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PSYCHOLOGICAL HEALTH IN PRESCHOOL CHILDREN WITH UNDERWEIGHT, OVERWEIGHT OR OBESITY

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ABSTRACT

Objective: To examine if underweight (UW), overweight (OW) or obesity (OB) were associated with psychological difficulties in preschool children.

Design: Regional cohort study.

Setting: Oppland County, Norway.

Methods: At the school entry health assessment at 5-6 years of age, parents completed questionnaires on sociodemographic, health and lifestyle factors of the child and the family, and on neurocognitive development of the child. They assessed the psychological health of the child with the Strengths and Difficulties Questionnaire (SDQ). Public health nurses measured the weight and height of all the children. They reported age, sex, height and weight anonymously for the children who declined to participate.

Participants: We obtained necessary information on 1088 of 1895 (57%) of eligible children. The proportion of UW, OW and OB was slightly higher among the children who declined.

Main outcome measures: SDQ subscale and total difficulties scores.

Results: The mean scores and proportion of scores ≥ the 90th percentile had a curvilinear pattern from UW through normal weight (NW), OW and OB with NW as nadir, but the pattern was only statistically significant for the mean Emotional problems, Peer problems and Total SDQ scales, and for the Total SDQ score ≥ the 90th percentile (TDS90). After adjusting for relevant social, developmental, health and behavioural characteristics, only the association between UW and TDS90 remained significant.

Conclusions: The study suggests that UW, but not OW or OB, is an independent risk factor for having psychological symptoms in preschool children.

Key words: Child, Obesity, Overweight, The Strengths and Difficulties Questionnaire, Underweight

WHAT IS ALREADY KNOWN ON THIS TOPIC

- Underweight, overweight and obesity are associated with psychological symptoms in older children and adolescents.
- The significance of psychological symptoms related to weight has rarely been reported, and with conflicting results, in preschool children.

WHAT THIS STUDY ADDS

- In 5-6-year-old children, obesity and underweight, but not overweight, were associated with psychological symptoms, as assessed with the Strengths and Difficulties Questionnaire.
- After adjusting for social, health and lifestyle factors in the family, only underweight was associated with psychological symptoms

INTRODUCTION

The obesity epidemic is a major threat to the health of the individual and societies.[1] The high proportion of children with overweight (OW) or obesity (OB) is particularly worrisome since they are at high risk of OB as adults.[2] We [3] and others [4-7] have shown that a variety of well-intended intervention programs to curtail OB in children have had minor or no significant effect. The intervention programs have generally been oriented towards improving dietary habits and physical activity. Given the limited success, the significance of psychological aspects during early childhood needs to be explored in order to increase our understanding of why prevention and treatment are so difficult.

OB is associated with depression, low self-esteem and reduced health related quality of life in adults,[8] children and adolescents.[9-13] However, it is not settled whether, or to what extent, psychological factors may predispose to OW or OB, or simply are a result of having a high body mass index (BMI). Mühlig et al. suggested that the association between OB and depression was limited to older children,[10] and Geoffroy et al. found less depression in seven-year-old children with OB than among peers without OB.[14] Studies are conflicting regarding the significance of attention deficit hyperactivity disorder (ADHD) and other behavioural difficulties as risk factors for OW and OB.[15-18]

Studies on associations between underweight (UW) and psychological symptoms in early childhood are scarce. Geoffrey et al. found that UW was associated with depressive symptoms from age 11 years to mid adulthood, but not at seven years.[14]

Few studies have addressed psychological issues and weight in preschool children. In a regional Norwegian cohort of 5-6-year-old children, we found that OW and OB, but not UW, were associated with unfavourable sociodemographic factors and habits.[19] The aim of the present paper was to examine if the children with UW, OW or OB in this cohort had more psychological symptoms than the children with a normal weight (NW). Our hypothesis was

that children at this age may not have been exposed to significant psychological consequences of their BMI, such as bullying, and that any psychological symptoms associated with weight categories other than NW might be considered risk factors for developing unhealthy weights.

MATERIALS AND METHODS

Participants

Parents of all children entering school in Oppland County, Norway, in 2007, were invited to participate at the routine school entry health check-up at 5-6 years of age. Oppland county was one of 20 counties in Norway in 2007 and had a population of approximately 183 000 at the time of the study. The county had two cities with 25000 - 30000 inhabitants in each and otherwise rural areas with towns of variable sizes.

Consenting parents completed questionnaires on sociodemographic, health and lifestyle factors of the children and family members, and on neurocognitive development of the children. They assessed their children's psychological health with the Norwegian version of the Strengths and Difficulties Questionnaire (SDQ).[20,21]

The public health nurses measured the height and weight of all eligible children. For the families who declined to participate, the nurses reported age, sex, height and weight anonymously to the research group. From these data we have previously concluded that the participating children were probably representative of all the eligible children.[19]

Patient and Public Involvement statement

Public health care clinics, but not families, were involved concerning content and design.

Anthropometric measurements, health and habits

Height and weight were measured according to national guidelines.[22] Body mass index (BMI) was calculated as weight/height^2 (kg/m^2), and BMI standard deviation scores (BMI

SDS) were based on Norwegian references.[23] Definitions of the weight groups UW, NW, OW and OB were based on the sex and age specific BMI criteria of the International Obesity Task Force for the children [24,25] and according to the WHO classification for their parents.[26]

Details on sociodemographic factors, health and habits were published in a previous report.[19] In the present paper we dichotomized each parent's education and the following variables from frequency scores on sets of variables in the questionnaire: Nutritional standard, physical activity, physical health related problem, dental caries, difficulties in fine motor, language or social skills or sleep, and behavioural difficulties in the family. Details are presented in Appendix 1.

The Strengths and Difficulties Questionnaire (SDQ)

The SDQ is a screening tool to detect mental health problems in 4 -16-year-old children.[20] The questionnaire consists of 25 items addressing five subscales with five items in each: Emotional problems scale, Hyperactivity scale, Conduct problems scale, Peer problems scale, and Prosocial scale. Each scale is scored with a range of 0-10. For the subscales other than the Prosocial scale, higher scores mean more symptoms, and scores at or above the 90th percentile are associated with significant mental health problems.[20] The Prosocial scale is scored opposite to the other subscales, and a score below the 10th percentile may indicate a behaviour problem. A Total difficulty score (TDS) is created by summing the scores from the first four subscales (range 0-40), and a TDS at or above the 90th percentile (TDS90) is considered a high risk of having a psychiatric disorder. [20] On an Impact scale, the parents state whether the child has any difficulties with emotions, concentration, behaviour or in social contact with other people, and if so, which impact this has on everyday life (range 0-10).

The SDQ has been formally translated and validated in Norway.[21] It has been widely used in all the Scandinavian countries, and the distribution of SDQ scores are very similar for comparable age groups within Norway and between the Nordic countries.[27]

Statistics

Descriptive statistics are presented as counts and per cents (%) for categorical variables and as means and standard deviations (SD) for continuous variables. We explored the differences in characteristics between the four weight groups UW, NW, OW and OB by using one-way analysis of variance (ANOVA) for continuous and the χ^2 test for categorical variables. When ANOVA or χ^2 tests across all weight groups showed significant differences, we performed post hoc pairwise testing, comparing the other weight groups to NW with the Dunnet's t-test for continuous and the χ^2 test for categorical variables.

We tested the significance of the weight groups UW, OW and OB as compared to NW, on outcome in terms of TDS90 vs. lower TDS scores by logistic regression analyses, both unadjusted and adjusted. We adjusted for variables that differed significantly between groups in the ANOVA or χ^2 test analyses, and for variables that we considered relevant from earlier literature and from a theoretical perspective. We adjusted according to two models: In model 1 we adjusted for the family related covariates, i.e. the mother's and father's education, weight category, and having a job or being out of work, mother smoking, behavioural difficulties in the family, two or one caretaker, and having siblings or not. In Model 2 we added the following health and lifestyle covariates of the child to the family related covariates: Sex, Nutritional standard score, Physical activity score, Any physical health related problem, Difficulties in fine motor, language and social skills or sleep, and Dental caries. Associations were described as odds ratio (OR) and 95% confidence interval (CI). The explanatory variables were tested for interactions and multicollinearity.

We used SPSS Statistics for Windows V 25.0 for all the analyses. P values ≤ 0.05 were considered statistically significant. BMI standard deviation score (BMI SDS) were calculated using R V.2.6.0 (The R foundation for Statistical Computing, Vienna, Austria) using Norwegian growth references.[23]

Ethics

The study was approved by the Regional Committee on Medical Research Ethics (REK 1.2006.3491) and the Norwegian Data Protection Official for Research (02-2006 SI). A signed consent was obtained from one of the parents.

RESULTS

Of 1895 eligible families, 1119 participated, but analyses were limited to 1088 (57.4%) due to incomplete information for 31 children.

There were significant differences between groups on a number of health-related and sociodemographic factors (Table 1a). In the pairwise analyses, family factors such as low parental education, parents being out of work, single parenthood, non-Western ethnicity, mother smoking, OW or OB in parents, higher BMI SDS of siblings, and behavioural difficulties among parents or siblings were all associated with OW or OB in the children. UW was only associated with low weight in other family members (Table 1a).

There were significant curvilinear associations between mean scores on the SDQ subscales Emotional problems and Peer problems and weight category with NW as nadir. Scores on the Hyperactivity scale and Prosocial scale, but not the Impact score, showed similar trends (Table 1b). There was a similar tendency for the proportion of children with subscale scores at or above the 90% percentile (Table 1b). For the mean TDS and TDS90 the curvilinear association was statistically significant (Table 1b).

In the unadjusted logistic regression analyses, TDS90 was significantly associated with weight group (Table 2). However, compared to the children with NW, the risk of TDS90 was only significantly higher for children with UW and OB, not OW (Table 2). TDS90 was also associated with most of the other family and child related social, health and lifestyle factors (Table 2). When adjusted for family related factors in a multiple logistic regression analysis (Model 1), TDS90 was only significantly associated with UW, mother being out of work and behaviour difficulties in the family. When adding child-related variables to the family factors (Model 2), TDS90 was only significantly related to UW, mother being out of work and skills related to fine motor, language or social function, or sleep behaviour (Table 2). There were no significant interactions or collinearity between the explanatory variables.

DISCUSSION

The broad picture from the present unadjusted analyses was that children with UW and OB, but not OW, had more psychological problems, expressed as emotional symptoms, peer related problems and TDS90, than children with NW. However, unrelated to weight category, psychological problems were also significantly associated with numerous unfavourable family and child related factors. After adjusting for such factors, only UW was independently associated with having psychological problems, although the same tendency was also observed for OB.

