Prospective associations of parental smoking, alcohol use, marital status, maternal satisfaction, and parental and childhood body mass index at 6.5 years with later problematic eating attitudes

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BACKGROUND: Few studies have prospectively investigated whether early-life exposures are associated with pre-adolescent eating attitudes.

OBJECTIVE: The objective of this study is to prospectively investigate associations of parental smoking, alcohol use, marital status, measures of maternal satisfaction, self-reported parental body mass index (BMI) and clinically measured childhood BMI, assessed between birth and 6.5 years, with problematic eating attitudes at 11.5 years.

METHODS: Observational cohort analysis nested within the Promotion of Breastfeeding Intervention Trial, a cluster-randomised trial conducted in 31 maternity hospitals and affiliated polyclinics in Belarus. Our primary outcome was a Children's Eating Attitudes Test (ChEAT) score ≥ 22.5 (85th percentile), an indicator of problematic eating attitudes. We employed multivariable mixed logistic regression models, which allow inference at the individual level. We also performed instrumental variable (IV) analysis using parents' BMIs as instruments for the child's BMI, to assess whether associations could be explained by residual confounding or reverse causation.

SUBJECTS: Of the 17 046 infants enrolled between 1996 and 1997 across Belarus, 13 751 (80.7%) completed the ChEAT test at 11.5 years.

RESULTS: In fully adjusted models, overweight children at age 6.5 years had a 2.14-fold (95% confidence interval (CI): 1.82, 2.52) increased odds of having ChEAT scores ≥ 85th percentile at age 11.5 years, and those who were obese had a 3.89-fold (95% CI: 2.95, 5.14) increased odds compared with normal-weight children. Children of mothers or fathers who were themselves overweight or obese were more likely to score ≥ 85th percentile (P for trend ≤ 0.001). IV analysis was consistent with a child’s BMI causally affecting future eating attitudes. There was little evidence that parental smoking, alcohol use, or marital status or maternal satisfaction were associated with eating attitudes.

CONCLUSION: In our large, prospective cohort in Belarus, both parental and childhood overweight and obesity at 6.5 years were associated with pre-adolescent problematic eating attitudes 5 years later.
of hunger, a characteristic associated with overeating, excess weight gain and unhealthy eating behaviours,\textsuperscript{15,16} and having negative emotions (sadness, guilt or shame) about eating.\textsuperscript{17,18} These features (overeating, restraint and negative self-esteem) are apparent from childhood to early adulthood.\textsuperscript{4,14–23}

Studies of family influences on pre-adolescent eating disorders and behaviours have been small (in studies identified by us, the median sample size was 290, the largest comprising 2862 girls\textsuperscript{20–24}); therefore, power may have been insufficient to detect true associations. Most studies have been cross-sectional and are prone to reverse causation (whereby, for example, pre-adolescent body mass index (BMI) could be a consequence, rather than cause, of problematic eating attitudes). In addition, previous studies included information on few covariates and hence were limited in their ability to control for potential confounders. We present prospective associations of early-life exposures with problematic eating attitudes among 13 751 pre-adolescents from the Promotion of Breastfeeding Intervention Trial (PROBIT) in the Republic of Belarus. Situated in Eastern Europe, Belarus is a middle-income, former republic of the USSR (Introduction::Belarus, https://www.cia.gov/library/publications/the-world-factbook/geos/bo.html), with high levels of adult literacy, clean water supply, good sanitation levels and healthcare coverage, long postnatal follow-up and 3 years obligatory maternal leave and low child mortality; however, with recent major economic changes, Belarus has a relatively low Gross Domestic Product and high rates of premature adult mortality.\textsuperscript{25} We investigated parental alcohol intake and BMI, maternal BMI and measures of maternal satisfaction with marriage, child and motherhood, assessed between birth and 6.5 years of age, with the self-reported eating attitudes of the children 5 years later, at 11.5 years of age.

**MATERIALS AND METHODS**

We conducted an observational analysis based on children (and parents) enrolled in PROBIT at birth, who attended follow-up visits throughout infancy and at 6.5 and 11.5 years of age. Trial methods have been described previously.\textsuperscript{26} Briefly, PROBIT was a multicentre, cluster-randomised controlled trial of an intervention to promote increased breastfeeding duration and exclusivity, conducted in the Republic of Belarus. Conducted between June 1996 and December 1997, the trial enrolled 17 046 infants born in 1996–1997 from 31 maternity hospitals (2.5 kg and 5 min Apgar score of \(\geq 7\)) that elicited information on maternal smoking status and alcohol use and smoking during pregnancy only, postnatal period only, both pre- and post-natal periods, or not at all.

