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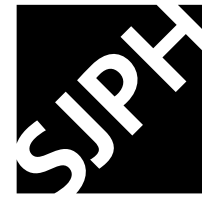
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ORIGINAL ARTICLE

## Trends in overweight and obesity in Danish children and adolescents: 2000–2008 – exploring changes according to parental education

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### Abstract

**Aims:** To examine the hypotheses that an overall levelling off in the prevalence of overweight and obesity during the period 2000–2008 has occurred, and that increasing social inequality in overweight and obesity exists in a nationally representative sample of Danish children and adolescents. **Methods:** The population comprised a random sample of 1849 children aged 4–14 years who participated in the Danish National Survey of Diet and Physical Activity in 2000–2002, 2003–2004 and 2005–2008. Parental education was chosen as an indicator of children's socioeconomic status. Body mass index (BMI) was calculated from parent-reported weight and height. Subjects were classified as overweight and obese according to the International Obesity Task Force age- and gender-specific BMI cut-off values. Crude prevalence estimates and logistic regression models were used to analyse trends in overweight and obesity as the main outcome measures. **Results:** An increase was found in the crude prevalence of overweight (including obesity) in boys (12.8–21.7%,  $p = 0.0006$ ), but not in girls (17.6–15.9%,  $p = 0.56$ ), between 2000–2002 and 2005–2008. The prevalence of overweight increased significantly in boys of parents with low educational level only. A strong inverse social gradient in overweight and obesity was documented for boys and girls during the whole survey period. **Conclusions:** The present study showed an increase in the prevalence of overweight in Danish boys, but not in girls. This increase was due to increasing social inequality in overweight among boys. Public health initiatives aimed at preventing and reducing overweight and obesity should consider gender difference and especially target boys with parents of low educational level.

**Key Words:** Denmark, development, obesity, Scandinavia, social disparity, socioeconomic status

### Introduction

Overweight and obesity in children has increased rapidly in Denmark and the rest of the world during the last decades [1–3]. The development of childhood obesity – now considered a global epidemic [4] – has been observed up until the early 2000s and since then a levelling-off has been reported in several European countries, including Denmark, in Australia and in the US [5–7].

The short- and long-term consequences of overweight and obesity in childhood and adolescence are, among other things, psychosocial problems, such as negative self-esteem and self-concept, and greater risk of diseases in adulthood such as type 2-diabetes

and coronary heart disease [8,9]. Overweight and obesity in childhood have a tendency to persist into adulthood [8]. Because of the adverse psychosocial and physical health outcomes, overweight and obesity should be prevented early during childhood.

An inverse social gradient in children's prevalence of overweight and obesity has been found in most cross-sectional studies [10,11] and the view of obesity as a social phenomenon is confirmed [12]. A Nordic Plan of Action was launched in 2006 to reduce the number of overweight and obese in the Nordic countries, especially among children and youth, and to use targeted action to reach risk groups

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and combat social inequality in health [13]. One of the goals for 2011 in this plan was to prevent deepening of existing differences between social groups with regard to overweight and obesity, and at best reduce these differences. Surveys to regularly monitor overweight and obesity were highlighted as an important part of the plan, in order to provide information on groups of risk and develop public health initiatives to prevent and reduce overweight and obesity and the related social gradient.

We have previously documented a significant increase in overweight in Danish children and adolescents from 1995 to 2000–2002 [3]. Since the year 2000, an overall levelling-off has been reported in children and adolescents from Europe and Australia with the levelling-off being less evident in the lower socioeconomic (SES) groups [5,6,14,15]. However, little is known about the development of overweight and obesity in children and adolescents from Scandinavia and across groups of different parental education. The aim of the present study was to examine the hypotheses that an overall levelling-off in the prevalence of overweight and obesity during the time period from 2000 to 2008 has occurred and that increasing social inequality in overweight and obesity exists in a nationally representative sample of Danish children and adolescents. Social inequality was examined across groups of parental education.

