REVIEW ARTICLE

Association Between Depressive Symptoms in Childhood and Adolescence and Overweight in Later Life

Review of the Recent Literature

Eryn T. Liem, MD; Pieter J. J. Sauer, MD, PhD; Albertine J. Oldehinkel, PhD, MSc; Ronald P. Stolk, MD, PhD

Objective: To present an overview of the association between depressive symptoms in childhood and adolescence and subsequent overweight in later life.

Data Sources: MEDLINE, EMBASE, and Web of Science for all indexed journals from January 1, 1997, to May 30, 2007.

Study Selection: Abstracts of 513 articles were reviewed manually. Studies were excluded if unrelated to depressive symptoms and overweight (n=460), if they were conducted in an adult population (n=10) or in a population of all age groups (n=2), or if they were performed in clinic-based populations of overweight participants. In total, 32 articles were reviewed including 21 cross-sectional and 11 longitudinal reports.

Main Exposure: Depressive symptoms in childhood and adolescence.

Main Outcome Measure: Overweight.

Results: Four cross-sectional studies that satisfied our quality criteria revealed an association between depressive symptoms and overweight in girls aged 8 to 15 years, reporting different effect sizes including a correlation coefficient of 0.14 and a regression coefficient of 0.27. Four longitudinal studies in accord with our quality criteria suggest that depressive symptoms in childhood or adolescence are associated with a 1.90- to 3.50-fold increased risk of subsequent overweight (95% confidence intervals varying from 1.02 to 5.80, respectively).

Conclusion: These results support a positive association between depressive symptoms at age 6 to 19 years and overweight in later life, assessed after a period of 1 to 15 years.

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Author Affiliations: Departments of Pediatrics (Drs Liem and Sauer), Psychiatry (Dr Oldehinkel), and Epidemiology (Drs Liem and Stolk), and Graduate School of Behavioral and Cognitive Neurosciences (Dr Oldehinkel), University Medical Center Groningen, University of Groningen, Groningen; and Department of Child and Adolescent Psychiatry, Erasmus Medical Center, Sophia Children's Hospital, Rotterdam (Dr Oldehinkel), the Netherlands.

WORLDWIDE, THE prevalence of childhood overweight is increasing. In the United States between 2002 and 2004, the prevalence of overweight in 6- to 19-year-old individuals was 31.8% among males and 30.3% among females.[1] In Europe, numbers vary from 10% to 20% in the northern areas to 20% to 35% in Mediterranean areas.[2] This results in an increased prevalence of complications of overweight such as hypertension, dyslipidemia, and diabetes mellitus type 2. For example, the Centers for Disease Control and Prevention estimates that one-third of the children born in the United States in 2000 will eventually develop diabetes.[3] Thus, prevention of overweight is a major public health concern. Targeted and tailored preventive strategies that consider cost-effectiveness need to be developed, and, therefore, important predictors of overweight in childhood and adolescence need to be determined. Predictors of overweight in childhood and adolescence are also appropriate to identify groups at high risk. A recent review identified both somatic factors such as dietary intake and parental overweight and psychosocial factors such as lifestyle, temperament, socioeconomic status, and parental control of feeding as possible predictors of overweight.[4] Depressive symptoms have been described as a predictor and as a consequence of overweight, primarily in adults but also in adolescents.[5] Identifying treatable predictors such as depressive symptoms could lead to better strategies for prevention of overweight.

Adolescence is a decisive period in human life because of the multiple changes that occur between childhood and adulthood. Puberty is the primary neurohormonal determinant of both physiologic and psychologic changes, although other social and behavioral factors must also be considered in this process.[6] In adolescence, both overweight and depressive

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symptoms become more common, increasing the likelihood of simultaneous occurrence. This raises questions about a possible association or common cause, as described in an early review article on obesity-depression associations in the population.[5] In contrast to the common idea that overweight might lead to unhappiness and consequently to depressive symptoms, recent reports suggest that depressive symptoms could also precede overweight[5] and thereby could be a risk factor for the development of overweight.

