European Journal of Public Health, Vol. 21, No. 2, 158–165

doi:10.1093/eurpub/ckq041 Advance Access published on 23 April 2010

Socio-economic position and adiposity among children and their parents in the Republic of Belarus

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Received 18 September 2009, accepted 19 March 2010

Background: Socio-economic differences in the prevalence of overweight/obesity may be one factor through which health inequalities arise and may vary by the population studied. **Methods:** Analysing a cohort of 13 889 children born in Belarus between June 1996 and December 1997, the authors investigated associations of parental educational attainment and highest household occupation with: (i) measured body mass index (BMI), waist circumference and skinfold thicknesses at age 6.5 years and (ii) the parents' reported BMI. **Results:** Overall, 10% of children, 37% of mothers and 53% of fathers were either overweight or obese. Children from non-manual households were 27% [95% confidence interval (CI): 10%, 47%] more likely to be overweight/obese (based on BMI) than those from manual households. They also had larger waist circumferences and higher percentage body fat (calculated from subscapular and triceps skinfolds). Similar associations for being overweight/obese were seen for fathers [odds ratio (OR), 1.10; 95% CI: 1.02, 1.18], but mothers from non-manual households were less likely to be overweight/obese: (OR, 0.84; 95% CI: 0.79, 0. 90). Associations of childhood and parental overweight/obesity with higher educational status of either parent were similar to those observed for non-manual households. **Conclusion:** We observed socio-economic differentials in overweight/obesity prevalence among children and their parents in Belarus. More affluent children and their fathers were more likely to be overweight/obese but the reverse was found for mothers.

Keywords: body fat, obesity, overweight, socio-economic factors, waist circumference

Introduction

The prevalence of excess body weight is high and rising in many countries and is a major public health concern.[1] Obesity is associated with an increased risk of several chronic diseases[2] and socio-economic differences in obesity prevalence may be one mechanism through which inequalities in health and mortality arise.[3] In countries with low levels of economic development, overweight and obesity are more common among affluent adults and children.[4] In economically developed countries, overweight and obesity are more common among poorer women and children,[3–5] although this pattern is less consistent among men,[3,4] and inequalities in obesity prevalence in some countries may be narrowing.[6]

Many countries from Eastern Europe and the former Soviet Union have transition economies (changing from centrally planned to free market economies), experiencing different stages of social and economic development. Studies examining inequalities in overweight/obesity prevalence in these countries reveal mixed findings. Children with less educated parents are generally more likely to be overweight or obese.[7,8] However, a recent study in 35 countries found that among adolescents those from more affluent backgrounds in Croatia, Estonia and Latvia were more likely to be overweight/obese.[8] Among adults, lower socio-economic position has been associated with a greater prevalence of obesity, particularly among women.[9,10] Most of these studies involved either children or adults and few simultaneously examined the socio-economic patterning of obesity in both children and their parents.[7] Few studies have examined inequalities in central adiposity, which is more detrimental to health than peripheral fat tissue, even in childhood.[11]

The Republic of Belarus has a transition economy and is a middle-income former Soviet Socialist Republic, with low-income inequality.[12] Belarus has features in common with many high-income countries: high adult literacy and low infant mortality rates, but it also has high rates of adult mortality, principally from cardiovascular disease, which is related to obesity.[12,13] We are unaware of any previous published studies from Belarus reporting on the socio-economic patterning of obesity or related health outcomes.

We examined socio-economic inequalities in general and central adiposity by occupational and educational status, among children and their parents in Belarus. In addition, we examined the effect of selected demographic, anthropometric, health behaviour and family-related variables on these associations.