## Methods

### *Study population*

The study population included 4–14-year-old children and adolescents who participated in the Danish National Survey of Diet and Physical Activity (DANSDA) in 2000–2002, 2003–2004 and 2005–2008. The nationally representative surveys were cross-sectional and conducted continuously during 2000–2002, 2003–2004 and 2005–2008, comprising three simple random samples of non-institutionalized Danish citizens drawn from the Danish Civil Registration System. Participants received an invitation letter and were afterwards contacted by telephone. For the families who agreed to participate, verbal informed consent was obtained from a parent of each child prior to their participation.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and was approved by the Danish Data Protection Agency. The Danish National Committee on Health Research Ethics decided that the current study did not require their approval according to Danish Law.

### *Measures*

Information about core variables of children's weight and height and parental education was obtained through a face-to-face interview at participants' home. Trained and experienced interviewers performed the interviews after training courses conducted by the research group responsible for the surveys. One of the parents, usually the mother (88% of all children), reported weight and height of the participating child and their own educational level.

Parental education was chosen as an indicator of children's and adolescents' SES because studies have shown education to be the strongest and most consistent dimension of SES associated with overweight and obesity in children and adolescents in Western developed countries [10]. This indicates the importance of socio-cultural capital for weight status in children and adolescents. The educational variable included a combination of school education and further education, which is qualifying after school. The educational level of parents were categorized into three groups: "low educational level ( $\leq 13$  years)" (basic school  $\leq 12$  years or vocational education 13 years), "medium educational level (13–14 years)" (short higher education 13–14 years) or "high educational level ( $\geq 15$  years)" (medium higher education 15–16 years or long higher education  $\geq 17$  years). Parental education was defined on the basis of well-established, standard questions used in other Danish population surveys [16], and was classified in accordance with the standard used by Statistics Denmark. Body mass index (BMI) was calculated from parent-reported weight and height of the child by dividing body weight in kilograms by height in meters squared ( $\text{kg}/\text{m}^2$ ). Children and adolescents were classified as overweight and obese according to the International Obesity Task Force age- and gender-specific child BMI cut-off points corresponding to BMI values of 25 and 30  $\text{kg}/\text{m}^2$  for adults [17]. Children were categorized as being overweight if they exceeded BMI cut-off points for overweight or obesity.

### *Statistical analysis*

Descriptive analyses of the trends in overweight and obesity among children and adolescents were carried out in order to compare our results with the previously reported data [3]. Crude prevalence estimates of overweight and obesity were constructed by simple counting of the data material, that is, counting the numbers of overweight and obese children and adolescents for each gender and survey year. Differences in crude prevalence estimates between survey periods were analysed by means of  $z$  tests (presented in Figure 1).