In particular, atypical depression has been considered related to development of overweight.[7] Despite the term "atypical," it is a common form of depression.[8] Atypical depression is characterized by mood reactivity and neurovegetative symptoms such as weight gain, hyperphagia, and hypersomnia, which renders it interesting in the association between depressive symptoms and overweight. Atypical depression has been described in children and adolescents, although it is not a distinct entity in this age group.[9]

The objective of this review was to evaluate the evidence for the role of depressive symptoms in childhood and adolescence as a risk factor for overweight. Because we were interested in early risk factors for overweight, we focused on studies with a baseline measurement in childhood or adolescence in which at least 1 follow-up measurement was performed. We defined childhood as age 1 to 12 years and adolescence as age 13 to 19 years. To introduce the existing literature, assessment of depressive symptoms and overweight are briefly explained. Current hypotheses about the mechanisms involved in the relationship between depressive symptoms and overweight are also discussed.

METHODS

STUDY RETRIEVAL

A preliminary search of PubMed revealed that before 1997, no longitudinal studies in children and adolescents examining the association between depressive symptoms and overweight had been published. Moreover, most of the cross-sectional studies have been published in the last 10 years. Therefore, we performed searches of MEDLINE, EMBASE, and Web of Science in May 2007 for all indexed journals from January 1, 1997, to May 30, 2007. Keywords included *depression*, *depressive disorder*, *internalizing disorders*, *mental disorders*, *obesity*, and *overweight* limited to "all child." Additional studies were identified in the bibliographies of the articles. Only English-language articles that were peer reviewed were considered. This resulted in 513 articles, of which abstracts were reviewed manually. Most articles concerned a different topic (n=460), such as "Exercise Therapy as a Treatment for Psychologic Conditions in Obese and Morbidly Obese Adolescents: A Randomized, Controlled Trial,"[10] and "The Link Between Short Sleep Duration and Obesity: We Should Recommend More Sleep to Prevent Obesity."[11] Studies were excluded if conducted in an adult population (n=10) or in a population of all age groups (n=2). Reviews (n=5) were excluded as well. In addition, clinic-based populations of obese children and adolescents seeking treatment (n=5) were excluded because populations seeking treatment differ from population-based samples and, therefore, were considered beyond the scope of this article. In view of the limited number of published articles on longitudinal research, cross-sectional studies were reviewed as well, to support the existence of an association between depressive symptoms and overweight. We extracted age, sex, and sample size of the population; measure of depressive symptoms; assessment of weight and height (measurement or self-report); main result (positive, negative, or no association), and effect size. If available, odds ratios (ORs) or β levels were used as indicators of effect size. If not, other available measures such as correlations and maximum explained variances were extracted. First, we included all studies that satisfied the inclusion and exclusion criteria (n=32, including 21 cross-sectional and 11 longitudinal reports). Second, we focused on the quality of the various studies. Quality was determined by 4 criteria, namely, whether studies were based on questionnaires specifically validated for depressive symptoms; whether investigators measured body mass index (BMI; calculated as weight in kilograms divided by height in meters squared) rather than using self-reported values; whether they also evaluated important confounding variables, specifically, sex, race/ethnicity, and socioeconomic status[5]; and whether investigators reported an effect size. Four cross-sectional and 4 longitudinal studies were in accord with these criteria.

ASSESSMENT OF DEPRESSIVE SYMPTOMS AND OVERWEIGHT

Depressive symptoms can be assessed using various methods, depending on the perspective and taxonomic system but also on the nature of the sample being investigated. Various definitions of adolescent depressive symptoms have been adopted, specifically, depressed mood, syndromes that include depressive symptoms, and depressive disorder according to the *Diagnostic and Statistical Manual of Mental Disorders*.[35] These 3 approaches entail different measurement tools. Depressed mood and depressive syndromes are generally assessed using questionnaires that result in continuous measures, whereas *Diagnostic and Statistical Manual of Mental Disorders* depressive disorders are usually ascertained by diagnostic interviews, resulting in dichotomous outcomes. Despite differences in the various measurement tools, previous research has shown consistencies in the identification of depressed mood and depressive symptoms.[36] Nevertheless, not all studies included in this review used questionnaires that have been validated for assessment of depressive symptoms. Especially in large epidemiologic surveys, questions about depressive symptoms are commonly part of a broader evaluation of general psychosocial health. This implies that these surveys should be cautiously interpreted. To this extent, we evaluated the use of validated questionnaires in a quality assessment.