Methods

The study cohort comprises children and their parents who were recruited into the Promotion of Breastfeeding Intervention Trial (PROBIT)[14] and attended a follow-up interview and examination when the children were aged 6.5 years. This observational cohort is nested within a multicentre, cluster-randomized controlled trial located in Belarus, in which the experimental intervention was promotion of breastfeeding and modelled on the Baby-Friendly Hospital Initiative.[15] Briefly, 31 maternity hospitals and their affiliated polyclinic (outpatient clinics where children are followed-up for routine health care) were randomly assigned to receive the breastfeeding promotion or to continue with prevailing practices. Between June 1996 and December 1997, 17 046 mother–infant pairs were recruited during their postpartum hospital stay. Inclusion criteria specified that infants were full-term ($\geq$37 weeks gestation), healthy, singleton births, weighing at least 2500 g, with an Apgar score $\geq$5 at 5 min and mothers were healthy and intended to breastfeed. These children were followed-up at polyclinic visits at 1, 2, 3, 6, 9 and 12 months. Since all mothers initially breastfed, the experimental intervention was designed to increase the duration and exclusivity of breastfeeding. The randomization procedure resulted in two groups with a similar distribution of potential confounding factors (e.g. birthweight and parental education). When the children were aged 6.5 years, they were invited to a follow-up interview and examination between December 2002 and April 2005; 13 889 (81.5%) children were examined at 31 polyclinics by one of 38 trained study paediatricians.[16] Monitoring visits were conducted during recruitment and follow-up to ensure compliance with study protocols.

At age 6.5 years, the following anthropometric measures were taken in duplicate and the mean reading used in all analyses:[16] standing height; weight; waist circumference; and subscapular and triceps skinfold thickness. Seventeen (0.1%) of the 13 889 children had missing data for at least one of these measures. At the same visit, the examining paediatrician recorded parental height and weight (and other covariates) obtained from an interview with the accompanying parent/legal guardian. For most (91%) of the children, the mother reported height and weight for both herself and the child's father; in a minority (8%), the father/guardian reported for both parents (for 1% of children, this information was not recorded). In total 1379 (10%) of the fathers and 161 (1%) of the mothers did not have data for height and weight.

A re-measurement audit was used to assess the reproducibility of the children's measurements at follow-up.[16] Briefly, 190 randomly selected children (approximately five per paediatrician) were re-examined by one of the Minsk-based study paediatricians (auditors), 5.3–32.6 months (mean 17.7 months) after the initial examination. The auditors were blinded to the initial measurements taken by the polyclinic paediatricians. The test–retest correlation was high (Pearson correlation coefficient $\geq$0.84) for height, body mass index (BMI) and waist circumference, but was modest for subscapular (0.65) and triceps (0.59) skinfold thickness, reflecting the greater known difficulty of measuring skinfolds.

The mother reported parents' occupations and education levels when the child was enrolled into the study during the postpartum hospital stay. In Belarus, at the time of the trial, mothers' jobs were guaranteed during 3 years of obligatory maternity leave[17] and therefore we asked the mothers to report their usual (before pregnancy) occupation. Eight categories of occupation based on national classifications were supplied to us by the Belarusian investigators. Occupation was classified as: manual worker/farmer (manual); and service worker (non-manual). Those who reported they were pupils, students, housewives, unemployed or whose occupation was unknown were coded as missing, because the relationship of these categories to usual socio-economic position was unclear. The highest household occupation was calculated as the higher of the occupation categories for the mother or the father; a non-manual worker was regarded as a higher occupational status than a manual worker (the reference category). Highest household occupation was missing for 6.5% ($n = 899$) of households. The average monthly wage in the agricultural sector in Belarus (2008) was 398 000 Belarusian rubles (Br) (187USD) and in the housing and communal services, 580 000Br (273USD).[18] Educational status was recoded from seven to three categories: initial, incomplete or common secondary; advanced secondary or partial university; and completed university. The category 'unknown' was coded as missing. No mother and 468 (3%) fathers had missing data for educational attainment.

The location of the polyclinic was categorized as either East or West of Minsk and as urban or rural. Urban/rural location was based on the size of the village/town that the hospital and affiliated polyclinic served. The mother reported the following baseline variables: parent's age (years), number of older siblings (0, 1, 2+), marital status (registered marriage, unregistered marriage/unmarried) and maternal smoking during pregnancy. The father's age was not obtained for 494 (3.6%) children. Smoking during pregnancy was recoded to yes/no from the number of cigarettes smoked per day. The child's birthweight (in grams) was abstracted from the medical record. During the first 12 months, breastfeeding history from the mother was regularly recorded. A binary variable was obtained for those exclusively breastfed at 3 months (yes/no), with exclusivity defined by World Health Organization criteria.[19]