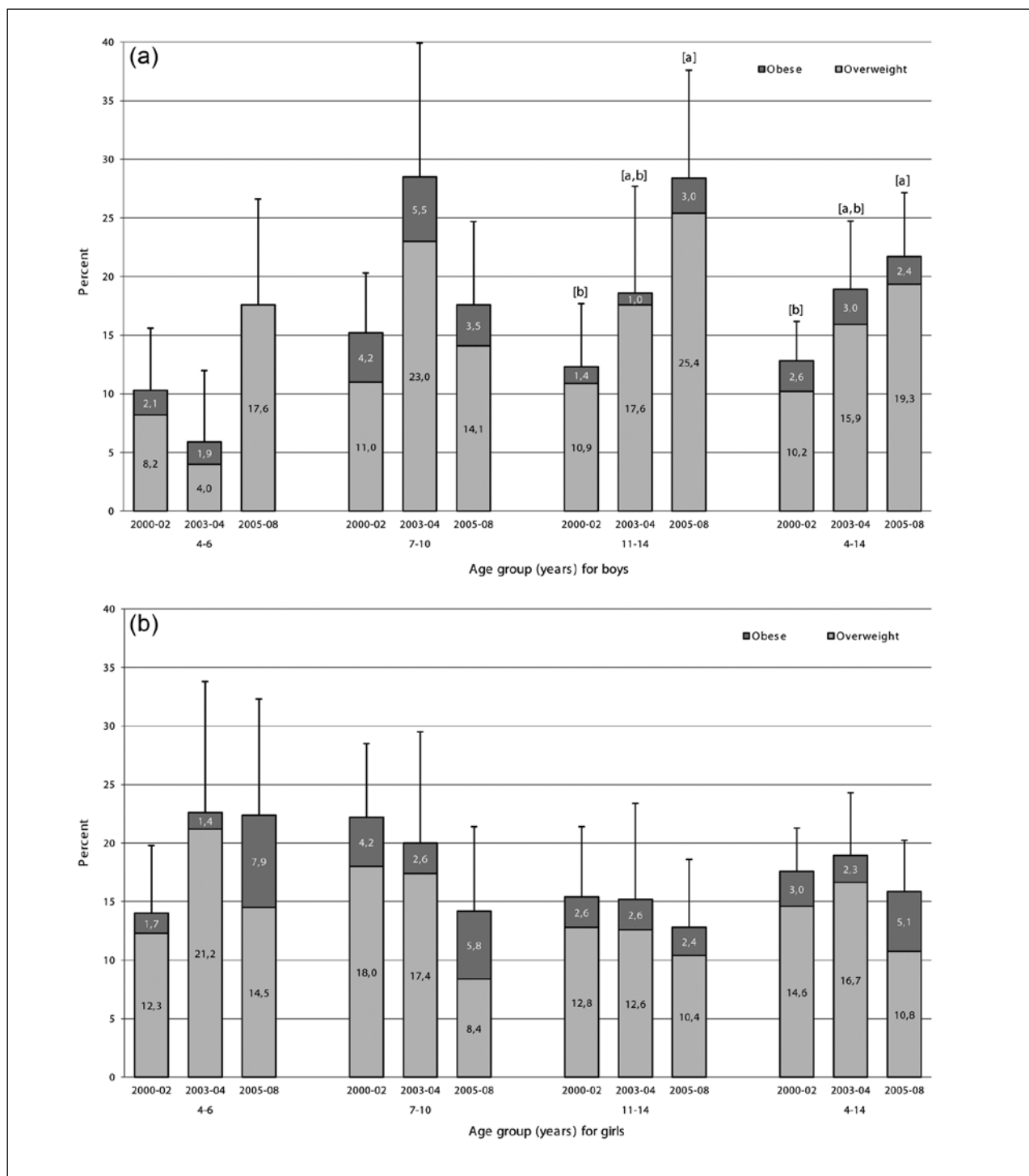


Figure 1. The crude prevalence estimates of overweight (excluding obesity) and obesity among 4–14-year-old Danish boys (Figure 1a) and girls (Figure 1b) in 2000–2002, 2003–2004 and 2005–2008. Crude prevalence estimates of overweight (including obesity) with unlike superscript letters (a, b) were significantly different between survey periods ( $P < 0.05$ ) within each age group ( $\chi^2$  test).

The descriptive analyses were supplemented by logistic regression models that examined the association of parental education with overweight and obesity. The probabilities of overweight and obesity were

fitted with two different logistic regressions models, with gender (boys, girls), age group (4–6 years, 7–10 years, 11–14 years), parental education (low, medium, high) and survey year (2000–2002, 2003–2004,

Table I. Characteristics of the study population from the Danish National Survey of Diet and Physical Activity (DANSDA) 2000–2002, 2003–2004 and 2005–2008.

	2000–2002	2003–2004	2005–2008
	( <i>n</i> = 938)	( <i>n</i> = 412)	( <i>n</i> = 594)
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)
<i>Gender</i>			
Boys	484 (51.6)	207 (50.2)	295 (49.7)
Girls	454 (48.4)	205 (49.8)	299 (50.3)
<i>Age (years)</i>			
4–6	272 (29.0)	125 (30.3)	142 (23.9)
7–10	379 (40.4)	141 (34.2)	217 (36.5)
11–14	287 (30.6)	146 (35.4)	235 (39.6)
<i>Parental education (years)<sup>a</sup></i>			
Low (< 13)	511 (59.6)	238 (61.7)	263 (47.0)
Medium (13–14)	117 (13.6)	47 (12.2)	56 (10.0)
High (> 15)	230 (26.8)	101 (26.2)	240 (42.9)

<sup>a</sup>Low (< 13 years): basic school < 12 years or vocational education 13 years; Medium (13–14 years): short higher education 13–14 years; High (> 15 years): medium higher education 15–16 years or long higher education > 17 years. Attending school and upper secondary school (12 years) were not included in the analyses.