For assessment of overweight in large epidemiologic surveys, BMI is recommended. This is not a direct measure of body fatness because it does not differentiate between muscle tissue and fat tissue, contrary to, for example, dual-energy x-ray absorptiometry.[37] However, weight and height measurements for BMI are practical and show a low measurement error and high reliability.[37] It has been reported that BMI is more accurate when weight and height are measured clinically than when obtained by self-reported measurements at home. Overweight and obesity are defined by BMI cutoff values based on large population-based surveys.[15,27]

RESULTS

CROSS-SECTIONAL STUDIES

Sixteen population-based cross-sectional studies in children and adolescents* suggest a positive association be-

*References 12-14, 17, 18, 21, 23-25, 28-34.

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tween depressive symptoms and overweight (Table 1). Of these, 8 studies reported ORs ranging from 1.67 to 3.72 and 95% confidence intervals (CIs) from 1.08 to 10.2. Four cross-sectional studies reported effect sizes based on continuous measures.[13,17,28,32] Statistically significant β levels varied from 0.07 to 0.27, with SEs of 0.02 to 0.10. Pine et al[17] reported no significant result using linear regression analysis but a significant result using logistic regression analysis. Two studies[12,34] reported correlations of 0.14 and 0.20, respectively. One study reported maximum explained variances of 0.003 and 0.005 ($P=.001$ and $P=.01$, respectively).[14] Two studies did not report any effect size.[25,31]

We found 3 studies that reported no association between overweight and depressive symptoms.[19,22,26] This could be explained by a small sample size in 1 study[19] and the use of a single-item questionnaire to evaluate depressive symptoms in another.[26] Moreover, these 3 studies did not provide any measure to quantify their findings.[19,22,26] One study based on self-reported weight and height reported a negative association.[20]

Four of the 20 cross-sectional studies satisfied our quality criteria (**Table 1**). In a population of 868 children aged 8 to 9 years, Erickson et al[12] reported a correlation of 0.14 between BMI and depressive symptoms in girls and no association in boys. Xie et al,[13] who conducted their study in 1655 Chinese adolescents aged 11 through 15 years, also found an association (regression coefficient, 0.27) only in girls.[13]

Wardle et al[14] described 2 studies; however, a validated questionnaire for depressive symptoms was used only in the smaller study in 1824 adolescents aged 14 to 15 years. Analysis of variance revealed a positive association ($F_{[2, 4231]}=6.97$; $P=.001$). However, logistic regression analysis showed that the OR (95% CI) for having a score on the Depressive Symptom Scale in the top quintile in obese adolescents compared with those with normal weight was not significant for either sex (girls, 0.89; 0.44-1.81, and boys, 1.25; 0.27-5.66). The authors concluded that their findings provided limited support for an association between depressive symptoms and overweight.

In 2101 Turkish adolescents aged 15 to 18 years, no statistically significant association was found (OR, 1.74; 95% CI, 0.96-3.23). However, this could have been because of the low incidence of overweight (9.0%).[16]

Thus, differences according to sex were found in the studies by Erickson et al[12] and Xie et al.[13] In 1 study in which subgroup analyses were performed according to race/ethnicity, significant differences were found between ethnic groups. Erickson et al[12] reported an effect in Asian American girls only, compared with white, Hispanic, and African American girls.[12] Whereas most studies were conducted primarily in white populations, 1 study was performed in a Chinese population.[13] This study by Xie et al[13] found a positive association in girls. Thus, racial/ethnic differences have been found, but the results are inconsistent. However, a positive association was found in both Asian populations studied. Socioeconomic status was adjusted for but did not change the associations. In addition to these covariates, pubertal status could be important in pediatric research. Puberty was not studied as a potential effect modifier in the mentioned studies.