The lack of significant psychological consequences of having OW or OB in this group of preschool children may be unexpected since OW and OB are associated with decreased health-related quality of life, lower self-esteem, depression, and emotional and behavioural symptoms in older children and adolescents.[9-13] It may also be unexpected because preschool children are conscious of and often express dissatisfaction with their body size, including a desire for a thinner or larger body shape. [28-30] However, despite this awareness, most preschool children seem to be satisfied with their appearance.[30,31] There may be

several reasons for their acceptance. The size may not have a psychological impact at this age since acceptance is largely dependent on the attitudes of the parents. [29] Although anti-obesity attitudes may occur as early as at 3-5 years of age, they do not generally occur in a playmate selection.[32] The vast majority of our children were in kindergarten from two years of age, and we suggest that this social setting over years may have reduced any tendencies to focus on body size. It has also been reported that girls who were followed from five to seven years of age, tended to idealize a larger body size than their own at five but a thinner size at seven.[31] However, despite a desire to have a different body size, the girls were satisfied with their appearance, even at eight years of age.[31] The authors therefore suggested that a desire for a different body size represents a cognitive construct without implying psychological consequences.

Our finding that the occurrence of psychological difficulties did not differ between children with OW and NW in any of the analyses, may not be surprising because we have previously shown that Norwegian children with OW are usually perceived by their parents as having a normal body proportion.[33] Furthermore, BMI may not be a good measure to differentiate between OW and NW in young children because OW may mainly be due to a high lean body mass.[34]

The finding that UW *per se* was associated with psychological difficulties has, to our knowledge, not been reported previously for this age group. A systematic review concluded that approximately equal proportions of children found it desirable to be either thinner or larger, but the authors emphasized difficulties in interpreting the findings due to great methodological weaknesses with most of the studies.[29] We have previously reported that the children with UW in the present cohort also had a shorter stature than their peers, in particular compared to their peers with OW and OB.[19] Later in childhood, children with UW, which also implies shorter stature and lower muscle mass at that age, were almost as

likely to be teased by peers as children with OB.[35] Dominance, and even bullying and victimization, are common phenomenon during preschool years,[36] and we suggest that the children with UW may suffer from being the weaker or least robust part in a kindergarten setting.

There has been an ongoing debate on the significance of ADHD or other behavioural problems as risk factors for OW and OB. Two meta-analyses concluded that ADHD is a risk factor for adolescent and adult OW and OB, but not [16] or possibly a minimal risk factor [15] for childhood OW and OB. Cortese et al. did not state the age of included children in their meta-analysis, but from the text it is unlikely that young children were included.[15] No preschool children were included in the systematic review by Nigg et al.[16] There was no association between behavioural problems and OW or OB in our study, which is in line with the findings in a large Norwegian cohort followed prospectively and assessed with The Child behaviour Checklist at 18 and 36 months of age.[37] In another Norwegian study of 6-12-year old children, mothers of children with OW and OB rated their children lower on energy, optimism, compliance, concentration, perseverance, and self-confidence, and higher on egocentricity, irritability, and anxiety than mothers of children with lower BMIs on the Norwegian Hierarchical Personality Inventory for Children.[38] These children were older, but we cannot exclude that preschool children with OB may have psychological symptoms that was not detected with the SDQ.

The strengths of the study were the unselected regional setting where we could assume that the participants were reasonably representative of all the eligible children and families, and the extensive information on the families and children who participated. The major weaknesses were the somewhat limited number of participants with weights other than NW and dependencies on reports by parents on questionnaires rather than professional assessments.

CONCLUSION

Our results suggest that the excess occurrence of psychological difficulties in preschool children with OW and OB was due to stresses other than their body size. UW was associated with having psychological symptoms, and we suggest that the reason may be that children with UW are the weaker part in a group setting like kindergarten.

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Author contributions

Hilde Mjell Donkor: Planning, statistical analyses, interpretation of results and initial drafting and writing the paper. Helene Toxe: Participated in analyses and interpretation and initial drafting and writing of the paper. Jørgen Hurum: Conceptualization and design of the study, collection of data, planning and interpretation of the results. Geir Egil Eide: Planning of presentation and statistical analyses, interpretation of results and writing of the paper. Pétur Benedikt Júlíusson: Planning, presentation, analyses and interpretation of results and writing the paper. Robert Bjerknes: Planning, presentation, analyses and interpretation of results. Trond Markestad: Conceptualization and design of the study, collection of data, presentation and interpretation of results and writing the paper. All authors read and approved the final version of the paper.

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Conflict of interest/Competing interest

None of the authors states any conflicts of interest or competing interest.

Ethical approval

The study was approved by the Regional Committee on Medical Research Ethics (REK 1.2006.3491) and the Norwegian Data Protection Official for Research (02-2006 SI). A signed consent was obtained from one of the parents.

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Table 1 Associations between current weight category and the children's personal characteristics, health and habits, and current sociodemographic and health characteristics of parents and siblings (Table 1a), and between weight category and scores on the Strengths and Difficulties Questionnaire (SDQ) scales (Table 1b). Unselected regional cohort of five-year-old children in Oppland county, Norway.

Table 1a

Characteristics	Valid n	All (n = 1088)	Current weight category* Underweight (n = 85)	Normal weight (n = 850)	Overweight (n = 115)	Obese (n = 38)	Overall p-value†
Children's health and habits							
Age in years, *mean (SD)*	1088	5.72 (0.43)	5.63 (0.42)	5.73 (0.44)	5.65 (0.37)	5.82 (0.57)	0.030
Girls, *%*	1088	52.5	51.8	51.4	59.1	57.9	0.408
BMI SDS, *mean (SD)*	1085	0.01 (1.03)	-1.91 (0.55)‡	-0.10 (0.65)	1.41 (0.27)‡	2.36 (0.44)‡	< 0.001
Physical activity poorer than peers§, %	1073	5.1	5.9	3.8	8.0‡	24.3‡	< 0.001
Any physical health problems**, %	1016	28.1	26.0	28.2	27.1	31.6	0.928
Dental caries, *%*	1079	20.0	18.8	18.7	21.9	34.2‡	0.043
Low nutritional standard††, *%*	1070	12.8	9.5	13.3	12.6	13.5	0.771
Difficulties with skills or sleep‡‡, %	1062	29.1	28.6	28.9	28.7	37.1	0.767
Kindergarten from 2 years of age, %	1033	92.1	91.5	92.7	91.6	82.4	0.155

Sociodemographic factors and health characteristics of parents and siblings							
Municipality w/n > 20 000, *%*	1087	32.4	38.8	32.6	30.4	18.4	0.157
Low maternal education, *%*	1068	44.9	45.0	41.7	56.7‡	81.1‡	< 0.001
Low paternal education, *%*	1037	60.7	51.9	58.9	72.1‡	85.7‡	< 0.001
Both parents low education , *%*	1077	38.4	37.0	35.4	50.0‡	73.7‡	< 0.001
Mother out of work, *%*	1069	8.2	8.5	7.5	9.7	18.9	0.090
Father out of work, *%*	1046	4.8	4.9	4.0	7.0	15.2‡	0.017
Parent(s) non-Western, *%*	1088	2.7	3.5	2.1	3.5	10.5‡	0.014
Living with one caretaker, *%*	1073	13.0	9.8	12.0	17.5	29.7‡	0.005
No siblings, *%*	1065	9.1	3.6	9.0	16.8‡	2.9	0.009
Mother smoking, *%*	1088	19.0	14.1	16.6	32.2‡	44.7‡	< 0.001
Current BMI mother, *mean (SD)*	981	24.32 (3.85)	23.06 (3.31)	24.07 (3.66)	26.03 (4.15)‡	27.52 (5.12)‡	< 0.001
Current BMI father, *mean (SD)*	924	26.38 (3.30)	25.13 (2.72)‡	26.25 (3.16)	27.57 (3.75)‡	28.89 (4.33)‡	< 0.001
BMI SDS average for siblings	630	-0.21 (1.23)	-0.76 (1.26)‡	-0.24 (1.20)	0.26 (1.06)‡	0.55 (1.45)‡	< 0.001
Mother currently obese, *%*	980	9.1	6.5	7.2	16.2‡	34.3‡	< 0.001
Father currently obese, *%*	924	13.0	3.9‡	11.2	26.4‡	37.5‡	< 0.001
Both parents currently obese, *%*	891	2.7	1.4	2.0	3.4	19.4‡	< 0.001
Behaviour difficulties in family, *%*	1088	6.2	2.4	5.4	10.4‡	18.4‡	0.001

Table 1b

SDQ item§§	Valid n	All (n = 1088)	Current weight category* Underweight (n = 85)	Normal weight (n = 850)	Overweight (n = 115)	Obese (n= 38)	Overall p-value†
Emotional problems scale, *mean (SD)*	1059	1.16 (1.43)	1.48 (1.80)	1.13 (1.38)	1.02 (1.25)	1.69 (1.93)	**0.013**
Conduct problems scale, *mean (SD)*	1059	0.91 (1.08)	1.00 (1.05)	0.89 (1.07)	0.95 (1.15)	1.14 (1.18)	0.443
Hyperactivity scale, *mean (SD)*	1057	2.23 (1.90)	2.29 (2.24)	2.17 (1.87)	2.43 (1.88)	2.89 (1.82)	0.085
Peer problems scale, *mean (SD)*	1058	0.71 (1.24)	0.93 (1.25)	0.66 (1.18)	0.86 (1.52)	1.11 (1.43)	**0.024**
Prosocial scale, *mean(SD)*	1057	8.64 (1.41)	8.78 (1.20)	8.63 (1.40)	8.71 (1.47)	8.36 (1.90)	0.474
Total difficulties score, *mean (SD)*	1056	5.02 (3.82)	5.67 (4.43)	4.84 (3.63)	5.26 (4.27)	6.83 (4.55)‡	**0.005**
Impact scale, *mean (SD)*	1046	0.12 (0.71)	0.07 (0.26)	0.12 (0.71)	0.15 (0.93)	0.14 (0.55)	0.887
Emotional problems scale ≥ 90-percentile, *%*	1059	15.7	20.5	15.2	14.2	19.4	0.541
Conduct problems scale ≥ 90-percentile, *%*	1059	22.6	28.9	22.4	17.7	27.8	0.259
Hyperactivity scale ≥ 90-percentile, *%*	1057	11.8	12.0	11.2	13.3	22.2	0.229
Peer problem scale ≥ 90-percentile, *%*	1058	22.3	26.8	20.9	24.8	36.1	0.100
Prosocial scale ≤ 10-percentile, *%*	1057	19.2	13.4	19.2	21.2	25.0	0.415
Total difficulties score ≥ 90-percentile, *%*	1056	10.3	18.3‡	8.7	11.5	25.0‡	**0.001**

Abbreviations: BMI = body mass index; SD: standard deviation; SDS = standard deviation score [23], SDQ = Strength and Difficulties Questionnaire

* Based on the age and sex specific BMI criteria by the International Obesity Task Force.[24,25]

† P-value from comparing all weight groups, i.e. from one-way analysis of variance for continuous, and chi square for categorical variables.

