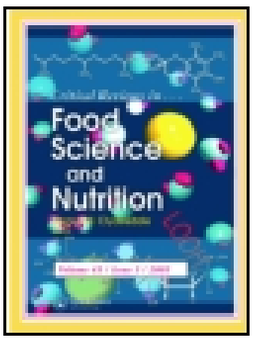

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# Association between overweight/obesity with depression, anxiety, low self-esteem, and body dissatisfaction in children and adolescents: a systematic review and meta-analysis of observational studies

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REVIEW



# Association between overweight/obesity with depression, anxiety, low self-esteem, and body dissatisfaction in children and adolescents: a systematic review and meta-analysis of observational studies

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**ABSTRACT**

**Purpose:** Childhood and Adolescent overweight and obesity may be associated with psychological problems. We aimed to conduct a systematic review and summarize published articles on the association between overweight/obesity with risk of depression, anxiety, low self-esteem, and body dissatisfaction among children and adolescents.

**Methods:** PubMed and Scopus databases were used to conduct a comprehensive search and identify eligible literature published prior to July 2020. The random-effects models (DerSimonian–Laird method) were applied to pool the effect sizes. Subgroup analysis was performed to find potential sources of heterogeneity.

**Results:** 28 studies (3 prospective cohorts and 25 cross-sectional) were included in the current systematic review and meta-analysis. The total sample sizes ranged from 244 to 60252. A positive significant association was found between overweight (pooled risk estimate: 1.15, 95% CI: 1.00–1.31, $P = 0.04$) and obesity (pooled risk estimate: 1.53, 95% CI: 1.16–2.02, $P = 0.003$) with risk of low self-esteem, respectively. A significant positive association was found between obesity and risk of body dissatisfaction (pooled risk estimate: 4.05, 95% CI: 2.34–7.023, $P = 0.0001$). Moreover, no association was found between overweight and risk of body dissatisfaction among children and adolescents. Also, no association was observed between overweight/obesity and risk of depression and anxiety.

**Conclusions:** Findings showed a positive association between obesity and the risk of body dissatisfaction and low self-esteem among children and adolescents. Moreover, there was a significant positive association between overweight and the risk of low self-esteem.

**KEYWORDS**
Anxiety; depression; self-esteem; body dissatisfaction; obesity

## Introduction

Adolescence is a critical period in terms of psychological development in human life (Druss, Rosenheck, and Sledge 2000; Ackner 2005; Stice et al. 2005; Tanofsky-Kraff et al. 2006). Obesity among children and adolescents is an increasingly significant public health concerns over the past 30 years which could immensely contribute to psychological disorders. Depression is a major public health issue imposing great socioeconomic burden on society. Based on international evidence, the prevalence rate of depression is estimated between 2% and 5.6% in adolescents (Ackner 2005). The proportion of body dissatisfaction among girls varied between 24% and 46%, whereas it ranged from 12% to 26% among boys in recent large community-based studies (Druss, Rosenheck, and Sledge 2000; Cash and Fleming 2002; Bearman et al. 2006). Body dissatisfaction attributes to the preoccupations with weight, body shape and body fat and is of prime importance due to the fact that it can be partly accounted for onset of depression and low self-esteem (Cash and Fleming 2002). Most of these psychological outcomes seem to be related and an initiator of a vicious psychological circle (Goldfield et al. 2010). For instance, low self-esteem and body dissatisfaction can predispose this age group to mental health consequences such as depression and anxiety (Paxton et al. 2006). Therefore, assigning an approach to control the high prevalence of such disorders among children and adolescents is of vital importance.

Recent insights indicate that inflammatory process could affect psychological disorders (Howren, Lamkin, and Suls 2009; Dowlati et al. 2010). Excess weight is considered a low-grade chronic inflammation (de Heredia, Gómez-Martínez, and Marcos 2012). A large number of pro-inflammatory cytokines are expressed from adipose tissue which is regarded as a link between excess weight and inflammation

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(Wisse 2004). Therefore, the underlying mechanism which relates overweight and obesity to adverse psychological outcomes may be the activation of inflammatory, oxidative and nitrosative stress (IO&NS) pathways. Such pathways have been shown to increase neurodegeneration (Maes et al. 2011).

Based on previous studies the relationship between obesity and psychological disorders in children and adolescents remains inconsistent in the scientific world. While several observational studies showed that obesity has been positively associated with psychological disorders (Erermis et al. 2004; Sjöberg et al. 2005; Bjornelv, Nordahl, and Holmen 2011; Ting et al. 2012), others did not found any association at all (Wardle et al. 2006; Wells et al., 1999).

; Boutelle et al. 2010; Kubzansky, Gilthorpe, and Goodman 2012; Zakeri et al. 2012; Roberts and Hao 2013).

A recent review on body image disturbance in overweight/obese children showed a weak association between obesity and body image disturbance (Ting et al. 2012). Moreover, a meta-analysis published by Quek et al suggested that non-western and female obese children and adolescents were significantly more likely to have depression and severe depressive symptoms (Quek et al. 2017). A meta-analysis conducted by Sutaria et al revealed that no association was found between overweight and depression in children. It should be noted that the inclusion criteria in the mentioned study was to some extent different from our study for some reasons. In a study by Sweeting et al. the association between changes in weight (subjects who become obese or slim down) and mood disorders was calculated while we did not consider changes in the weight status (Sweeting, Wright, and Minnis 2005). The aim of our study was to examine the effect of overweight or obesity (weight status) on prospective psychological disorders. Moreover, several studies included in the previous meta-analysis examined the association between weight status and depression during transition to adulthood while our study was supposed to include just children and adolescents (Anderson et al. 2007; Sanderson et al. 2011; Frisco, Houle, and Lippert 2013). In addition, unlike Sutaria meta-analysis we did not include Anderson et al. study since the results were reported across different ethnicities and not in overall population (Anderson et al. 2011; Sutaria et al. 2019); however, the findings might be misleading owing to the lack of inclusion of one published study in the field in the cohort studies which had our criteria for inclusion (Wang et al. 2009).

Also, there has also been one meta-analysis of weight status and anxiety in children and adolescents conducted on cross-sectional studies which showed a moderate association between weight status and anxiety. Although, Pearson's correlation coefficient was used as an index of effect size for mentioned study (Burke and Storch 2015). Therefore, the objective of this meta-analysis of observational studies was to systematically evaluate the association between overweight/obesity with risk of depression, anxiety, low self-esteem, and body dissatisfaction among children and adolescents.

## Methods

This systematic review was carried out according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidance (Liberati et al. 2009).

### Search strategy

A comprehensive and systematic literature search was done in online databases (PubMed and Scopus) for published studies prior to 22nd August 2020. The query syntax for PubMed and Scopus are reported in Supplementary material, Table 1. No initial restriction on time of publication and language was considered. The bibliographies of included studies and relevant reviews were also studied to prevent the possibility of missing any publication. To speed up screening process, all publications were saved into an EndNote library (version X7, for Windows, Thomson Reuters, Philadelphia, PA, USA) and duplicate citations were all deleted. PROSPERO registration code is 207692.

### Selection criteria

All observational studies (either prospective, case-control, or cross-sectional) representing the quantitative measures of association between overweight/obesity and depression, anxiety, body dissatisfaction and self-esteem in children and adolescents were included in this meta-analysis. The focus of our study was on children and adolescents (participants aged $\leq$19 years old). Studies which categorized participants weight on the basis on body mass index (BMI), body fat (BF), or Dual-energy X-ray absorptiometry (DXA) were considered eligible. Also, no restriction criteria were imposed on include studies in terms of outcome assessment tools, and all studies which used either self-rating or diagnostic rating scales were entered. We only included studies with extractable odds ratio (OR), relative risk (RR) or hazard ratio (HR). The fully adjusted measure of association was extracted, if available. To avoid risk of bias, when several publications with the similar data sets were available, the publication with the most complete information was included in meta-analysis.

### Excluded studies

The initial search resulted in a total of potentially 15356 publications, of which 15324 were from electronic databases, and 32 were hand-searched in relevant reviews and report. After removing duplicated studies, 11345 articles were considered for citation screening. Based on titles and abstracts screening, 11234 publications including animal studies, letters, book chapters, methodological papers, position papers, short communications, non-observational studies, and review articles were eliminated. Out of 111 remaining articles for full-text evaluation, 83 studies were excluded based on the following: (a) prospective studies reporting the prospective effect of mental disorders on obesity and overweight ($n = 7$); (b) cohorts with follow-up transition to

