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ORIGINAL ARTICLE

Overweight and obesity among Norwegian schoolchildren: Changes from 1993 to 2000

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Abstract

Aim: The aim of the present study was to investigate the prevalence rate of overweight and obesity in a nationwide survey of fourth- and eighth-grade Norwegian schoolchildren, the changes in overweight rates among eighth graders from 1993 to 2000, and to investigate factors associated with overweight. *Methods:* Cross-sectional dietary surveys were conducted on nationally representative samples of eighth graders in 1993, and among fourth and eighth graders in 2000. Self-reported weight and height was available from 1,650 eighth graders in 1993, and from 664 fourth and 825 eighth graders in 2000. Data on dietary pattern, social class, and physical activity were also available. *Results:* In 2000 the prevalence of overweight and obesity among the fourth graders was 18.5% and 3.6%, respectively, and among the eighth graders 11.5% and 1.8%, respectively. A marked increase in overweight and obesity among Norwegian eighth graders from 1993 to 2000 was observed; the prevalence of overweight and obesity increased by 4 and 0.9 percentage points, respectively. Social class, time spent watching TV or in front of a computer, and breakfast frequency were associated with the odds of being overweight. An inverse relation between intake of sweets and overweight was observed. Validation studies demonstrated a high correlation between self-reported and measured height and weight in both age groups. *Conclusion:* The present study demonstrates a high prevalence of overweight and obesity among schoolchildren, especially among fourth graders in Norway. Moreover, the proportion of overweight and obese children has increased greatly among eighth graders during the last decade.

Key Words: *body mass index, children, overweight, trend*

Introduction

The prevalence of overweight and obesity among children and adolescents is increasing worldwide [1]. Increases in childhood overweight and obesity have important public health consequences. Being obese as a child has both immediate and long-term implications for individuals, as well as for society as a whole [2]. Thus national data on the prevalence of overweight and obesity among children, and a better understanding of the determinants of children's weight problem are important for successful health promotion.

Studies among Norwegian male conscripts and adults have shown an increase in the prevalence of overweight and obesity in these age groups [3,4]. Measurements among schoolchildren in Oslo [5] indicate that a similar trend may be in progress among Norwegian children, but we lack national data on childhood overweight and obesity. Moreover, studies focusing on factors associated with overweight among Norwegian children are scarce. Research from other countries has identified multiple factors that are associated with an increased risk of overweight among children including low social class, low level of physical activity, high level of sedentary lifestyle, high fat intake, and parental body weight [6–8]. A few studies have also identified intake of soft drinks and sugar as important factors in relation to risk of being overweight [9,10]. In Norway, children are getting a high percentage of their energy from sugar, and the intake of sugar has

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increased in this age group during the last decade [11]. Therefore, investigating the relationship between overweight and intake of sugar and sugar containing food items among Norwegian children is warranted.

The aim of the present study was to investigate the prevalence rate of overweight and obesity in a nationwide survey of fourth- and eighth-grade schoolchildren, and the changes in overweight rates among eighth graders from 1993 to 2000. Moreover, the aim was to investigate whether risk factors such as fat intake, total energy intake, level of activity, level of sedentary life style, social class, and potential risk factors such as intake of soft drinks, sweets, and frequency of breakfast eating, are associated with risk of overweight among Norwegian children in 2000. To document the quality of the self-reported weight and height data included in the analyses, results from a validation study are also presented.

Methods

This study was based on two nationwide dietary surveys conducted in 1993 and 2000, and two validation studies of self-reported weight and height conducted in 2001 and 2003.

In 1993, eighth-grade pupils in a random sample of 39 primary and lower secondary schools were invited to participate in a dietary survey [12]. In total, 1,986 pupils were invited and 1,705 (86%) completed the study. Of these, 1,650 participants (802 girls and 848 boys) reported weight and height. In 2000, fourth- and eighth-grade pupils from a random sample of 103 primary and lower secondary schools were invited to participate in a dietary survey [11]. In total, 1,018 pupils from the fourth grade and 1,181 from the eighth grade were invited. Of these, 815 (80%) fourth graders and 1,005 (85%) eighth graders completed the study. Among the pupils in fourth grade, 664 (336 girls and 328 boys) reported their weight and height, as did 825 eighth graders (425 girls and 400 boys). Detailed presentations of the methodology applied in these studies have been published elsewhere [11,12]. The validation studies are described in a later section.