‡ P-value ≤ 0.05 in post hoc pairwise comparison with the normal weight group using Dunnett's t-test (continuous variables) and chi χ^2 test (categorical). Only performed when overall p ≤ 0.05.

§ Computed from the three dimensions on physical activity: Frequency, Intensity, and Endurance, each scored from 1 to 3 (better than peers, like peers, poorer than peers), giving a total score of 3-9, where 9 meant poorer than peers in all 3 dimensions. The figure is the prevalence of children with a score of 6 or higher.

** Any current or previous chronic illnesses.

†† At least three of the following: sweets >1 day/week, soft drink >1 day/week, fast food >1 day/week, breakfast <4 days/week, vegetables <2 days/week, fruit <5 days/week.

‡‡ If the child scored lower than their peers on fine motor, language or social skills, had sleep problems after two years of age, or if they had received any professional interventions within physiotherapy, speech therapy, psychology or psychiatry, or had received any extra support in kindergarten after two years of age.

§§ Symptom scores range from 0 to 10, Total difficulties score is the sum of the first four symptom scores (range 0-40). High score in the symptom scores means more problems, except for the Prosocial scale, which is scored opposite. Impact range 0-10.

Table 2 Logistic regression analyses of associations between Total difficulties Score ≥ 90th percentile (TDS90) on The Strengths and Difficulties Questionnaire (SDQ) and weight category in an unselected regional cohort of five-year-old children in Oppland county, Norway. Results are presented unadjusted and adjusted for family and child related factors.

Explanatory variable		Unadjusted			Adjusted model 1 (n = 806)			Adjusted model 2*and† (n = 782)		
Category	n	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Weight group child (NW reference)	825			**0.002**			**0.038**			**0.031**
UW	82	2.34	(1.27, 4.31)		2.76	(1.28, 5.96)		2.95	(1.32, 6.59)	
OW	113	1.36	(0.73, 2.54)		1.30	(0.58, 2.91)		1.45	(0.63, 3.32)	
OB	36	3.49	(1.58, 7.70)		2.26	(0.82, 6.26)		2.49	(0.85, 7.32)	
Low maternal education	1037	2.23	(1.47, 3.39)	**< 0.001**	1.62	(0.91, 3.45)	0.101	1.63	(0.89, 2.96)	0.111
Low paternal education	1006	2.23	(1.37, 3.62)	**0.001**	1.38	(0.74, 2.59)	0.307	1.35	(0.71, 2.56)	0.365
Weight group mother (NW reference)	605			0.170			0.740			0.729
UW	17	1.42	(0.32, 6.37)		1.14	(0.14, 9.25)		0.99	(0.12, 8.54)	
OW	243	1.33	(0.81, 2.17)		1.39	(0.78, 2.47)		1.40	(0.77, 2.54)	
OB	88	2.01	(1.06, 3.81)		1.07	(0.45, 2.56)		1.05	(0.42, 2.59)	
Weight group father (NW reference)	326			0.511			0.539			0.604
OW	454	1.19	(0.72, 1.96)		1.38	(0.78, 2.45)		1.32	(0.73, 2.40)	
OB	118	1.49	(0.75, 2.95)		1.31	(0.59, 2.91)		1.03	(0.44, 2.38)	
Mother out of work	1037	4.15	(2.44, 7.07)	**< 0.001**	3.33	(1.59, 6.97)	**0.001**	3.17	(1.48, 6.79)	**0.003**
Father out of work	1018	2.26	(1.06, 4.81)	**0.035**	0.62	(0.17, 2.26)	0.468	0.61	(0.15, 2.41)	0.476
Mother smoking	1056	1.70	(1.08, 2.67)	**0.021**	1.15	(0.61, 2,15)	0.673	1.10	(0.57, 2.12)	0.775
Living with one caretaker	1043	1.36	(0.78, 2.36)	0.282	1.13	(0.48, 2.69)	0.778	1.11	(0.45, 2.74)	0.823
Siblings	1035	0.66	(0.36, 1.21)	0.177	1.00	(0.40, 2.46)	0.994	1.07	(0.43, 2.67)	0.893
Behaviour difficulties in the family	1056	2.59	(1.38, 4.85)	**0.003**	2.61	(1.19, 5.74)	**0.017**	2.16	(0.95, 4.91)	0.065
Girl	1056	0.71	(0.47, 1.05)	0.086				0.81	(0.47, 1.37)	0.424
Physical activity score poorer than for peers	1044	2.99	(1.55, 5.77)	**0.001**				1.38	(0.49, 3.93)	0.544
Low nutritional standard	1040	1.48	(0.86, 2.55)	0.158				1.07	(0.51, 2.24)	0.862
Dental caries	1049	2.07	(1.34, 3.19)	**0.001**				1.38	(0.74, 2.58)	0.312
Difficulties in fine motor, language or social skills, or sleep	1033	3.42	(2.28, 5.13)	**< 0.001**				2.95	(1.73, 5.02)	**< 0.001**

Abbreviations: OR = Odds ratio; CI = confidence interval; NW = normal weight; UW = underweight; OW = overweight; OB = obesity.[24,25]

* Family related covariates: Low maternal education, low paternal education, weight category mother, weight category father, mother out of work, father out of work, mother smoking, living with one caretaker, siblings and ADHD in the family.

† Lifestyle covariates: Sex, combined physical activity score poorer than peers, low nutritional standard, dental caries and difficulties in fine motor, language or social skills, or sleep.

Appendix 1. Construction of dichotomized variables related to social factors, health, habits and skills.

Maternal and paternal education was defined as low vs. high, where low was no education beyond high school. *Nutritional score* (low vs. high) was based on frequency of different meals and consumption of various food and drink items. A low score was defined as at least three of the following: sweets > 1 day/week, soft drink > 1 day/week, fast food > 1 day/week, breakfast < 4 days/week, vegetables < 2 days/week, and fruit < 5 days/week. *Physical activity score* was defined as lower than peers if the child was inferior to peers on at least one of the three categories frequency, intensity, or endurance. *Any physical health related problem* was defined as "yes" if the child had a current or previously specified chronic somatic illness. The list was extensive. *Dental caries* was included as a proxy for health-related habits and was dichotomized as ever or never had caries. The variable *Difficulties in fine motor, language or social skills or sleep* was based on the parents' evaluation on questions related to developmental skills and habits. The variable was dichotomized to "yes" or "no", where "yes" meant that the child scored lower than their peers on any of these areas, or if the child had received any professional interventions, i.e. within physiotherapy, speech therapy, psychology, psychiatry, or had received any extra professional support in kindergarten after two years of age. The variable *Behavioural difficulties in the family* was recorded as "yes" if any family member other than the child had ADHD, difficulties with attention or other behavioural difficulties.

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PSYCHOLOGICAL HEALTH IN PRESCHOOL CHILDREN WITH UNDERWEIGHT, OVERWEIGHT OR OBESITY. A REGIONAL COHORT STUDY.

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ABSTRACT

Objective: To examine if underweight (UW), overweight (OW) or obesity (OB) were associated with psychological difficulties in preschool children.

Design: Regional cohort study.

Setting: Oppland County, Norway.

Methods: At the school entry health assessment at 5-6 years of age, parents completed questionnaires on sociodemographic, health and lifestyle factors of the child and the family, and on neurocognitive development of the child. They assessed the psychological health of the child with the Strengths and Difficulties Questionnaire (SDQ). Public health nurses measured the weight and height of all the children. They reported age, sex, height and weight anonymously for the children who declined to participate.

Participants: We obtained necessary information on 1088 of 1895 (57%) of eligible children. The proportion of UW, OW and OB was slightly higher among the children who declined.

Main outcome measures: SDQ subscale and total difficulties scores.

Results: The mean scores and proportion of scores ≥ the 90th percentile had a curvilinear pattern from UW through normal weight (NW), OW and OB with NW as nadir, but the pattern was only statistically significant for the mean Emotional problems, Peer problems and Total SDQ scales, and for the Total SDQ score ≥ the 90th percentile (TDS90). After adjusting for relevant social, developmental, health and behavioural characteristics, only the association between UW and TDS90 remained significant.

Conclusions: The study suggests that UW, but not OW or OB, is an independent risk factor for having psychological symptoms in preschool children.

Key words: Child, Obesity, Overweight, The Strengths and Difficulties Questionnaire, Underweight

WHAT IS ALREADY KNOWN ON THIS TOPIC

- Underweight, overweight and obesity are associated with psychological symptoms in older children and adolescents.
- The significance of psychological symptoms related to weight has rarely been reported, and with conflicting results, in preschool children.

WHAT THIS STUDY ADDS

- In 5-6-year-old children, obesity and underweight, but not overweight, were significantly associated with psychological symptoms, as assessed with the Strengths and Difficulties Questionnaire.
- After adjusting for social, health and lifestyle factors in the family, only underweight was significantly associated with psychological symptoms

INTRODUCTION

The obesity epidemic is a major threat to the health of the individual and societies.[1] The high proportion of children with overweight (OW) or obesity (OB) is particularly worrisome since they are at high risk of OB as adults.[2] We [3] and others [4-7] have shown that a variety of well-intended intervention programs to curtail OB in children have had minor or no significant effect. The intervention programs have generally been oriented towards improving dietary habits and physical activity. Given the limited success, the significance of psychological aspects during early childhood needs to be explored in order to increase our understanding of why prevention and treatment are so difficult.

OB is associated with psychological comorbidities, such as depression, low self-esteem and reduced health related quality of life in adults,[8] older children and adolescents.[9-13] However, it is not settled whether, or to what extent, psychological factors may predispose to OW or OB, or simply are a result of having a high body mass index (BMI). Studies are conflicting regarding the significance of attention deficit hyperactivity disorder (ADHD) and other behavioural difficulties as risk factors for OW and OB.[14-16] Studies on psychological symptoms related to unhealthy weights in young children are scarce, but it has been suggested that neither OW or OB [10,17,18] nor underweight (UW) [18] may be associated with psychological symptoms in preschool children. In particular, we lack knowledge related to UW. However, UW in this age group has been associated with increased parental concern [19] and with food avoidant behaviour and an altered parent-child interaction around meals, [20] which may suggest risks of psychological consequences.

In a regional Norwegian cohort of 5-6-year-old children, we found that OW and OB, but not UW, were associated with unfavourable sociodemographic factors and lifestyles.[21|] The aim of the present paper was to examine if the children with UW, OW or OB in this cohort had

more psychological symptoms than the children with a normal weight (NW). Our hypothesis was that children at this age may not have been exposed to significant psychological consequences of their BMI, such as bullying, and that any psychological symptoms associated with weight categories other than NW might be considered risk factors for developing unhealthy weights.