Covariates recorded at follow-up were parental smoking, alcohol intake and number of siblings. Smoking (yes/no) for both parents was derived as above, and was missing for 120 mothers (1%) and 1292 fathers (9%). Parental alcohol intake was derived by combining average frequency of alcohol consumption and amount of alcohol consumed at these times, (categorized as <1, 1–2, >2 units per week for mothers and <1, 1–2, 3–4, >4 units per week for fathers). One unit of alcohol is equivalent to 25 ml of vodka/spirit.[20] Data regarding alcohol intake were missing for 2% of mothers ($n = 232$) and 10% of fathers ($n = 1437$). The number of younger siblings since the birth of the study child (0, 1, 2+) was also recorded, and was missing for 112 children (1%). The institutional ethical review board of the Montreal Children's Hospital approved the study, and participating mothers gave signed consent in Russian.

BMI was calculated as weight in kilograms divided by height in meters squared. Childhood thinness, overweight and obesity were defined by models which give age- and sex-specific thresholds, with trajectories which are equivalent at the age of 18 to a BMI of $\leq$17 (for thinness),[21] $\geq$25 to $\leq$30 (for overweight)[22] and $\geq$30 (for obesity).[22] These three BMI cut-offs were also used among parents. The cut-off for thinness was chosen as recommended by Cole *et al.*[21] Percentage body fat was derived using the equations of Slaughter *et al.*[23] from subscapular and triceps skinfold measurements. The child's exact age, calculated from date of birth and date of follow-up examination, was used in all analyses.

The crude association between the socio-economic indicators and continuous outcomes was estimated using linear regression. Logistic regression was used for the analysis of BMI (overweight/obese BMI versus normal BMI) and waist circumference and percentage body fat ($\geq$90th percentile versus <90th percentile). As approximately 10% of children were classified as overweight/obese,[22] the ≥90th percentile cut-off was chosen to capture the same proportion of children with high waist circumferences and percentage body fat. Multivariable regression (linear or logistic) was used to adjust for covariates. For children, the crude model was adjusted for age at follow-up, gender of child and study trial arm (Model 1); we then additionally adjusted for environmental factors (urban/rural location and East/West Belarus, Model 2); and finally, we additionally adjusted for factors measured around birth and age 6.5 years (Model 3). In model 3, factors measured at 6.5 years were considered markers for potential mediators of associations between family socio-economic position and obesity i.e. parental BMI, smoking, and alcohol intake, and additional siblings since birth were considered to reflect the environment within which the child grew up and which could influence obesity risk. For waist circumference and percentage body fat, the basic model (equivalent to Model 1 above) and the multiply adjusted model (equivalent to Model 3 above) were computed. For the parents, the basic model adjusted for age and study trial arm (Model 1) was additionally adjusted for environmental factors (Model 2), own factors (including smoking, alcohol and number of children, Model 3) and partner's factors (smoking, alcohol and age, Model 4). Robust standard errors were used to compute confidence intervals (CIs) and *P*-values after accounting for possible non-independence of measurements by hospital/polyclinic site (clustering). The study trial arm (intervention or control) was included as a dummy variable in all regression models, although the intervention was not associated with any of the measures of childhood adiposity at age 6.5 years.[16] Differences in association by sex (for both children and parents) were investigated using the likelihood ratio test for interaction based on the maximally adjusted models. All analyses were conducted using Stata version 10.0 (Stata Corporation, Texas).

Results

Of 17 046 infants enrolled at baseline, 13 889 (81.5%) had measurements at age 6.5 years.

Supplementary tables S1 and S2 detail the characteristics of the girls and boys, and their parents, measured at baseline and follow-up. Overall, 44% of children came from manual households. At age 6.5 years, 10% of girls and 9% of boys were overweight/obese. Girls had higher percentage body fat (15.7% versus 14.5%) than boys. Overall, 37% of mothers and 53% of fathers were overweight/obese. There was little difference in the social characteristics among those living in the East versus the West of Belarus e.g. of mothers that completed university education, 48% lived in the East when compared with 52% in the West.