The study protocols were approved by the National Committees for Research Ethics in Norway and the Norwegian Social Science Data Services. Written informed consent was obtained from the parents and the 13-year-old students.

Definition of overweight and obesity

Self-reported weight and height were used to calculate BMI (BMI=weight(kg)/height^2(m^2)) for each participant. The international cut-off points for BMI for overweight and obesity, based on centile curves defined to pass through the BMI of 25 and 30 kg/m^2 at age 18 in a survey of six nationally representative growth studies conducted by Cole et al. [13], were used to produce estimates of the prevalence of overweight and obesity. The BMI cut-off point values for 8-, 9-, 12-, 13-, and 14-year-olds were used, as the participants reported the age only in whole years.

Validity of self-reported weight and height

Validation studies were performed to evaluate the validity of the self-reported weight and height data among the schoolchildren. The sample for the validation studies was drawn from schools that did not take part in the nationwide dietary survey in 2000. The number of pupils in the studies was 88 fourth graders (50 girls and 38 boys) and 71 eighth graders (36 girls and 35 boys). The participants were given a short questionnaire and filled in their weight and height at home. The parents may have helped the children to do so, but this was not requested in the instructions. The same procedure was used in the 2000 survey. A few days later weight and height were measured at school by the project staff. The weight was measured with light clothing, i.e. T-shirt, trousers, socks.

Table I. Difference[a] between measured and self-reported weight, height, and body mass index (BMI). Median, 25th and 75th percentiles; n=88 fourth graders and n=71 eighth graders.

	Height (cm)		Weight (kg)		BMI	
	Girls	Boys	Girls	Boys	Girls	Boys
Fourth grade	0 (0; 0)	0 (0; 0)	1.3 (0.6; 2.2)	1.0 (−0.4; 1.7)	0.8 (0.2; 1.1)	0.5 (0; 1.1)
Eighth grade	0 (0; 0)	0 (0; 0)	0.3 (−0.2; 0.9)	0 (−0.3; 0.8)	0.1 (−0.1; 0.4)	0 (−0.2; 0.3)

[a]Measured value – self-reported value.

There were no differences in measured and self-reported height (Table I). However, the pupils underestimated their weight, and the underestimation was largest for the youngest girls. The BMI values calculated from the self-reported data were significantly lower than the measured values for both age groups and gender (Table I). Pearson correlation coefficients between BMI estimated from the self-reported and the measured weight and height were 0.93 (95% CI: 0.88; 0.96) and 0.92 (95% CI: 0.88; 0.96) among fourth-grade girls and boys, respectively. The corresponding figures for eighth-grade pupils were 0.96 (95% CI: 0.92; 0.98) for girls and 0.82 (95% CI: 0.67; 0.91) for boys. The sensitivity of BMI estimated from the self-reported height and weight to identify overweight among the 159 fourth and eighth graders was 83% (25/30) (95% CI: 69%; 97%) and the specificity was 100%.

Dietary and lifestyle data from the 2000 survey

Dietary data from the 2000 survey were collected for four consecutive days using an 18-page pre-coded food diary. The method has been presented in detail elsewhere [14]. In brief, the diary has lists of 277 drinks, food items, and dishes grouped together according to a typical Norwegian diet. Each food group is supplemented with open-ended alternatives. The design of the pre-coded food diary is similar to a cross-table with food listed on the left and time intervals at the top. Food amounts are presented in predefined household units or as portions estimated from photographs. The participants indicate an eating event by filling in how many units they have eaten of each food item in the correct time span. Daily intake of foods, energy, and nutrients were computed using a food database and software system developed at the Institute of Nutrition Research, University of Oslo [15]. The food database is mainly based on the official Norwegian food composition table and it is continuously supplemented with data on new food items and nutrients [15].