MATERIALS AND METHODS

Participants

Parents of all children entering school in Oppland County, Norway, in 2007, were invited to participate at the routine school entry health check-up at 5-6 years of age. The invitation was conveyed by the local public health nurses, and at least one parent gave written consent. Oppland county was one of 20 counties in Norway in 2007 and had a population of approximately 183 000 at the time of the study. The county had two cities with 25000 - 30000 inhabitants in each and otherwise rural areas with towns of variable sizes.

Consenting parents completed questionnaires on sociodemographic, health and lifestyle factors of the children and family members, and on neurocognitive development of the children. They assessed their children's psychological health with the Norwegian version of the Strengths and Difficulties Questionnaire (SDQ).[22,23]

The public health nurses measured the height and weight of all eligible children. For the families who declined to participate, the nurses only reported age, sex, height and weight anonymously to the research group. From these data we have previously concluded that the participating children were fairly representative of all the eligible children, although the prevalence of UW, OW and OB was slightly higher among those who declined (10.1% vs. 7.8%, 13.5% vs. 10.6%, and 4.7% vs. 3.5%, respectively, p=0.018).[21]

Patient and Public Involvement statement

Public health care clinics, but not families, were involved concerning content and design.

Anthropometric measurements, health and habits

Height and weight were measured according to national guidelines.[24] Body mass index (BMI) was calculated as weight/height^2 (kg/m^2), and BMI standard deviation scores (BMI SDS) were based on Norwegian references.[25] Definitions of the weight groups UW, NW, OW and OB were based on the sex and age specific BMI criteria of the International Obesity Task Force for the children [26,27] and according to the WHO classification for their parents.[28]

Details on sociodemographic factors, health and habits were published in a previous report.[21] We dichotomized parent's education and the following variables from frequency scores on sets of variables in the questionnaire: Nutritional standard, physical activity, physical health related problem, dental caries, difficulties in fine motor, language or social skills or sleep, and behavioural difficulties in the family. Details are presented in Appendix 1.

The Strengths and Difficulties Questionnaire (SDQ)

The SDQ is a screening tool to detect mental health problems in 4 -16-year-old children.[22] The questionnaire consists of 25 items addressing five subscales with five items in each: Emotional problems scale, Hyperactivity scale, Conduct problems scale, Peer problems scale, and Prosocial scale. Each item is scored on a three-point scale: not true, somewhat true and certainly true, and each scale is scored with a range of 0-10. For the subscales other than the Prosocial scale, higher scores mean more symptoms, and scores at or above the 90th percentile are associated with significant mental health problems.[22] The Prosocial scale is scored opposite to the other subscales, and a score below the 10th percentile may indicate a behaviour problem. A Total difficulty score (TDS) is created by summing the scores from the first four subscales (range 0-40), and a TDS at or above the 90th percentile (TDS90) is considered a

high risk of having a psychiatric disorder.[22] On an Impact scale, the parents state whether the child has any difficulties with emotions, concentration, behaviour or in social contact with other people, and if so, which impact this has on everyday life (range 0-10).

The SDQ has been formally translated and validated in Norway.[23] It has been widely used in all the Scandinavian countries, and the distribution of SDQ scores are very similar for comparable age groups within Norway and between the Nordic countries.[29]

Statistics

Descriptive statistics are presented as counts and per cents (%) for categorical variables and as means and standard deviations (SD) for continuous variables. We explored the differences in characteristics between the four weight groups UW, NW, OW and OB by using one-way analysis of variance (ANOVA) for continuous and the χ^2 test for categorical variables. When ANOVA or χ^2 tests across all weight groups showed significant differences, we performed post hoc pairwise testing, comparing the other weight groups to NW with the Dunnet's t-test for continuous and the χ^2 test for categorical variables.

We tested the significance of the weight groups UW, OW and OB as compared to NW, on outcome in terms of TDS90 vs. lower TDS scores by logistic regression analyses, both unadjusted and adjusted. We adjusted for variables that differed significantly between groups in the ANOVA or χ^2 test analyses, and for variables that we considered relevant from earlier literature and from a theoretical perspective. We adjusted according to two models: In model 1 we adjusted for the family related covariates, i.e. the mother's and father's education, weight category, and having a job or being out of work, mother smoking, behavioural difficulties in the family, two or one caretaker, and having siblings or not. In Model 2 we added the following health and lifestyle covariates of the child to the family related covariates: Sex, Nutritional standard score, Physical activity score, Any physical health

related problem, Difficulties in fine motor, language and social skills or sleep, and Dental caries. Associations were described as odds ratio (OR) and 95% confidence interval (CI). The explanatory variables were tested for interactions and multicollinearity.

We used SPSS Statistics for Windows V 25.0 for all the analyses. P values ≤ 0.05 were considered statistically significant. BMI standard deviation score (BMI SDS) were calculated using R V.2.6.0 (The R foundation for Statistical Computing, Vienna, Austria) using Norwegian growth references.[25]

Ethics

The study was approved by the Regional Committee on Medical Research Ethics (REK 1.2006.3491) and the Norwegian Data Protection Official for Research (02-2006 SI). A signed consent was obtained from one of the parents.

RESULTS

Of 1895 eligible families, 1119 participated, but analyses were limited to 1088 (57.4%) due to incomplete information for 31 children.

There were significant differences between groups on a number of health-related and sociodemographic factors (Table 1a). In the pairwise analyses, low physical activity and family factors such as low parental education, parents being out of work, single parenthood, non-Western ethnicity, mother smoking, and OW or OB in parents and siblings were all significantly associated with OW or OB in the children. UW was only associated with low weight in other family members (Table 1a).

There were significant curvilinear associations between mean scores on the SDQ subscales Emotional problems and Peer problems and weight category with NW as nadir. Scores on the Hyperactivity scale and Prosocial scale, but not the Impact score, showed similar trends

(Table 1b). There was a similar tendency for the proportion of children with subscale scores at or above the 90% percentile (Table 1b). For the mean TDS and TDS90 the curvilinear association was statistically significant (Table 1b).

In the unadjusted logistic regression analyses, TDS90 was significantly associated with weight group (Table 2). However, compared to the children with NW, the risk of TDS90 was only significantly higher for children with UW and OB, not OW (Table 2). TDS90 was also associated with most of the other family and child related social, health and lifestyle factors (Table 2). When adjusted for family related factors in a multiple logistic regression analysis (Model 1), TDS90 was only significantly associated with UW, mother being out of work and behaviour difficulties in the family. When adding child-related variables to the family factors (Model 2), TDS90 was only significantly related to UW, mother being out of work and skills related to fine motor, language or social function, or sleep behaviour (Table 2). Because missing values for the parents' weight groups reduced the sample size, we also estimated models 1 and 2 without these two variables (n = 950 and n= 911). The results did not change substantially. There were no significant interactions or collinearity between the explanatory variables.

DISCUSSION

The broad picture from the unadjusted analyses was that children with UW and OB, but not OW, had more psychological problems, expressed as emotional symptoms, peer related problems and TDS90, than children with NW. However, unrelated to weight category, psychological problems were also significantly associated with numerous unfavourable family and child related factors. After adjusting for such factors, only UW was independently

associated with having psychological problems, although the same tendency was also observed for OB.

The lack of significant psychological consequences of having OW or OB may be unexpected since such association is well documented in later life.[9-13] It may also be unexpected because preschool children are conscious of and often express dissatisfaction with their body size, including a desire for a thinner or larger body shape. [30-32] However, despite this awareness, most preschool children seem to be satisfied with their appearance.[32,33] There may be several reasons for their acceptance The size may not have a psychological impact at this age since acceptance is largely dependent on the attitudes of the parents. [31] Although anti-obesity attitudes may occur as early as at 3-5 years of age, they do not generally occur in a playmate selection.[34] The vast majority of our children were in kindergarten from two years of age, and we suggest that this social setting over years may have reduced any tendencies to focus on body size. It has also been reported that girls who were followed from five to seven years of age, tended to idealize a larger body size than their own at five but a thinner size at seven.[33] However, despite a desire to have a different body size, the girls were satisfied with their appearance, even at eight years of age.[33] The authors therefore suggested that a desire for a different body size represented a cognitive construct without implying psychological consequences.

Our finding that the occurrence of psychological difficulties did not differ between children with OW and NW in any of the analyses, may not be surprising because we have previously shown that Norwegian children with OW are usually perceived by their parents as having a normal body proportion.[35] Furthermore, BMI may not be a good measure to differentiate between OW and NW in young children because OW may mainly be due to a high lean body mass.[36]

The finding that UW *per se* was associated with psychological difficulties has, to our knowledge, not been reported previously for this age group. A systematic review concluded that approximately equal proportions of preschool children found it desirable to be either thinner or larger, but the authors emphasized difficulties in interpreting the findings due to great methodological weaknesses with most of the studies.[31] Later in childhood, children with UW, which also implies shorter stature and lower muscle mass, were almost as likely to be teased by peers as children with OB.[37] Dominance, and even bullying and victimization, are common phenomenon during preschool years,[38] and we suggest that the children with UW may suffer from being the weaker or least robust part in a kindergarten setting. Alternatively, that parents' worry for their lean children [19,20] or restrictive attitude to their children's eating behaviour [20] may have had a negative influence on the children's mental health. However, we suggest that the latter explanation is less likely since UW, as opposed to OW and OB, was not associated with sociodemographic or family behavioural factors, but with low weight and length at birth and their parents' BMI which may imply genetic predisposition [21].

There has been an ongoing debate on the significance of ADHD or other behavioural problems as risk factors for OW and OB. Two meta-analyses concluded that ADHD is a risk factor for adolescent and adult OW and OB, but not [15] or possibly a minimal risk factor [14] for childhood OW and OB. Cortese et al. did not state the age of included children in their meta-analysis, but from the text it is unlikely that young children were included.[14] No preschool children were included in the systematic review by Nigg et al.[15] There was no association between behavioural problems and OW or OB in our study, which is in line with the findings in a large Norwegian cohort followed prospectively and assessed with The Child behaviour Checklist at 18 and 36 months of age.[39] In another Norwegian study of 6-12-year old children, mothers of children with OW and OB rated their children lower on energy,

optimism, compliance, concentration, perseverance, and self-confidence, and higher on egocentricity, irritability, and anxiety than mothers of children with lower BMIs on the Norwegian Hierarchical Personality Inventory for Children.[40] These children were older, but we cannot exclude that preschool children with OB may have psychological symptoms that was not detected with the SDQ.