Overall, 180 (3%) girls, 135 (2%) boys, 81 (0.6%) mothers and 7 (0.1%) fathers were classified as thin and have been excluded from the main analyses, as have those with incomplete data on any covariates used in the maximally adjusted models. Therefore, 10 870 children (78% of the 13 889), 11 211 (81%) mothers and 11 132 (80%) fathers were included in the analyses. The association of each socio-economic indicator with BMI, waist circumference and skinfolds assessed as continuous variables did not differ significantly between girls and boys (all *P*-values for sex interaction ≥0.1). Thus, all remaining analyses are presented for girls and boys combined. Child BMI was positively correlated with mother's BMI and father's BMI (correlation coefficient = 0.19 for either parent). Children from non-manual households or whose parents had higher educational attainment had higher average BMIs, waist circumferences and subscapular and triceps skinfold thicknesses. Table 1 shows the associations of parental education and household occupation with the odds of child overweight/obesity at age 6.5 years. In the basic model, children with university educated or non-manual occupation parents had a 38% to 62% increased odds of overweight/obesity (*P* for trend < 0.01). These associations were attenuated with adjustment: children with university educated or non-manual occupation parents had a 27–49% increased odds of being overweight/obese (*P* for trend < 0.01) in the maximally adjusted model.

Table 2 shows the association of the socio-economic indicators with ≥90th percentile of waist circumference and percentage body fat in children. Each indicator of socio-economic position was positively associated with measures of adiposity in the basic model. A similar positive association was seen in the basic model between socio-economic position indicators and percentage body fat; in the multiply adjusted model, this association remained strong for mother's education. Associations were similar for subscapular and triceps skinfolds when analysed separately (results not shown).

The main covariable that diminished the association between socio-economic indicators and childhood adiposity outcomes (in tables 1 and 2) was father's BMI. Children from non-manual households were 39% (95% CI: 19%, 61%) more likely to be overweight/obese than those from manual households in the basic model; this reduced to 31% (95% CI: 12%, 53%) on further adjustment for father's BMI. In contrast, the covariable that most strengthened the association between socio-economic indicators and childhood adiposity was mother's BMI. In the basic model as above, children from non-manual households changed from 39% (95% CI: 19%, 61%) more likely to be overweight/obese to 43% (95% CI: 21%, 68%) more likely to be overweight/obese, on adjustment for mother's BMI. On stratifying fathers' BMI into two groups (higher or lower than the median), there was little evidence of a difference in the association of socio-economic indicators with childhood adiposity between the two strata in the maximally adjusted model (*P interaction > 0.2*). Children from non-manual households were 31% more likely to be overweight/obese if the father was more than or equal to median of fathers weight (95% CI: 9%, 57%) and 20% more likely to be overweight/obese if the father was less than median weight (95% CI: −5%, 52%).

The adjusted odds ratios (ORs) for each socio-economic indicator and overweight/obesity amongst mothers and fathers are shown in tables 3 and 4. Mothers from more educated or non-manual households were 22–44% less likely to be overweight/obese in the basic model. In contrast, fathers from more educated or non-manual households were 15–26% more likely to be overweight/obese. These associations were attenuated with adjustment for covariates. Fathers with partners who completed university were 16% more likely to be overweight/obese (*P* for trend = 0.02). The main covariate that diminished the association between socio-economic indicators and mother's overweight/obesity status was the number of children before the birth of the study child (maternal parity); for fathers, the main covariate was their smoking status. Of those mothers that attained the lowest level of education, 12% had two or more children whereas, of those mothers with the highest category of education only 5% had two or more children before the birth of the study child (chi-squared test, *P < 0.01*). The association between socio-economic indicators and overweight/obesity differed between mothers and fathers (*P* for sex interaction <0.01 for all three socio-economic measures).

Table 1 Association of socio-economic indicators with overweight and obesity[a] among children aged 6.5 years from Belarus (2002–05) ($n = 10\,870$)