Data about parents' highest educational level, time spent watching TV or in front of a computer, how often the participants exercised until they were out of breath and/or sweaty, and how often they ate breakfast during the week were reported in a short questionnaire completed by the participants at home, where they might have received help from their parents. The response categories for watching TV or computer usage were recoded into (a) watch TV/use computer 1 hour or less per day, (b) 2–3 hours per day, and (c) 4 hours per day or more. Frequency of exercise was categorized into (a) active 3 times a month or less, (b) active 1–3 times a week, and (c) active 4–7 times a week. The frequency of breakfast eating was categorized into (a) 2 times or less per week, (b) 3–5 times per week, and (c) 6–7 times per week.

Social class was defined based on the highest school education achieved by either mother or father. "Low" social class was assigned to those who attended school for up to nine years; "middle" to those who attended school for 10–12 years; "high" to those who achieved an advanced level of education (13 or more years). Social class was available for 96% of the students included in the present study.

Statistical analysis

The means, medians, 25th, and 75th percentiles of BMI for each age and gender were calculated. The Wilcoxon matched-pairs rank-sum test and Pearson correlation coefficient were used for comparisons between measured and reported BMI in the validation study. Comparing weight, height, and BMI between the 1993 and 2000 survey we adjusted for age; moreover we took account of the effect of study design (cluster=schools) using Proc MIXED in SAS. Differences between percentile cut-off values were tested using percentiles regression in Stata adjusting for age. Change in prevalence rate of overweight and obesity between 1993 and 2000 was tested using chi-squared statistics.

Multiple logistic regression analysis was applied to study overweight in relation to social class, gender, age, physical activity, and time spent watching television or in front of a computer, total energy intake, percentage of energy from fat and sugar, and intake of sweetened soft drinks and sweets, and frequency of eating breakfast. Variables that were associated with overweight at a p-value of less than 0.10 in a univariate analysis were entered in the final model. The results are presented as adjusted odds ratios (ORs) with 95% confidence intervals (CIs). For the values presented in Table III, we have taken account of the design effect using generalized estimation equations (GEE) by using repeated statements in the GENMOD procedure in SAS. Tests for trends across categories were performed by treating the categories as continuous variables in the logistic regression analyses.

Statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) version 11.0, the SAS software, version 8.2 (SAS Institute, Inc, Cary, NC) and Intercooled Stata 7.0.

Results

Prevalence of overweight and obesity

When applying the BMI reference values recommended for international use, the age-standardized prevalence of overweight and obesity was 11.5% and 1.1% among eighth-grade girls and 11.5% and 2.5% among same-age boys in 2000 (Table II). The prevalence of overweight among the fourth grade pupils was 6–7 percentage points higher than among the eighth graders, and the prevalence of obesity was almost 3 percentage points higher among the younger girls compared with the older girls ($p<0.01$). No significant difference in obesity was observed for the boys in the two age groups (Table II).

The height was significantly higher among the eighth graders in 1993 compared with the eighth graders in 2000; this was found for both sexes ($p<0.001$) (Table II). A significant difference in body weight between the two surveys was observed for boys ($p<0.001$) but not for girls ($p=0.45$). There was no change in average (median) BMI from 1993 to 2000 among eighth graders (Table II). The 85th and 95th percentile cut-off points for BMI increased from 1993 to 2000, except for the 85th percentile cut-off point for eighth-grade boys (Table II). However, only the increase observed in the 85th percentile cut-off point for eighth-grade girls was significant ($p=0.019$). The prevalence of overweight between 1993 and 2000 increased by 3.7 and 4.2 percentage points for eighth-grade girls and boys, respectively ($p<0.001$ for gender combined). The corresponding increases for obesity were 0.5 and 1.3 percentage points ($p=0.05$ for both sexes combined).

Factors associated with overweight

The odds of being overweight were significantly higher among fourth graders than among eighth-grade pupils (Table III). No difference in odds was observed by gender. Children's odds of being overweight increased twofold from high to low social class. Time spent watching TV or in front of a computer was positively associated with overweight; the odds ratio for pupils watching TV or using a computer for four hours or more per day was 2.5 relative to those watching for one hour or less. Total energy intake was not associated with overweight. Intake of sweets was negatively associated with overweight. The pupils in the highest quartile of sweet intake had 50% lower odds for being overweight as compared with those in the lowest quartile of sweet intake. No association was found in the univariate analysis for dietary items as a percentage of energy from fat and sugar and intake of sweetened soft drink. The pupils who had breakfast 5 times or less per week had higher odds for being overweight compared with those having breakfast 6–7 times per week.