At the child’s birth, mothers reported their marital status, classified as registered marriage, unregistered (‘common law’) marriage or unmarried. At 6.5 months, their current marital status was re-evaluated using dichotomous questions: (i) married (registered/unregistered) and living with the same husband as when the child was born, (ii) married (registered) with a different husband, (iii) married (unregistered) with a different husband, (iv) divorced, (v) separated or (vi) widowed. From this, we generated a categorical variable reflecting whether the mother’s marital status had changed between birth and at 6.5 years from the child’s point of view: (i) married with the same husband (stable two-parent family), (ii) married with a different husband (transition into a step family), (iii) separated/divorced/widowed (transition into a single-parent family) and (iv) stayed unmarried (stable single-parent family). At 6.5 years, mothers reported their level of satisfaction with their child, husband and mothering on a scale from 1 (very dissatisfied) through 7 (perfectly satisfied). We collapsed these variables into ‘dissatisfied’ (1–3), ‘satisfied’ (4–5) and ‘perfectly satisfied’ (6–7). Associations relating paternal smoking/alcohol consumption, and the mother’s satisfaction with her husband, to ChEAT scores were limited to stable marriages, because it was unclear to which man the mother’s response referred in marriages with a new husband or partner.

Weights and heights of the children at 6.5 and 11.5 years were measured by paediatricians at research clinics, as described previously.\textsuperscript{29,30} At 6.5 years, mothers reported their own and the child’s father’s weight and height for most (91%) children; a minority (8%) of the fathers/guardians reported for both parents. BMI was calculated as weight (kg) divided by height\(^2\) (m\(^2\)). As in previous studies,\textsuperscript{25,31,32} childhood overweight and obesity were defined by age- and sex-specific models recommended by Cole et al.\textsuperscript{31,32} with trajectories equivalent at age 18 years to the World Health Organization’s defined BMI thresholds of \(\leq 17\) kg m\(^{-2}\) (thinness), \(> 17\) to \(< 25\) kg m\(^{-2}\) (normal weight), \(\geq 25\) to \(< 30\) kg m\(^{-2}\) (overweight) and \(\geq 30\) kg m\(^{-2}\) (obesity).\textsuperscript{33} Parental BMI was categorised according to these WHO thresholds.\textsuperscript{33} Assumed to be errors, height and weight measurements in excess of \(\pm 0.5\) s.d. from the mean (29 mothers, 27 fathers and 125 children) were excluded from analyses.

**Measurement of eating attitudes**

At the PROBIT III research clinic, children self-completed a modified version of the ChEAT, originally a 26-item questionnaire assessing a variety of eating attitudes and behaviours ranging from 1 (always) to 6 (never).\textsuperscript{34} Children were asked to complete the questionnaire without interference from either parents or the paediatricians. Each question contributes to an assessment of problematic eating attitudes, including food preoccupation, peer and media pressure about eating, weight and body image, dieting, purging and restriction of food. ChEAT is therefore a quantitative indicator of problematic eating attitudes that may be symptomatic of more severe eating disorders. One study based on the UK general practice found that 10% of young adults who scored highly on the related Eating Attitudes Test had a clinical diagnosis of disordered eating, and more than one-third had clinically important concerns and weight preoccupation\textsuperscript{35} compared with randomly selected individuals who scored below the threshold, where no full or partial disordered eating syndromes were found. In addition, recent studies have shown that ChEAT is positively correlated with other validated measures of disturbed eating, including the Eating Disorder Examination Adapted for Children, Revised Eating Disorder Inventory-Body Dissatisfaction Subscale, Rosenberg Self Esteem Scale and Child Depression Inventory.\textsuperscript{36} We translated the ChEAT into Russian and then back to English to verify meaning; we are not aware of any validation studies in Belarus or other Russian-speaking populations.

As Maloney et al.\textsuperscript{37} found that one question (‘I can show self-control around food’) was negatively correlated with the questionnaire, we administered 25 questions only, where the original six-item Likert scale was simplified to a three-item scale: ‘often’, ‘sometimes’ and ‘never’. In preliminary factor analyses, question 25 (‘I enjoy trying new rich foods’)
was inversely correlated with total ChEAT score and was removed from the
analysis, which was based on the 24-item ChEAT-26. Responses were
scored as 3 ('often'), 1.5 ('sometimes') and 0 ('never'), giving a 0–72 range
for ChEAT-24, a similar range (0–78) from ChEAT-26.