**Table 1.** Characteristics of eligible studies

| Author(year) | Design | Country | Age | Gender | N Sample size | N Cases | EXP assessment | Outcome | Outcome assessment | EXP | OR, RR or HR (95%CI) | Adjustments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wang et al. (2008) | Cross-sectional | Canada | 10-11 | F/M | 4945<br>Nw:3293<br>OV:1162<br>OB: 490 | | BMI ≥ 25<br>Adjusted for children | Self-esteem | Q | OV | OR: 1.17 (0.96-1.42) | 1,2,3,4,5 |
| Ting et al. (2012) | Cross-sectional | Republic of China | 15-7 | F/M | 859<br>Nw:671<br>OV:95<br>OB:93 | 39<br>OV:18<br>OB: 21 | BMI ≥ 30<br>97th > BMI ≥95th | Depression | CES-D | OB<br>OV | OR: 1.44 (1.12-1.84)*<br>OR: 2.23 (1.30-3.82)* | 1,2,3 |
| Swallen et al. (2005) | Cross-sectional | USA | 12-14 | F/M | 3814<br>Nw:3189<br>OV:333<br>OB:292 | 665 | BMI ≥ 97th<br>97th > BMI ≥95th | Depression | CES-D | OB<br>OB<br>OV | OR: 1.68 (0.93-3.02)*<br>OR: 0.99 (0.60-1.62)<br>OR:1.24 (0.85-1.82) | 1,2,4 |
| | | | | | | 570 | BMI ≥ 97th | Self-esteem | RSES | OB<br>OV | OR: 1.36 (0.87-2.15)<br>OR: 0.73 (0.46-1.16) | |
| Sjoberg, et al. (2005) | Cross-sectional | Sweden | 15-17 | F/M | 4808<br>Nw:3927<br>OV:750<br>OB:131 | 849<br>Nw:687<br>OV:127<br>OB:35 | BMI ≥25<br>Adjusted for children | Depression | DSM-IV | OV | OR: 0.95 (0.76-1.19) | 4,5,6,7 |
| Roberts et al. (2015) | Cross-sectional | USA | 11-17 | F/M | 4175 | 4175 | BMI ≥30<br>BMI ≥95th | Depression | DSM-IV | OB<br>OB | OR: 1.66 (1.11-2.48)*<br>OR: 1.21 (0.22-6.57) | 1,2,4,8,9,25 |
| | | | | M | | 1041 | | | | | OR: 2.31 (0.15-3.46) | |
| | | | | F | | 3134 | | | | | OR: 0.88 (0.32–2.40) | |
| Ozmen et al. (2007) | Cross-sectional | Turkey | 15-18 | F/M | 2101<br>Nw:1888<br>OV:189<br>OB:24 | | BMI ≥25<br>Adjusted for children | Depression | CDI | OV | OR: 1.74 (0.95-3.23) | – |
| | | | | | | | | Self-esteem | RSES | | OR: 0.85 (0.38-1.90) | |
| | | | | | | 991 | | Body dissatisfaction | Q | | OR: 0.59 (0.39-0.87)* | |
| Morrison et al. (2015) | Cross-sectional | Canada | 8-17 | F/M | 244 | 88 | DXA | Depression | CES-DC | BF | OR: 1.08 (0.99-1.15) | – |
| Mikkila et al. (2003) | Cross-sectional | Finland | 14-16 | F | 60252 | | RW ≥120% | Body dissatisfaction | Q | OB | OR: 9.39 (8.15-10.82)* | 1,2,3,4,5 |
| | | | | M | | | | | | | OR: 6.81 (6.13-7.56)* | |
| Merikangas et al. (2012) | Cross-sectional | USA | 12-19 | F/M | 4150 | | BMI ≥95th | Depression | DSM-IV | OB | OR: 1.60 (0.90-2.90) | 1,2,3,4,5 |
| | | | | M | | | | | | | OR: 2.70 (1.10-7.10)* | |
| | | | | F | | | | | | | OR: 1.3 (0.60-2.70) | |
| McClure et al. (2010) | Cross-sectional | USA | 12-16 | F/M | 4458<br>Nw:3253<br>OV:692<br>OB:513 | 889<br>Nw:587<br>OV:146<br>OB:156 | 95th > BMI ≥85th | Self-esteem | Harter's self-perceptions profile | OV | OR: 1.26 (1.02-1.56)* | 4,11,12,13,14 |
| Ferrari et al. (2015) | Cross-sectional | Southern Brazil | 7-17<br>pre-pubescent | M | 1541<br>NW:185<br>OV:24<br>NF:166<br>HF:43 | 190<br>NW:28<br>OV:17<br>NF:18<br>HF:27 | BMI ≥95th<br>BMI ≥25<br>Adjusted for children<br>Lohman criteria | Body dissatisfaction | Q | OB<br>OV<br>BF | OR: 2.05 (1.63-2.57)*<br>OR: 7.17 (0.72-7.91)<br>OR: 5.77 (1.63-20.42)* | 1,2,3,4,5 |
| | | | pubescent | | NW:856<br>OV:197<br>NF:702<br>HF:502 | NW:171<br>OV:148<br>NF:112<br>HF:207 | | | | OV<br>BF | OR: 5.25 (3.06-9.010)*<br>OR: 2.42 (1.60-3.66)* | |
| | | | Post-pubescent | | NW:191<br>OV:88<br>NF:178<br>HF:66 | NW:29<br>OV:25<br>NF:23<br>HF:32 | | | | OV<br>BF | OR: 3.77 (1.33-10.70)*<br>OR: 1.50 (0.58-3.86) | |

(*continued*)

**Table 1.** Continued.

| Author(year) | Design | Country | Age | Gender | N Sample size | N Cases | EXP assessment | Outcome | Outcome assessment | EXP | OR, RR or HR (95%CI) | Adjustments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Jansen et al. (2008) | Cross-sectional | Netherland | 9-10 | F/M | 3800<br>1900 | 963<br>OV:458<br>OB:505 | BMI ≥25<br>Adjusted for children | Depression | SDIC | OV | OR: 0.86 (0.66-1.11) | 4,15 |
| | | | | | | | BMI ≥30 | | | OB | OR: 0.96 (0.64-1.43) | |
| | | | | | 1900 | 754<br>OV:412<br>OB:342 | | Anxiety | social anxiety scale | OV | OR: 1.03 (0.78-1.36) | |
| | | | | | | | | | | OB | OR: 0.77 (0.49-1.26) | |
| Friedlander et al. (2003) | Cross-sectional | USA | 8-11 | F/M | 371 | | 95th > BMI ≥85th | Self-esteem | CHQ-PF50 | OV | OR: 3.50 (1.90-6.30)* | 2 |
| Franklin et al. (2006) | Cross-sectional | Australia | 6-10 | F | 2491<br>Nw:1905<br>OV:359<br>OB:227 | | 95th > BMI ≥85th | Self-esteem | Harter Self-perception Profile for Children | OV | RR: 2.37 (1.42-3.95)* | – |
| | | | | | | | BMI ≥95th | | | OB | RR: 4.12 (2.56-6.63)* | |
| | | | | M | | | | | | OV | RR: 1.69 (0.93-3.97) | |
| | | | | | | | | | | OB | RR: 2.52 (1.37-4.61)* | |
| Feio Costa et al. (2016) | Cross-sectional | Brazil | 7-10 | M | 1521<br>Nw:960<br>OV:356<br>OB:205 | | BMI > z-score +1 and ≤ z-score +2 | Body dissatisfaction | desired" minus "actual | OV | OR: 2.46 (1.33-4.56)* | 1,3,15 |
| | | | | | | | BMI > z-score +2 | | | OB | OR: 13.96 (4.03-8.36)* | |
| | | | | | | | | | | BF | OR: 1.94 (0.90-4.20) | |
| | | | | F | | | | | | OV | OR: 3.94 (1.48-10.48)* | |
| | | | | | | | | | | OB | OR: 3.50 (0.39-31.45) | |
| | | | | | | | | | | BF | OR: 3.39 (1.32-8.71)* | |
| Bjornelv, Nordahl, and Holmen (2011) | Cross-sectional | Norway | 13-19 | M | 4819<br>Nw:3413<br>OV:1158<br>OB:248 | | BMI ≥25<br>Adjusted for children | Depression | SCL-5 | OV | OR: 1.00 (0.95-1.05) | 9,17 |
| | | | | | | | | Self-esteem | RSES | | OR: 0.90 (0.87-0.96) | |
| | | | | | | | | Anxiety | SCL-5 | | OR: 1.00 (0.95-1.05) | |
| | | | | | | | BMI ≥30<br>Adjusted for children | Depression | | OB | OR: 0.80 (0.77-0.92) | |
| | | | | | | | | Self-esteem | | | OR: 0.90 (0.84-1.03) | |
| | | | | | | | | Anxiety | | | OR: 0.80 (0.77-0.92)* | |
| | | | | F | | | | Depression | | OV | OR: 0.90 (0.91-0.99)* | |
| | | | | | | | | Self-esteem | | | OR: 0.90 (0.86-0.94)* | |
| | | | | | | | | Anxiety | | | OR: 0.90 (0.91-0.99)* | |
| | | | | | | | | Depression | | OB | OR: 0.90 (0.87-1.03) | |
| | | | | | | | | Self-esteem | | | OR: 0.8 (0.74-0.89)* | |
| | | | | | | | | Anxiety | | | OR: 0.90 (0.87-1.03) | |
| Assari et al. (2015) | Cross-sectional | USA | 15 | M | 1170 | | BMI appropriate for the age and gender group | Depression | DSM-IV | OB | OR: 1.30 (0.50-3.37) | 1,4,18 |
| | | | | F | | | | | | | OR: 0.63 (0.24-1.66) | |
| Bazargan-Hejazi et al. (2010) | Cross-sectional | USA | 12-17 | F/M | 3279<br>NM:2814<br>OV:465 | 54<br>OV:54 | BMI ≥95th | Depression | CES-D | OV | OR: 0.71 (0.42-1.19) | 2,17 |
| Erermis et al. (2004) | Cross-sectional | Turkey | 12-16 | F/M | 90<br>NM:30<br>OB:60 | 16<br>OB:16 | BMI > z-score +2 | Depression | DSM-IV | OB | OR: 5.09 (1.08-23.8)* | – |
| | | | | | | 15<br>NW:2<br>OB:13 | | Anxiety | | | OR: 3.87 (0.81-18.43) | |
| Berg, Simonsson, and | Cross-sectional | Sweden | 15 | M | 989<br>NM:789 | | BMI > z-score +2 | Body dissatisfaction | Q | OB | OR: 5.39 (2.85-10.19)* | – |

(*continued*)