The strengths of the study were the unselected regional setting where we could assume that the participants were reasonably representative of all the eligible children and families, and the extensive information on the families and children who participated. We cannot exclude selection bias since we had no information on social or health issues on families who declined to participate. However, the participation rate varied from 20% to 85% in the different municipalities (21) suggesting that varying motivation by public health nurses to recruit families had a greater impact on the participation rate than potential selection bias. The somewhat limited number of participants with weights other than NW and dependencies on reports by parents on questionnaires rather than professional assessments were other weaknesses.

CONCLUSION

Our results suggest that the excess occurrence of psychological difficulties in preschool children with OW and OB was due to stresses related to family factors rather than their body size. UW was associated with having psychological symptoms, also after adjusting for family-related factors. We suggest that the reason may be that children with UW are the weaker part in a group setting like kindergarten although we cannot exclude that parental concern or restrictive attitudes were of significance

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Author contributions

Hilde Mjell Donkor: Planning, statistical analyses, interpretation of results and initial drafting and writing the paper. Helene Toxe: Participated in analyses and interpretation and initial drafting and writing of the paper. Jørgen Hurum: Conceptualization and design of the study, collection of data, planning and interpretation of the results. Geir Egil Eide: Planning of presentation and statistical analyses, interpretation of results and writing of the paper. Pétur Benedikt Júlíusson: Planning, presentation, analyses and interpretation of results and writing the paper. Robert Bjerknes: Planning, presentation, analyses and interpretation of results. Trond Markestad: Conceptualization and design of the study, collection of data, presentation and interpretation of results and writing the paper. All authors read and approved the final version of the paper.

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Conflict of interest/Competing interest

None of the authors states any conflicts of interest or competing interest.

Ethical approval

The study was approved by the Regional Committee on Medical Research Ethics (REK 1.2006.3491) and the Norwegian Data Protection Official for Research (02-2006 SI). A signed consent was obtained from one of the parents.

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Table 1 Associations between current weight category and the children's personal characteristics, health and habits, and current sociodemographic and health characteristics of parents and siblings (Table 1a), and between weight category and scores on the Strengths and Difficulties Questionnaire (SDQ) scales (Table 1b). Unselected regional cohort of five-year-old children in Oppland county, Norway. Footnotes apply to both Tables 1a and 1b.

Table 1a

Characteristics	Valid n	All (n = 1088)	Current weight category* Underweight (n = 85)	Normal weight (n = 850)	Overweight (n = 115)	Obese (n = 38)	Overall p-value†
Children's health and habits							
Age in years, *mean (SD)*	1088	5.72 (0.43)	5.63 (0.42)	5.73 (0.44)	5.66 (0.37)	5.82 (0.57)	0.030
Girls, *%*	1088	52.5	51.8	51.4	59.1	57.9	0.408
BMI SDS, *mean (SD)*	1085	0.01 (1.03)	-1.91 (0.55)‡	-0.10 (0.65)	1.41 (0.27)‡	2.36 (0.44)‡	< 0.001
Physical activity poorer than peers§, %	1073	5.1	5.9	3.8	8.0‡	24.3‡	< 0.001
Any physical health problems**, %	1016	28.1	26.0	28.2	27.1	31.6	0.928
Any dental caries - parent report, *%*	1079	20.0	18.8	18.7	25.9	34.2‡	0.043
Low nutritional standard††, *%*	1070	12.8	9.5	13.3	11.6	13.5	0.771
Difficulties with skills or sleep‡‡, %	1062	29.1	28.6	28.9	28.7	37.1	0.767
Kindergarten from 2 years of age, %	1033	92.1	91.5	92.7	90.6	82.4	0.155

Sociodemographic factors and health characteristics of parents and siblings							
Municipality w/n > 20 000, *%*	1087	32.4	38.8	32.6	30.4	18.4	0.157
Low maternal education, *%*	1068	44.9	45.0	41.7	56.2‡	81.1‡	< 0.001
Low paternal education, *%*	1037	60.7	51.9	58.9	72.‡	85.7‡	< 0.001
Both parents low education , *%*	1077	38.4	37.0	35.4	50.‡	73.7‡	< 0.001
Mother out of work, *%*	1069	8.2	8.5	7.5	9.7	18.9	0.090
Father out of work, *%*	1046	4.8	4.9	4.0	7.0	15.2‡	0.017
Parent(s) non-Western, *%*	1088	2.7	3.5	2.1	3.5	10.5‡	0.014
Living with one caretaker, *%*	1073	13.0	9.8	12.0	17.5	29.7‡	0.005
No siblings, *%*	1065	9.1	3.6	9.0	16.‡	2.9	0.009
Mother smoking, *%*	1088	19.0	14.1	16.6	32.‡	44.7‡	< 0.001
Current BMI mother, *mean (SD)*	981	24.32 (3.85)	23.06 (3.31)	24.07 (3.66)	26.03 (4.15)‡	27.52 (5.12)‡	< 0.001
Current BMI father, *mean (SD)*	924	26.38 (3.30)	25.13 (2.72)‡	26.25 (3.16)	27.57 (3.75) ‡	28.89 (4.33) ‡	< 0.001
BMI SDS average for siblings	630	-0.21 (1.23)	-0.76 (1.26)‡	-0.24 (1.20)	0.26 (1.06)‡	0.55 (1.45)‡	< 0.001
Mother currently obese, *%*	980	9.1	6.5	7.2	16.‡	34.3‡	< 0.001
Father currently obese, *%*	924	13.0	3.9‡	11.2	26.‡	37.5‡	< 0.001
Both parents currently obese, *%*	891	2.7	1.4	2.0	3.4	19.4‡	< 0.001
Behaviour difficulties in family, *%*	1088	6.2	2.4	5.4	10.‡	18.4‡	0.001

Table 1b

SDQ item§§	Valid n	All (n = 1088)	Current weight category* Underweight (n = 85)	Normal weight (n = 850)	Overweight (n = 115)	Obese (n= 38)	Overall p-value†
Emotional problems scale, *mean (SD)*	1059	1.16 (1.43)	1.48 (1.80)	1.13 (1.38)	1.02 (1.25)	1.69 (1.93)	**0.013**
Conduct problems scale, *mean (SD)*	1059	0.91 (1.08)	1.00 (1.05)	0.89 (1.07)	0.95 (1.15)	1.14 (1.18)	0.443
Hyperactivity scale, *mean (SD)*	1057	2.23 (1.90)	2.29 (2.24)	2.17 (1.87)	2.43 (1.88)	2.89 (1.82)	0.085
Peer problems scale, *mean (SD)*	1058	0.71 (1.24)	0.93 (1.25)	0.66 (1.18)	0.86 (1.52)	1.11 (1.43)	**0.024**
Prosocial scale, *mean(SD)*	1057	8.64 (1.41)	8.78 (1.20)	8.63 (1.40)	8.71 (1.47)	8.36 (1.90)	0.474
Total difficulties score, *mean (SD)*	1056	5.02 (3.82)	5.67 (4.43)	4.84 (3.63)	5.26 (4.27)	6.83 (4.55)‡	**0.005**
Impact scale, *mean (SD)*	1046	0.12 (0.71)	0.07 (0.26)	0.12 (0.71)	0.15 (0.93)	0.14 (0.55)	0.887
Emotional problems scale ≥ 90-percentile, *%*	1059	15.7	20.5	15.2	14.2	19.4	0.541
Conduct problems scale ≥ 90-percentile, *%*	1059	22.6	28.9	22.4	17.7	27.8	0.259
Hyperactivity scale ≥ 90-percentile, *%*	1057	11.8	12.0	11.2	13.3	22.2	0.229
Peer problem scale ≥ 90-percentile, *%*	1058	22.3	26.8	20.9	24.8	36.1	0.100
Prosocial scale ≤ 10-percentile, *%*	1057	19.2	13.4	19.2	21.2	25.0	0.415
Total difficulties score ≥ 90-percentile, *%*	1056	10.3	18.3‡	8.7	11.5	25.0‡	**0.001**

Abbreviations: BMI = body mass index; SD: standard deviation; SDS = standard deviation score [23], SDQ = Strength and Difficulties Questionnaire

* Based on the age and sex specific BMI criteria by the International Obesity Task Force.[24,25]

† P-value from comparing all weight groups, i.e. from one-way analysis of variance for continuous, and chi square for categorical variables.

‡ P-value ≤ 0.05 in post hoc pairwise comparison with the normal weight group using Dunnett's t-test (continuous variables) and chi χ^2 test (categorical). Only performed when overall $p \leq 0.05$.

§ Computed from the three dimensions on physical activity: Frequency, Intensity, and Endurance, each scored from 1 to 3 (better than peers, like peers, poorer than peers), giving a total score of 3-9, where 9 meant poorer than peers in all 3 dimensions. The figure is the prevalence of children with a score of 6 or higher.

** Any current or previous chronic illnesses.

†† At least three of the following: sweets >1 day/week, soft drink >1 day/week, fast food >1 day/week, breakfast <4 days/week, vegetables <2 days/week, fruit <5 days/week.

‡‡ If the child scored lower than their peers on fine motor, language or social skills, had sleep problems after two years of age, or if they had received any professional interventions within physiotherapy, speech therapy, psychology or psychiatry, or had received any extra support in kindergarten after two years of age.

§§ Symptom scores range from 0 to 10, Total difficulties score is the sum of the first four symptom scores (range 0-40). High score in the symptom scores means more problems, except for the Prosocial scale, which is scored opposite. Impact range 0-10.

Table 2 Logistic regression analyses of associations between Total difficulties Score ≥ 90th percentile (TDS90) on The Strengths and Difficulties Questionnaire (SDQ) and weight category in an unselected regional cohort of five-year-old children in Oppland county, Norway. Results are presented unadjusted and adjusted for family and child related factors.