In previous work within Caucasian populations from Europe, North
America and Australia, children with high ChEAT scores, ranging between
the 75th and 91st percentiles, were predisposed to eating disorders.22,34,36–39
Moreover, lower thresholds can generate more false-positive results than
higher thresholds.36,40 Therefore, we defined our threshold closer to the
upper end of the range for problematic eating attitudes as a ChEAT-24
score \( \geq 22.5 \), corresponding to the 85th percentile in our data. In a
sensitivity analysis, we investigated associations using a ChEAT-24 score
\( \geq 25.5 \) (91st percentile, comparable to Maloney et al.37). We did not
investigate ChEAT-24 scores as a continuous outcome, as the scores
were positively skewed and had a bimodal distribution (10.1% of children
reported total scores of 0, that is, answered ‘never’ to all 24 questions).

An audit was conducted an average of 1.3 years (range 0.2–2.4) after
the initial clinic visit to assess the reproducibility of the polyclinic
data. Percentage agreement for ChEAT scores \( \geq 85 \)th percentile was
85.1% comparing original and audit results for 141 randomly selected
children with complete ChEAT scores for both visits. Cohen’s kappa for
chance-corrected agreement was 0.46 (95% confidence interval (CI): 0.30,
0.63), indicating moderate test–retest reproducibility.

Ethics
PROBIT III was approved by the Belarusian Ministry of Health and received
ethical approval from the McGill University Health Centre Research Ethics

Table 1. Characteristics of participants in the PROBIT, Belarus, followed up at age 11.5 years

| Characteristics | Total number of individuals for each variable (N) | Percentages (%) or mean (s.d.) or median (IQR) where specified (N = 13 751) |
|-----------------|---------------------------------|---------------------------------------------------------------------|
| Female (%)      | 13 751                          | 48.5                                                               |
| Median (IQR) age at physical examination (years) | 13 730                          | 11.5 (11.3–11.8)                                                   |
| Urban vs rural (% in urban)         | 13 751                          | 57.9                                                               |
| West vs East of Belarus (% in west) | 13 751                          | 52.6                                                               |
| Within intervention arm (%)        | 13 751                          | 53.5                                                               |
| **Mother’s alcohol intake from pregnancy to PROBIT II (N = 12 531)**a |          |                                                                    |
| Consumed < 1 unit per week          | 5412                            | 43.2                                                               |
| Prenatal only                       | 88                              | 0.7                                                               |
| Postnatal only                      | 6721                            | 43.6                                                               |
| Pre- and post-natal                 | 310                             | 2.5                                                               |
| **Mother’s smoking from pregnancy to PROBIT II (N = 12 339)** |          |                                                                    |
| None                             | 10 517                          | 85.2                                                               |
| Prenatal only                      | 81                              | 0.7                                                               |
| Postnatal only                     | 1537                            | 12.5                                                              |
| Pre- and postnatal                  | 204                             | 1.7                                                               |
| Father’s smoking at 6.5 years (% in highest category)b | 10 266                          | 7.4                                                               |
| Father’s alcohol intake at 6.5 years (% in highest category)b | 10 243                          | 27.1                                                              |
| Marital status (% persistent marriage) | 12 532                          | 82.4                                                              |
| Mother’s satisfaction with husband (% perfectly satisfied) at 6.5 years | 10 176                          | 32.6                                                              |
| Mother’s satisfaction with child (% perfectly satisfied) at 6.5 years | 12 575                          | 63.5                                                              |
| Mother’s satisfaction with motherhood (% perfectly satisfied) at 6.5 years | 12 539                          | 78.0                                                              |
| **Maternal BMI category (%) at PROBIT II (N = 12 719)**c |          |                                                                    |
| Underweight                        | 75                              | 0.6                                                               |
| Normal                            | 7949                            | 62.5                                                              |
| Overweight                        | 3265                            | 25.7                                                              |
| Obese                             | 1430                            | 11.2                                                              |
| **Paternal BMI category (%) at PROBIT II (N = 11 609)**c |          |                                                                    |
| Underweight                        | 5                               | 0.04                                                              |
| Normal                            | 5461                            | 47.0                                                              |
| Overweight                        | 5010                            | 43.2                                                              |
| Obese                             | 1133                            | 9.8                                                               |
| **Child BMI category (%) at PROBIT II (N = 12 851)**c |          |                                                                    |
| Underweight                        | 290                             | 2.3                                                               |
| Normal                            | 11 293                          | 87.9                                                              |
| Overweight                        | 993                             | 7.7                                                               |
| Obese                             | 275                             | 2.1                                                               |
| **Child BMI category (%) at PROBIT III (N = 13 741)**c |          |                                                                    |
| Underweight                        | 338                             | 2.5                                                               |
| Normal                            | 11 283                          | 82.1                                                              |
| Overweight                        | 1732                            | 12.6                                                              |
| Obese                             | 388                             | 2.8                                                               |
| Highest household occupation (% non-manual workers) | 12 836                          | 56.6                                                              |
| Mother’s education (% completed university) | 13 751                          | 13.6                                                              |
| Father’s education (% completed university) | 13 316                          | 13.2                                                              |
| ChEAT scores \( \geq 85 \)th percentile (that is, score \( \geq 22.5 \)) | 13 751                          | 17.3                                                              |