	Number of children overweight/ obese	Percentage children overweight/obese	OR and 95% CI of overweight/obese versus normal weight					
			Model 1		Model 2		Model 3	
Mother's education								
Initial/incomplete/common secondary	288	8.0	1.0		1.0		1.0	
Advanced secondary/partial university	560	9.8	1.26	1.06–1.49	1.22	1.04–1.42	1.11	0.95–1.31
Completed university	195	12.4	1.62	1.32–1.99	1.56	1.27–1.92	1.49	1.21–1.85
P-value for trend			*<0.001*		*<0.001*		*0.001*	
Father's education								
Initial/incomplete/common secondary	352	8.4	1.0		1.0		1.0	
Advanced secondary/partial university	526	10.1	1.24	1.06–1.45	1.20	1.04–1.38	1.15	1.0–1.32
Completed university	165	11.2	1.38	1.13–1.69	1.33	1.09–1.63	1.40	1.13–1.72
P-value for trend			*0.001*		*0.003*		*0.003*	
Highest household occupation								
Manual worker	371	8.0	1.0		1.0		1.0	
Non-manual worker	672	10.8	1.39	1.19–1.61	1.36	1.18–1.57	1.27	1.10–1.47
P-value for trend			*<0.001*		*<0.001*		*0.001*	

Model 1: adjusted for age, gender of child and study trial arm. Model 2: as Model 1 and additionally adjusted for environmental factors: urban or rural residence and East or West of Belarus. Model 3: as Model 2 and additionally adjusted for factors measured around birth and at age 6.5 years: Measured at birth: maternal smoking during pregnancy, birthweight, breastfeeding at 3 months, parent's marital status, siblings at birth, maternal age and paternal age. Measured when study child was aged 6.5 years: maternal BMI, paternal BMI, maternal smoking, paternal smoking, maternal alcohol intake, paternal alcohol intake and additional siblings. In all Models, robust standard errors were used to compute CIs and *P*-values to account for clustering by polyclinic

a: As defined by ref. (22)

Discussion

Belarusian fathers and children from manual occupation or less educated households (the reference category) were less likely to be overweight/obese. However, mothers from manual occupation or less educated households were more likely to be overweight/obese. Among children, waist circumference and percentage body fat measurements were also higher among those from non-manual or more educated families. In general, these associations were robust to adjustment for a wide range of potential confounding covariates or potential mediators of these associations. The covariate which resulted in the greatest attenuation of the association between socio-economic position and childhood adiposity was father's BMI. In contrast, adjustment for maternal BMI resulted in a strengthening of the associations. These changes in the coefficient upon adjustment for parental BMI are, as would be expected, given the positive association between educational attainment and father's BMI, but inverse association between educational attainment and mother's BMI and the fact that both parent's BMI are positively associated with offspring BMI. The main covariate that diminished the association between socio-economic position and mother's overweight/obesity status was parity. Less educated mothers are likely to have more children than more educated mothers, suggesting that the association between socio-economic position and mother's adiposity may in part be mediated by the effects of parity.[24]

Limitations of the study include the fact that the parents' heights and weights were not measured; most were reported by the mother and thus may be prone to measurement error. If the error is random across socio-economic groups, then the expectation would be for this to bias the effect estimates towards the null; though we acknowledge that bias could be in either direction. Previous studies indicate that BMI tends to be underestimated when self-reported but with no clear socio-economic distribution.[25,26] BMI is likely to be less accurate if reported by a partner. Thus, we may have underestimated overweight/obesity prevalence among fathers in particular; nevertheless, we still found strong associations of socio-economic position and overweight/obesity in this group. BMI tends to overestimate adiposity in taller children and underestimate it in shorter children.[27] Nonetheless, BMI is a well-recognized proxy for general adiposity in children.[5] The equations of Slaughter *et al.* (used to convert subscapular and triceps skinfolds to percentage body fat) may overestimate body fat in children and compare poorly with other methods of body fat estimation.[28] Nevertheless, our findings were similar when we analysed subscapular and triceps skinfolds separately (results not shown).

Parents who were in school, housewives or unemployed were excluded from our analysis, but this is unlikely to explain the associations we observed. In addition, no measures were available of some important factors on the causal pathway between socio-economic position and overweight/obesity, such as physical activity and diet, which could help to explain the findings. However, other markers for childhood environment were available, such as parental smoking, alcohol intake and the number of siblings, and these were included in the analysis.