**Table 1.** Continued.

| Author(year) | Design | Country | Age | Gender | N Sample size | N Cases | EXP assessment | Outcome | Outcome assessment | EXP | OR, RR or HR (95%CI) | Adjustments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ringqvist (2005) | | | | | OV:157<br>OB:43 | 53<br>OV:34<br>OB:19 | | | | | | |
| | | | | | | | BMI > z-score +1 and ≤ z-score +2 | | | OV | OR: 1.88 (1.22-2.90)* | |
| Halfon, Larson, and Slusser (2013) | Cross-sectional | USA | 10-17 | F/M | 43297<br>OB:6927<br>OV:6495 | OB:1728<br>OV:1728 | BMI ≥95th | Depression | clinical history | OB<br>OV | OR: 1.41 (1.04-1.93)*<br>OR: 1.33 (0.98-1.82) | 1,2,3,4,23 |
| | | | | | | OB:2161<br>OV:2161 | | Anxiety | | OB<br>OV | OR: 1.27 (0.95-1.70)<br>OR: 1.21 (0.88-1.65) | |
| Zakeri et al. (2012) | Cross-sectional | Iran | 10-18 | F/M | 9172<br>OB:538<br>OV:848 | OB: 166<br>OV:259 | z-score > 2 | Depression | Q | OB<br>OV | OR: 1.03 (0.85-1.25)<br>OR: 1.00 (0.85-1.17) | – |
| | | | | | | OB: 5<br>OV:106 | | Anxiety | Q | OB<br>OV | OR: 0.79 (0.58-1.06)<br>OR: 1.04 (0.84-1.29) | – |
| Wardle et al. (2006) | Cross-sectional | UK | 11 | F | 1742<br>OB:110 | | BMI ≥30 | Depression | CES-D | OB | OR: 0.89 (0.44-1.81) | – |
| | | | 11 | M | 2578<br>OB:113 | | | | | | OR: 1.25 (0.27-5.66) | – |
| Wake et al. (2002) | Cross-sectional | Australia | 5-13 | M | 1430<br>OV:255<br>OB:50 | OV:59<br>OB:26 | BMI ≥25<br>BMI ≥30 | Self-esteem | CHQ | OV<br>OB | OR: 1.40 (0.90-2.00)<br>OR: 1.80 (1.00-3.20) | 1,7 |
| | | | | F | | | | | | OV<br>OB | OR: 1.80 (1.30-2.60)*<br>OR:1.8 (1.00-3.20) | |
| Kubzansky et al. (2011) | Cross-sectional | USA | 14.4 at wave1 | F/M | 1386 | 1337 | BMI ≥25<br>Adjusted for children<br>BMI ≥30 | Depression | CES-D | OV<br>OB | OR: 0.99 (0.85-1.15)<br>OR: 1.10 (0.87-1.38) | 1,2,3,4,20 |
| | | | | | 1386 | 1337 | | Anxiety | SSAI | OV<br>OB | OR: 1.13 (1.01-1.28)*<br>OR: 1.30 (1.07-1.57)* | |
| Wang et al. (2009) | Cohort (2 years) | Canada | 10-11 | F/M | 2018 | | BMI ≥25<br>Adjusted for children<br>BMI ≥30 | Self-esteem | | OV<br>OB | OR: 1.36 (0.87-2.14)<br>OR: 1.15 (0.59-2.26) | 3,9,13,22,24 |
| | Cohort (4 years) | | 10-11 | | 1806 | | | | | OV<br>OB | OR: 1.03 (0.64-1.66)<br>OR: 1.82 (1.01-3.78)* | |
| Roberts et al. (2013) | Cohort (1 year) | USA | 11-17 | F/M | 3134 | | 95th > BMI ≥85th | Body dissatisfaction | DSM-IV | OV | OR: 1.05 (0.77-1.43) | 1,2,4 |
| | | | | | | | | Anxiety | | | OR: 1.10 (0.64-1.92) | |
| | | | | | | | | Depression | | | OR: 1.00 (0.80-1.25) | |
| | | | | | | | | Self-esteem | | | OR: 0.92 (0.73-1.15) | |
| | | | | | | | BMI ≥95th | Body dissatisfaction | | OB | OR: 1.30 (0.98-1.74) | |
| | | | | | | | | Depression | | | OR: 1.11 (0.90-1.38) | |
| | | | | | | | | Self-esteem | | | OR: 1.04 (0.83-1.31) | |
| | | | | | | | | Anxiety | | | OR: 0.79 (0.44-1.40) | |
| | | | | M | | | | Body dissatisfaction | | OV | OR: 1.15 (0.76-1.73) | |
| | | | | | | | | Anxiety | | | OR: 0.90 (0.42-1.95) | |
| | | | | | | | | Depression | | | OR: 0.87 (0.65-1.17) | |
| | | | | | | | | Self-esteem | | | OR: 0.77 (0.57-1.04) | |
| | | | | | | | | Body dissatisfaction | | OB | OR: 1.40 (0.95-2.04) | |
| | | | | | | | | Depression | | | OR: 1.04 (0.79-1.36) | |
| | | | | | | | | Self-esteem | | | OR: 0.97 (0.73-1.29) | |
| | | | | | | | | Anxiety | | | OR: 0.79 (0.34-1.82) | |
| | | | | F | | | | Body dissatisfaction | | OV | OR: 0.90 (0.61-1.33) | |
| | | | | | | | | Anxiety | | | OR: 1.43 (0.71-2.88) | |
| | | | | | | | | Depression | | | OR: 1.21 (0.89-1.63) | |
| | | | | | | | | Self-esteem | | | OR: 1.05 (0.77-1.43) | |

(*continued*)

**Table 1.** Continued.

| Author(year) | Design | Country | Age | Gender | N Sample size | N Cases | EXP assessment | Outcome | Outcome assessment | EXP | OR, RR or HR (95%CI) | Adjustments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Body dissatisfaction | | OB | OR: 1.38 (0.97-1.95) | |
| | | | | | | | | Depression | | | OR: 1.35 (1.01-1.82)* | |
| | | | | | | | | Self-esteem | | | OR: 1.19 (0.88-1.62) | |
| | | | | | | | | Anxiety | | | OR: 1.04 (0.52-2.06) | |
| Boutelle et al. (2010) | Cohort (1 year) | USA | 11-15 | F/M | 496 | | 95th > BMI ≥85th | Depression | DSM–IV | OV | OR: 0.61 (0.24-1.57) | 1,20,21 |
| | | | | | | | BMI> 95th | | | OB | OR: 1.62 (0.77-3.38) | |

Adjustments: Age(1), gender(2), parental education(3), social and demographic characteristics (4), parental employment (5), shaming experience(6), family constellation(7), diet (8), physical activity (9), weight status at wave1 (10), personality characteristics(11), Daily TV usage(12), Grades in schools(13), team sports(14), country of origin(15), school (15), sex-related medical condition except asthma(16), smoking(17), parental overweight(18), nutritional variables(19), early puberty(20),previous depression(21), parental emotional problems (22), race (23), alcohol (24),perceived weight (25).

Abbreviations: N: Number; F: Female; M: Male; Normal weight: NW; Overweight: OV; Obesity: OB; BF: Body fat; Q: Questionnaire; CES-D: The Center for Epidemiologic Studies Depression Scale; RSES: Rosenberg Self-esteem Scale; DSM-IV: The Diagnostic and Statistical Manual of Mental Disorders; SDIC: Short Depression Inventory for Children; CHQ-PF50: Child Health Questionnaire – Parent Form 50; SSAI: Spielberger State-Anxiety Inventory; OR: Odds Ratio.

*$P$-value $< 0.05$.

adulthood ($n = 5$); (c) studies reporting weight gain or weight loss based on the criteria other than BMI categories ($n = 3$); (d) studies on young adults ($n = 4$); (e) studies with similar population ($n = 4$); (f) odds ratio was not available and could not be calculated ($n = 51$); (g) published in a language other than English ($n = 3$); and (h) studies with no full text ($n = 5$). A flow diagram which summarizes search strategy is provided in Figure 1.

### Data extraction

For each study, detailed information was briefly provided on: study information (first author's name, publication year, study design and study origin), sample characteristics (mean age and gender, total population, and case size), measurement tool for assessing weight status and psychological outcomes, association estimates and covariates adjusted for in the analysis. When the required data was available, ORs were calculated for studies not reported risk estimates (Higgins, Li, and Deeks 2019). Cohort studies considering the association between weight status and risk of psychological outcomes in adulthood were excluded (Anderson et al. 2007; Sanderson et al. 2011; Frisco, Houle, and Lippert 2013). Among the two Studies with cross-sectional and prospective design with the same datasets, the cohort study conducted by Robert et al. was selected and the cross-sectional study by Wang et al. was excluded (Wang et al. 2009; Roberts and Hao 2013). If studies assessed exposures using different measures (such as BMI and body fat percentage), we combined risk estimates corresponding to those measures to reach a single risk estimate prior to statistical analysis.

Selection of relevant studies was performed by two independent reviewers (MM and HM). Any dispute was resolved by discussion or by a third author arbitration (LA).

### Quality assessment of studies

Quality of eligible studies was assessed using adaptations of the Newcastle-Ottawa Quality Assessment Scale (Wells et al. 1999). According to this questionnaire each study can be evaluated in terms of selection (4 points), comparability (2 points), and ascertainment of either exposure or outcome (3 points). Based on this star scoring system, each prospective study can be given a maximum of nine points for parameters in three domains: selection (a maximum of 4 points); comparability (a maximum of 2 points); and assessment of exposure (a maximum of 3 points). Additionally, each cross-sectional study can be awarded a maximum of ten points based on the parameters in the following three domains: selection (a maximum of 5 points), comparability (a maximum of 2 points), and assessment of exposure (a maximum of 3 points). According to NOS, one-to-three stars express low quality, four-to-six stars express moderate quality, and seven-to-nine stars express high quality (Roberts and Duong 2015). Quality assessment was assessed independently by two authors and any disagreements were solved by discussion (Supplementary material, Table 2).

### Statistical analysis

ORs, HRs and RRs were chosen to calculate log RRs and standard errors (SEs) for the association between obesity/overweight and each psychological outcome. The random-effects model (DerSimonian–Laird) was applied to draw pooled risk estimates for the association between overweigh/obesity and risk of psychological outcomes. Q-statistics together with $I^2$ was considered to trace inter-study heterogeneity. The presence of intra-study heterogeneity was represented at $I^2 \geq 50\%$ and was defined as significant at $p < 0.1$. Subgroup analysis using a fixed-effect model was performed on the following criteria: design (prospective/cross-sectional), geographical region (America/Europe/Asia/Australia), gender (female/male/both genders) and quality assessment score ($>6/\leq 6$). The ORs for obese and overweight subjects were pooled separately and normal weight children and adolescents were considered as the reference group. Then Forrest plots were provided for each comparison. The possibility of reporting bias was tested by checking funnel plot asymmetry as well as verified by the statistical evidence of Egger's test (Egger et al. 1997). To examine possible publication bias and to define whether the final pooled effect sizes were affected by a single or several publications, sensitivity analysis was performed. Data analysis was performed on the platform of Stata, version 11.2 (Stata Corp, College Station, TX). In all the mentioned polled analysis, the level of significance was set at $P$ value $< 0.05$.