Abbreviations: BMI, body mass index; ChEAT, Children’s Eating Attitudes Test; IQR, interquartile range; PROBIT, Promotion of Breastfeeding Intervention Trial; WHO, World Health Organization. aMother’s alcohol consumption \( \geq 1 \) unit per week by period or father’s alcohol consumption \( \leq 4 \) units per week. bHighest category for father’s smoking was \( \geq 20 \) cigarettes per day. cCategories of BMI for underweight, overweight and obesity in children were defined by Cole et al.31,32 and are mapped onto the WHO categories for adults. The WHO definitions were used for adults.
Board, the Human Subjects Committee at Harvard Pilgrim Health Care and the Avon Longitudinal Study of Parents and Children Law and Ethics Committee. A parent/legal guardian provided written informed consent in Russian at enrolment and at follow-up visits, and all children provided written assent at 11.5 years.

Statistical analysis

To assess how each question contributed to the variance of ChEAT scores, we conducted a principal components analysis to verify the factor structure of the ChEAT questionnaire (Supplementary Table 1). Factors obtained in our analyses were similar to those reported previously. We investigated associations of exposures measured during infancy and at 6.5 years with problematic eating attitudes (ChEAT score ≥ 85th percentile) at 11.5 years using multivariable mixed logistic regression models; these employed the ‘xtmelogit’ command in STATA (STATA Corp, College Station, TX, USA), which allows inference at the individual level within clusters (there was a moderate degree of within-polyclinic clustering of ChEAT scores). In addition, we conducted a principal components analysis to verify the factor structure of the ChEAT questionnaire (Supplementary Table 1). Factors obtained in our analyses were similar to those reported previously. We built the following cluster-adjusted models: a basic model controlling for age and sex, and a fully adjusted model additionally controlling for location of polyclinic (urban/rural and East/West Belarus), treatment group (intervention/control), parental education measured at PROBIT I (initial, incomplete or common secondary, advanced secondary or partial university, and completed university) and highest household occupation (non-manual worker (including farmer)/service worker (non-manual) categorised as in previous studies), and employed the ‘xtmelogit’ command in STATA (STATA Corp, College Station, TX, USA), which allows inference at the individual level within clusters (there was a moderate degree of within-polyclinic clustering of ChEAT scores). In addition, we conducted a principal components analysis to verify the factor structure of the ChEAT questionnaire (Supplementary Table 1). Factors obtained in our analyses were similar to those reported previously.

To determine its effect on results.

Finally, we performed instrumental variable (IV) analysis using the parents’ BMIs as instruments for the child’s BMI, to assess whether prospective associations of the child’s BMI with problematic eating attitudes were causal and not explained by residual confounding or reverse causation. An IV is reliably associated with a risk factor (here, the child’s BMI) and with the outcome (here, problematic eating attitudes) only because of its association with the risk factor. The instrument must not be associated with confounding factors and must not be influenced by the outcome so as not to be biased by reverse causation (see Table 1 of Davey Smith et al.). We used the BMI of each parent as the ‘instrument’ because parents’ BMIs are positively associated with the child’s BMI (Pearson’s correlation coefficient = 0.2 in PROBIT); associations of potential confounders with parents’ BMIs were weaker than child BMI and, for some, in the opposite direction; and unless problematic eating attitudes in the

