Scandinavian Journal of Public Health

http://sjp.sagepub.com

Prevalence and trends in overweight and obesity among children and adolescents in Denmark

Jeppe Matthiessen, Margit Velsing Groth, Sisse Fagt, Anja Biltoft-Jensen, Anders Stockmarr, Jens Strodl Andersen and Ellen Trolle

Scand J Public Health 2008; 36; 153
DOI: 10.1177/1403494807085185

The online version of this article can be found at:
http://sjp.sagepub.com/cgi/content/abstract/36/2/153

Published by:
SAGE Publications
http://www.sagepublications.com

On behalf of:
Associations of Public Health in the Nordic Countries

Additional services and information for *Scandinavian Journal of Public Health* can be found at:

Email Alerts: http://sjp.sagepub.com/cgi/alerts

Subscriptions: http://sjp.sagepub.com/subscriptions

Reprints: http://www.sagepub.com/journalsReprints.nav

Permissions: http://www.sagepub.com/journalsPermissions.nav

Citations (this article cites 26 articles hosted on the SAGE Journals Online and HighWire Press platforms):
http://sjp.sagepub.com/cgi/content/refs/36/2/153

Downloaded from http://sjp.sagepub.com by on March 11, 2008
© 2008 Associations of Public Health in the Nordic Countries Regions. All rights reserved. Not for commercial use or unauthorized distribution.

Scandinavian Journal of Public Health, 2008; 36: 153–160

ORIGINAL ARTICLE

Prevalence and trends in overweight and obesity among children and adolescents in Denmark

JEPPE MATTHIESSEN[1], MARGIT VELSING GROTH[1], SISSE FAGT[1], ANJA BILTOFT-JENSEN[1], ANDERS STOCKMARR[2], JENS STRODL ANDERSEN[3] & ELLEN TROLLE[1]

[1]*Department of Nutrition, National Food Institute, Technical University of Denmark, Søborg, Denmark,* [2]*Department of Veterinary Diagnostics and Research, Section for Epidemiology, National Food Institute, Technical University of Denmark, Søborg, Denmark, and* [3]*Department of Microbiology and Risk Assessment, Danish Zoonosis Centre, National Food Institute, Technical University of Denmark, Søborg, Denmar*

Abstract

Aim: To study the current prevalence and trends in overweight and obesity among children and adolescents in Denmark from 1995 to 2000–2002. *Methods:* Cross-sectional national dietary surveys were conducted in 1995 and 2000–2002. The analysis was based on two random population samples from the Danish civil registration system. Body mass index (BMI) was calculated from self-reported height and weight for 1,026 and 1,152 children and adolescents (4–18 years), who participated in 1995 and 2000–2002, respectively. The prevalence of overweight and obesity was defined according to the international age and gender-specific child BMI cut-off points. In the statistical analysis, overweight and obesity were included in the prevalence of overweight. *Results:* Mean BMI increased significantly between 1995 and 2000–2002 for all combinations of age groups (4–6, 7–10, 11–14 and 15–18 years) and genders. Prevalence of overweight increased between survey years for boys and girls for all age groups (4–6, 7–10, 11–14 and 15–18 years), although formal statistical significance was not reached ($p > 0.05$). When all children and adolescents (4–18 years) were analysed, the prevalence of overweight rose significantly from 10.9% (95% confidence interval (CI) 9.0–12.8) to 14.4% (95% CI 12.5–16.3) between 1995 and 2000–2002 ($p=0.01$), whereas the increase in the prevalence of obesity did not reach significance (1995, 2.3% (95% CI 1.3–3.3) vs. 2000–2002, 2.4% (95% CI 1.6–3.3); $p=0.74$). ***Conclusions:*** **The present study revealed a significant increase from 1995 to 2000–2002 in mean BMI for boys and girls for all age groups and a significant increase in the prevalence of overweight when all Danish children and adolescents (4–18 years) were analysed.**

Key Words: *Body mass index, children, Denmark, obesity, trend*

Background

The prevalence of overweight and obesity on a global level has increased dramatically during recent decades, and the development is now considered to represent a global epidemic [1,2]. The obesity epidemic represents a growing threat to public health, due to its substantial contribution to the global burden of chronic diseases. These include type 2 diabetes, cardiovascular disease, and a variety of cancers. The impact of morbidity and mortality associated with the rising prevalence of obesity has been estimated to represent between 2% and 7% of total healthcare costs for several developed countries [1].