## Results

### Systematic review findings

A total of 25 cross-sectional studies and 3 prospective cohort studies were included in the current systematic review and meta-analysis. All the included prospective studies examined overweight and obesity leading to psychological problems. The median duration of prospective cohort studies ranged between 1 and 4 years. The majority of the studies were from the US (n = 16) (Friedlander et al. 2003; Swallen et al. 2005; Wang and Veugelers 2008; Wang et al. 2009; Bazargan-Hejazi et al. 2010; Boutelle et al. 2010; McClure et al. 2010; Kubzansky, Gilthorpe, and Goodman 2012; Halfon, Larson, and Slusser 2013; Roberts and Hao 2013; Assari and Caldwell 2015; Ferrari et al. 2015; Roberts and Duong 2015; Costa et al. 2016) and Europe ($n = 6$) (Mikkilä et al. 2003; Berg, Simonsson, and Ringqvist 2005; Sjöberg et al. 2005; Wardle et al. 2006; Jansen et al. 2008; Bjornelv, Nordahl, and Holmen 2011) with some studies in Asia ($n = 4$) (Erermis et al. 2004; Ozmen et al. 2007; Ting et al. 2012; Zakeri et al. 2012) and Australia ($n = 2$) (Wake et al. 2002; Franklin et al. 2006). Mean age of participants varied between 5 and 19 years. While 19 studies considered both genders as a whole (Friedlander et al. 2003; Erermis et al. 2004; Sjöberg et al. 2005; Swallen et al. 2005; Ozmen et al. 2007; Jansen et al. 2008; Wang and Veugelers 2008; Wang et al. 2009; Bazargan-Hejazi et al. 2010; Boutelle et al. 2010; McClure et al. 2010; Kubzansky, Gilthorpe, and Goodman 2012; Merikangas et al. 2012; Ting et al. 2012; Zakeri et al.

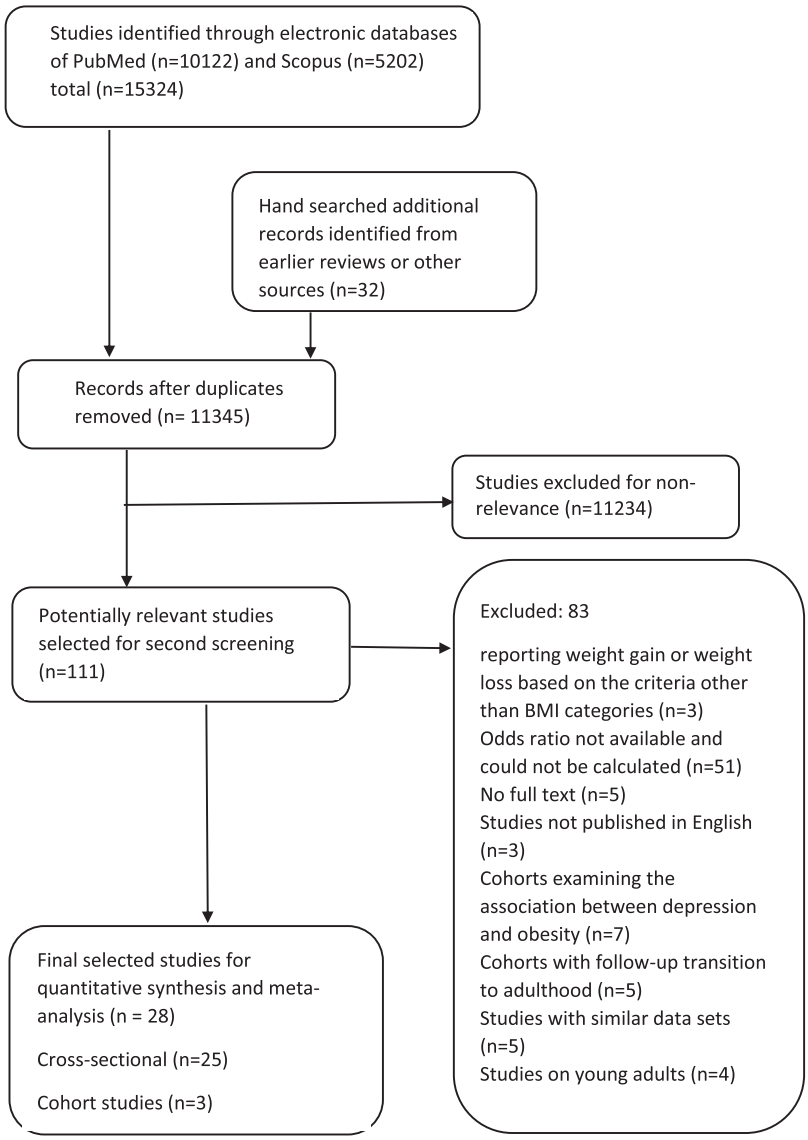


**Figure 1.** The flowchart describing systematic literature search and study selection.

2012; Halfon, Larson, and Slusser 2013; Roberts and Hao 2013; Morrison et al. 2015; Roberts and Duong 2015), 10 studies investigated gender specific associations (Wake et al. 2002; Mikkilä et al. 2003; Franklin et al. 2006; Wardle et al. 2006; Bjornelv, Nordahl, and Holmen 2011; Merikangas et al. 2012; Roberts and Hao 2013; Assari and Caldwell 2015; Roberts and Duong 2015; Costa et al. 2016). Additionally, 2 studies were only restricted to male subjects (Berg, Simonsson, and Ringqvist 2005; Ferrari et al. 2015). Total sample size ranged from 244 to 60252. More detailed characteristics of eligible studies are provided in Table 1.

Overweight and obesity was defined on the basis of BMI $\geq$25 kg/m$^2$ and BMI $\geq$30 kg/m$^2$ in 10 studies (Wake et al. 2002; Sjöberg et al. 2005; Wardle et al. 2006; Ozmen et al. 2007; Jansen et al. 2008; Wang and Veugelers 2008; Wang et al. 2009; Bjornelv, Nordahl, and Holmen 2011; Kubzansky, Gilthorpe, and Goodman 2012; Ferrari et al. 2015), in 3 studies it was defined by 97th > BMI $\geq$95th and BMI $\geq$97th (Swallen et al. 2005; Bazargan-Hejazi et al. 2010; Ting et al. 2012), in 7 studies it was defined by 85th > BMI $\geq$95th and BMI $\geq$95th (Friedlander et al. 2003; Franklin et al. 2006; Boutelle et al. 2010; McClure et al. 2010; Merikangas et al. 2012; Roberts and Hao 2013; Roberts and Duong 2015), in 4 studies it was defined by z-score +1< BMI $\leq$ z-score +2 and BMI > z-score +2 (Erermis et al. 2004; Berg, Simonsson, and Ringqvist 2005; Zakeri et al. 2012; Costa et al. 2016), and in 1 remaining studies body fat was defined by DXA. Besides, the cut off point for normal weight is below the 91st centile in both sexes, or between 18 and 24.9 kg/m$^2$ (Ferrari et al. 2015).

With regard to psychological problems, a wide range of assessment was applied in studies. Seven indices were applied to assess depression including Center for Epidemiologic Studies Depression Scale (CES-D) (Swallen et al. 2005; Wardle et al. 2006; Bazargan-Hejazi et al. 2010; Kubzansky, Gilthorpe, and Goodman 2012; Ting et al. 2012; Morrison et al. 2015), Short Depression Inventory for Children (SDIC) (Jansen et al. 2008), Diagnostic and Statistical Manual of Mental Disorders of the American Psychiatric Association (DSM-IV) (Erermis et al. 2004; Sjöberg et al. 2005; Boutelle et al. 2010; Merikangas et al. 2012; Roberts and Hao 2013; Assari and Caldwell 2015;