### Table 2. Association between potential confounders and ChEAT scores ≥ 85th percentile in PROBIT, Belarus

| Confounders & | N (%) of ChEAT scores ≥ 22.5 | OR (95% CI)
|--------------|-----------------------------|---------------------|
| **Urban (city)** (n = 7956) | 1300 (16.3) | 1.00 (Ref) |
| **Rural (village)** (n = 5795) | 1082 (18.7) | 1.08 (0.51, 2.29) |
| **West of Belarus** (n = 7238) | 1165 (16.1) | 1.00 (ref) |
| **East of Belarus** (n = 6513) | 1217 (18.7) | 1.27 (0.60, 2.69) |
| **Age of child (years)** | | 0.90 (0.84, 0.96) |
| 10.2–11.4 (n = 4583) | 844 (18.4) |
| 11.4–11.7 (n = 4589) | 774 (16.9) |
| 11.7–14.5 (n = 4558) | 758 (16.6) |
| **Sex (female vs male)** | | 1.00 (ref) |
| Male (n = 7076) | 997 (14.1) |
| Female (n = 6675) | 1385 (20.8) |
| 1.62 (1.47, 1.77) |
| 0.0001 |
| **Maternal education** | | 0.97 |
| Incomplete secondary or common (n = 4823) | 865 (17.9) |
| Advanced secondary or partial (n = 7064) | 1216 (17.2) |
| Completed university (n = 1864) | 301 (16.2) |
| 1.00 (0.93, 1.08) |
| 0.23 |
| **Paternal education** | | 0.26 |
| Incomplete secondary or common (n = 5232) | 895 (17.1) |
| Advanced secondary or partial university (n = 6328) | 1127 (17.8) |
| Completed university (n = 1756) | 285 (16.2) |
| 1.04 (0.97, 1.12) |
| 0.26 |
| **Highest household occupation** | | 0.80 |
| Manual worker/farmer (n = 5571) | 995 (17.9) |
| Non-manual worker (n = 7265) | 1237 (17.0) |
| 0.99 (0.89, 1.09) |

Abbreviations: ChEAT, Children’s Eating Attitudes Test; CI, confidence interval; OR, odds ratio; PROBIT, Promotion of Breastfeeding Intervention Trial; Ref, reference group. *N-values in each row heading represent the number of individuals within each cell of that row, respectively, where percentages within each cell are proportions of the corresponding N-value. For example, 18.7% (1082/5 795) of individuals who live in rural areas have ChEAT scores ≥ 22.5 compared with 16.3% (1300/7956) of individuals who live in urban areas. TAll effect-estimates account for age, sex and clustering by hospital/polyclinic and represent the OR, giving the change in odds (95% CI) of having a ChEAT score ≥ 22.5 (85th percentile) per change or unit increase in the level of each binary or ordered categorical variable, respectively. For example, an OR of 1.08 (95% CI: 0.51, 2.29; P = 0.84) indicates that there is a 8% increased odds of having a ChEAT score above the 85th percentile among individuals who live in rural areas compared with those who live in urban areas. *Not adjusted for age. 4OR and P-value for trend. *Not adjusted for sex.
child act as a strong marker for their parents’ eating attitudes, they are unlikely to cause variation in parental BMI, avoiding reverse causation. In an IV analysis, the component of variation within the risk factor of interest explained by the instrument is used to provide an unbiased and unconfounded assessment of causality between the risk factor and outcome. We used the ‘gmm’ command in STATA to compute IV estimates using the BMI of the mother and father as separate instruments for their child’s BMI. We conducted all analyses using STATA version 12 (STATA Corp).

RESULTS

Of the 17,046 children enrolled, 13,879 (81.4%) attended the PROBIT III visit at a median age of 11.5 years (interquartile range, 11.3–11.8). Of these, 13,751 (80.7%) had usable and complete ChEAT data and 48.5% were girls (Table 1). At 6.5 years, 2.1% of children (223 girls and 67 boys) were underweight, 7.2% (498 girls and 495 boys) were overweight and 2.0% (148 girls and 127 boys) were obese; 10.4% and 8.2% of mothers and fathers, respectively, were obese.

Table 3. Associations of family exposures with problematic eating attitudes at age 11.5 years (ChEAT scores $>85$th percentile) in PROBIT, Belarus