The increasing prevalence rate of overweight and obesity among children and adolescents is of special concern, since overweight and obesity in childhood and adolescence are linked to subsequent morbidity and mortality in adulthood [2–4]. Negative health implications are associated with this excess weight: development of cardiovascular risk factors; reduced capacity for physical activity; and significant

Correspondence: Jeppe Matthiessen, Department of Nutrition, National Food Institute, Technical University of Denmark, Mørkhøj Bygade 19, DK-2860 Søborg, Denmark. Tel: +45 72 34 74 44. Fax: +45 72 34 71 19. E-mail: jem@food.dtu.dk

(Accepted 15 May 2007)

© 2008 the Nordic Societies of Public Health
DOI: 10.1177/1403494807085185

Downloaded from http://sjp.sagepub.com by on March 11, 2008
© 2008 Associations of Public Health in the Nordic Countries Regions. All rights reserved. Not for commercial use or unauthorized distribution.

psychosocial problems, such as teasing, bullying and low self-esteem [3–5]. Overweight and obesity in childhood and adolescence has a tendency to continue into adulthood [3,4]. Therefore, due to the increasing proportion of overweight and obese children and adolescents, the global community faces a health crisis that will affect the next generation of adults. Thus, current prevalence and trends in overweight and obesity among children and adolescents should be closely monitored, and action plans implemented if necessary.

The rapid increase in the prevalence of overweight and obesity strongly indicates that unfavourable changes in environmental and behavioural factors are the main reasons for the higher proportion of overweight and obese children and adolescents [1,6]. It is generally agreed that sedentary lifestyles and energy-dense diets contribute to the development of overweight and obesity [1,6].

Previous studies have shown that overweight and obesity among schoolchildren in Copenhagen and in Danish male conscripts has increased significantly since World War II [7,8]. Studies elucidating status and trends in overweight and obesity among Danish children and adolescents are either not nationally representative [7,9] or include only a few selected age groups [10,11]. None of these studies has published data on preschool children.

Aim

The aim of the present study was to study the current prevalence and trends in overweight and obesity in a wide age range of Danish children and adolescents [4–18 years], on the basis of data from two national dietary surveys conducted in 1995 and 2000–2002.

Methods

The present study was based on two cross-sectional national dietary surveys, called the Danish National Dietary Survey 1995 and 2000–2002, conducted during three periods in 1995 (February, May and August) and continuously during 2000–2002. The analysis was based on two random samples of children and adolescents aged 4–18 years. Information about height, weight, social background, health, practices, attitudes and knowledge of diet was obtained through a personal face-to-face interview lasting for approximately 30 minutes. Consequently, data about height and weight were self-reported. Trained interviewers from PLS Consult (1995; $n=60$) and SFI-Survey (2000–2002; $n=65$) were responsible for the interviews after a training course conducted by the research group responsible for the surveys.

When children younger than 15 years of age participated in the surveys, one of their parents, usually the mother (90% of all children), was interviewed, and reported their child's height and weight; whereas adolescents equal to or older than 15 years of age were interviewed and reported their own height and weight. Although one of the parents was interviewed, children below 14 years of age were allowed to participate in the interview. No information was collected on how up to date the parents and the adolescents were about their child's or their own current height and weight.

Subjects

In 1995, the study population was a random sample from the Danish civil registration system, aged 4–18 years, stratified by age (1-year age groups) and gender. In total, 1,453 children and adolescents were invited, and 1,135 completed the interview; a participation rate of 78%. Height and weight were reported for 1,026 participants (488 boys and 538 girls; response rate for height and weight 71%). In 2000–2002, the study population was a simple random sample (without stratification of age and gender) from the Danish civil registration system, aged 4–18 years. In total, 1,517 children and adolescents were invited, and 1,192 completed the interview; a participation rate of 79%. Height and weight were reported for 1,152 participants (573 boys and 579 girls; response rate for height and weight 76%). In both surveys, the participation rate was highest among the parents of the 11–14-year-old girls (1995, 78%; 2000–2002, 83%) and lowest among the 15–18-year-old boys (1995, 55%; 2000–2002, 58%), who themselves were interviewed. In comparison with national data from Statistics Denmark, the distribution of gender and age for the participants in the two national dietary surveys could be characterized as close to representative for the Danish population of children and adolescents aged 4–18 years.

Definition of overweight and obesity

Body mass index (BMI) was calculated from the self-reported height and weight. BMI reference values for Danish children and adolescents are available [12], but so far no specific national age and gender cut-off points for overweight and obesity have been defined. Hence, the prevalence of

Downloaded from http://sjp.sagepub.com by on March 11, 2008
© 2008 Associations of Public Health in the Nordic Countries Regions. All rights reserved. Not for commercial use or unauthorized distribution.

overweight and of obesity in children and adolescents was defined according to the international age- and gender-specific child BMI cut-off points [13], corresponding to BMI values of 25 and 30 kg/m^2 for adults aged >18 years. BMI cut-off points for full years were used, as the participants reported their age in whole years. One 13-year-old boy with a BMI of 55 was excluded because of inconsistencies in data. Comparison of the international BMI cut-off points for the 4–18-year-olds [13] with the Danish BMI reference values [12] shows that the international cut-off points for overweight and obesity lie above the Danish 90th and 99th percentile curve for boys and girls for all age groups, except for the 4–6-year-old girls. The Danish reference values are comparable to those of The Netherlands, which is one of the six nationally representative samples constituting the international reference population of the child BMI cut-off points [13].