LONGITUDINAL STUDIES

We found 11 reports on the longitudinal association between depressive symptoms in childhood[38-42] and adolescence[38-48] and subsequent overweight in adolescence and young adulthood in which a correction was made for overweight at baseline (**Table 2**). Two studies did not find such an association,[39,47] which could have been because of limited sample size of a young age group in 1 of the studies.

Nine longitudinal studies reported a positive association between depressive symptoms in childhood and adolescence and subsequent overweight.[38,40-46,48] Odds ratios, reported in 7 studies, varied from 1.30 to 4.62, and 95% CIs ranged from 1.0 to 12.74.[38,41-46] Hasler et al[48] reported a hazard ratio of 11.52 in girls, which might be an overestimation because only retrospective data on childhood depressive symptoms were available, potentially resulting in a recall bias.[48] Two studies reported results from linear regression analyses with regression coefficients varying from 0.02 to 0.11.[43,44] Linear mixed models revealed greater yearly gains in BMI z score of 0.09 U/y in girls with a history of depression.[40] Another study reported a higher adult BMI in participants who had major depressive disorder in childhood compared with an adult population without childhood depression (mean [SD] difference, 1.9 [4.7]).[41]

Four of the 11 longitudinal studies were in accord with our quality criteria (Table 2). These included 1 study in which an association was not found. Tanofsky-Kraff et al[39] studied 146 children at risk for adult overweight, defined as being overweight (65.1% at the first measurement) or having at least 1 overweight parent. In this population, depressive symptoms at age 6 to 12 years did not significantly predict increase in body fat mass as measured by BMI and dual-energy x-ray absorptiometry 4 years later. That the sample size was limited (n=146 children), most of the children were already overweight, and most (n=111) were younger than 10 years at baseline could have been responsible for these outcomes. Those authors hypothesized that depressive symptoms might be a more potent predictor of fat gain in older children. In a longitudinal study assessing depressive symptoms in both early and late adolescence, a significant association was found only between late adolescent depressive symptoms and adult overweight.[38]

An association was found in the other 3 studies. Goodman and Whitaker[44] reported a 2.39-fold (95% CI, 1.05-5.45) increased risk of subsequent overweight in children with depressive symptoms. Their study was performed in a population of 9374 children aged 12 to 19 years at baseline and who were reassessed after 1 year.[44]

Franko et al[43] performed a study in a cohort of 1554 female participants who were evaluated at 3 assessment points (mean age, 16.5, 18.6, and 21.4 years).[43] They reported an OR (95% CI) of 3.11 (1.13-5.12) for the association between depressive symptoms at assessment point 1 and overweight at point 3, and 3.50 (1.26-5.80) for the association between points 2 and 3.

A cohort of 177 children aged 6 to 17 years at baseline were followed up for 10 to 15 years by Pine et al.[41] They concluded that depressive disorder predicted adult

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Table 1. Cross-sectional Studies Correlating Youth Depressive Symptoms and Overweight