| Exposures | % of ChEAT scores $>85$th percentile$^a$ | Fully adjusted OR$^b$ | 95% CI |
|-----------|-------------------------------------|-----------------------|------|
| Maternal smoking from pregnancy to PROBIT II | | | |
| None ($n=10,517$) | 17.3 | 1.00 (Ref) | |
| Prenatal only ($n=81$) | 12.4 | 0.76 | 0.35, 1.69 |
| Postnatal only ($n=1,537$) | 20.8 | 1.12 | 0.96, 1.31 |
| Both pre- and postnatal ($n=204$) | 21.6 | 0.97 | 0.63, 1.48 |
| $P$-value for heterogeneity | | | 0.51 |
| Maternal alcohol intake from pregnancy to PROBIT II | | | |
| < 1 Unit per week throughout ($n=5,412$) | 17.5 | 1.00 (Ref) | |
| $\geq$ 1 Unit per week prenatal only ($n=88$) | 18.2 | 1.13 | 0.61, 2.11 |
| $\geq$ 1 Unit per week postnatal only ($n=6,721$) | 18.2 | 1.11 | 0.99, 1.24 |
| $\geq$ 1 Unit per week pre- and postnatal ($n=310$) | 10.0 | 1.00 | 0.62, 1.62 |
| $P$-value for heterogeneity | | | 0.91 |
| Paternal smoking at PROBIT II (cigarettes per day) | | | |
| None ($n=3,379$) | 17.6 | 1.00 (Ref) | |
| 1–9 ($n=7,084$) | 18.1 | 1.00 | 0.88, 1.15 |
| 10–19 ($n=2,635$) | 18.2 | 1.05 | 0.91, 1.20 |
| $\geq$ 20 ($n=756$) | 19.6 | 1.05 | 0.84, 1.30 |
| $P$-value for trend | | | 0.50 |
| Paternal alcohol intake at PROBIT II | | | |
| $< 2$ Units per week ($n=4,656$) | 18.3 | 1.00 (Ref) | |
| $2$–$4$ Units per week ($n=2,815$) | 16.9 | 0.98 | 0.85, 1.12 |
| $> 4$ Units per week ($n=2,772$) | 18.8 | 1.08 | 0.94, 1.24 |
| $P$-value for trend | | | 0.33 |
| Marital status at birth and after 6.5 years | | | |
| Married, same husband ($n=10,329$) | 18.0 | 1.00 (ref) | |
| Married, different husband ($n=617$) | 20.1 | 1.04 | 0.82, 1.33 |
| Separated/divorced/widowed ($n=1,373$) | 17.1 | 0.97 | 0.82, 1.15 |
| Stayed unmarried ($n=213$) | 13.2 | 0.88 | 0.35, 2.18 |
| $P$-value for heterogeneity | | | 0.88 |
| Marital satisfaction | | | |
| Dissatisfied ($n=953$) | 17.5 | 1.00 (ref) | |
| Satisfied ($n=5,008$) | 18.0 | 1.05 | 0.87, 1.28 |
| Perfectly satisfied ($n=3,315$) | 18.2 | 1.00 | 0.81, 1.23 |
| $P$-value for trend | | | 0.70 |
| Child satisfaction | | | |
| Dissatisfied ($n=213$) | 16.9 | 1.00 (ref) | |
| Satisfied ($n=4,377$) | 17.3 | 0.81 | 0.54, 1.22 |
| Perfectly satisfied ($n=7,085$) | 18.3 | 0.73 | 0.49, 1.10 |
| $P$-value for trend | | | 0.03 |
| Motherhood satisfaction | | | |
| Dissatisfied ($n=85$) | 18.8 | 1.00 (ref) | |
| Satisfied ($n=2,675$) | 18.0 | 1.12 | 0.60, 2.11 |
| Perfectly satisfied ($n=977$) | 17.9 | 1.02 | 0.55, 1.92 |
| $P$-value for trend | | | 0.22 |

Abbreviations: ChEAT, Children’s Eating Attitudes Test; CI, confidence interval; OR, odds ratio; PROBIT, Promotion of Breastfeeding Intervention Trial; Ref, reference group. $^a$ ORs (and $P$-value) for trend represent the change in odds (95% CI) of having ChEAT scores $>22.5$ (85th percentile) per unit increase in each ordered categorical variable. $^b$ Adjusted for age, sex, location of polyclinic, treatment group, maternal/paternal occupation/education and polyclinic site.
Girls were more likely to have ChEAT scores ≥85th percentile (20.8% vs 14.1%, respectively) than boys. No other potential confounders were associated with ChEAT scores ≥85th percentile, apart from an inverse association with age (Table 2). There were no important associations of parental smoking or alcohol intake, change in marital status or maternal satisfaction with problematic eating attitudes (Table 3). In the fully adjusted model, the child’s BMI measured at 6.5 years was positively associated with problematic eating at 11.5 years: 1 s.d. increase in BMI was associated with a 34% increased odds (95% CI: 29%, 40%) of having ChEAT scores ≥85th percentile (OR per s.d. increase in BMI: 1.09 (95% CI: 1.04, 1.15)). Compared with normal-weight children, overweight children at age 6.5 years had >2-fold increased odds of having ChEAT scores ≥85th percentile at age 11.5 years (fully adjusted OR: 2.14; 95% CI: 1.82, 2.52), and those who were obese, nearly a 4-fold increased odds (fully adjusted OR: 3.89; 95% CI: 2.95, 5.14) (Table 4). In addition, children of mothers or fathers who were themselves overweight or obese were more likely to score ≥85th percentile on the ChEAT questionnaire (OR per s.d. increase in the child’s BMI: 1.08 (95% CI: 1.03, 1.14) for mothers and fathers, respectively).