2005–2008) and interactions between these as explanatory variables. Interactions were included to test whether trends in overweight and obesity varied within groups of parental education. Significant interactions were further scrutinized. Significance testing was performed using the (Chi-square) Likelihood Ratio test and *p* values below 0.05 were considered to be significant. Prevalence estimates of overweight and obesity and their 95% CI were calculated from the logistic regression estimates through the inverse logistic transformation. To account for non-response, all presented prevalence estimates were weighted using census data from Statistics Denmark to reflect the general population of children and adolescents in Denmark according to gender, age and survey year (descriptive analyses) and gender, age, parental education and survey year (logistic regression models). All analyses were carried out by use of S-PLUS® version 8.0 professional edition.

## Results

### *Study population*

Characteristics of the study population of children and adolescents are given in Table I. The study population comprised 1944 children and adolescents. In total, 1155, 526 and 768 Danish children and adolescents were invited to participate in 2000–2002, 2003–2004 and 2005–2008, respectively, of which 901 (78.0%), 392 (74.5%) and 556 (72.4%) completed the interview and had plausible values for both weight and height and were available for analysis.

### *Trends in overweight and obesity*

The descriptive analyses found a significant increase in the crude prevalence estimate of overweight (including obesity) in 4–14-year-old boys from 2000–2002 to 2005–2008 (from 12.8% (95% CI: 9.4; 16.2) to 21.7% (16.3; 27.2), *p* = 0.0006, Figure 1a), and analyses based on age groups found the only significant increase in overweight during this survey period among 11–14-year-old boys (from 12.3% to 28.4%, *p* = 0.003). For girls aged 4 to 14 years, no significant change in overweight was found from 2000–2002 to 2005–2008 (from 17.6% (13.9; 21.3) to 15.9% (11.5; 20.2), *p* = 0.56, Figure 1b).

The logistic regression models showed a similar pattern to the descriptive analyses. However, an earlier rise was evident among boys aged 4 to 14 years; that is between 2000–2002 to 2003–2004 (from 13.4% (10.7; 16.7) to 17.7% (15.7; 19.8), *p* = 0.02, not tabulated), rather than the 2000–2002 to 2005–2008 rise shown by the descriptive analyses. No other significant changes were found in the prevalence of overweight, between gender, age groups or survey years.

For obesity, neither the descriptive analyses nor the logistic regression models showed significant changes over time or within survey years, in either gender or age groups, suggesting stability in obesity prevalence.

### *Trends in overweight and obesity according to parental education*

Parental education was significantly associated with the prevalence of overweight and obesity in children

Table II. Significant logistic regression coefficients for the trend analysis of *overweight* (including obesity) for boys and girls, and the associated prevalence estimates, grouped by parental education and survey year. Survey years 2003–2004 and 2005–2008 were collapsed within each educational group due to insignificant differences. The medium and high educational group were collapsed similarly. *P* values are for test groups relative to the reference group (low education, 2003–2008).

Overweight						
	Boys			Girls		
	$\beta$ (95% CI)	Prevalence (95% CI)	<i>p</i> value ( $\beta$ )	$\beta$ (95% CI)	Prevalence (95% CI)	<i>p</i> value ( $\beta$ )
<i>Parental education</i>						
Low, 2003–2008 (reference)	-1.32 (-1.50; -1.14)	21.1 (18.3; 24.2)	-	-1.32 (-1.50; -1.14)	21.1 (18.3; 24.2)	-
Low, 2000–2002	-1.81 (-2.17; -1.44)	14.1 (10.3; 19.1)	<0.02	-1.32 (-1.50; -1.14)	21.1 (18.3; 24.2)	NS
Medium/High, 2003–2008	-1.99 (-2.21; -1.77)	12.0 (9.9; 14.6)	<0.0001	-1.99 (-2.21; -1.77)	12.0 (9.9; 14.6)	< 0.0001
Medium/High, 2000–2002	-1.99 (-2.21; -1.77)	12.0 (9.9; 14.6)	<0.0001	-1.99 (-2.21; -1.77)	12.0 (9.9; 14.6)	< 0.0001

Table III. Significant logistic regression coefficients for the trend analysis of *obesity* for boys and girls, and the associated prevalence estimates, grouped by parental education. Survey years 2000–2002, 2003–2004 and 2005–2008 were collapsed within each educational group due to insignificant differences. The medium and low educational group were collapsed similarly. *P* values are for test groups relative to the reference group (medium/low education).