Discussion

This study presents the first national prevalence data of overweight and obesity among Norwegian

Table II. Height, weight, body mass index (BMI), and prevalence of overweight and obesity among eighth graders in 1993 and 2000, and among fourth graders in 2000. Mean, [median], (25th and 75th percentiles).

	Eighth grade 1993		Eighth grade 2000		Fourth grade 2000	
	Girls	Boys	Girls	Boys	Girls	Boys
Number	848	802	425	400	336	328
Age (years)	13.4 [13.0] (13.0; 14.0)	13.5 [13.0] (13.0; 14.0)	12.9 [13.0] (13.0; 13.0)	12.9 [13.0] (13.0; 13.0)	8.9 [9.0] (9.0; 9.0)	8.9 [9.0] (9.0; 9.0)
Weight (kg)	50.2 [50.0] (45.0; 55.0)	52.1 [50.5] (45.0; 58.0)	49.7 [49.0] (44.0; 55.0)	49.2 [48.0] (42.0; 55.0)	32.0 [31.0] (28.0; 35.0)	32.3 [31.0] (28.0; 35.0)
Height (cm)	163 [164] (159; 167)	165 [165] (159; 170)	161 [161] (157; 165)	161 [160] (154; 167)	137 [137] (132; 141)	137 [137] (133; 141)
BMI (kg/m^2)	18.9 [18.6] (17.4; 20.2)	19.1 [18.7] (17.4; 20.3)	19.1 [18.6] (17.3; 20.8)	19.0 [18.4] (17.2; 18.4)	17.1 [16.7] (15.3; 18.4)	17.1 [16.7] (15.4; 18.1)
85th percentile[a]	21.1	21.2	21.7	21.1	19.4	19.5
95th percentile[a]	23.0	23.6	24.0	24.3	22.1	21.4
Overweight[b] (%)	7.8	7.3	11.5	11.5	18.8	17.3
Obesity[b] (%)	0.6	1.2	1.1	2.5	4.0	3.0

[a]85th (95th) percentile cut-off point of BMI (kg/m^2). [b]The definitions of overweight and obesity based on the international cut-off points for BMI[20]. The cut-off points used for overweight were: 18.44, 19.10, 21.22, 21.91, and 22.62 for 8-, 9-, 12-, 13- and 14-year-old boys, respectively. The corresponding figures for girls were 18.35, 19.07, 21.68, 22.58, and 23.34. The cut-off points used for obesity were: 21.60, 22.77, 26.02, 26.84, and 27.63 for 8-, 9-, 12-, 13- and 14-year-old boys, respectively. The corresponding figures for girls were 21.57, 22.81, 26.67, 27.76, and 28.57.

Table III. Adjusted odds ratio (OR) (and 95% confidence interval (CI)) for overweight according to participant characteristics (n=1,432).

Characteristic	Overweight	
	N_O (N_N)[b]	Adj. OR[a] (95% CI)
Age		
Eighth grade	87 (689)	1.00
Fourth grade	123 (533)	2.35 (1.71, 3.23)
Gender		
Boy	105 (597)	1.00
Girl	105 (625)	1.05 (0.74, 1.49)
Social class		
High	92 (620)	1.00
Middle	106 (565)	1.22 (0.89, 1.68)
Low	12 (37)	2.17 (1.22, 4.05)
p-trend[c]		0.05
Watching TV and/or using computer		
⩽1 hour per day	92 (520)	1.00
2–3 hours per day	82 (579)	1.04 (0.78, 1.42)
>4 hours per day	36 (123)	2.54 (1.58, 4.10)
p-trend[c]		0.008
Energy (kJ/day)[d]		
Quartile 1 (5624)	61 (297)	1.00
Quartile 2 (7498)	44 (314)	0.70 (0.45, 1.08)
Quartile 3 (8944)	63 (295)	1.11 (0.71, 1.75)
Quartile 4 (11903)	42 (316)	0.87 (0.53, 1.43)
p-trend[c]		0.99
Sweets (g/day)[d]		
Quartile 1 (2)	68 (386)	1.00
Quartile 2 (16)	50 (311)	0.71 (0.47, 1.03)
Quartile 3 (35)	56 (304)	0.78 (0.49, 1.23)
Quartile 4 (89)	36 (321)	0.48 (0.29, 0.81)
p-trend[c]		0.02
Eating breakfast (times/week)[d]		
6–7	166 (1052)	1.00
3–5	24 (89)	1.99 (1.25, 3.18)
⩽2	20 (81)	1.69 (0.99, 2.89)
p-trend[c]		0.006