Statistical analysis

Owing to correlation between participation rate and age/gender, sampling weights were used not only for the 1995 survey but for each combination of survey year, 1-year age group and gender when compiling estimates at a population level. The reference population used was that of the 2000–2002 survey data corrected for participation rate. Hence, sampling weights represent the proportion of the groups in the reference population. Age was categorized, in accordance with the Nordic Nutrition Recommendations 1996, into the following groups: 4–6, 7–10, 11–14 and 15–18 years. Results are presented as means (with 95% confidence interval (CI)) and 90th percentile cut-off point of BMI for each gender and age group. The distribution of BMI for the 1995 and 2000–2002 surveys were adjusted for non-representative within-group age distribution, by calculating the group mean and frequency as weighted averages, letting each one-year age group contribute according to the population frequency of the 1-year age group. Potential differences in BMI between the surveys were analysed statistically using maximum-likelihood inference. In order to compare the Danish population of 4–18-year-old persons between survey years, artificial 1995 and 2000–2002 populations were constructed as estimates for the distribution of BMI for the whole population at the given time. This construction was necessary because of the 1995 sampling scheme not being completely representative, and varying levels of non-respondents among age groups. The artificial populations were used solely for population comparisons, and do not form the basis of any of the analytical models described below. For each combination of gender, survey year and 1-year age groups, BMI observations were repeated a number of times; the largest integer was smaller than 1,000 times the ratio of the population frequency and the survey frequency. The repeated observations were then gathered in two survey year BMI distributions, such that the contribution of each gender/age group to these artificial 1995 and 2000–2002 populations corresponded to the 2000–2002 frequency. BMI density was then estimated by calculating the interval frequency for intervals of ¼ kg/m^2, and constructing the function with the interval frequencies as constant values in each interval of ¼ kg/m^2. This density was then smoothed twice with a standard gaussian kernel and a window size of 1. BMI turned out to be non-normally distributed and was transformed with the function $f(x)=\log(x)/x^{3/2}$ to obtain normality, the transformation being optimal for normality (Kolmogorov–Smirnoff test statistic) among the class $f_a(x)=x^a\log(x)$, with a being any real number. The transformed BMI was then fitted with a standard analysis of variance model, with gender, age, age group and survey year as explanatory variables. Unless otherwise stated, all inferences concerning BMI are based on this model. In order to obtain a smooth relationship between BMI and age, BMI was subsequently fitted with a generalized additive model (GAM) with age represented in one-year age groups. In its most general form, the GAM comprises a number of functions f_j, describing the relationship between the explanatory variables X (gender, age and survey year) and the dependent variable BMI.

$$f(BMI)=\alpha+\sum_{j=1}^{p} f_j(X_j)+\varepsilon,$$

Here we use $p=3$, a cubic spline consisting of piecewise third-order polynomials, which showed the best fit, and the model comprises interaction between gender, survey year and cubic spline. Reduction of the GAM was done with likelihood ratio tests on a 5% significance level.

In the statistical analysis, overweight prevalence rates include children and adolescents who were classified as overweight or obese. The probability of overweight was fitted with a logistic regression model, with explanatory variables similar to those in the BMI analysis of variance. Unless otherwise stated, all inferences concerning the probability of overweight are based on this model. The reason for including both age and age group is to minimize the somewhat arbitrary effects caused by the cut-off

Downloaded from http://sjp.sagepub.com by on March 11, 2008
© 2008 Associations of Public Health in the Nordic Countries Regions. All rights reserved. Not for commercial use or unauthorized distribution.

used for categorization of the groups. Since the age group acts as a covariate in the logistic regression model and interacts with gender, comparisons with other studies with different age groups are based on weighted averages of observed overweight (which includes obesity), rather than estimates from the logistic regression model. Because of too few cases (1995, $n=25$; 2000–2002, $n=26$), a logistic regression was not carried out for the analysis of probability for obesity for boys and girls for age groups, except for the whole group of 4–18-year-old boys and/or girls. This analysis was carried out using weighted estimates for each combination of gender, age group and survey year, where the estimates were obtained as frequencies from the study populations.

The calculations were done in S-PLUS 6.2 prof. *p*-values below 0.05 were considered to be significant.