Obesity			
Boys and girls			
	$\beta$ (95% CI)	Prevalence (95% CI)	<i>p</i> value ( $\beta$ )
<i>Parental education</i>			
Medium/Low (reference)	-3.29 (-3.60; -2.98)	3.6 (2.7; 4.8)	-
High	-4.09 (-4.75; -3.43)	1.7 (0.9; 3.1)	< 0.0001

and adolescents. For overweight, a significant interaction was found between education, gender and survey year as a result of boys of parents with low educational level in 2000–2002 differing from the rest of the low educational group (boys 2003–2008 and girls 2000–2008, Table II). This was the only significant gender difference found during the whole survey period, with boys in the low educational group in 2000–2002 having a lower prevalence during this survey year. No significant difference was found between age groups during the survey period. The group “low education, 2003–2008” was chosen as reference, as this was the relevant group to compare boys of parents with low educational level in 2000–2002 with in order to examine time trends within the low educational group.

The prevalence of overweight increased significantly in boys of parents with low educational level between 2000–2002 and 2005–2008 (from 14.1% to 21.1%,  $p = 0.02$ ). No significant differences were found between 2003–2004 and 2005–2008, and between the medium and high educational group during the whole survey period. The common prevalence rate of overweight for the medium and high educational group was significantly lower than the

prevalence in the low educational group in 2003–2008 ( $p < 0.0001$ ). No changes were found in boys of parents with medium or high educational levels (2000–2008: 12.0%). The prevalence of overweight among girls of parents with low educational level was high compared with the medium and high educational group during the whole survey period (low: 21.1% – medium/high: 12.0%,  $p < 0.0001$ ). This indicates that the social differences in overweight persisted for girls from 2000 to 2008. Despite a better starting point in 2000–2002 (14.1%), in 2003–2008, boys of parents with low educational level reached the same prevalence rate of overweight as girls of parents with low educational level had in 2000–2002 (21.1%). Consequently, social inequality in overweight in 2005–2008 was high for both genders (low: 21.1% – high: 12.0%,  $p < 0.0001$ ).

For obesity, the prevalence rate did not differ significantly between the low and medium educational group during the whole survey period. The prevalence of obesity was 3.6% for the low and medium group, compared to 1.7% for high educational level ( $p < 0.0001$ , Table III) with no difference between genders ( $p = 0.63$ ), age groups ( $p = 0.12$ ) or survey years ( $p = 0.89$ ).



## Discussion

The present study provides new knowledge on the development of overweight and obesity in Danish children and adolescents overall and particularly according to the educational level of parents. This study is among the first to report nationally-representative data on overweight and obesity since the year 2000 and covers a wide age range of children and adolescents and all regions of Denmark.

Our results support the hypothesis that there is a potential levelling off in the prevalence of overweight, however this was only found in girls, whereas a levelling off was not evident in boys. The prevalence of overweight in girls has stabilized from 2000–2002 to 2005–2008 after a previously observed increase between 1995 and 2000–2002 [3]. This is in agreement with data on overweight and obesity from nine countries showing a more significant trend for stabilization in girls than boys [6]. The continuing increase in overweight among Danish boys is worrying from a public health perspective. According to the logistic regression analysis the prevalence of overweight increased in Danish boys from 2000–2002 to 2003–2004, whereas there was no change between 2003–2004 and 2005–2008. This could indicate that a potential stabilization has occurred later in boys than girls. However, a longer time period will be needed to determine how the obesity epidemic develops as previous studies have demonstrated that the prevalence of overweight and obesity rises in phases in which stability is followed by further increases [18]. As trends are not necessarily homogeneous in Scandinavia and other parts of the world, overall these results suggest that the levelling off in the childhood obesity epidemic could be specific in terms of gender, age, SES or education, country and starting year.