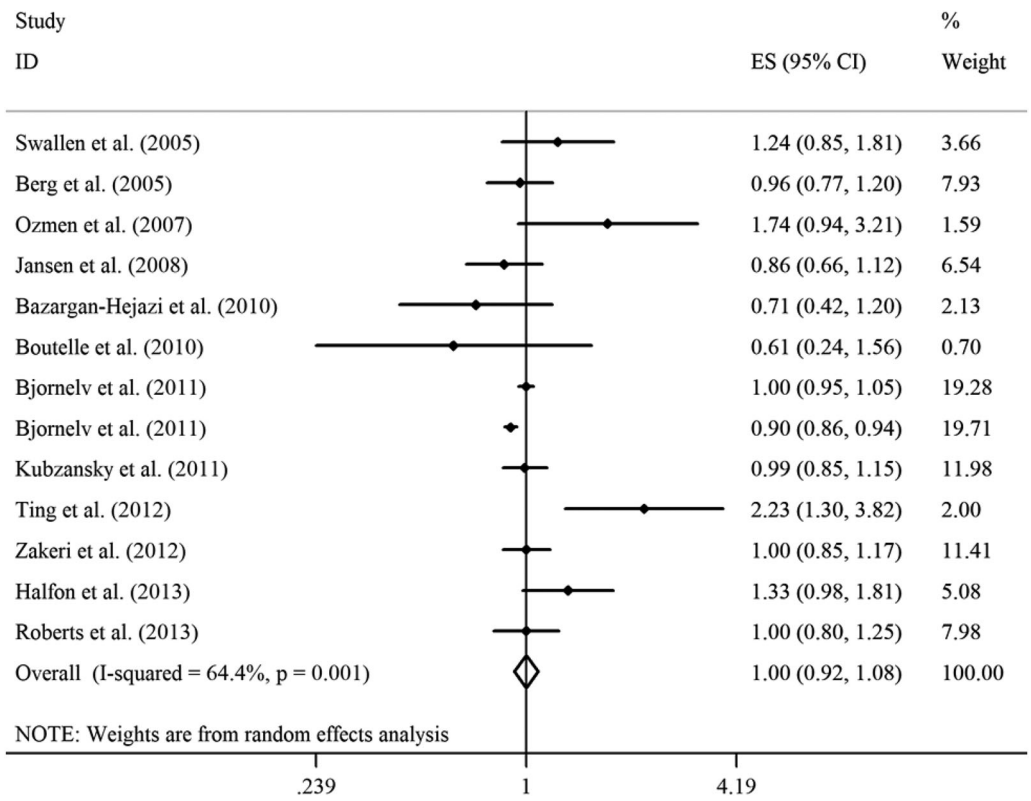


**Figure 2.** Forest plot of the association between overweight and depression using a random-effects model.

Roberts and Duong 2015), Children's Depression Inventory (CDI) (Ozmen et al. 2007) and SCL-5 (Bjornelv, Nordahl, and Holmen 2011). To evaluate anxiety, social anxiety disorder (Jansen et al. 2008), Short Scale Anxiety Sensitivity Index (SSAI) (Kubzansky, Gilthorpe, and Goodman 2012), DSM–IV (Erermis et al. 2004; Roberts and Hao 2013) and SCL-5 (Bjornelv, Nordahl, and Holmen 2011) were used. Self-esteem was determined using the Child Health Questionnaire (CHQ) (Wake et al. 2002; Friedlander et al. 2003), Rosenberg self-esteem scale (RSES) (Swallen et al. 2005; Ozmen et al. 2007; Bjornelv, Nordahl, and Holmen 2011), Harter (Franklin et al. 2006) and body dissatisfaction was specified by DSM-IV (Roberts and Hao 2013). Out of included studies, twenty-one studies reported adjusted effect sizes along with 95% CIs regarding the association between overweight/obesity and psychological disorders (Wake et al. 2002; Friedlander et al. 2003; Mikkilä et al. 2003; SjöBerg, Simonsson, and Ringqvist 2005; Swallen et al. 2005; Jansen et al. 2008; Wang and Veugelers 2008; Wang et al. 2009; Bazargan-Hejazi et al. 2010;Boutelle et al. 2010; McClure et al. 2010; Bjornelv, Nordahl, and Holmen 2011; Kubzansky, Gilthorpe, and Goodman 2012; Merikangas et al. 2012; Ting et al. 2012; Halfon, Larson, and Slusser 2013; Roberts and Hao 2013; Assari and Caldwell 2015; Ferrari et al. 2015; Roberts and Duong 2015; Costa et al. 2016), whereas others did not adjust for any probable confounders (Erermis et al. 2004; Berg, Simonsson, and Ringqvist 2005; Franklin et al. 2006; Wardle et al. 2006; Ozmen et al. 2007; Zakeri et al. 2012; Morrison et al. 2015).

Although several studies showed a significant association between children and adolescents overweight and the risk of depression in both gender (Ting et al. 2012), others did not report any significant association (Sjöberg et al. 2005; Ozmen et al. 2007; Jansen et al. 2008; Bazargan-Hejazi et al. 2010; Boutelle et al. 2010; Kubzansky, Gilthorpe, and Goodman 2012; Zakeri et al. 2012; Halfon, Larson, and Slusser 2013; Roberts and Hao 2013). We found either significant or non-significant results for different genders in three studies (Bjornelv, Nordahl, and Holmen 2011; Merikangas et al. 2012; Roberts and Hao 2013). Moreover, one study showed a significant association between children and adolescent's overweight and the risk of anxiety (Kubzansky, Gilthorpe, and Goodman 2012) while several studies did not show any association (Bjornelv, Nordahl, and Holmen 2011; Zakeri et al. 2012; Halfon, Larson, and Slusser 2013; Roberts and Hao 2013). With regard to children and adolescent's overweight in relation with the risk of low self-esteem, several studies showed significant positive associations in both genders (Friedlander et al. 2003; McClure et al. 2010), while others did not show any association (Swallen et al. 2005; Ozmen et al. 2007; Wang and Veugelers 2008; Wang et al. 2009; Roberts and Hao 2013). Three studies reported significant associations between overweight girls and the risk of low self-esteem, while no significant associations were found in overweight boys in relation with low self-esteem (Wake et al. 2002; Franklin et al. 2006; Bjornelv, Nordahl, and Holmen 2011). Overall, included studies provided a positive significant association between children and adolescent's overweight in relation with the risk of body dissatisfaction (Berg, Simonsson, and Ringqvist 2005; Ozmen et al. 2007; Ferrari et al. 2015; Costa et al. 2016) except for one study (Roberts and Hao 2013).

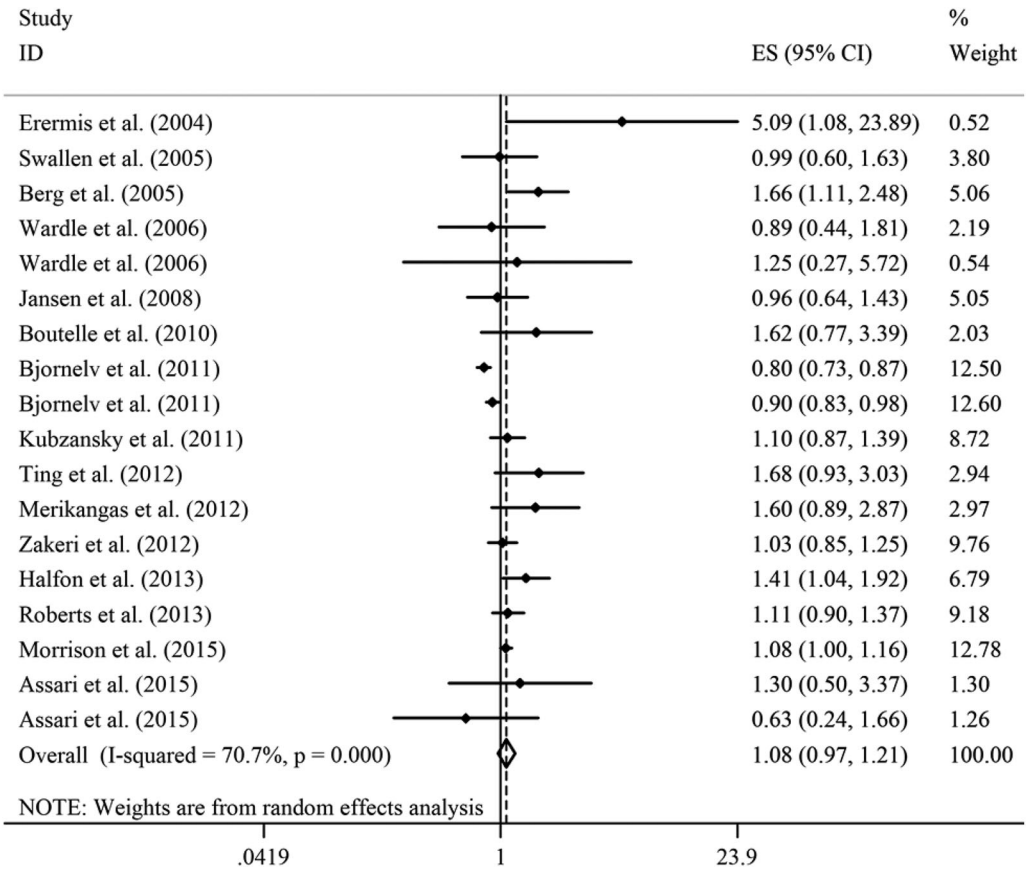


**Figure 3.** Forest plot of the association between obesity and depression using a random-effects model.

Notwithstanding several studies showed a significant association between children and adolescents obesity and the risk of depression in both gender (Erermis et al. 2004; Sjöberg et al. 2005; Ting et al. 2012; Halfon, Larson, and Slusser 2013), others did not report any significant association (Wardle et al. 2006; Jansen et al. 2008; Bazargan-Hejazi et al. 2010; Boutelle et al. 2010; Bjornelv, Nordahl, and Holmen 2011; Kubzansky, Gilthorpe, and Goodman 2012; Zakeri et al. 2012; Assari and Caldwell 2015; Morrison et al. 2015; Roberts and Duong 2015) and depression. We found either significant or non-significant results for different genders in three studies (Bjornelv, Nordahl, and Holmen 2011; Merikangas et al. 2012; Roberts and Hao 2013). Moreover, one study showed a positive significant association between children and adolescent's obesity and the risk of anxiety in both gender (Kubzansky, Gilthorpe, and Goodman 2012), while several studies did not show any association (Erermis et al. 2004; Zakeri et al. 2012; Halfon, Larson, and Slusser 2013; Roberts and Hao 2013). One study showed an inverse significant association between obese boys and anxiety (Jansen et al. 2008), while no significant association was found between obese girls as well as overweight children/adolescents and the risk of anxiety (Bjornelv, Nordahl, and Holmen 2011; Roberts and Hao 2013). With regard to children and adolescent's obesity in relation with the risk of low self-esteem, several studies showed significant positive associations (Franklin et al. 2006; Wang and Veugelers 2008; Wang et al. 2009; McClure et al. 2010) while others did not show any association (Wake et al. 2002; Swallen et al. 2005; Roberts and Hao 2013). Overall, included studies provided a positive significant association between children and adolescent's obesity in relation with the risk of body dissatisfaction (Berg, Simonsson, and Ringqvist 2005; Ferrari et al. 2015; Costa et al. 2016) except for one study (Roberts and Hao 2013).

## Meta-analysis findings

### Depression

No association was observed between overweight and risk of depression (pooled risk estimate: 1.00, 95% CI: 0.92–1.08, $P = 0.97$) ($I^2$ = 64.4%, P-heterogeneity = 0.001) (Figure 2). Moreover, there was not any relationship between obesity and risk of depression (pooled risk estimate: 1.08, 95% CI: 0.97–1.21, $P = 0.17$) ($I^2$ = 70.7%, P-heterogeneity = 0.0001).