We found that absolute levels of overweight/obesity are relatively low among children in Belarus when compared with the USA (~10% when compared with >30%, respectively).[29] In comparison to other studies, the association between socio-economic position and adiposity among children in Belarus is similar to that among preschool children from developing countries[30] and adolescents in some transition economies (Croatia, Estonia and Latvia)[8] where adiposity is more prevalent among children with more educated/affluent parents. Our results are in contrast to those from western developed countries[5] and some other transition

Table 2 Association of socio-economic indicators with ≥90th percentile versus <90th percentile of measures of central and general adiposity among children aged 6.5 years from Belarus (2002–05) ($n = 10\,870$)

	Waist circumference						Percentage body fat					
	Children in ≥90th percentile		OR and 95% CI[a]				Children in ≥90th percentile		OR and 95% CI[a]			
	n	%	Basic model		Multiply adjusted model		*n*	%	Basic model		Multiply adjusted model	
Mother's education												
Initial/incomplete/common secondary	324	9.0	1.0		1.0		276	7.7	1.0		1.0	
Advanced secondary/partial university	591	10.4	1.19	1.01, 1.41	1.09	0.94, 1.27	524	9.2	1.24	0.99, 1.56	1.08	0.87, 1.35
Completed university	191	12.1	1.41	1.17, 1.71	1.30	1.10, 1.54	203	12.9	1.79	1.42, 2.26	1.51	1.21, 1.89
P for trend			*0.001*		*0.007*				*<0.001*		*0.004*	
Father's education												
Initial/incomplete/common secondary	380	9.0	1.0		1.0		332	7.9	1.0		1.0	
Advanced secondary/partial university	539	10.4	1.19	1.04, 1.37	1.16	1.03, 1.31	502	9.7	1.28	1.03, 1.60	1.19	0.98, 1.44
Completed university	187	12.7	1.48	1.22, 1.79	1.52	1.28, 1.81	169	11.4	1.54	1.11, 2.11	1.37	0.99, 1.89
P for trend			*<0.001*		*<0.001*				*0.006*		*0.041*	
Highest household occupation												
Manual worker	380	8.2	1.0		1.0		360	7.8	1.0		1.0	
Non-manual worker	726	11.6	1.50	1.29, 1.75	1.40	1.21, 1.62	643	10.3	1.39	1.15, 1.67	1.19	0.99, 1.44
P for trend			*<0.001*		*<0.001*				*0.001*		*0.064*	

Basic Model: adjusted for age, gender of child and study trial arm. Multiply adjusted model: Basic model additionally adjusted for all factors: urban or rural residence and East or West of Belarus, maternal smoking during pregnancy, birthweight, breastfeeding at 3 months, parent's marital status, siblings at birth, maternal age and paternal age measured around birth. In addition, maternal BMI, paternal BMI, maternal smoking, paternal smoking, maternal alcohol intake, paternal alcohol intake and additional siblings measured when study child was aged 6.5 years. Robust standard errors were used to compute CIs and *P*-values to account for clustering by polyclinic

a: ≥90th percentile versus <90th percentile

Table 3 Association of socio-economic indicators with overweight and obesity among mothers from Belarus (2002–05) ($n = 11\,211$)

	Number of mothers overweight/obese	% Mothers overweight/obese	OR and 95% CI overweight/obese versus normal weight mothers							
			Model 1		Model 2		Model 3		Model 4	
Mother's education										
Initial/incomplete/common secondary	1483	40	1.0		1.0		1.0		1.0	
Advanced secondary/partial university	2229	38	0.85	0.76, 0.94	0.87	0.78, 0.97	0.90	0.81, 1.00	0.92	0.83, 1.02
Completed university	582	36	0.57	0.51, 0.65	0.59	0.53, 0.66	0.65	0.57, 0.74	0.66	0.58, 0.75
P for trend			*<0.001*		*<0.001*		*<0.001*		*<0.001*	
Father's education										
Initial/incomplete/common secondary	1779	41	1.0		1.0		1.0		1.0	
Advanced secondary/partial university	2014	38	0.86	0.79, 0.93	0.88	0.81, 0.96	0.90	0.83, 0.98	0.91	0.84, 0.98
Completed university	501	33	0.56	0.49, 0.65	0.58	0.50, 0.66	0.61	0.53, 0.71	0.60	0.52, 0.69
P for trend			*<0.001*		*<0.001*		*<0.001*		*<0.001*	
Highest household occupation										
Manual worker	1924	40	1.0		1.0		1.0		1.0	
Non-manual worker	2370	37	0.78	0.72, 0.84	0.79	0.74, 0.84	0.83	0.77, 0.89	0.84	0.79, 0.90
P for trend			*<0.001*		*<0.001*		*<0.001*		<0.001	