One explanation of the gender difference could be a less favourable development in physical activity among boys than girls, for example in time spent on sports and screen time. Between 2000 and 2008, screen-time increased and time spent on sports did not change in boys whereas the opposite was seen in girls (data not shown; [see supplementary file 1]). Gender differences in weight concern, body perception and dieting may also play a role: boys are less likely than girls to perceive themselves as overweight or obese and to be dieting [19], possibly because cultural norms and societal pressure from mass media and advertisement do not dictate as strict standards of ideal weight for males as for females [20].

### *Social inequality and overweight and obesity*

The hypothesis of increasing social inequality in overweight was confirmed by the present study for

boys. We did observe heterogeneity in overweight trends across educational groups, as the prevalence of overweight increased in boys of parents with low educational level only whereas stabilization was observed in boys of parents with medium and high educational level. Other Danish and Swedish studies of schoolchildren have also found increasing social inequality in overweight and obesity [21,22]. However, none of these studies have documented a gender-specific polarization in overweight and obesity across educational or SES groups. Sundblom et al. [22] did find some evidence of a widening gender-specific gap in obesity, as prevalence rates rose in boys from socioeconomically disadvantaged areas only. Moreover, in line with our findings, Sundblom et al. [22] showed that lower SES boys had a better starting point of obesity than girls in 1999. The limitations of the Swedish study of schoolchildren, however, was that it only included 10-year-old children in Stockholm County and SES was not determined on an individual level.

The increasing social gradient may be a result of different receptions of public health messages and interventions promoting healthy eating and physical activity by different SES groups and genders, as suggested by Sundblom et al. [22]. It is possible that public health initiatives aimed at preventing overweight and obesity have been more successful for girls overall and for boys of parents with high educational level [23] where a higher health consciousness has been documented [24,25].

A strong inverse social gradient in overweight and obesity was documented for both boys and girls during the whole survey period. The prevalence of overweight was 76% higher and prevalence of obesity more than two times higher in children and adolescents of parents with low educational level when compared with children and adolescents of parents with high educational level. These results support the conclusions of social inequality in overweight and obesity by most studies from Western developed countries [10,11].

### *Strengths and limitations*

A major strength of the present study lies in the nationwide character: the three consecutive data sets were based on representative samples of children and adolescents with all age groups between 4 and 14 years represented, and it provides the most recent trends in overweight and obesity in all regions of Denmark. The high response rate (72%–78%) of the population adds support for the representativeness. However, children of parents with low educational level were under-represented. Thus, the possibility of systematic differences in overweight and obesity

between participating and non-participating children and adolescents in DANSDA cannot be ruled out.

We believe it is a limitation that the sample size is somewhat small for detailed examination of overweight and obesity trends for the age range studied. This could lead to a loss of statistical power. The use of parent-reported weight and height is a limitation also as it may have resulted in biased estimates of the true prevalence of overweight and obesity due to misclassification errors, especially among young children [26–28]. However, this may only have impact on the observed trends if parental reporting has changed during the survey period which seems unlikely. We have previously assessed the validity of parent-reported child overweight in 43 randomly selected children aged 4 to 14 years retrieved from the Danish Civil Registration System [29]. Results showed that the prevalence of parent-reported overweight was overestimated by five percentage points (28%–23%). This finding is in agreement with previous reports [26,27], but should nevertheless be interpreted with caution due to the small sample size. Several other studies have investigated reporting bias in overweight and obesity derived from parent-reported weight and height, but they give inconsistent results [27,28]. Thus the picture is less clear than in adults where the prevalence of overweight and obesity are systematically underestimated [30].

In conclusion, the present study showed that since the year 2000, there has been a levelling off in the prevalence of overweight in Danish girls aged 4 to 14 years, but an increase in boys. The development across educational groups was heterogeneous as the increase in boys was due to increasing social inequality in overweight. An overall strong inverse social gradient in overweight and obesity was documented in boys and girls in the present study. Thus, the social gap persists in girls and is widening in boys. Public health initiatives aimed at preventing and reducing overweight and obesity should consider gender differences and especially target boys with parents of low educational level. A broader primary prevention strategy to promote healthy weight among children and adolescents could be to raise educational levels of parents as a high level of education may contribute to protect against childhood overweight and obesity.

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### Conflict of interest

None declared.

### Ethical standards

The research performed in the Danish National Survey of Diet and Physical Activity complies with the current laws of Denmark.

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