### Subgroup analysis (depression)

Geographical region and study design were detected as probable sources to which heterogeneity could be attributed between overweight and depression (Supplementary material, Table 3). The association between overweight and depression was significant among girls (pooled risk estimate: 0.90, 95% CI: 0.86–0.94, $P = 0.001$). Geographical region, study design, quality assessment and gender were detected as potential sources of heterogeneity between obesity and depression. A significant association was observed between obesity and depression in all subgroups.

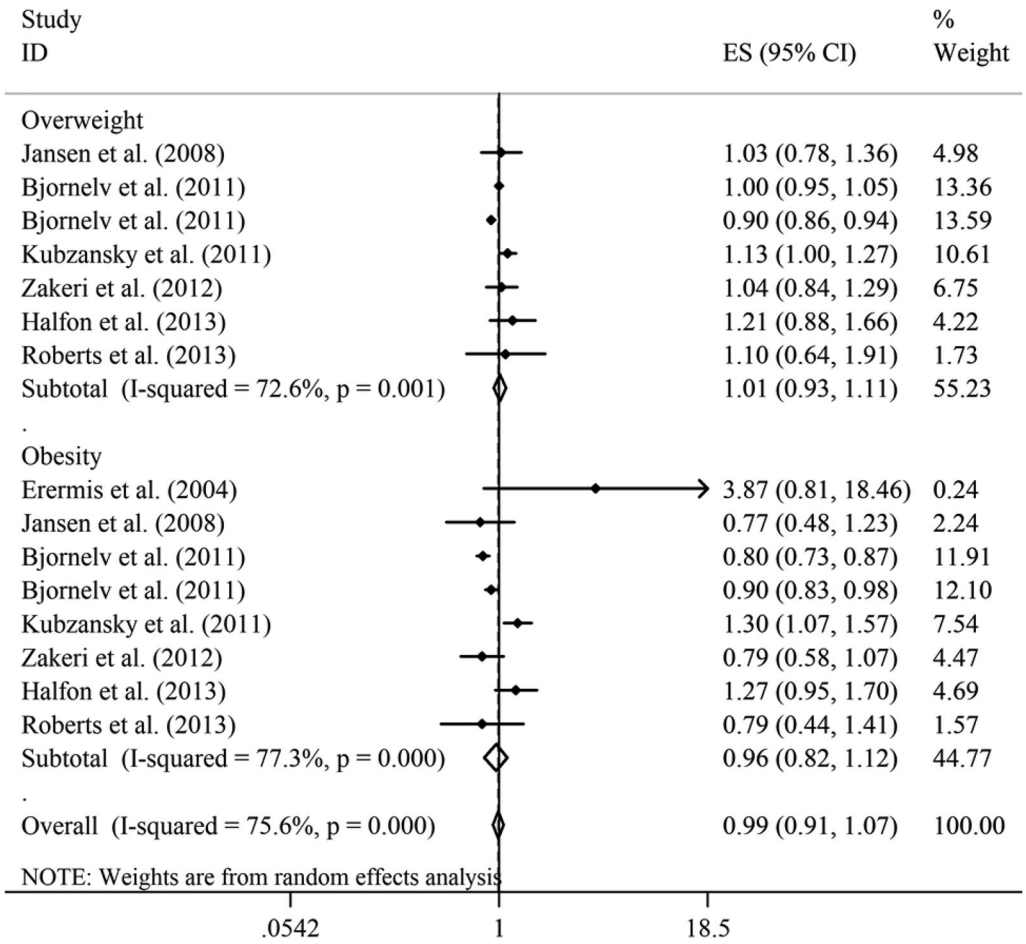


**Figure 4.** Forest plot of the association between overweight / obesity and anxiety using a random-effects model.

### *Anxiety*

No associations were found between either overweight (pooled risk estimate: 1.01, 95% CI: 0.93–1.11, $P = 0.75$) ($I^2$ = 72.6%, P-heterogeneity = 0.001) or obesity (pooled effect size: 0.96, 95% CI: 0.82–1.12, $P = 0.59$) ($I^2$ = 77.3%, P-heterogeneity = 0.0001) with the risk of anxiety, respectively (Figure 4).

### *Subgroup analysis (anxiety)*

Geographical region, quality assessment and gender were detected as potential sources of heterogeneity between overweight and anxiety (Supplementary material, Table 4). The association between overweight and anxiety was significant in studies on American population, as well as low-quality studies. There was a significant relationship between overweight and risk of anxiety in studies conducted on both gender (pooled risk estimate: 1.11, 95% CI: 1.01–1.21, $P = 0.02$), and females (pooled risk estimate: 0.90, 95% CI: 0.86–0.94, $P = 0.001$).

Geographical region was detected to be source of heterogeneity for the association between obesity and anxiety (Supplementary material, Table 4). The association between obesity and risk of anxiety was significant in studies among American and European population. A positive association was observed between obesity and anxiety in studies with high-quality (pooled risk estimate: 0.85, 95% CI: 0.75–0.96, $P = 0.01$), as well as those which were conducted on boys (pooled risk estimate: 0.80, 95% CI: 0.73-0.87, $P = 0.001$), and girls (pooled risk estimate: 0.90, 95% CI: 0.83–0.98, $P = 0.01$) separately.

### *Low self-esteem*

A positive significant association was found between overweight and risk of low self-esteem (pooled risk estimate: 1.15, 95% CI: 1.00–1.31, $P = 0.04$) ($I^2$ = 83.1%, P-heterogeneity = 0.0001). Moreover, there was a significant positive association between obesity and risk of low self-esteem (pooled risk estimate: 1.53, 95% CI: 1.16–2.02, $P = 0.003$) ($I^2$ = 92.5%, P-heterogeneity = 0.0001) (Figure 5).

### *Subgroup analysis (low self-esteem)*

Geographical region and study design were detected as sources of heterogeneity between overweight and low self-esteem (Supplementary material, Table 5). A significant positive association was found between overweight and low self-esteem in studies conducted on European (pooled risk estimate: 0.90, 95% CI: 0.87–0.93, $P = 0.001$), as well as those with cross-sectional designs (pooled risk estimate: 1.20, 95% CI: 1.03–1.40, $P = 0.01$).

With regard to obesity, study design, geographical region and quality assessment score were detected as sources of heterogeneity between studies (Supplementary material,

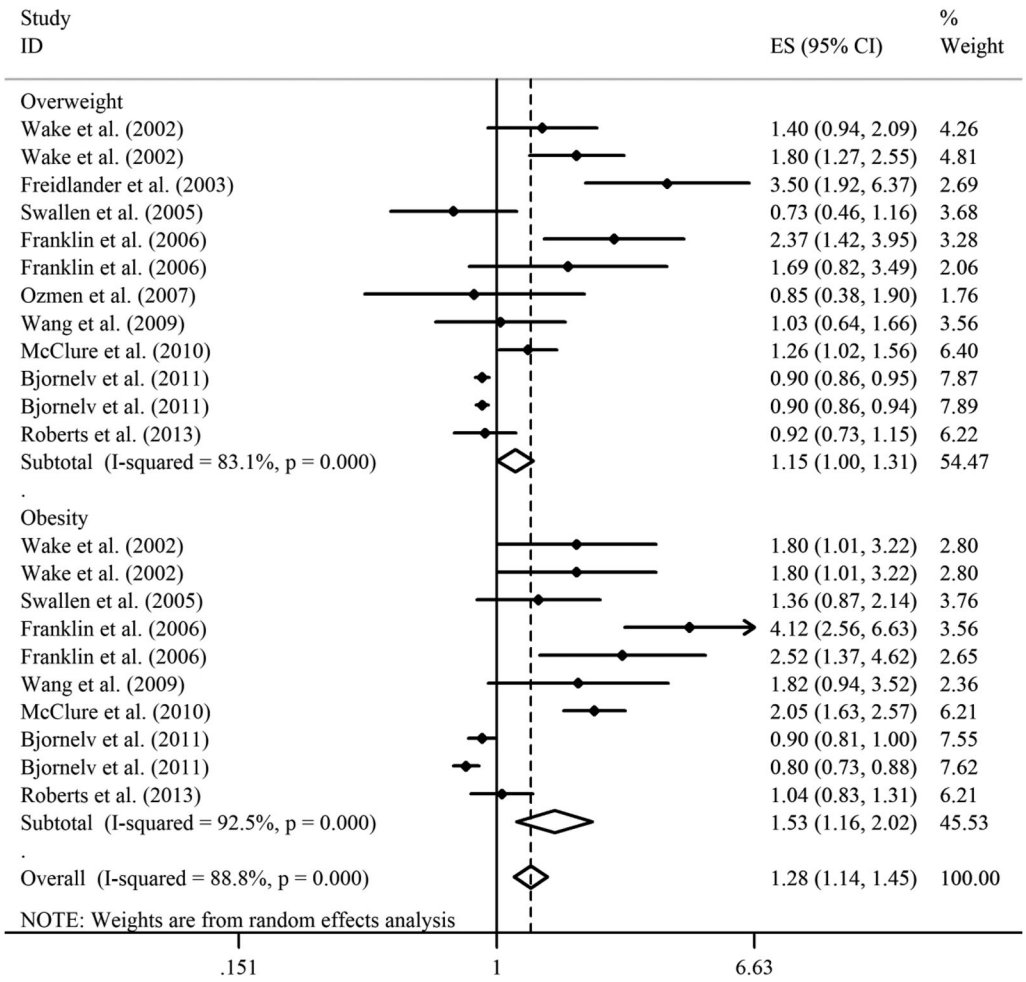


**Figure 5.** Forest plot of the association between overweight / obesity and low self-esteem using a random-effects model.

Table 5). A significant association was found between obesity and low self-esteem in the subgroups of geographical region, quality assessment score and studies with cross-sectional design.

### *Body dissatisfaction*

No significant association was found between overweight and risk of body dissatisfaction among children and adolescents (pooled risk estimate: 1.90, 95% CI: 0.97–3.72, $P = 0.06$) ($I^2$ = 92.0%, P-heterogeneity = 0.0001). While, there was a significant positive association between obesity and risk of body dissatisfaction (pooled risk estimate: 4.05, 95% CI: 2.34–7.023, $P = 0.0001$) ($I^2$ = 96.3%, P-heterogeneity = 0.0001) (Figure 6).