Positive association of maternal and paternal BMI as instruments, respectively; 1.46 (95% CI: 1.28, 1.67) and 1.42 (95% CI: 1.22, 1.65), using PROBIT, Belarus

### Table 4. Associations of child’s and parents’ BMI at Age 6.5 years with problematic eating attitudes at age 11.5 years (ChEAT scores ≥85th percentile) in PROBIT, Belarus

| Exposures a | % ChEAT scores ≥22.5 | Basic OR b | 95% CI | Adjusted OR c | 95% CI |
|-------------|----------------------|------------|-------|---------------|-------|
| **Child’s BMI, PROBIT II (kg m⁻²)** | | | | | |
| Normal (n = 11293) | 16.5 | 1.00 (Ref) | | | 1.00 (Ref) |
| Underweight (n = 290) | 15.5 | 0.87 | 0.62, 1.22 | 0.84 | 0.59, 1.20 |
| Overweight (n = 993) | 28.5 | 2.16 | 1.85, 2.53 | 2.14 | 1.82, 2.52 |
| Obese (n = 275) | 40.4 | 3.80 | 2.90, 4.97 | 3.89 | 2.95, 5.14 |
| OR per s.d. | 1.33 | 1.28, 1.39 | 1.34 | 1.29, 1.40 |
| P-value for trend | <0.0001 | | | | <0.0001 |
| **Maternal BMI, PROBIT II (kg m⁻²)** | | | | | |
| Normal (n = 7949) | 17.2 | 1.00 (Ref) | | | 1.00 (Ref) |
| Underweight (n = 75) | 17.3 | 0.97 | 0.52, 1.80 | 1.18 | 0.63, 2.23 |
| Overweight (n = 3265) | 18.3 | 1.10 | 0.98, 1.23 | 1.10 | 0.98, 1.23 |
| Obese (n = 1430) | 20.8 | 1.29 | 1.11, 1.49 | 1.29 | 1.11, 1.50 |
| OR per s.d. | 1.09 | 1.05, 1.14 | 1.09 | 1.04, 1.15 |
| P-value for trend | 0.0001 | | | | 0.0002 |
| **Paternal BMI at PROBIT II (kg m⁻²)** | | | | | |
| Normal (n = 5461) | 17.2 | 1.00 (Ref) | | | 1.00 (Ref) |
| Overweight (n = 5010) | 18.4 | 1.09 | 0.98, 1.22 | 1.11 | 0.99, 1.24 |
| Obese (n = 1133) | 20.5 | 1.28 | 1.08, 1.51 | 1.27 | 1.06, 1.51 |
| OR per s.d. | 1.08 | 1.03, 1.13 | 1.09 | 1.03, 1.14 |
| P-value for trend | 0.001 | | | | 0.001 |

**Abbreviations:** BMI, body mass index (kg m⁻²); ChEAT, Children’s Eating Attitudes Test; CI, confidence interval; OR, odds ratio; PROBIT, Promotion of Breastfeeding Intervention Trial; Ref, reference group; WHO, World Health Organization. aCategories of BMI for underweight, overweight and obesity in children are defined by Cole et al.31,32 and are mapped onto the WHO categories for adults. The WHO definitions were used for adults. bAll effect-estimates are adjusted for age, sex and clustering by hospital/polyclinic and represent the OR giving the change in odds (95% CI) of having a ChEAT score ≥22.5 (85th percentile) per s.d. increase in BMI (kg m⁻²). cAdjusted for age, sex, location of polyclinic, treatment group, maternal/paternal occupation/education, maternal smoking status from pregnancy to PROBIT II and cluster (polyclinic site).

**DISCUSSION**

In our large, prospective cohort study in Belarus, both parental BMI and childhood BMI at 6.5 years were positively associated with pre-adolescent problematic eating attitudes 5 years later. There was little evidence that parental smoking, maternal alcohol intake, change in marital status or maternal satisfaction measures were associated with future problematic eating attitudes among the offspring.

The observation that children with higher BMI at 6.5 years had higher ChEAT scores is consistent with cross-sectional data showing that overweight (BMI ≥95th percentile) and at-risk for overweight (BMI between 85th and 95th percentile) children had higher total ChEAT scores compared with non-overweight children.44 In PROBIT, children who were overweight or obese at age 6.5 years had, respectively, twofold and nearly fourfold increased risks of having ChEAT scores ≥85th percentile 5 years later. Given that nearly 10% of children were overweight or obese at 6.5 years, these results highlight the importance of childhood overweight and obesity for the future development of problematic eating attitudes in later life.