[a]Odds ratios (OR) and 95% confidence intervals (CI) adjusted for all other variables in the table. [b]N_0=Number of overweight and N_N=number of not overweight within current independent variable, total n=1432. [c]Test for linear trend. [d]Mean quartile values.

schoolchildren. A marked increase in overweight and obesity among eighth graders from 1993 to 2000 was observed, measured by both the BMI percentile cut-off points and the prevalence rate according to the international BMI reference values [13]. The prevalence of overweight and obesity among the fourth graders was higher than among the eighth graders in the 2000 sample. Social class, time spent watching TV or in front of a computer, and breakfast frequency were found to be associated with the odds of being overweight among Norwegian schoolchildren. Furthermore, an inverse relation between intake of sweets and overweight was observed.

Comparing our data on prevalence of childhood overweight and obesity with what is observed in other countries in the same age groups, we find that children in Norway have a lower prevalence of both overweight and obesity than observed in the UK and the US [16,17]. However, the prevalence rate is comparable to what has been observed in the same age groups in other Nordic countries [18–21]. A trend towards increasing overweight and obesity has been seen in children and adolescents in several developed countries during recent decades [19,20,22]. Applying the international reference values proposed by Cole and colleagues [13] the prevalence of overweight among Norwegian eighth graders has increased by 57% and 47% for boys and girls, respectively, from 1993 to 2000. The corresponding increases for obesity were 108% and 83%. These data suggest that the prevalence of both overweight and obesity is increasing rapidly among Norwegian eighth graders. Increased prevalence of obesity was also observed among Norwegian male conscripts (approximately 18-year-olds) in the period 1985 to 1995 [3].

The present study used the reference BMI curves published by Cole et al. [13] to estimate the prevalence of overweight and obesity since no national reference values are available for Norway. However, we only collected the age of the children in whole years, while the cut-points for overweight and obesity according to Cole et al. [13] are more precisely identified by using age in half-year intervals. Some imprecision may therefore be built into the results by this limitation. Using international reference values like those proposed by Cole et al. [13] facilitates international comparison. In a study by Flegal et al. [16], comparing the US growth charts from the Centres for Disease Controls and the Cole et al. [13] references, they found that the two methods gave similar but not identical results. In general, for the age groups included in the present study the references of Cole et al. gave lower estimates for overweight and obesity than did the CDC-US growth charts.

The BMI used in the present study is based on self-reported weight and height, which may introduce some errors. However, the validation studies done on the reporting method used in the 2000 study demonstrated a high correlation between self-reported and measured height and weight in both age groups. Moreover, there was high sensitivity and specificity according to identified overweight. Therefore, we conclude that the proportions of

overweight and obesity found in the 2000 study are valid, and if anything we might slightly underreport the overweight and obesity rates.

The methods used for collection of self-reported weight and height in the 1993 and the 2000 survey differed slightly. This may introduce some errors when looking at the changes in BMI from 1993 to 2000. In the 2000 survey the eighth graders completed the questionnaire, including questions about height and weight, at home. The eighth graders in the 1993 survey did not take the questionnaire home, but they were able to ask parents for information and bring that to school the next day. The degree to which the pupils in the 1993 and the 2000 survey received any help from their parents for weight and height data is not known.

No significant difference was observed between average BMI for the eighth graders in 1993 and in 2000, but there was significant difference in height and body weight. This difference can probably be explained by the difference in age between the participants in the two surveys: the eighth graders in 1993 were half a year older than the eighth graders in 2000.

In the present study, the odds of being overweight increased twofold from high to low social class (measured by parental education). Other studies have found the adolescent age-span to be a time period characterized by a lack of socioeconomic health gradients with regard to health-related behaviour and health–disease outcomes [23,24]. This does not seem to be the case for socioeconomic status and risk of overweight. A review study from 1989 found that the relationship between socioeconomic status and obesity was inconsistent among children in developed countries [7]. However, later studies from the US, Australia, and several European countries have observed an inverse relationship between parents' education and/or income and risk of childhood obesity [25–28]. Results on this relationship among children/adolescents from the Nordic countries are scarce; however, in a large group of Finnish 14- to 16-year-old adolescents a similar inverse association to that seen in our study was observed [29].