Explanatory variable		Unadjusted			Adjusted model 1 (n = 950)			Adjusted model 2*and † (n = 911)		
Category	n	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Weight group child (NW reference)	825			**0.002**			**0.029**			**0.040**
UW	82	2.34	(1.27, 4.31)		2.59	(1.29, 5.19)		2.75	(1.31, 5.74)	
OW	113	1.36	(0.73, 2.54)		1.09	(0.53, 2.21)		1.21	(0.58, 2.52)	
OB	36	3.49	(1.58, 7.70)		2.19	(0.84, 5.70)		2.02	(0.73, 5.60)	
Low maternal education	1037	2.23	(1.47, 3.39)	**< 0.001**	1.43	(0.86, 2.39)	0.172	1.43	(0.83, 2.45)	0.195
Low paternal education	1006	2.23	(1.37, 3.62)	**0.001**	1.65	(0.94, 2.92)	0.082	1.65	(0.92, 2.98)	0.093
Mother out of work	1037	4.15	(2.44, 7.07)	**< 0.001**	3.51	(1.86, 6.63)	**0.001**	3.31	(1.70, 6.44)	**<0.001**
Father out of work	1018	2.26	(1.06, 4.81)	**0.035**	1.32	(0.56, 3.16)	0.527	1.15	(0.44, 3.02)	0.776
Mother smoking	1056	1.70	(1.08, 2.67)	**0.021**	1.09	(0.62, 1.91)	0.763	1.07	(0.60, 1.92)	0.825
Living with one caretaker	1043	1.36	(0.78, 2.36)	0.282	0.84	(0.41, 1.70)	0.626	0.87	(0.41, 1.82)	0.710
Siblings	1035	0.66	(0.36, 1.21)	0.177	0.77	(0.37, 1.59)	0.483	0.87	(0.41, 1.85)	0.720
Behaviour difficulties in the family	1056	2.59	(1.38, 4.85)	**0.003**	1.57	(0.74, 3.34)	0.245	1.23	(0.56, 2.73)	0.606
Girl	1056	0.71	(0.47, 1.05)	0.086				0.83	(0.52, 1.33)	0.443
Physical activity score poorer than for peers	1044	2.99	(1.55, 5.77)	**0.001**				2.13	(0.96, 4.71)	0.063
Low nutritional standard	1040	1.48	(0.86, 2.55)	0.158				1.23	(0.64, 2.37)	0.530
Dental caries	1049	2.07	(1.34, 3.19)	**0.001**				1.47	(0.85, 2.55)	0.164
Difficulties in fine motor, language or social skills, or sleep	1033	3.42	(2.28, 5.13)	**< 0.001**				3.14	(1.95, 5.04)	**<0.001**

Abbreviations: OR = Odds ratio; CI = confidence interval; NW = normal weight; UW = underweight; OW = overweight; OB = obesity.[26,27]

* Family related covariates: Low maternal education, low paternal education, mother out of work, father out of work, mother smoking, living with one caretaker, siblings and ADHD in the family.

† Lifestyle covariates: Sex, combined physical activity score poorer than peers, low nutritional standard, dental caries and difficulties in fine motor, language or social skills, or sleep.

Appendix 1. Construction of dichotomized variables related to social factors, health, habits and skills.

Maternal and paternal education was defined as low vs. high, where low was no education beyond high school. *Nutritional score* (low vs. high) was based on frequency of different meals and consumption of various food and drink items. A low score was defined as at least three of the following: sweets > 1 day/week, soft drink > 1 day/week, fast food > 1 day/week, breakfast < 4 days/week, vegetables < 2 days/week, and fruit < 5 days/week. *Physical activity score* was defined as lower than peers if the child was inferior to peers on at least one of the three categories frequency, intensity, or endurance. *Any physical health related problem* was defined as "yes" if the child had a current or previously specified chronic somatic illness. The list was extensive. *Dental caries* was included as a proxy for health-related habits and was dichotomized as ever or never had caries. The variable *Difficulties in fine motor, language or social skills or sleep* was based on the parents' evaluation on questions related to developmental skills and habits. The variable was dichotomized to "yes" or "no", where "yes" meant that the child scored lower than their peers on any of these areas, or if the child had received any professional interventions, i.e. within physiotherapy, speech therapy, psychology, psychiatry, or had received any extra professional support in kindergarten after two years of age. The variable *Behavioural difficulties in the family* was recorded as "yes" if any family member other than the child had ADHD, difficulties with attention or other behavioural difficulties.

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Psychological health in preschool children with underweight, overweight or obesity. A regional cohort study

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PSYCHOLOGICAL HEALTH IN PRESCHOOL CHILDREN WITH UNDERWEIGHT, OVERWEIGHT OR OBESITY. A REGIONAL COHORT STUDY.

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ABSTRACT

Objective: To examine if underweight (UW), overweight (OW) or obesity (OB), or body mass index (BMI) expressed as its standard deviation score (BMI SDS), were associated with psychological difficulties in preschool children.

Design: Regional cohort study.

Setting: Oppland County, Norway.

Methods: At the routine school entry health assessment at 5-6 years of age, parents were invited to participate by local public health nurses. The parents completed questionnaires on sociodemographic, health and lifestyle factors of the child and the family, and on the child's neurocognitive development. They assessed psychological health with the Strengths and Difficulties Questionnaire (SDQ). Public health nurses measured weight and height on all eligible children and reported age, sex, height, and weight anonymously for the children who declined to participate.

Participants: We obtained information on 1088 of 1895 (57%) eligible children. The proportion of UW, OW and OB was slightly higher among the children who declined.

Main outcome measures: SDQ subscale and total difficulties scores.

Results: The mean SDQ scores and proportion of scores ≥ the 90th percentile had a curvilinear pattern from UW through normal weight (NW), OW and OB with NW as nadir, but the pattern was only significant for the mean Emotional problems, Peer problems and Total SDQ scales, and for the Total SDQ score ≥ the 90th percentile (TDS90). After adjusting for relevant social, developmental, health, and behavioural characteristics TDS90 was only significantly associated with UW in multiple logistic regression analyses, and only with the lowest quartile of BMI SDS in a linear spline regression analysis.

Conclusions: The study suggests that UW and low BMI, but not OW, OB or higher BMI, are independent risk factors for having psychological symptoms in preschool children.

Key words: Child, Obesity, Overweight, The Strengths and Difficulties Questionnaire, Underweight

WHAT IS ALREADY KNOWN ON THIS TOPIC

- Underweight, overweight and obesity are associated with psychological symptoms in older children and adolescents.
- The significance of psychological symptoms related to weight has rarely been reported, and with conflicting results, in preschool children.

WHAT THIS STUDY ADDS

- In 5-6-year-old children, obesity and underweight, but not overweight, were significantly associated with psychological symptoms, as assessed with the Strengths and Difficulties Questionnaire.
- After adjusting for social, health and lifestyle factors in the family, only underweight and a low BMI were significantly associated with psychological symptoms.

INTRODUCTION

The obesity epidemic is a major threat to the health of the individual and societies.[1] The high proportion of children with overweight (OW) or obesity (OB) is particularly worrisome since they are at high risk of OB as adults.[2] We [3] and others [4-7] have shown that a variety of well-intended intervention programs to curtail OB in children have had minor or no significant effect. The programs have generally been oriented towards improving dietary habits and physical activity. Given the limited success, the significance of psychological aspects during early childhood needs to be explored to increase our understanding of why prevention and treatment are so difficult.

OB is associated with psychological comorbidities, such as depression, low self-esteem and reduced health related quality of life in adults,[8] older children and adolescents.[9-13] However, it is not settled whether, or to what extent, psychological factors may predispose to OW or OB, or simply are a result of having a high body mass index (BMI). Studies are conflicting regarding the significance of attention deficit hyperactivity disorder (ADHD) and other behavioural difficulties as risk factors for OW and OB.[14-16] Studies on psychological symptoms related to unhealthy weights in young children are scarce, but it has been suggested that neither OW or OB, [10,17,18] nor underweight (UW), [18] may be associated with psychological symptoms in preschool children. In particular we lack knowledge related to UW. However, UW in this age group has been associated with increased parental concern [19] and with food avoidant behaviour and an altered parent-child interaction around meals, [20] which may suggest risks of psychological consequences.

In a regional Norwegian cohort of 5-6-year-old children, we found that OW and OB, but not UW, were associated with unfavourable sociodemographic factors and lifestyles.[21|] The aim of the present paper was to examine if the children with UW, OW or OB in this cohort had

more psychological symptoms than the children with a normal weight (NW), or whether psychological symptoms were related to certain BMI scores. Our hypothesis was that children at this age may not have been exposed to significant psychological consequences of their BMI, such as bullying, and that any psychological symptoms associated with weight categories other than NW might be considered risk factors for developing unhealthy weights.

MATERIALS AND METHODS

Participants

Parents of all children entering school in Oppland County, Norway, in 2007, were invited to participate at the routine school entry health assessment at 5-6 years of age. Oppland county had a population of approximately 183000. The county had two cities with 25000 - 30000 inhabitants in each and otherwise rural areas with towns of variable sizes.

Consenting parents completed questionnaires on sociodemographic, health and lifestyle factors of the children and family members, and on neurocognitive development of the children. They assessed their children's psychological health with the Norwegian version of the Strengths and Difficulties Questionnaire (SDQ).[22,23]

The public health nurses measured the height and weight of all eligible children. For the families who declined, the nurses reported age, sex, height, and weight anonymously. We have previously concluded that the participating children were fairly representative of all the eligible children, although the prevalence of UW, OW and OB was slightly higher among those who declined.[21]

Patient and Public Involvement statement

Public health care clinics, but not families, were involved concerning content and design.

Anthropometric measurements, health and habits

Height and weight were measured according to national guidelines.[24] BMI was calculated as weight/height^2 (kg/m^2), and BMI standard deviation scores (BMI SDS) were based on Norwegian references.[25] Definitions of the weight groups UW, NW, OW and OB were based on the sex and age specific BMI criteria of the International Obesity Task Force for the children [26,27] and according to the WHO classification for their parents.[28]

Details on sociodemographic factors, health and habits were published in a previous report.[21] We dichotomized parent's education and the following variables from frequency scores on sets of variables in the questionnaire: Nutritional standard, physical activity, physical health related problem, dental caries, difficulties in fine motor, language or social skills or sleep, and behavioural difficulties in the family. Details are presented in Appendix 1.

The Strengths and Difficulties Questionnaire (SDQ)

The SDQ is a screening tool to detect mental health problems in 4 -16-year-old children.[22] The questionnaire consists of 25 items addressing five subscales with five items in each: Emotional problems scale, Hyperactivity scale, Conduct problems scale, Peer problems scale, and Prosocial scale. Each item is scored on a three-point scale: not true, somewhat true and certainly true, and each scale is scored with a range of 0-10. For the subscales other than the Prosocial scale, higher scores mean more symptoms, and scores at or above the 90th percentile are associated with significant mental health problems.[22] The Prosocial scale is scored opposite to the other subscales, and a score below the 10th percentile may indicate a behaviour problem. A Total difficulty score (TDS) is created by summing the scores from the first four subscales (range 0-40), and a TDS at or above the 90th percentile (TDS90) is considered a high risk of having a psychiatric disorder.[22] On an Impact scale, the parents state whether the child has any difficulties with emotions, concentration, behaviour or in social contact with other people, and if so, which impact it has on everyday life (range 0-10).