Results

Mean BMI increased significantly between 1995 and 2000–2002 for all combinations of age group and gender (Table I). With the exception of the 11–14-year-old boys and the 4–6-year-old girls, the 90th percentile BMI increased (0.3–1.3 kg/m^2) for all age groups. Figure 1a shows the estimated BMI distributions for the survey years 1995 and 2000–2002. In Figure 1b, the difference between the two distributions is seen as a right-handed shift that amounts to 4.7% of the probability mass, which is shifted from BMI values below 17.25 kg/m^2 (1995) to BMI values above 17.25 kg/m^2 (2000–2002) during the 5–7-year study period. The transformation is mainly seen from the interval 13–17.5 kg/m^2 (1995) to the interval 17.5–28 kg/m^2 (2000–2002).

The fitted GAM shows a highly significant non-linear relationship between BMI and age regression ($p<0.0001$; Figure 2); however, the curvature does not change for the different survey years. For the GAM model, gender was not significant ($p=0.38$), but the difference between survey years is highly significant ($p<0.0001$).

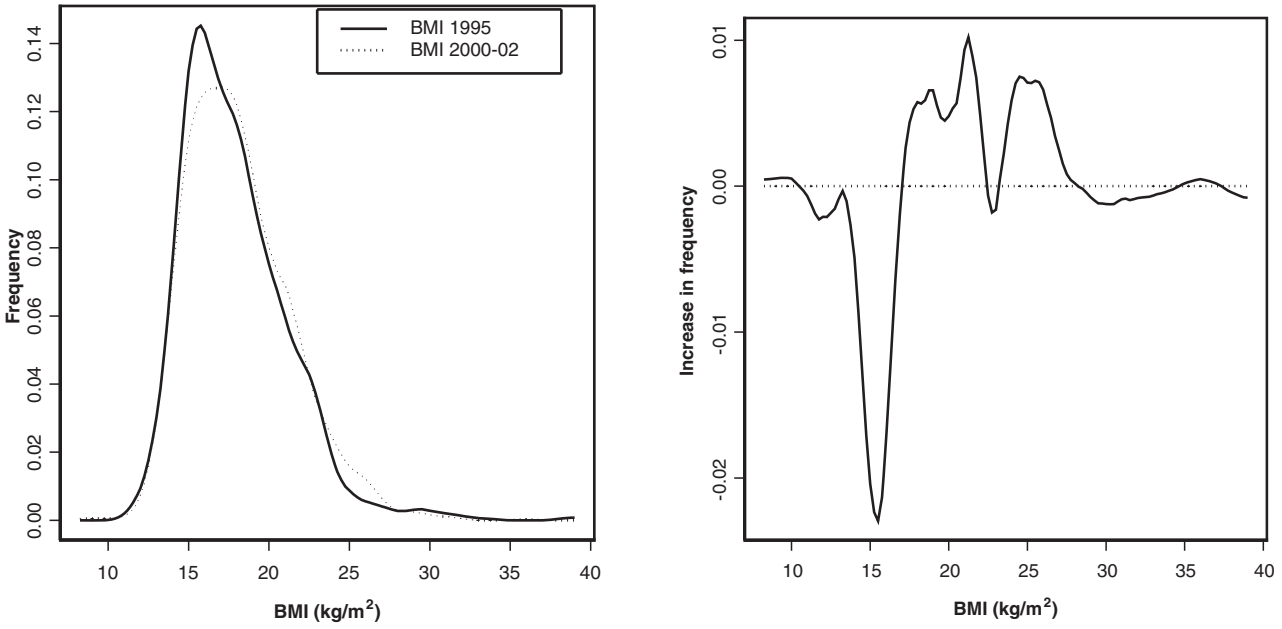
Between 1995 and 2000–2002, the logistic regression model showed that the prevalence of overweight increased in boys and girls for all age groups, although formal statistical significance was not reached for any of the groups ($p>0.05$; Figure 3). However, there was a systematic increase in overweight prevalence for boys and girls for the same age group during the 5–7-year study period. Although not statistically significant between survey years, the increase in the prevalence of overweight from 1995 to 2000–2002 was highest among 7–10-year-old girls, who had the highest prevalence rate of all age

Table I. Mean self-reported body mass index (BMI) and 90th percentile BMI for Danish boys and girls in 1995 and 2000–2002.

	Age group (years)											
	4–6			7–10			11–14			15–18		
	1995		2000–2002	1995		2000–2002	1995		2000–2002	1995		2000–2002
Boys (*n*)	115		135	161		191	144		141	68		105
Mean BMI (kg/m^2) (95% CI)	15.2	(15.1–15.2)	15.4***	(15.3–15.5)	16.3	(16.2–16.3)	16.5***	(16.5–16.6)	18.2	(18.2–18.3)	18.6***	(18.5–18.7)	20.6	(20.4–20.8)	21.0**	(20.8–21.2)
90th percentile (kg/m^2)	17.6		18.0	18.8		19.5	21.9		21.8	25.2		25.5
Girls (*n*)	124		129	170		167	163		137	81		146
Mean BMI (kg/m^2) (95% CI)	15.2	(15.0–15.3)	15.4*	(15.2–15.5)	16.3	(16.2–16.4)	16.6***	(16.5–16.6)	18.2	(18.1–18.3)	18.5***	(18.4–18.6)	20.7	(20.5–20.9)	21.1**	(20.9–21.3)
90th percentile (kg/m^2)	18.0		17.4	20.0		20.5	22.3		22.8	23.0		24.3

*$p<0.05$; **$p<0.01$; ***$p<0.001$.