### *Subgroup analysis (body dissatisfaction)*

Geographical region, quality assessment and gender were detected as sources of heterogeneity between overweight and body dissatisfaction (Supplementary material, Table 6). A significant positive association was found between overweight and risk of body dissatisfaction in studies with cross-sectional design (pooled risk estimate: 2.18, 95% CI: 0.92–5.13, $P = 0.07$) and group of girls (pooled risk estimate: 3.94, 95% CI: 1.48–10.48, $P = 0.006$) and boys (pooled risk estimate: 2.90, 95% CI: 1.51–5.56, $P = 0.001$) separately, as well as all subgroups of geographical region and studies with quality assessment score of below six (pooled risk estimate: 2.62, 95% CI: 1.07–6.42, $P = 0.03$).

With regard to obesity, study design, Geographical region, quality assessment and genders all tended to be sources of heterogeneity between obesity and risk of body dissatisfaction (Supplementary material, Table 6). Significant positive associations were found between obesity and risk of body dissatisfaction in all subgroups.

### *Sensitivity analysis*

Findings of the sensitivity analysis showed that the association between overweight (Supplementary material, Figure 1) and obesity (Supplementary material, Figure 2) with the risk of depression, anxiety, low self-esteem, and body dissatisfaction did not rely on a single or a few publications.

### *Publication bias*

Visual inspection of the funnel plot (Supplementary material, Figures 3 and 4) and the results of the Egger's test was used to examine publication bias. No evidence of publication bias was observed regarding the association between overweight and risk of depression ($P = 0.13$), anxiety

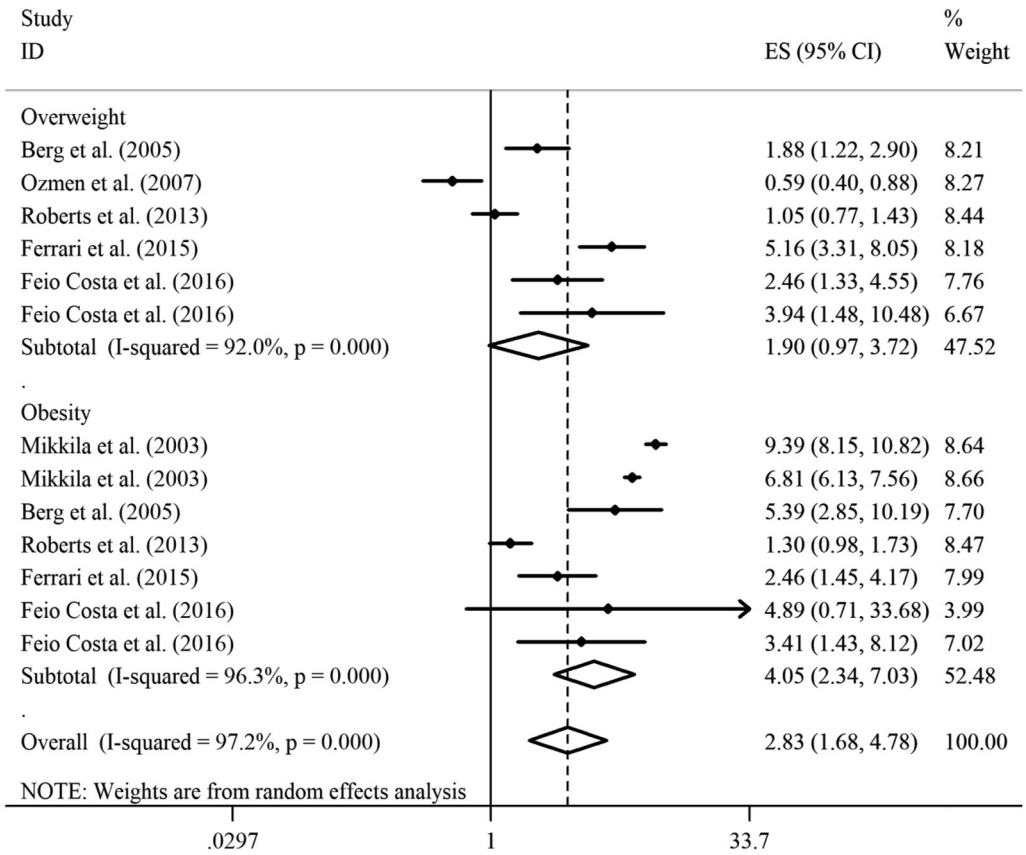


**Figure 6.** Forest plot of the association between overweight / obesity and body dissatisfaction using a random-effects model.

($P = 0.16$), low self-esteem ($P = 0.01$), and body dissatisfaction ($P = 0.31$). Moreover, Egger's statistic demonstrated no significant publication bias regarding the association between obesity and risk of depression ($P = 0.04$), anxiety ($P = 0.0.31$), low self-esteem ($P = 0.006$), and body dissatisfaction ($P = 0.29$).

## Discussion

This is the first comprehensive systematic review and meta-analysis to summarize available data on the associations between overweight as well as obesity and risk of all psychological disorders including depression, anxiety, self-esteem and body dissatisfaction in children and adolescents. In this meta-analysis, we found that obese children and adolescents significantly have a higher risk of body dissatisfaction and lower self-esteem. We also found that overweight children and adolescents had a significantly great risk of low self-esteem.

In the present study, no association was observed between overweight as well as obesity and depression. In line with our results, Quek et al demonstrated that overweight children and adolescents were not likely to have depression, while obese subjects were more likely to suffer from depression (Quek et al. 2017). It should be noted that relationships were more detectable in female children and adolescents and in the cross-sectional rather than longitudinal analyses which is exactly in line with our results (Mühlig et al. 2016). Another review by Y. Mühlig et al revealed evidence for a weak association between obesity in childhood or adolescence and the risk of depression (Mühlig et al. 2016). Furthermore, the findings of a study by Mannan et al. suggested a significant association between obesity and depression. However, children and adolescents in several included studies were followed until adulthood which is not in accordance with our approach in the current meta-analysis (Mannan et al. 2016). Our finding was contrary to the results of a recent review which reported a significant association between obesity and depression in children and adolescents. However, this study conducted on children and adolescents below 12 years of age (Korczak et al. 2013).

In this study, no association was observed between overweight as well as obesity and anxiety. Our results were in agreement with a review by Sanders et al which revealed that in just one out of three studies, being overweight and obese children were more likely to be associated with anxiety symptoms rather than normal-weight (Sanders et al. 2015). A meta-analysis by Burke et al. concluded that a small but significant association existed between obesity and anxiety specifically among children under 12 years and girls which are totally contrary to our results. This controversy may be due to the methodological differences in the reporting of effect sizes (Burke and Storch 2015) and differences in the measurement of weight status and indicators of psychopathological symptoms. Another important factor influencing results in previous literature is cultural differences that showed expression of anxiety was different across cultures (Viner et al. 2006).

In the current study, a significantly greater risk of low self-esteem was observed among overweight and obese children and adolescents. In accordance with our results, a meta-analysis by Miller et al suggested that lower self-esteem was associated with heavier weight with the effect sizes larger in women rather than men (Miller and Downey 1999). Moreover, in a systematic review by Griffiths et al, there was strong evidence of the association between children's and adolescents' obesity and low self-esteem (Griffiths, Parsons, and Hill 2010).

In our study, obese children and adolescents significantly have a higher risk of body dissatisfaction. In accordance with our meta-analysis on overweight children and adolescents, extensive review of the literature indicates that obese children are significantly more likely to report high levels of body dissatisfaction (Heinberg and Thompson 2009; Smolak and Levine, 2004).

The mechanisms underlying the obesity/overweight and psychological disorders may be perceived stigmatization, bullying and victimization. In addition, higher BMI may have a direct effect on mood. Accordingly, the higher prevalence of depression in female rather than male may be related to higher measure of visceral fat in female gender (Organization 2008). Besides, unhealthy nutritional habits might potentially affect both obesity and depression (Quirk et al. 2013). Several common pathological mechanisms involved in obesity and depression are discussed: chronic systemic inflammation (Berk et al. 2013), the dopaminergic reward system, vitamin D deficiency (Anglin et al. 2013), and neuroendocrine mechanisms via leptinmelanocortinergic-BDNF signaling (Su et al. 2011) have all been mentioned as the causes of both psychological disorders and obesity.

In this study, our objective was to investigate whether overweight/obesity was associated with the risk of depression, anxiety, low self-esteem, and body dissatisfaction in children and adolescents. It should be noted that in most included studies in our meta-analysis, norm-referenced measures of weight status (adjusting for age and sex by national or international standards) were used. It is suggested that researchers should be aware of the importance of using norm-referenced standardized measures of weight status when conducting research among pediatric sample, since using other measures such as BMI are likely to attenuate results. The current meta-analysis is comprised of three available longitudinal studies yielding evidence for the association between children/adolescents obesity or overweight and subsequent risk of psychological disorders in late adolescent. Studies which tracked the subjects into adulthood were not considered in our meta-analysis due to the fact that early adulthood forms a particularly vulnerable period for the development of both obesity and psychological disorders. Also, the rise in sex hormone production in adulthood implies that genetic, epigenetic and environmental factors are substantially different before and after puberty and this may affect the results (Mühlig et al. 2016). To assess the risk association, OR, RR and HR were used to yield more precise effect estimates. This gives additional strength to this review.

Some limitation deserve attention. Firstly, the analysis was hampered by a lack of samples reporting racial and ethnic information and the majority of the studies examined Caucasian populations. More diverse populations from different ethnic and racial backgrounds are warranted to provide more realistic estimates. Secondly, adjustment of health and lifestyle factors as factors that have a major impact on childhood mental health and childhood obesity is necessary for examining the association between overweight/obesity and the risk of physiological. However, they were not adjusted for in several studies. Thirdly, the studies in the current study, as well as previous meta-analyses, did not investigate the comparison of psychological disorders among overweight/obese subjects who are seeking to lose weight with subjects who are not which may affect the results (Burke and Storch 2015). Lastly, different diagnostic criteria and assessments were used to determine depression, anxiety, low self-esteem, and body dissatisfaction between studies, and the characterization of overweight and obesity differed among included studies.