We found increased odds of being overweight with increasing time watching television or using a computer. Most studies in children looking at the relationship between television viewing and body mass index have found a positive relationship [30–32]. In the present study information on television and computer use was combined in one question, and we are not able to separate the time used for watching television and the time used in front of a computer. In an Australian study [32] among 5- to 13-year-olds no association was observed between BMI and video game/computer time but this was seen for television viewing.

The dietary causes of obesity are complex and poorly understood. In a recent WHO report it was concluded that there is convincing evidence that high intake of energy-dense foods (high in fat and/or sugars) increases the risk of weight gain and obesity [33]. In the present study, we did not find an association between overweight and percentage of energy from fat or total energy intake. Our findings are highly vulnerable to the probable confounding effects of post hoc changes in dietary patterns as a consequence of weight gain, and to dietary under-reporting. Applying the method proposed by Goldberg et al. [34] to identify under-reporters in terms of energy intake in the present study, we found that the estimated percentage of under-reporters among the overweight pupils was higher than among the pupils of normal weight (data not shown). The lack of association found for energy intake may also be explained by the fact that the overweight children are more inactive, and thereby need less energy.

In a prospective study among 11-year-old children, Ludwig et al. [10] found a positive association between BMI and intake of soft drinks. Moreover, results from a recent controlled trial in primary schools in England found that a reduction in number of carbonated drinks consumed was associated with a reduction in number of overweight and obese children [35]. The referenced WHO report [33] states that there is evidence that sugar-sweetened soft drinks probably increase risk of weight gain and overweight. In the present study no association with overweight was observed for intake of sweetened soft drinks or percentage of energy from sugar. On the contrary, an inverse relation between intake of sweets (candy and chocolate) and overweight was observed. The same observation was seen in 91% of the 34 countries included in the World Health Organization *Health Behaviour in School-Aged Children* 2001–2002 cross-sectional survey [36]. Again, this association may be confounded since the overweight children may have under-reported their intake of sweets.

There have been few reports on the relationship between meal pattern and obesity in children [37,38]. In some recent studies among schoolchildren, it was seen that a lower proportion of overweight children consume breakfast compared with the normal-weight children [39,40]. In the present study we found that the pupils who had breakfast five times or less per week were at higher odds of being overweight compared with those

reporting having breakfast almost every day. A Swedish study among 15- to 16-year-olds has shown that a meal pattern omitting breakfast a few times per week was related to a clustering of less healthy lifestyle factors (e.g. smoking, unhealthy diet) and to a lower socioeconomic status [41]; this tendency for clustering may be part of the explanation for the association between breakfast frequency and overweight found in the present study.

One of the limitations of the prevalence data from the 2000 survey is the proportion of missing data on height and weight for the fourth- and eighth-grade students (18–19%). This problem was smaller in 1993, as only 4% of the participants did not report height or weight at that time. This may reflect an increased sense of weight/height being sensitive information. However, comparing participants reporting their height and weight with those not reporting this information in the 2000 sample revealed no differences between the two groups when comparing factors included in the regression model. A second limitation of our study is the cross-sectional design. To understand how a complex set of factors from multiple contexts interact with each other to place a child at risk of overweight, prospective studies with a broader approach should be prioritized. We need to look at factors in the close surroundings such as the family and the school, as well as in the larger social context of the community and the society.

The present study demonstrates a high prevalence of overweight and obesity among schoolchildren, especially among fourth graders in Norway, and that sedentary behaviour such as watching television or sitting in front of a computer, low social class, and skipping breakfast were associated with increased odds of being overweight. Moreover, our findings suggest that the proportion of overweight and obesity has increased greatly during the last decade among eighth graders. These findings warrant immediate action from public health policy-makers. In particular, the focus should be on increasing opportunities for active leisure time, examining disparities between lower and higher social economic groups that may affect their dietary and activity patterns, and examining ways to increase breakfast consumption by schoolchildren.

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