Model 1: Adjusted for mother's age and study trial arm. Model 2: as Model 1 and additionally adjusted for environmental factors: urban or rural residence and East or West of Belarus residence. Model 3: as Model 2 and additionally adjusted for mothers factors: mothers smoking during pregnancy, current smoking, alcohol intake, number of children (at study child's birth and aged 6.5 years) and exclusive breastfeeding of the study child for 3 months. Model 4: as Model 3 and additionally adjusted for husbands or partner's factors: father current smoking, alcohol intake and age. Robust standard errors were used to compute CIs and *P*-values to account for clustering by polyclinic

Table 4 Association of socio-economic indicators with overweight and obesity among fathers from Belarus (2002–05) ($n = 11\,132$)

	Number of fathers overweight/obese	Percentage of fathers overweight/obese	OR and 95% CI overweight/obese versus normal weight fathers							
			Model 1		Model 2		Model 3		Model 4	
Mother's education										
Initial/incomplete/common secondary	1843	50	1.0		1.0		1.0		1.0	
Advanced secondary/partial university	3154	54	1.18	1.07, 1.30	1.19	1.08, 1.31	1.15	1.05, 1.26	1.14	1.04, 1.25
Completed university	928	57	1.26	1.08, 1.46	1.27	1.09, 1.48	1.19	1.02, 1.38	1.16	1.00, 1.35
P for trend			*0.001*		*0.001*		*0.012*		*0.018*	
Father's education										
Initial/incomplete/common secondary	2225	52	1.0		1.0		1.0		1.0	
Advanced secondary/partial university	2835	54	1.08	0.98, 1.18	1.09	1.00, 1.19	1.06	0.96, 1.16	1.05	0.96, 1.15
Completed university	865	57	1.15	0.99, 1.33	1.16	1.00, 1.35	1.06	0.91, 1.23	1.05	0.91, 1.22
P for trend			*0.052*		*0.032*		*0.305*		*0.371*	
Highest household occupation										
Manual worker	2417	51	1.0		1.0		1.0		1.0	
Non-manual worker	3508	55	1.15	1.06, 1.26	1.16	1.07, 1.26	1.11	1.03, 1.19	1.10	1.02, 1.18
P for trend			*0.001*		*<0.001*		*0.005*		*0.011*	

Model 1: Adjusted for father's age and study trial arm. Model 2: as Model 1 and additionally adjusted for environmental factors: urban or rural residence and East or West of Belarus residence. Model 3: as Model 2 and additionally adjusted for father's factors: fathers current smoking, alcohol intake and number of children (at study child's birth and aged 6.5 years). Model 4: as Model 3 and additionally adjusted for wife or partner's factors: mothers smoking during pregnancy, current smoking, alcohol intake and age. Robust standard errors were used to compute CIs and *P*-values to account for clustering by polyclinic

economies,[7,8,30] which report a higher prevalence of overweight/obesity among children from poorer backgrounds.

Amongst adults in Belarus, the overall prevalence of overweight/obesity among women and men was lower than that reported in the USA (37% and 53% when compared with 62% and 71%, respectively).[31] Our findings among women are consistent with recent findings in developing countries[32] and developed countries,[3,33] and other transition economies,[3,10,34] whilst our results among men are similar to those found in some developing countries,[4,32] and some[34] transition economies.

Comparisons between countries suggest that the relative wealth and economic development of a country may be important factors in the socio-economic patterning of obesity in adults and children, and this may be particularly important in transition economies where major economic changes are taking place.[8,32] It has been found that the burden of obesity shifts from the more affluent socio-economic groups to the poorer groups, as a country's wealth increases.[32] This shift occurs at an earlier stage of economic development among women, than it does for men.[32] Our findings in Belarus seem to support this view.

Data from the World Bank database (http://web.worldbank.org/) indicate that Gross Domestic Product (GDP) of Belarus has risen rapidly since 2002. In 2000, 41.9% of the population was below the poverty line and in 2002, this had decreased to 18.5%. These indicators point to a recent rise in GDP and drop in poverty rates in Belarus, suggesting a rising standard of living generally. In other transition economies, ownership of cars, TVs and computers, fast food consumption, alcohol and smoking have increased in the past decade,[35] all of which are factors associated with obesity. Our data suggest that susceptibility to these obesogenic factors may be socially patterned in Belarus.