Downloaded from http://sjp.sagepub.com by on March 11, 2008
© 2008 Associations of Public Health in the Nordic Countries Regions. All rights reserved. Not for commercial use or unauthorized distribution.



(a) (b)

Figure 1. Trends in the distribution of body mass index (BMI) (a) and increase in the frequency of BMI (b) among 4–18-year-old Danish boys and girls in 1995 and 2000–2002. The prevalence for a given BMI interval is calculated as the integral of the frequency over the BMI interval.

groups in 2000–2002 (20.5% (95% CI 15.6–25.4)). After analysis of each year of age from 4 to 18 years inclusive, the estimated probability of finding an overweight or obese child was higher in 2000–2002 than in 1995 for boys and girls up to 12 years of age, except for the 6-year-old boys and the 10- and 12-year-old girls. The pattern was less clear for 13–18-year-old boys and girls (data not shown). No formal statistical significance assessment has been performed for the one-year age groups. When all children and adolescents (4–18 years) were analysed, the prevalence of overweight rose significantly from 10.9% (95% CI 9.0–12.8) to 14.4% (95% CI 12.5–16.3) between 1995 and 2000–2002 (p=0.01, data not shown). This corresponds to a 32% relative increase in the prevalence of overweight during the 5–7-year study period, or an annual incidence of 0.5–0.7%. When obesity was analysed separately, the increase in the prevalence between 1995 and 2000–2002 for the 4–18-year-old boys and girls did not reach significance (1995, 2.3% (95% CI 1.3–3.3) vs. 2000–2002, 2.4% (95% CI 1.6–3.3); p=0.74, data not shown). When 4–18-year-old boys and girls were analysed separately, no statistical difference was found in the prevalence of obesity during the 5–7-year study period (boys, p=0.20; girls, p=0.42). In 2000–2002, no significant difference in overweight prevalence was observed between boys and girls for the same age group or between different age groups for boys. However, we found a significantly higher prevalence of overweight among girls aged 7–10 years as compared with the 11–14-year-old (p=0.008) and the 15–18-year-old girls (p<0.0001).

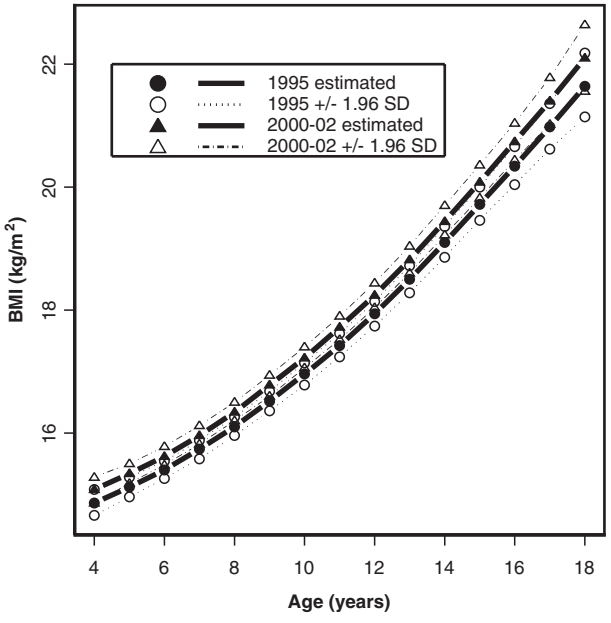


Figure 2. Fitted body mass index (BMI) as a function of age, stratified on survey year, among 4–18-year-old Danish boys and girls in 1995 and 2000–2002. The smooth function is fitted with a linear local regression with a span of 0.5.

Downloaded from http://sjp.sagepub.com by on March 11, 2008
© 2008 Associations of Public Health in the Nordic Countries Regions. All rights reserved. Not for commercial use or unauthorized distribution.