Source	Population, No.; Age, y	Measure of Depressive Symptoms	BMI[a] (Weight and Height From Self-report or Measured)		Main Result	Effect Size
			S/Md	BMI		
Studies in Accord With Quality Criteria						
Erickson et al,[12] 2000	868; 8-9	CDI[a]	Md	Continuous	+	r=0.14; $P<.01$ F
Xie et al,[13] 2005	1655; 11-15	CES-D[a]	Md	Continuous	+	β=0.27 (SE 0.10); $P<.05$ F
Wardle et al,[14] 2006	4320; 11	SDQ-ES	Md	Overweight and obesity (Cole et al[15])	+	R^2=0.003; P=.001
	1824; 14-15	CES-D[a]	Md	Overweight and obesity (Cole et al[15])	+	R^2=0.005; P=.01
Ozmen et al,[16] 2007	2101; 15-18	CDI[a]	Md	Overweight: BMI (Cole et al[15])	0	OR, 1.74 (95% CI, 0.96-3.23)
Other Studies						
Pine et al,[17] 1997	644; 22	DIS[a]	S	Continuous Cutoff, 80th percentile	+	β=0.40 (SE 0.22) (NS) M β=−0.92 (SE 0.27) (NS) F OR=1.54 (95% CI, 1.09-2.17) F
Neumark-Sztainer et al[18] 1997	31 122 (all female); 12-18	Validated questionnaire[a]	S	Overweight: BMI ≥85th percentile Obesity: BMI ≥95th percentile	+	NS OR, 1.32 (95% CI, 1.09-1.60) M OR, 1.24 (95% CI, 1.01-1.55) F
Renman et al,[19] 1999	116; 14-18	YSR[a] (internalizing subscale)	Md	Severe obesity: BMI ≥30 or ≥99.6th percentile	0	Not reported
Pesa et al,[20] 2000	3197 F 12-18	Validated questionnaire[a]	S	Overweight: BMI >25	–	DFC, −0.10; P=.01
Falkner et al,[21] 2001	9943; 12-17	Nonvalidated questionnaire	S	Overweight: BMI ≥85th percentile (NHANES I) Obesity: BMI ≥95th percentile (NHANES I)	+	OR, 0.98-1.09 (95% CI, 0.65-1.65) (depending on subscale of questionnaire) OR, 1.38-1.79 (95% CI, 1.08-2.65) (depending on subscale of questionnaire)
Lamertz et al,[22] 2002	2939; 14-24	M-CIDI[a] SCL-90-R[a]	S	Obesity: BMI ≥95th percentile	0	Not reported
Mustillo et al ,[23] 2003	991; 16	CAPA	Md	Trajectories	+	OR. 3.72 (95% CI, 1.27-10.2) M
Datar and Sturm,[24] 2004	9949; 5	SRS	Md	Overweight: BMI ≥95th percentile	+	OR, 1.54 (95% CI, 1.09-2.17) F
Berg et al,[25] 2005	989 (all male); 15	Nonvalidated questionnaire	S	Overweight: BMI (Cole et al[15]) Obesity: BMI (Cole et al[15])	+	Not reported
Daniels,[26] 2005	7993; 16-18	Nonvalidated questionnaire	S	Overweight: BMI ≥85th percentile (CDC[27]) Obesity: BMI ≥95th percentile (CDC[27])	0	Not reported
Needham and Crosnoe,[28] 2005	18 924; 12-18	CES-D[a]	S	Continuous	+	β=0.08 (SE 0.02); $P<.01$
Sjöberg et al,[29] 2005	4703; 15-17	DSRS[a]	S	Overweight: BMI (Cole et al[15]) Obesity: BMI (Cole et al[15])	+	OR, 0.96 (95% CI, 0.77-1.12) OR, 1.67 (95% CI, 1.12-2.49)
Richardson et al,[30] 2006	3101; 11-17	SCL-90[a]	S	Obesity: BMI ≥95th percentile (CDC[27])	+	OR, 2.17 (95% CI, 1.25-3.77) F OR, 1.95 (95% CI, 1.19-3.18) M
Sweeting et al,[31] 2006	2127; 11-15	KDS[a] DISC[a] (age 15)	Md	Obesity: BMI >95th percentile	+	Not reported (M, age 11)
ter Bogt et al,[32] 2006	1826; 11-16	YSR[a] (internalizing subscale)	S	Overweight: BMI ≥ +1.1 SD	+	β=0.07 (SE not reported); $P<.01$
Viner et al,[33] 2006	2789; 11-14	SDQ	Md	Obesity: BMI ≥95th percentile (CDC[27])	+	OR, 1.5 (95% CI, 1.1-2.1)
Young-Hyman et al,[34] 2006	164; mean (SD), 11.9 (2.5)	CDI[a]	Md	Continuous: z-score (based on CDC[27])	+	r=0.20; $P<.01$