The SDQ has been formally translated and validated in Norway.[23] It has been widely used in all the Scandinavian countries, and the distribution of SDQ scores are very similar for comparable age groups within Norway and between the Nordic countries.[29]

Statistics

Descriptive statistics are presented as counts and per cents (%) for categorical variables and as means and standard deviations (SD) for continuous variables. We explored the differences in characteristics between the four weight groups UW, NW, OW and OB by using one-way analysis of variance (ANOVA) for continuous and the χ^2 test for categorical variables. When ANOVA or χ^2 tests across all weight groups showed significant differences, we performed post hoc pairwise testing, comparing the other weight groups to NW with the Dunnet's t-test for continuous and the χ^2 test for categorical variables (Table 1).

We tested the significance of the weight groups UW, OW and OB as compared to NW, on outcome in terms of TDS90 vs. lower TDS scores by logistic regression analyses, both unadjusted and adjusted. We adjusted for variables that differed significantly between groups in the ANOVA or χ^2 test analyses, and for variables that we considered relevant from earlier literature and from a theoretical perspective. We adjusted according to two models: In Model 1 we adjusted for the family related covariates, and in Model 2 we added health and lifestyle covariates of the child to the family related covariates (Table 2). Associations were described as odds ratio (OR) and 95% confidence interval (CI). The explanatory variables were tested for interactions and multicollinearity. We also explored if TDS90 was associated with BMI SDS in linear spline regression analyses. [30]

We used Stata for the spline analysis and SPSS Statistics for Windows V 25.0 for the other analyses. P values ≤ 0.05 were considered statistically significant. BMI standard deviation

score (BMI SDS) were calculated using R V.2.6.0 (The R foundation for Statistical Computing, Vienna, Austria) using Norwegian growth references.[25]

Ethics

The study was approved by the Regional Committee on Medical Research Ethics (REK 1.2006.3491) and the Norwegian Data Protection Official for Research (02-2006 SI). A signed consent was obtained from one of the parents.

RESULTS

Of 1895 eligible families, 1119 participated, but analyses were limited to 1088 (57.4%) due to incomplete information for 31 children.

There were significant differences between groups on a several health-related and sociodemographic factors (Table 1a). In the pairwise analyses, low physical activity and family factors such as low parental education, parents being out of work, single parenthood, non-Western ethnicity, mother smoking, and OW or OB in parents and siblings were all significantly associated with OW or OB in the children. UW was only associated with low weight in other family members (Table 1a).

There were significant curvilinear associations between mean scores on the SDQ subscales Emotional problems and Peer problems and weight category with NW as nadir. Scores on the Hyperactivity scale and Prosocial scale, but not the Impact score, showed similar trends (Table 1b). There was a similar tendency for the proportion of children with subscale scores at or above the 90% percentile (Table 1b). For the mean TDS and TDS90 the curvilinear association was statistically significant (Table 1b).

In the unadjusted logistic regression analyses, TDS90 was significantly associated with weight group (Table 2). However, compared to the children with NW, the risk of TDS90 was

only significantly higher for children with UW and OB, not OW (Table 2). TDS90 was also associated with most of the other family and child related social, health and lifestyle factors, but not with the parents' weight (Table 2). When adjusted for family related factors (Model 1), TDS90 was only significantly associated with UW, mother being out of work and behaviour difficulties in the family. When adding child-related variables to the family factors (Model 2), TDS90 was only significantly associated with UW, mother being out of work and skills related to fine motor, language or social function, or sleep behaviour (Table 2). Parental weight was not included in the models because missing values reduced the sample size to 806 in Model 1 and 782 in Model 2. However, the results were essentially the same when this variable was included. There were no significant interactions or collinearity between the explanatory variables.

In the multiple linear spline regression with knots dividing the data on BMI SDS into four quartiles, we found a significantly higher, but decreasing risk of TDS90 with increasing BMI SDS within the first quartile (OR = 0.48, 95% CI: 0.26 to 0,87), but no changes from the low risk in the 2nd and later quartiles. The results for the other included risk factors did not change substantially.

DISCUSSION

The broad picture from the unadjusted analyses was that children with UW and OB, but not OW, had more psychological problems, expressed as emotional symptoms, peer related problems and TDS90, than children with NW. However, after adjusting for numerous unfavourable family and child related factors, only UW and a BMI SDS similar to UW were independently associated with having psychological problems.

The lack of significant psychological consequences of having OW or OB may be unexpected since such associations are well documented in later life.[9-13] It may also be unexpected because preschool children are conscious of and often express dissatisfaction with their body size, including a desire for a thinner or larger body shape. [31-33] However, despite this awareness, most preschool children seem to be satisfied with their appearance.[33,34] The size may not have a psychological impact at this age because acceptance is largely dependent on the attitudes of the parents. [32] Furthermore, although anti-obesity attitudes may occur as early as at 3-5 years of age, they do not generally occur in a playmate selection.[35] The vast majority of our children were in kindergarten from two years of age, and we suggest that this social setting over years may have reduced any tendencies to focus on body size. It has also been reported that girls who were followed from five to seven years of age, tended to idealize a larger body size than their own at five, but a thinner size at seven.[34] However, despite a desire to have a different body size, the girls were satisfied with their appearance, even at eight years of age.[34] The authors therefore suggested that a desire for a different body size represented a cognitive construct without implying psychological consequences.

Our finding that the occurrence of psychological difficulties did not differ between children with OW and NW in any of the analyses, may not be surprising because we have previously shown that Norwegian children with OW are usually perceived by their parents as having a normal body proportion.[36] Furthermore, BMI may not be a good measure to differentiate between OW and NW in young children because OW may mainly be due to a high lean body mass.[37]

The finding that UW *per se* was associated with psychological difficulties has, to our nowledge, not been reported previously for this age group. In later childhood, children with UW, which also implies shorter stature and lower muscle mass, were almost as likely to be teased by peers as children with OB.[38] Dominance, and even bullying and victimization, are

common phenomenon during preschool years,[39] and we suggest that the children with UW may suffer from being the weaker or least robust part in a kindergarten setting. Alternatively, that parents' worry for their lean children [19,20] or restrictive attitude to their children's eating behaviour, [20] may have had a negative influence on the children's mental health. However, we suggest that the latter explanation is less likely since UW, as opposed to OW and OB, was not associated with sociodemographic or family behavioural factors, but with low weight and length at birth and their parents' BMI which may imply genetic predisposition [21].

There has been an ongoing debate on the significance of ADHD or other behavioural problems as risk factors for OW and OB. Two meta-analyses concluded that ADHD is a risk factor for adolescent and adult OW and OB, but not [15] or possibly a minimal risk factor [14] for childhood OW and OB. Cortese et al. did not state the age of included children in their meta-analysis, but from the text it is unlikely that young children were included.[14] No preschool children were included in the systematic review by Nigg et al.[15] There was no association between behavioural problems and OW or OB in our study, which is in line with the findings in a large Norwegian cohort who was assessed with The Child behaviour Checklist at 18 and 36 months of age.[40] In another Norwegian study of 6-12-year old children, mothers of children with OW and OB rated their children lower on energy, optimism, compliance, concentration, perseverance, and self-confidence, and higher on egocentricity, irritability, and anxiety than mothers of children with lower BMIs on the Norwegian Hierarchical Personality Inventory for Children.[41] These children were older, but we cannot exclude that preschool children with OB may have psychological symptoms that was not detected with the SDQ.

The strengths of the study were the unselected regional setting where we could assume that the participants were reasonably representative of all the eligible children and families, and

the extensive information on the families and children who participated. We cannot exclude selection bias since we had no information on social or health issues on families who declined to participate. However, the participation rate varied from 20% to 85% in the different municipalities (21) suggesting that varying motivation by public health nurses to recruit families had a greater impact on the participation rate than potential selection bias. The somewhat limited number of participants with weights other than NW and dependencies on reports by parents on questionnaires rather than professional assessments were other weaknesses.

CONCLUSION

Our results suggest that the excess occurrence of psychological difficulties in preschool children with OW and OB was due to stresses related to family factors rather than their body size. UW and a low BMI was associated with having psychological symptoms, also after adjusting for family-related factors. We suggest that the reason may be that children with UW are the weaker part in a group setting like kindergarten although we cannot exclude that parental concern or restrictive attitudes were of significance.

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Author contributions

Hilde Mjell Donkor: Planning, statistical analyses, interpretation of results and initial drafting and writing the paper. Helene Toxe: Participated in analyses and interpretation and initial drafting and writing of the paper. Jørgen Hurum: Conceptualization and design of the study, collection of data, planning and interpretation of the results. Robert Bjerknes: Planning, presentation, analyses and interpretation of results Geir Egil Eide: Planning of presentation and statistical analyses, interpretation of results and writing of the paper. Petur Benedikt Julíusson: Planning, presentation, analyses and interpretation of results and writing the paper. Trond Markestad: Conceptualization and design of the study, collection of data, presentation and interpretation of results and writing the paper. All authors read and approved the final version of the paper.

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Conflict of interest/Competing interest

None of the authors states any conflicts of interest or competing interest.

Ethical approval

The study was approved by the Regional Committee on Medical Research Ethics (REK 1.2006.3491) and the Norwegian Data Protection Official for Research (02-2006 SI). A signed consent was obtained from one of the parents.

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Table 1 Associations between current weight category and the children's personal characteristics, health and habits, and current sociodemographic and health characteristics of parents and siblings (Table 1a), and between weight category and scores on the Strengths and Difficulties Questionnaire (SDQ) scales (Table 1b). Unselected regional cohort of five-year-old children in Oppland county, Norway. Footnotes apply to both Tables 1a and 1b.