Our results also indicate that the association of BMI with subsequent problematic eating attitudes was equally strong in boys and girls, a finding at odds with some literature, which suggests that being overweight in early life has a stronger influence in developing problematic eating attitudes in girls.6,7,10–14,24,44–47 However, as described in the introduction, most previous studies were cross-sectional and had limited power.6,7,10–14,24 In agreement with prospective studies that used ChEAT, girls had a greater risk of problematic eating attitudes than boys.22,38
Children of overweight parents are at greater risk of becoming overweight themselves, as body weight and shape have strong genetic and family environmental determinants. Overweight children as young as 5 years old report lower body esteem than thinner children, perhaps because thinner body shapes are supported by social and parental pressures in contrast to heavier body weights. Being overweight as a child or having overweight parents may contribute to the development of problematic eating attitudes as an approach to controlling weight. Our study strengths are its large sample size generating precise effect estimates, excellent follow-up rate and prospective data collection, but there are limitations. As the parental weights and heights were verbally reported, they may be prone to measurement error and reporting bias. However, as parental information was reported years before CheAT scores were collected, any error should be random, attenuating rather than inflating observed associations. Other potential confounders, including physical activity of the child, presence of parental eating disorders, cultural perceptions of body image and physical/sexual abuse, were not measured. Within this cohort, the prevalence of overweight and obesity among children and mothers was considerably lower compared with many other countries, particularly in the United States. By extension, these findings may therefore be of greater importance in areas where the burden of childhood obesity is a much greater national health problem. On the other hand, due to varying socioeconomic and confounding structures between countries, these results may not generalise to areas with different levels of overweight and obesity.

Although BMI was measured 5 years before problematic eating assessment, it is possible that problematic eating attitudes were already present by 6.5 years, however, information on eating attitudes was not available before 11.5 years. Thus, any observed association of BMI at 6.5 years with eating attitudes at 11.5 years could reflect an influence of pre-existing disordered eating on BMI. However, there are two pieces of evidence supporting the inference that a child’s BMI causally affects future eating attitudes. First, IV and conventional regression estimates were similar. Although there may be some residual bias, our IV analyses using parents’ BMI as a proxy for the child’s BMI should be less affected by confounding or reverse causation than the conventional regression analyses. However, as eating disorders may be partly heritable (evidence suggests that ~54% of the variance in 11-year-old pubertal and 17-year-old twins is explained by genetic factors), and as there is a possible genetic correlation between disordered eating and BMI, we cannot completely disregard reverse causation.

Second, in intention-to-treat analyses comparing children randomly allocated to the intervention versus control arm of PROBIT (Skugarevsky, et al. Psychiatry and Medical Psychology Department, Belarusian State Medical University, unpublished manuscript), the intervention was associated with a reduced risk of problematic eating attitudes at 11.5 years; however, the intervention had no effect on BMI at 6.5 or 11.5 years. If eating attitudes influenced child’s BMI, the breastfeeding promotion intervention would have had a positive effect on both BMI and eating attitudes, which we do not observe.

The predictive value of the CheAT questionnaire in relation to future risk of developing an eating disorder is uncertain. Nevertheless, studies using alternative measures of disordered eating have shown that children expressing problematic eating attitudes in early life have an increased risk of developing eating disorders. For example, children aged 1–10 years with eating conflicts and struggles with food, as assessed by maternal interview, had a six- to sevenfold increased risk of being diagnosed with anorexia nervosa in adolescence and young adulthood. However, it is unclear how other measures of problematic eating attitudes can approximate the prognostic value of the CheAT questionnaire, or what the optimum threshold for defining problematic eating attitudes should be.

In our study, the use of either the 85th or 91st percentiles as thresholds for problematic eating gave similar results. In conclusion, our study showed that parental and childhood BMI at 6.5 years were positively associated with problematic eating attitudes 5 years later. We observed little evidence of associations of parental smoking and alcohol intake, change in marital status, or maternal satisfaction measures with offspring problematic eating attitudes. Our results highlight the potential public health importance of preventing childhood overweight in early primary school years for future avoidance of disturbed eating attitudes and behaviours.

**CONFLICT OF INTEREST**
The authors declare no conflict of interest.

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**AUTHOR CONTRIBUTIONS**
The hypothesis and statistical analysis plan were developed by OS, KHW, MSK and RMM. MSK, EO, MG, GDS and RMM obtained funding for PROBIT fieldwork. RP, NB and NS coordinated the fieldwork under the supervision of OS, RMM, EO, MSK and KV. KHW performed the statistical analysis. KHW and RMM wrote the first draft of the paper, had full access to all the data in the study and take responsibility for the integrity of the data and accuracy of the analysis. All authors critically commented on and approved the final submitted version of the paper.

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