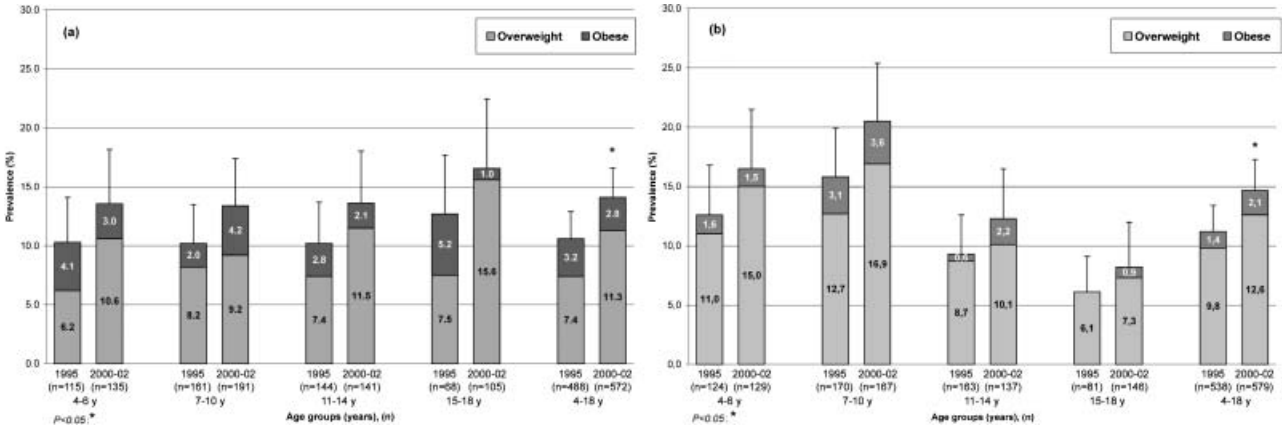


Figure 3. Prevalence of overweight and obesity among Danish boys (a) and girls (b) in different age groups in 1995 and 2000–2002.

Discussion

The present study is the first one to publish the latest representative population data on BMI and prevalence of overweight and obesity in a wide age range of children and adolescents in Denmark. Our main finding was a significant increase during the 5–7-year study period in mean BMI for boys and girls for all age groups; this included preschool children. Furthermore, we found a significant increase in the prevalence of overweight from 1995 to 2000–2002 when analysing all 4–18-year-old boys and/or girls (Figure 3). This indicates that the general population of Danish children and adolescents has become heavier during the last decade.

National and international comparability of the prevalence and trends in children and adolescents are often hampered by the use of different methodologies and definitions of overweight and obesity. Comparison of the results of the present study with other nationally representative studies using the international definition of overweight and published after 2000 provides consistent findings, although some differences are observed. We found a comparable prevalence estimate of overweight to that in studies using anthropometric measures among 7–11-year-old children [14] and 14–16-year-old boys [10], but only one-third as many 14–16-year-old overweight girls in the Danish National Dietary Survey 1995 as compared to a Danish school survey in 1996–97 [10]. The most likely explanation for this is that height and weight were measured in the school survey. In addition, the school survey had a 10% higher participation rate. This points to a true prevalence of overweight among adolescent girls that is higher than reported in the Danish National Dietary Survey 1995 and possibly also in the 2000–2002 survey. Therefore, the low overweight prevalence among the 15–18-year-old girls in the current study (Figure 3b) could indicate underreporting. Other studies have shown that overweight girls are especially prone to underestimate their body weight [15–17], most likely because they consider weight as sensitive information. Our findings are, however, in agreement with the results from the Danish WHO Health Behaviour in School-aged Children Study (HBSC), based on self-reported height and weight [11,18]. The prevalence of overweight among boys and girls aged 11, 13 and 15 years increased from 9.7% in 1995 to 14.1% in 2000–2002 in the present study, whereas the prevalence increased from 10.5% in 1998 to 13.9% in 2002 in the Danish HBSC [11].

When the prevalence of overweight and obesity in 1997–98 among 11-, 13- and 15-year-old schoolchildren from the Danish HBSC was compared to data from the USA and other European countries participating in the HBSC survey, Denmark was one of the countries with the lowest prevalence rates, except for the 15-year-old girls [15,18]. In Denmark, the prevalence of overweight and obese schoolchildren, aged 10–16 years, was less than half the prevalence in the USA [15,18]. Comparison of our results with other self-reported measures from the Nordic countries shows that Denmark has a similar prevalence of overweight and obesity among children and adolescents as Sweden and Norway [15,18,19], but a slightly lower proportion of overweight adolescents than Finland [15,18], due to the high prevalence rate among the Finnish adolescent boys [20]. The prevalence of overweight based on anthropometric measures is among the lowest in Europe for Danish children aged 7–11 years, while Danish adolescents aged 14–17 years are in the middle [14]. Observing the secular trends and the current prevalence of overweight among children and adolescents, Denmark seems to be 5 years

Downloaded from http://sjp.sagepub.com by on March 11, 2008
© 2008 Associations of Public Health in the Nordic Countries Regions. All rights reserved. Not for commercial use or unauthorized distribution.

behind the UK [21] and almost 20 years behind the USA [22].