Abbreviations: β, Regression coefficient; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CAPA, Child and Adolescent Psychiatric Assessment (interview); CDC, Centers for Disease Control and Prevention; CES-D, Center for Epidemiological Studies Depression scale (questionnaire); CDI, Children's Depression Inventory (questionnaire); CI, confidence interval; DFC, discriminant function coefficient; DISC, Diagnostic Interview Schedule for Children (layperson interview); DIS, Diagnostic Interview Schedule (layperson interview); DSRS, Depression Self-Rating Scales of the *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition) (questionnaire); F, female; KDS, Kandel Depression Scale (questionnaire); M, male; M-CIDI, Munich–Composite International Diagnostic Interview; Md, measured; NHANES I, National Health and Nutrition Examination Survey I; NS, not statistically significant; OR, odds ratio; r, correlation coefficient; R^2, maximum explained variance; S, self-report; SCL-90-R, Symptom Checklist 90 Revised (questionnaire); SDQ-ES, Strengths and Difficulties Questionnaire–Emotional Symptoms scale (nonvalidated questionnaire); SE, standard error; SRS, Social Rating Scale (questionnaire); YSR, Youth Self-Report (questionnaire); +, positive association; –, negative association; 0, no association.

[a] Validated questionnaire or interview.

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Table 2. Longitudinal Studies on the Association Between Depressive Symptoms and Overweight

Source	Population, No.	Age at Baseline (Follow-up), y	Measure of Depressive Symptoms	BMI (Weight and Height From Self-report or Measured)	Main Result	Effect Size
Studies in Accord With Quality Criteria						
Pine et al,[41] 2001	177	6-17 (10-15)	K-SADS[a]	Measured and self-report: Continuous Overweight: BMI >25	+	BMI 1.9 ± 4.7 higher; $P<.01$ OR, 1.90 (95% CI, 1.02-3.40)
Goodman and Whitaker,[44] 2002	9374	12-19 (1)	CES-D[a]	Measured and self-report Continuous: *z*-score Obesity: BMI > 95th percentile (CDC[27])	+	β=0.11 (SE 0.05); $P=.045$ OR, 2.39 (95% CI, 1.05-5.45)
Franko et al,[43] 2005	1554 (all female)	16.5 (2 and 5)	CES-D[a]	Measured and self-report Continuous Obesity: 95th percentile (CDC[27])	+	β=0.03 (SE 0.009); $P=.002$ (W1-W3) β=0.02 (SE 0.008); $P=.01$ (W2-W3) OR, 3.11 (95% CI, 1.13-5.12); (W1-W3) OR, 3.50 (95% CI, 1.26-5.80) (W2-W3)
Tanofsky-Kraff et al,[39] 2006	146	6-12 (mean, 4.2±1.8; range, 0.1-7.9)	CDI[a]	DEXA: fat mass	0	β=0.004 (95% CI, –0.07 to 0.02)
Other Studies						
Bardone et al,[47] 1998	459 (all female)	15 (6)	DIS[a]	Measured: Continuous	0	β=0.06 (NS); SE and *P* not reported
Barefoot et al,[45] 1998	4726	17-25 (21-23)	OBD[a] NEO[a]	Measured and self-report: weight change	– If lean + If heavy	OR, 2.2 F OR, 1.3 M
Richardson et al,[38] 2003	881	11-15 18-21 (7-13, 26)	DIS[a]	Measured Cutoff: BMI 30	+	OR, 2.32 (95% CI, 1.29-3.83)
Hasler et al,[46] 2004	591	19 (20)	SPIKE[a]	Self-report Overweight: BMI >79th percentile	+ (atypical depression)	OR, 2.9 (95% CI, 1.3-6.5) F OR, 2.0 (95% CI, 1.0-4.2) M
Hasler et al,[48] 2005	591	<19 (20)	SPIKE[a]	Self-report Obesity: BMI ≥30	+	HR, 11.52 (SE 1.24); $P<.05$ F HR, 1.10 (SE 0.66); $P=.88$ M
Stice et al,[42] 2005	496 (all female)	11-15 (4)	K-SADS[a]	Measured Obesity: 95th percentile (CDC[27])	+	OR, 4.62 (95% CI, 1.67-12.74)
Anderson et al,[40] 2006	820	9-18 (2.5, 9.5, and 19)	DIS[a] SCID[a]	Self-report Continuous: *z*-score	+	Greater change in BMI *z* score of 0.09 (95% CI, 0.03-0.15) U/y; $P<.05$ F