Table 1a

Characteristics	Valid n	All (n = 1088)	Current weight category* Underweight (n = 89)	Normal weight (n = 844)	Overweight (n = 117)	Obese (n = 38)	Overall p-value†
Children's health and habits							
Age in years, *mean (SD)*	1088	5.72 (0.43)	5.66 (0.44)	5.72 (0.43)	5.66 (0.37)	5.82 (0.57)	0.105
Girls, *%*	1088	52.5	49.4	51.8	58.1	57.9	0.487
BMI SDS, *mean (SD)*	1085	0.01 (1.03)	-1.93 (0.56)‡	-0.10 (0.63)	1.42 (0.28)‡	2.36 (0.44)‡	< 0.001
Physical activity poorer than peers§, %	1073	5.1	5.6	3.8	7.9‡	24.3‡	< 0.001
Any physical health problems**, %	1016	28.1	27.2	28.2	26.6	31.6	0.943
Any dental caries - parent report, *%*	1079	20.0	19.1	18.7	25.4	34.2	0.051
Low nutritional standard††, *%*	1070	12.8	11.4	13.1	11.4	13.5	0.929
Difficulties with skills or sleep‡‡, %	1062	29.1	28.4	29.0	28.2	37.1	0.760
Kindergarten from 2 years of age, %	1033	92.1	91.6	92.7	90.7	82.4	0.163

Sociodemographic factors and health characteristics of parents and siblings							
Municipality w/n > 20 000, *%*	1087	32.4	38.2	32.6	30.8	18.4	0.178
Low maternal education, *%*	1068	44.9	44.0	41.6	56.9‡	81.1‡	< 0.001
Low paternal education, *%*	1037	60.7	51.8	58.8	72.7‡	85.7‡	< 0.001
Both parents low education , *%*	1077	38.4	36.5	35.3	50.9‡	73.7‡	< 0.001
Mother out of work, *%*	1069	8.2	8.1	7.5	10.4	18.9	0.072
Father out of work, *%*	1046	4.8	4.7	3.9	7.9	15.2‡	0.009
Parent(s) non-Western, *%*	1088	2.7	3.4	2.1	3.4	10.5‡	0.015
Living with one caretaker, *%*	1073	13.0	9.3	12.1	17.2	29.7‡	0.006
No siblings, *%*	1065	9.1	4.5	8.9	15.9‡	2.9	0.017
Mother smoking, *%*	1088	19.0	14.6	16.6	31.6‡	44.7‡	< 0.001
Current BMI mother, *mean (SD)*	981	24.32 (3.85)	23.03 (3.29)	24.07 (3.64)	26.09 (4.20)‡	27.52 (5.12)‡	< 0.001
Current BMI father, *mean (SD)*	924	26.38 (3.30)	25.09 (2.71)‡	26.26 (3.16)	27.54 (3.71) ‡	28.89 (4.33) ‡	< 0.001
BMI SDS average for siblings	630	-0.21 (1.23)	-0.79 (1.24)‡	-0.23 (1.20)	0.25 (1.06)‡	0.55 (1.45)‡	< 0.001
Mother currently obese, *%*	980	9.1	6.2	7.1	17.2‡	34.3‡	< 0.001
Father currently obese, *%*	924	13.0	3.8‡	11.3	25.9‡	37.5‡	< 0.001
Both parents currently obese, *%*	891	2.7	1.3	2.0	3.3	19.4‡	< 0.001
Behaviour difficulties in family, *%*	1088	6.2	3.4	5.3	10.3‡	18.4‡	0.001

Table 1b

SDQ item§§	Valid n	All (n = 1088)	Current weight category* Underweight (n = 89)	Normal weight (n = 844)	Overweight (n = 117)	Obese (n= 38)	Overall p-value†
Emotional problems scale, *mean (SD)*	1059	1.16 (1.43)	1.48 (1.82)	1.13 (1.37)	1.02 (1.24)	1.69 (1.93)	**0.011**
Conduct problems scale, *mean (SD)*	1059	0.91 (1.08)	0.95 (1.04)	0.89 (1.07)	0.97 (1.16)	1.14 (1.18)	0.474
Hyperactivity scale, *mean (SD)*	1057	2.23 (1.90)	2.29 (2.23)	2.17 (1.87)	2.43 (1.86)	2.89 (1.82)	0.088
Peer problems scale, *mean (SD)*	1058	0.71 (1.24)	0.93 (1.24)	0.66 (1.18)	0.84 (1.51)	1.11 (1.43)	**0.025**
Prosocial scale, *mean(SD)*	1057	8.64 (1.41)	8.80 (1.19)	8.63 (1.40)	8.69 (1.47)	8.36 (1.90)	0.440
Total difficulties score, *mean (SD)*	1056	5.02 (3.82)	5.63 (4.43)	4.84 (3.63)	5.26 (4.24)	6.83 (4.55)‡	**0.005**
Impact scale, *mean (SD)*	1046	0.12 (0.71)	0.07 (0.26)	0.12 (0.71)	0.15 (0.92)	0.14 (0.55)	0.879
Emotional problems scale ≥ 90-percentile, *%*	1059	15.7	20.7	15.2	13.9	19.4	0.487
Conduct problems scale ≥ 90-percentile, *%*	1059	22.6	27.6	22.3	19.1	27.8	0.453
Hyperactivity scale ≥ 90-percentile, *%*	1057	11.8	12.6	11.1	13.0	22.2	0.226
Peer problem scale ≥ 90-percentile, *%*	1058	22.3	27.9	20.8	24.3	36.1	0.0.78
Prosocial scale ≤ 10-percentile, *%*	1057	19.2	12.8	19.3	21.7	25.0	0.316
Total difficulties score ≥ 90-percentile, *%*	1056	10.3	18.6‡	8.7	11.3	25.0‡	**0.001**

Abbreviations: BMI = body mass index; SD: standard deviation; SDS = standard deviation score [23], SDQ = Strength and Difficulties Questionnaire

* Based on the age and sex specific BMI criteria by the International Obesity Task Force.[24,25]

† P-value from comparing all weight groups, i.e. from one-way analysis of variance for continuous, and chi square for categorical variables.

‡ P-value ≤ 0.05 in post hoc pairwise comparison with the normal weight group using Dunnett's t-test (continuous variables) and chi χ^2 test (categorical). Only performed when overall $p \leq 0.05$.

§ Computed from the three dimensions on physical activity: Frequency, Intensity, and Endurance, each scored from 1 to 3 (better than peers, like peers, poorer than peers), giving a total score of 3-9, where 9 meant poorer than peers in all 3 dimensions. The figure is the prevalence of children with a score of 6 or higher.

** Any current or previous chronic illnesses.

†† At least three of the following: sweets >1 day/week, soft drink >1 day/week, fast food >1 day/week, breakfast <4 days/week, vegetables <2 days/week, fruit <5 days/week.

‡‡ If the child scored lower than their peers on fine motor, language or social skills, had sleep problems after two years of age, or if they had received any professional interventions within physiotherapy, speech therapy, psychology or psychiatry, or had received any extra support in kindergarten after two years of age.

§§ Symptom scores range from 0 to 10, Total difficulties score is the sum of the first four symptom scores (range 0-40). High score in the symptom scores means more problems, except for the Prosocial scale, which is scored opposite. Impact range 0-10.

Table 2 Logistic regression analyses of associations between Total difficulties Score ≥ 90th percentile (TDS90) on The Strengths and Difficulties Questionnaire (SDQ) and weight category in an unselected regional cohort of five-year-old children in Oppland county, Norway. Results are presented unadjusted and adjusted for family and child related factors.

Explanatory variable		Unadjusted			Adjusted model 1 (n = 950)			Adjusted model 2*and † (n = 911)		
Category	n	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Weight group child (NW reference)	819			**0.002**			**0.017**			**0.023**
UW	86	2.41	(1.33, 4.37)		2.69	(1.37, 5.27)		2.87	(1.41, 5.85)	
OW	115	1.34	(0.72, 2.51)		1.04	(0.51, 2.12)		1.18	(0.57, 2.45)	
OB	36	3.51	(1.59, 7.76)		2.19	(0.84, 5.73)		2.02	(0.73, 5.62)	
Low maternal education	1037	2.23	(1.47, 3.39)	**< 0.001**	1.44	(0.86, 2.40)	0.167	1.44	(0.84, 2.46)	0.187
Low paternal education	1006	2.23	(1.37, 3.62)	**0.001**	1.66	(0.94, 2.93)	0.080	1.67	(0.93, 3.01)	0.086
Mother out of work	1037	4.15	(2.44, 7.07)	**< 0.001**	3.54	(1.87, 6.70)	**0.001**	3.34	(1.71, 6.50)	**<0.001**
Father out of work	1018	2.26	(1.06, 4.81)	**0.035**	1.33	(0.56, 3.18)	0.520	1.14	(0.44, 3.00)	0.785
Mother smoking	1056	1.70	(1.08, 2.67)	**0.021**	1.09	(0.63, 1.91)	0.753	1.06	(0.59, 1.91)	0.838
Living with one caretaker	1043	1.36	(0.78, 2.36)	0.282	0.85	(0.42, 1.71)	0.642	0.88	(0.42, 1.84)	0.732
Siblings	1035	0.66	(0.36, 1.21)	0.177	0.77	(0.38, 1.59)	0.486	0.88	(0.42, 1.87)	0.745
Behaviour difficulties in the family	1056	2.59	(1.38, 4.85)	**0.003**	1.55	(0.73, 3.30)	0.254	1.23	(0.56, 2.71)	0.610
Girl	1056	0.71	(0.47, 1.05)	0.086				0.84	(0.53, 1.35)	0.477
Physical activity score poorer than for peers	1044	2.99	(1.55, 5.77)	**0.001**				2.15	(0.97, 4.77)	0.059
Low nutritional standard	1040	1.48	(0.86, 2.55)	0.158				1.22	(0.64, 2.35)	0.550
Dental caries	1049	2.07	(1.34, 3.19)	**0.001**				1.47	(0.85, 2.54)	0.166
Difficulties in fine motor, language or social skills, or sleep	1033	3.42	(2.28, 5.13)	**< 0.001**				3.15	(1.96, 5.07)	**<0.001**

Abbreviations: OR = Odds ratio; CI = confidence interval; NW = normal weight; UW = underweight; OW = overweight; OB = obesity.[26,27]

* Family related covariates: Low maternal education, low paternal education, mother out of work, father out of work, mother's smoking, living with one caretaker, having siblings, and ADHD in the family. Weight group of parents is not included because missing values resulted in lower numbers, but the results were essentially the same when included (n= 806 in model 1 and n= 782 in model 2).

† Lifestyle covariates: Sex, combined physical activity score poorer than peers, low nutritional standard, dental caries and difficulties in fine motor, language or social skills, or sleep.

Appendix. Construction of dichotomized variables related to social factors, health, habits, and skills.

Parents' education was defined as low vs. high, where low was no education beyond high school. *Nutritional score* (low vs. high) was based on frequency of different meals and consumption of various food and drink items. A low score was defined as at least three of the following: sweets > 1 day/week, soft drink > 1 day/week, fast food > 1 day/week, breakfast < 4 days/week, vegetables < 2 days/week, and fruit < 5 days/week. *Physical activity score* was defined as lower than peers if the child was inferior to peers on at least one of the three categories frequency, intensity, or endurance. *Any physical health related problem* was defined as "yes" if the child had a current or previously specified chronic somatic illness. The list was extensive. *Dental caries* was included as a proxy for health-related habits and was dichotomized as ever or never had caries. The variable *Difficulties in fine motor, language or social skills or sleep* was based on the parents' evaluation on questions related to developmental skills and habits. The variable was dichotomized to "yes" or "no", where "yes" meant that the child scored lower than their peers on any of these areas, or if the child had received any professional interventions, i.e. within physiotherapy, speech therapy, psychology, psychiatry, or had received any extra professional support in kindergarten after two years of age. The variable *Behavioural difficulties in the family* was recorded as "yes" if any family member other than the child had ADHD, difficulties with attention or other behavioural difficulties.