The strength of the present study is that the data are based on two national representative population studies and that all age groups between 4 and 18 years are included, although the sample size is relatively small for the age spectrum studied. The response rate of height and weight data, from 1995 to 2000–2002, increased by 5%, which is opposite to the findings in Finland and Norway [19,23]. This increase probably reflects a greater interest than before from the parents, especially mothers, in their children's health, as parents reported the height and weight of the 4–14-year-old children in our study, while children and adolescents reported their own height and weight in the other Nordic studies.

One of the limitations of the current study is the use of self-reported height and weight, as it is known that people tend to overreport their height, and underreport their weight, especially the overweight and obese [24,25]. As a consequence, BMI values based on self-reported height and weight will underestimate the true prevalence of overweight and obesity. This phenomenon seems to be less pronounced in face-to-face interviews than in self-administered questionnaires [24].

It seems likely that this downward bias of BMI also exists for parent-reported height and weight of children, partly because overweight and obesity in children and adults is not a desired condition in industrialized countries. Moreover, some parents may not be familiar with their children's current height and weight [26], or may remember only how it was several months ago; this was an issue for the oldest adolescents, who also reported their own height and weight [15,25].

Most previous studies investigating the reliability of parental reporting found that the majority of parents (mothers) were accurate reporters [27,28], although they had a tendency to underestimate the weight of heavier children [26,27], especially boys [29]. The self-reported height and weight of children and adolescents may be inaccurate in some groups [17,30], and this method is not recommended for children less than 14 years of age, because of lack of reliability [30].

Several studies have found high correlations and/or accuracies between measured and self-reported estimates of children's and adolescents' height and weight [16,19,27,28], suggesting that self-reported overweight and obesity prevalence rates are fairly valid, even if these estimates may lead to some misclassification when used as categorical variables. In a Norwegian study, the sensitivity and specificity of self-reported BMI for identifying overweight among schoolchildren were 83% and 100%, respectively [19].

Except for adolescent girls, the current study resulted in comparable prevalence estimates to those in other studies using anthropometric as well as self-reported measures for Danish children and adolescents [10,11,14,18], supporting the validity of our results on the increasing trend observed in the present study. For the purpose of our study, i.e. to determine the latest trends in overweight and obesity among children and adolescents in Denmark, it is reasonable to assume that the validity of self-reported data remained constant over the short study period, as height and weight were reported in a similar way in the surveys of 1995 and 2000–2002. Thus, our results support the view that prevention of overweight and obesity should focus on children and adolescents, and that immediate action is needed to reverse unhealthy lifestyles related to overweight and obesity. This includes promotion of healthy diets, increased physical activity, and healthy body weights.

Conclusion

In conclusion, the present study revealed a significant increase from 1995 to 2000–2002 in mean BMI for boys and girls for all age groups, and a significant increase in the prevalence of overweight (1995, 10.9% (95% CI 9.0–12.8) vs. 1995, 14.4% (95% CI 12.5–16.3); $p=0.01$) when all Danish children and adolescents (4–18 years) were analysed.

Acknowledgements

The authors wish to thank Henrik Bach Hartkopp and Hanne-Jette Hinsch (both Department of Nutrition, National Food Institute) for their efforts in scanning, processing and controlling the quality of the collected data, and Inge Tetens (Head of Department of Nutrition, National Food Institute) for valuable comments on the manuscript.

References

[1] World Health Organization. Obesity: preventing and managing the global epidemic. World Health Organization Technical Report Series no. 894. Geneva: WHO; 2000.

[2] Ebbeling CB, Pawlak DB, Ludwig DS. Childhood obesity; public health crisis, common sense cure. Lancet 2002;360: 473–82.

[3] Reilly JJ, Methven E, McDowell ZC, Hacking B, Alexander D, Stewart L, Kelnar CJ. Health consequences of obesity. Arch Dis Child 2003;88:748–52.

[4] DiPietro L, Mossberg HO, Stunkard AJ. A 40-year history of overweight children in Stockholm: life-time overweight,

Downloaded from http://sjp.sagepub.com by on March 11, 2008
© 2008 Associations of Public Health in the Nordic Countries Regions. All rights reserved. Not for commercial use or unauthorized distribution.