Abbreviations: β, Regression coefficient; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); CDI, Children's Depression Inventory (questionnaire); CES-D, Center for Epidemiological Studies Depression scale (questionnaire); CI, confidence interval; DEXA, dual-energy x-ray absorptiometry; DIS, Diagnostic Interview Schedule (layperson interview); F, female; HR, hazard ratio; K-SADS, Schedule for Affective Disorders and Schizophrenia for School-Age Children (interview); M, male; NEO, NEO Personality Inventory (questionnaire); NS, not statistically significant; OBD, Obvious Depression subscale of the Minnesota Multiphase Personality Inventory (questionnaire); OR, odds ratio; SCID, Structured Clinical Interview for *Diagnostic and Statistical Manual of Mental Disorders* (Fourth Edition, Text Revision) (layperson interview); SE, standard error; SPIKE, Structured Psychopathological Interview and Rating of Social Consequences for Epidemiology (expert interview); W1, assessment point 1, W2, assessment point 2, W3, assessment point 3; +, positive association; –, negative association; 0, no association.
[a]Validated questionnaire or interview.

overweight with an OR of 1.90 (95% CI, 1.02-3.40). Adults who had depressive symptoms in childhood had, on average, a higher BMI (1.9 [4.7]).

The studies by Goodman and Whitaker[44] and Pine et al[41] both refuted sex distinctions, and the study by Franko et al[43] was performed in a cohort of girls only. Ethnicity was adjusted for in all 3 studies,[41,43,44] but none performed subgroup analyses. All 4 longitudinal studies that satisfied our quality criteria[39,41,43,44] adjusted for socioeconomic status, which did not influence the results.

COMMENT

Most cross-sectional and longitudinal research that satisfied our quality criteria supports an association between depressive symptoms in childhood and adolescence and subsequent overweight. Evidence from the 4 longitudinal studies suggests that depressive symptoms in childhood or adolescence are associated with a 1.90- to 3.50-fold increased risk for overweight in later life (95% CIs varying from 1.02 to 5.80). In the 4 cross-sectional studies, a correlation coefficient of 0.14 and a regression coefficient of 0.27 were reported in girls, supporting the findings from the few longitudinal studies.

STRENGTHS AND LIMITATIONS

The main strength of our review is the systematic search we performed of all available literature on the specific

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association between depressive symptoms in childhood and adolescence and subsequent overweight, evaluated longitudinally. Earlier reviews included studies of both adult and childhood depressive symptoms.[5,49-51] In addition, they were not systematic[5,49,50] and did not focus on depressive symptoms specifically, describing well-being,[52] mood disorders,[51] or psychopathologic conditions in general.[49]

Two limitations must be addressed. First, it is difficult to compare the included studies. Both the cross-sectional and the longitudinal studies differed in assessment methods. Body mass index was included either as a continuous variable in the analyses or dichotomized using cutoff values for overweight according to various criteria. Only 1 longitudinal study evaluated body fat measurements using dual-energy x-ray absorptiometry. This study did not find an association between depressive symptoms and body fat percentage, possibly because the sample size was limited, most of the children were already overweight, and most of the children were younger than 10 years at baseline.[39] Second, few studies have evaluated the presence of depressive symptoms in preadolescent children and the development of overweight in adolescence. Clearly, more studies are needed, not only regarding the association between depressive symptoms in adolescence and overweight in adulthood but also regarding the association between depressive symptoms and overweight at a younger age.

