (16%)	182 (12%)	51 99%)
Lived with both biological parents[d]	1,433 (51%)	1,375 (48%)	729 (46%)	240 (39%)

Physical or mental health problem[e]				
Absent	2,300 (82%)	2,345 (82%)	1,294 (82%)	510 (82%)
Present	172 (6%)	161 (6%)	109 (7%)	57 (9%)
Parent unavailable to ask	347 (12%)	345 (12%)	175 (11%)	54 (9%)
Young adult health before age 29:				
Any health problem limiting type of work or amount of work that respondent could do	357 (13%)	327 (11%)	262 (17%)	140 (23%)
Mental health problem requiring professional care, or leading to 1 or more missed days of usual activities, in the past 12 months[f]	86 (3%)	85 (3%)	49 (3%)	20 (3%)

[a] Data missing in 20 cases.
[b] Data missing in 19 cases.
[c] Data missing in 609 cases.
[d] Data missing in 27 cases.
[e] Data missing in 6 cases.
[f] Data missing in 245 cases.
BMI, body mass index; GED, graduate equivalency degree; SD, standard deviation

Table 2. Multivariable ordinal logistic regression of pain interference at age 29 (N = 6,999).

Variable	OR	95% CI	P
BMI trajectory			
Low normal	1.05	0.88, 1.24	0.582
High normal	Ref.		
Overweight	1.19	0.99, 1.44	0.070
Obese	1.63	1.28, 2.07	<0.001
Demographic characteristics:			
Female	1.41	1.22, 1.63	<0.001
Race/ethnicity			
Non-Hispanic White	Ref.		
Non-Hispanic Black	0.63	0.52, 0.77	<0.001
Hispanic	0.76	0.62, 0.92	0.006
Other	0.70	0.45, 1.09	0.111
Birth year	0.98	0.93, 1.03	0.336
Characteristics at age 29:			
Educational attainment			
Did not complete high school	1.41	1.10, 1.81	0.006
High school or GED	Ref.		
Four-year college degree	0.53	0.43, 0.65	<0.001
Graduate/professional degree	0.37	0.25, 0.55	<0.001
Number of children			
0	Ref.		
1	0.90	0.75, 1.09	0.300
2	0.90	0.74, 1.11	0.339
3+	1.02	0.81, 1.29	0.848
Marital status			
Never married	Ref.		
Married	0.93	0.79, 1.11	0.435
Separated/divorced/widowed	1.25	0.98, 1.60	0.072
Lack of health insurance	0.77	0.66, 0.91	0.002
Early life characteristics:			
Mother's educational attainment			
<12 years	0.85	0.69, 1.03	0.100
12 years (high school)	Ref.		
1-3 years of college	1.08	0.90, 1.30	0.414
4+ years of college	1.13	0.91, 1.41	0.262
Lived with both biological parents	0.81	0.70, 0.94	0.005
Physical or mental health problem			
Absent	Ref.		
Present	1.26	0.98, 1.63	0.075
Parent unavailable to ask	0.97	0.77, 1.23	0.817

BMI, body mass index; CI, confidence interval; GED, graduate equivalency degree; OR, odds ratio.

Table 3. Multivariable ordinal logistic regression of pain interference at age 29, controlling for measures of young adult health before age 29 (N = 6,999).

Variable	OR	95% CI	P
BMI trajectory			
Low normal	1.02	0.86, 1.22	0.797
High normal	Ref.		
Overweight	1.11	0.91, 1.35	0.303
Obese	1.47	1.15, 1.89	0.002
Demographic characteristics:			
Female	1.29	1.11, 1.50	0.001
Race/ethnicity			
Non-Hispanic White	Ref.		
Non-Hispanic Black	0.61	0.50, 0.74	<0.001
Hispanic	0.77	0.63, 0.95	0.013
Other	0.67	0.43, 1.06	0.090
Birth year	0.95	0.90, 0.998	0.043
Characteristics at age 29:			
Educational attainment			
Did not complete high school	1.21	0.94, 1.56	0.130
High school or GED	Ref.		
Four-year college degree	0.56	0.46, 0.70	<0.001
Graduate/professional degree	0.40	0.27, 0.60	<0.001
Number of children			
0	Ref.		
1	0.91	0.75, 1.10	0.338
2	0.90	0.73, 1.11	0.345
3+	0.99	0.78, 1.26	0.928
Marital status			
Never married	Ref.		
Married	1.00	0.84, 1.19	0.992
Separated/divorced/widowed	1.25	0.97, 1.61	0.078
Lack of health insurance	0.77	0.65, 0.91	0.002
Early life characteristics:			
Mother's educational attainment			
<12 years	0.82	0.67, 1.00	0.050
12 years (high school)	Ref.		
1-3 years of college	1.06	0.88, 1.28	0.555
4+ years of college	1.15	0.92, 1.44	0.217
Lived with both biological parents	0.81	0.70, 0.94	0.006
Physical or mental health problem			
Absent	Ref.		
Present	1.08	0.83, 1.42	0.554

Parent unavailable to ask	0.99	0.78, 1.26	0.918
Young adult health before age 29:			
Health problem limiting work	3.55	2.99, 4.23	<0.001
Mental health problem in past 12 months	2.24	1.62, 3.10	<0.001

BMI, body mass index; CI, confidence interval; GED, graduate equivalency degree; OR, odds ratio.

FIGURE CAPTIONS

Figure 1. Body mass index trajectories fitted to study sample.