The prevalence of obesity is rising in many parts of the world, a trend usually attributed to reduced physical activity and the spread of the 'Western diet' in the last few decades.[36] Growing evidence suggests that overweight and obesity are socially patterned[8,34] and so may contribute to trends in health inequalities in different populations.[37] There are few data regarding health inequalities in Belarus. However, in other former Soviet countries, less educated adults have worse self-reported health,[38] morbidity[38] and mortality[39] when compared with more educated adults. In our family-based study, we identified inequalities in the social patterning of overweight/obesity. The highest prevalence of overweight/obesity in children and their fathers was in non-manual/more educated households. However, in mothers the highest prevalence was in manual/less educated households. This information could be used to update public health knowledge on inequalities in overweight and obesity prevalence in Belarus and inform the development of potential intervention strategies. Further investigation is required to explore the mechanisms involved in the observed socio-economic pattering of childhood and adulthood obesity in Belarus.

Supplementary data

Supplementary data are available at *EURPUB* online.

Acknowledgements

The additional contributing members of the PROBIT Study Group are named. National Research and Applied Medicine Mother and Child Centre (Minsk, Belarus): Natalia Bazulko, Olga Gritsenko, Lidia Ovchinikova, and Julia Rizkovskaya. Polyclinic paediatricians: Drs Natalia Andreeva (Rogachev), Tatiana Avdeichuk (Brest), Elena Avsiuk (Vitebsk), Irina Baikevich (Slonim), Zinaida Bisucova (Zlobin), Irina Bujko (Oshmiany), Tamara Galushkina (Volkovysk), Marina Gotovchi (Brest), Danuta Iodkovskaya (Berestovitsa), Galina Ivanova (Mogilev), Larisa Kebikova (Minsk), Galina Kluchnikova (Ostrovets), Maria Kotliarovich (Soligorsk), Galina Kovalevskaya (Lepel), Natalia Krokas (Mosty), Nadezda Kushkova (Rechitsa), Afanasia Lazarenko (Klimovichi), Ludmila Lazuta (Minsk), Zinaida Liamkina (Borisov), Raisa Lisiura (Stolin), Tamara Nabedo (Novolukoml), Svetlana Pleskach (Baranovichi), Oksana Potapenko (Soligorsk), Svetlana Pridhodoskaya (Bereuza), Valentina Rahotskaya (Oshmiany), Irina Rogach (Mstislavl), Ludmila Rutkovskaya (Kobrin), Natalia Senchuk (Rechitsa), Elena Seraia (Baranovichi), Ludmila Sheveleva (Kobrin), Vera Shota (Svisloch), Anna Silvanovich (Shuchin), Lilia Smolskaya (Glubokoe), Valentina Solovey (Volkovysk), Zoya Solovyova (Dokshitsy), Natalia Tsarik (Svetlogorsk), Nadezda Turkovskaya (Zlobin), and Oxana Zarodova (Minsk Region).

Funding

The Canadian Institutes of Health Research (to M.K.) and from the European Union's project on Early Nutrition Programming: Long-term Efficacy and Safety Trials (grant code: FOOD-DT-2005-007036 to R.M.M. and G.D.S.). D.A.L. and G.D.S. work in a UK Medical Research Centre (grant code: G0600705). UK Economic and Social Research Council large grant (grant code: RES-060-23-0011 to D.A.L.). None of the funding bodies influenced the data collection, analysis or its interpretation for this paper. The views expressed are those of the authors and not necessarily any funding body.

Conflicts of interest: None declared.

Key points

- Studies examining inequalities in overweight/obesity prevalence among children and adults in eastern European and former Soviet countries reveal mixed findings. These associations have not previously been examined in Belarus, within families and using other measures of adiposity.
- We found that, in Belarus, children and their fathers from non-manual households were more likely to be overweight/obese, and their mothers less likely to be overweight/obese, than those from manual households.
- Children from non-manual households were also more likely to have larger waist circumferences and higher percentage body fat than those from manual households.
- The association between socio-economic position and adiposity may vary in different populations. This may have important public health implications.

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