MECHANISMS

Hypotheses about mechanisms having a role in the association between depressive symptoms and subsequent overweight include various social and biological risk factors for overweight that have been previously associated with depressive symptoms.[41] These include factors that could mediate or moderate the association and factors that could influence both depressive symptoms and overweight at different time points. These third factors include neurobiological mechanisms that could be implicated through 2 different pathways, specifically, serotonin and its metabolites and the hypothalamic-pituitary-adrenal axis. Central serotonergic pathways have been implicated in disturbances in mood and appetite,[53] and various studies suggest that both depressive symptoms and overweight are related to dysregulation of the hypothalamic-pituitary-adrenal axis.[54-56]

Factors that possibly mediate or moderate the association include reduced physical activity and use of antidepressant agents. Depressive symptoms are often accompanied by lethargy and social withdrawal, which could lead to reduced physical activity levels and, therefore, to increased risk of becoming overweight. However, this was considered a covariate in the studies by Needham and Crosnoe,[28] Goodman and Whitaker,[44] Barefoot et al,[45] and Hasler et al[46,48] to control for possible confounding. Physical activity was assessed using a questionnaire[28,44,45] or interview.[46,48] Adjusting for physical activity did not change the positive association found in these studies. Moreover, the study by Stice et al[42] evaluated physical activity, assessed using the Past Year Leisure Physical Activity Scale, as a predictor of overweight onset in adolescent girls. They did not find a significant longitudinal association, possibly because of reporting bias or highly fluctuating exercise behaviors over time. In accord with their findings, Berg et al[25] did not report different frequencies of physical activity, assessed using a questionnaire, in groups of adolescent boys with normal weight, overweight, or obesity. Inasmuch as all measures of physical activity were dependent on self-report, these results must be interpreted with caution. Reporting bias could have a role in the unaltered association between depressive symptoms and overweight when correcting for physical activity.

Use of antidepressant agents could also have a role in the association between depressive symptoms and overweight.[57] However, this was corrected for in the longitudinal studies by Pine et al[41] and Richardson et al,[38] which did not change the positive association found in these studies. Moreover, prescription of antidepressant agents is not common in pediatric populations.

It is also possible that an association between depressive symptoms and overweight is present in subtypes of depression. For example, atypical depression is characterized by, among other factors, increased appetite and excessive sleeping,[8] which could underlie later weight problems. Another possible mechanism is that in subgroups depressive symptoms are associated with developing binge eating disorder. This disorder is characterized by binge eating episodes accompanied by distress, loss of control, and absence of compensatory behaviors such as vomiting. The prevalence of binge eating in community-based studies has been reported to be 2% in German children aged 5 to 6 years,[58] 8% to 26% in North American (ie, Canada and the United States) and British adolescent girls,[59-62] and 2% to 13%[60] in US adolescent boys. Regular binge eating, defined as twice a week or more, was prevalent in 3% to 8%, respectively, of US and British adolescent girls[59,62] and in nearly 1% of American adolescent boys. A higher prevalence of approximately 30% has been reported in obese youngsters seeking treatment.[63] Results from a prospective study in adolescents confirms earlier reports that binge eating disorder is associated with onset of overweight.[64] Depressive symptoms have been described as a risk factor for onset of binge eating disorder in 2 studies in adolescent girls and young adult females (age range, 17-38 years).[64,65] This could be explained by the affect-regulation model, stating that binge eating provides relief of depressive symptoms.

CLINICAL IMPLICATIONS

Insofar as clinical implications, we can only draw tentative conclusions because further research that satisfies all quality criteria is needed. However, treatment programs for depressive symptoms should consider that depressive symptoms might have a role in the onset of increase in body weight. More specifically, binge eating and possibly even BMI should be evaluated. Treatment programs should be adapted to include prevention and treatment of overweight. On the other hand, in treating overweight individuals, it should be kept in mind that depressive symptoms could underlie the increase in body mass. Assessing depressive symptoms and binge eating warrants consideration, especially if treatment of over-

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weight fails. Assuming a causal pathway, evaluating and treating depressive symptoms in children and adolescents could lead to a reduction in the occurrence of overweight.

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Correspondence: Eryn T. Liem, MD, Department of Pediatrics, University Medical Center Groningen, University of Groningen,CA80, PO Box 30.001, 9700 RB Groningen, the Netherlands (e.t.liem@bkk.umcg.nl).
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Announcement

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