morbidity, and mortality. Int J Obes Relat Metab Disord 1994;18:585–90.
[5] Molnár D, Livingstone B. Physical activity in relation to overweight and obesity in children and adolescents. Eur J Pediatr 2000;159(Suppl 1):S45–55.
[6] World Health Organization. Diet, nutrition and the prevention of chronic diseases. Joint WHO/FAO Expert Consultation. World Health Organization Technical Report Series no. 916. Geneva: WHO; 2003.
[7] Pearson S, Olsen LW, Hansen B, Sørensen TIA. Stigning i overvægt og fedme blandt københavnske skolebørn i perioden 1947–2003 [Increase in overweight and obesity among school children in Copenhagen: 1947–2003]. Ugeskr Laeger 2005;167:158–62 (in Danish with an English summary).
[8] Astrup A, O'Hill J, Rössner S. The cause of obesity: are we barking up the wrong tree? Obes Rev 2004;5:125–7.
[9] Wedderkopp N. Atherosclerotic cardiovascular risc factors in Danish children and adolescents. PhD thesis. University of Southern Denmark, Faculty of Health Sciences; 2001.
[10] Petersen TA, Rasmussen S, Madsen M. Danske skolebørns BMI målt i perioden 1986/1987–1996/1997 sammenlignet med danske målinger fra 1971/1972 [BMI of Danish school children measured during the periods 1986/1987–1996/1997 compared to Danish measurements in 1971/1972]. Ugeskr Laeger 2002;164:5006–10 (in Danish with an English summary).
[11] Due P, Holstein BE, editors. Skolebørnsundersøgelsen 2002 (HBSC) [School-aged children survey 2002 (Health Behavior in School-Aged Children)]. Copenhagen: University of Copenhagen, Institute of Public Health; 2003 (in Danish). Available at: http://www.hbsc.dk/download/rapp-2002.pdf.
[12] Nysom K, Mølgaard C, Hutchings B, Michaelsen KF. Body mass index of 0 to 45-y-old Danes: reference values and comparison with published European reference values. Int J Obes 2001;25:177–84.
[13] Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 2000;320:1240–3.
[14] Lobstein T, Frelut ML. Prevalence of overweight among children in Europe. Obes Rev 2003;4:195–200.
[15] Lissau I, Overpeck MD, Ruan WJ, Due P, Holstein BE, Hediger ML. Body mass index and overweight in adolescents in 13 European countries, Israel, and the United States. Arch Pediatr Adolesc Med 2004;158:27–33.
[16] Strauss RS. Comparison of measured and self-reported weight and height in a cross-sectional sample of young adolescents. Int J Obes Relat Metab Disord 1999;23:904–8.
[17] Shannon B, Smiciklas-Wright H, Wang MQ. Inaccuracies in self-reported weights and heights of a sample of sixth-grade children. J Am Diet Assoc 1991;91:675–8.
[18] Janssen I, Katzmarzyk PT, Boyce WF, Vereecken C, Mulvihill C, Roberts C. Comparison of overweight and obesity prevalence in school-aged youth from 34 countries and their relationships with physical activity and dietary patterns. Obes Rev 2005;6:123–32.
[19] Andersen LF, Lillegaard IT, Øverby N, Lytle L, Klepp KI, Johansson L. Overweight and obesity among Norwegian school children: changes from 1993 to 2000. Scand J Public Health 2005;33:99–106.
[20] Kautiainen S. Trends in adolescent overweight and obesity in the Nordic countries. Scand J Nutr 2005;49:4–14.
[21] Lobstein TJ, James WP, Cole TJ. Increasing levels of excess weight among children in England. Int J Obes Relat Metab Disord 2003;27:1136–8.
[22] Flegal KM, Ogden CL, Wei R, Kuczmarski RL, Johnson CL. Prevalence of overweight in US children: comparison of US growth charts from the Centers for Disease Control and Prevention with other reference values for body mass index. Am J Clin Nutr 2001;73:1086–93.
[23] Kautiainen S, Rimpela A, Vikat A, Virtanen SM. Secular trends in overweight and obesity among Finnish adolescents in 1977–1999. Int J Obes Relat Metab Disord 2002;26:544–52.
[24] Kuskowska-Wolk A, Bergström R, Boström G. Relationship between questionnaire data and medical records of height, weight and body mass index. Int J Obes Relat Metab Disord 1992;16:1–9.
[25] Fortenberry JD. Reliability of adolescents' reports of height and weight. J Adolesc Health 1992;13:114–17.
[26] Davis H, Gergen PJ. Mexican-American mothers' reports of the weights and heights of children 6 months through 11 years old. J Am Diet Assoc. 94, 1994:512–16.
[27] Jackson J, Strauss CC, Lee AA, Hunter K. Parents' accuracy in estimating child weight status. Addictive Behav 1990;15:65–8.
[28] Epstein LH, McCurley J, Murdock RC Jr. Estimation of percent overweight within families. Addictive Behav 1991;16:369–75.
[29] Maynard LM, Galuska DA, Blanck HM, Serdula MK. Maternal perceptions of weight status of children. Pediatrics 2003;111:1226–31.
[30] Himes JH, Faricy A. Validity and reliability of self-reported stature and weight of US adolescents. Am J Hum Biol 2001;13:255–60.

Downloaded from http://sjp.sagepub.com by on March 11, 2008
© 2008 Associations of Public Health in the Nordic Countries Regions. All rights reserved. Not for commercial use or unauthorized distribution.