## Conclusion

There was a positive association between obesity and the risk of body dissatisfaction and low self-esteem among children and adolescents. Moreover, a direct association was observed between overweight and the risk of low self-esteem. Although the current meta-analysis provided a comprehensive review of the association of overweight/obesity with depression, anxiety, low self-esteem, and body dissatisfaction in children and adolescents, additional well-designed studies are needed

## Disclosure statement

The authors declare that they have no conflict of interest

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## References

Ackner, S. E. 2005. The obese patient: The psychosocial burden of obesity and the role of bariatric surgery. *Psychiatry (Edgmont (Pa: Township))* 2 (12):53–60.

Anderson, S. E., P. Cohen, E. N. Naumova, P. F. Jacques, and A. Must. 2007. Adolescent obesity and risk for subsequent major depressive disorder and anxiety disorder: Prospective evidence. *Psychosomatic Medicine* 69 (8):740–7. doi: 10.1097/PSY.0b013e31815580b4.

Anderson, S. E., D. M. Murray, C. C. Johnson, J. P. Elder, L. A. Lytle, J. B. Jobe, B. I. Saksvig, and J. Stevens. 2011. Obesity and depressed

mood associations differ by race/ethnicity in adolescent girls. *International Journal of Pediatric Obesity* 6 (1):69–78. doi: 10.3109/17477161003728477.

Anglin, R. E., Z. Samaan, S. D. Walter, and S. D. McDonald. 2013. Vitamin D deficiency and depression in adults: Systematic review and meta-analysis. *The British Journal of Psychiatry: The Journal of Mental Science* 202 (2):100–7. doi: 10.1192/bjp.bp.111.106666.

Assari, S., and C. H. Caldwell. 2015. Gender and ethnic differences in the association between obesity and depression among black adolescents. *Journal of Racial and Ethnic Health Disparities* 2 (4):481–93. doi: 10.1007/s40615-015-0096-9.

Bazargan-Hejazi, S., G. Alvarez, S. Teklehaimanot, N. Nikakhtar, and M. Bazargan. 2010. Prevalence of depression symptoms among adolescents aged 12-17 years in California and the role of overweight as a risk factor. *Ethn Dis* 20 (1):107–15.

Bearman, S. K., K. Presnell, E. Martinez, and E. Stice. 2006. The skinny on body dissatisfaction: A longitudinal study of adolescent girls and boys. *Journal of Youth and Adolescence* 35 (2):217–29. doi: 10.1007/s10964-005-9010-9.

Berg, I.-M., B. Simonsson, and I. Ringqvist. 2005. Social background, aspects of lifestyle, body image, relations, school situation, and somatic and psychological symptoms in obese and overweight 15-year-old boys in a county in Sweden. *Scandinavian Journal of Primary Health Care* 23 (2):95–101. doi: 10.1080/02813430510015313.

Berk, M., L. J. Williams, F. N. Jacka, A. O'Neil, J. A. Pasco, S. Moylan, N. B. Allen, A. L. Stuart, A. C. Hayley, M. L. Byrne, et al. 2013. So depression is an inflammatory disease, but where does the inflammation come from?. *BMC Medicine* 11 (1):200. doi: 10.1186/1741-7015-11-200.

Bjornelv, S., H. M. Nordahl, and T. L. Holmen. 2011. Psychological factors and weight problems in adolescents. The role of eating problems, emotional problems, and personality traits: The Young-HUNT study. *Social Psychiatry and Psychiatric Epidemiology* 46 (5):353–62. doi: 10.1007/s00127-010-0197-z.

Boutelle, K. N., P. Hannan, J. A. Fulkerson, S. J. Crow, and E. Stice. 2010. Obesity as a prospective predictor of depression in adolescent females. *Health Psychology: Official Journal of the Division of Health Psychology, American Psychological Association* 29 (3):293–8. doi: 10.1037/a0018645.

Burke, N. L., and E. A. Storch. 2015. A meta-analysis of weight status and anxiety in children and adolescents. *Journal of Developmental & Behavioral Pediatrics* 36 (3):133–45.

Cash, T. F., and E. C. Fleming. 2002. The impact of body image experiences: Development of the body image quality of life inventory. *The International Journal of Eating Disorders* 31 (4):455–60. doi: 10.1002/eat.10033.

Costa, L. C. F., D. A. S. Silva, M. Santos Alvarenga, and F. A. G. de Vasconcelos. 2016. Association between body image dissatisfaction and obesity among schoolchildren aged 7-10years. *Physiology & Behavior* 160:6–11. doi: 10.1016/j.physbeh.2016.03.022.

de Heredia, F. P., S. Gómez-Martínez, and A. Marcos. 2012. Obesity, inflammation and the immune system. *The Proceedings of the Nutrition Society* 71 (2):332–8. doi: 10.1017/S0029665112000092.

Dowlati, Y., N. Herrmann, W. Swardfager, H. Liu, L. Sham, E. K. Reim, and K. L. Lanctôt. 2010. A meta-analysis of cytokines in major depression. *Biological Psychiatry* 67 (5):446–57. doi: 10.1016/j.biopsych.2009.09.033.

Druss, B. G., R. A. Rosenheck, and W. H. Sledge. 2000. Health and disability costs of depressive illness in a major US corporation. *The American Journal of Psychiatry* 157 (8):1274–8. doi: 10.1176/appi.ajp.157.8.1274.

Egger, M., G. D. Smith, M. Schneider, and C. Minder. 1997. Bias in meta-analysis detected by a simple, graphical test. *BMJ (Clinical Research ed.)* 315 (7109):629–34. doi: 10.1136/bmj.315.7109.629.

Erermis, S., N. Cetin, M. Tamar, N. Bukusoglu, F. Akdeniz, and D. Goksen. 2004. Is obesity a risk factor for psychopathology among adolescents?. *Pediatrics International: Official Journal of the Japan Pediatric Society* 46 (3):296–301. doi: 10.1111/j.1442-200x.2004.01882.x.

Ferrari, E., G. Minatto, J. Berria, S. dos S Silva, Y. Fidelix, R. Ribeiro, K. Santos, and E. Petroski. 2015. Body image dissatisfaction and anthropometric indicators in male children and adolescents. *European Journal of Clinical Nutrition* 69 (10):1140–4. doi: 10.1038/ejcn.2014.252.

Franklin, J., G. Denyer, K. S. Steinbeck, I. D. Caterson, and A. J. Hill. 2006. Obesity and risk of low self-esteem: A statewide survey of Australian children. *Pediatrics* 118 (6):2481–7. doi: 10.1542/peds.2006-0511.

Friedlander, S. L., E. K. Larkin, C. L. Rosen, T. M. Palermo, and S. Redline. 2003. Decreased quality of life associated with obesity in school-aged children. *Archives of Pediatrics & Adolescent Medicine* 157 (12):1206–11. doi: 10.1001/archpedi.157.12.1206.

Frisco, M. L., J. N. Houle, and A. M. Lippert. 2013. Weight change and depression among US young women during the transition to adulthood. *American Journal of Epidemiology* 178 (1):22–30. doi: 10.1093/aje/kws462.

Goldfield, G. S., C. Moore, K. Henderson, A. Buchholz, N. Obeid, and M. F. Flament. 2010. Body dissatisfaction, dietary restraint, depression, and weight status in adolescents. *The Journal of School Health* 80 (4):186–92. doi: 10.1111/j.1746-1561.2009.00485.x.

Griffiths, L. J., T. J. Parsons, and A. J. Hill. 2010. Self-esteem and quality of life in obese children and adolescents: A systematic review. *International Journal of Pediatric Obesity: IJPO : An Official Journal of the International Association for the Study of Obesity* 5 (4):282–304. doi: 10.3109/17477160903473697.

Halfon, N., K. Larson, and W. Slusser. 2013. Associations between obesity and comorbid mental health, developmental, and physical health conditions in a nationally representative sample of US children aged 10 to 17. *Academic Pediatrics* 13 (1):6–13. doi: 10.1016/j.acap.2012.10.007.

Heinberg, L. J., and J. K.Thompson. 2009. Introduction: the obesity epidemic in children and adolescents. *Obesity in youth: Causes, consequences and cures*, 3-14. Washington: American Psychological Association.

Higgins, J. P., T. Li, and J. J. Deeks. 2019. Choosing effect measures and computing estimates of effect. In Cochrane handbook for systematic reviews of interventions:143–76. New York, NY: Wiley Online Library.

Howren, M. B., D. M. Lamkin, and J. Suls. 2009. Associations of depression with C-reactive protein, IL-1, and IL-6: A meta-analysis. *Psychosomatic Medicine* 71 (2):171–86.

Jansen, W., P. M. van de Looij-Jansen, E. J. de Wilde, and J. Brug. 2008. Feeling fat rather than being fat may be associated with psychological well-being in young Dutch adolescents. *The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine* 42 (2):128–36. doi: 10.1016/j.jadohealth.2007.07.015.

Korczak, D. J., E. Lipman, K. Morrison, and P. Szatmari. 2013. Are children and adolescents with psychiatric illness at risk for increased future body weight? A systematic review. *Developmental Medicine & Child Neurology* 55 (11):980–7. doi: 10.1111/dmcn.12168.

Kubzansky, L. D., M. S. Gilthorpe, and E. Goodman. 2012. A prospective study of psychological distress and weight status in adolescents/young adults. *Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine* 43 (2):219–28. doi: 10.1007/s12160-011-9323-8.

Liberati, A., D. G. Altman, J. Tetzlaff, C. Mulrow, P. C. Gøtzsche, J. P. A. Ioannidis, M. Clarke, P. J. Devereaux, J. Kleijnen, and D. Moher. 2009. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. *Journal of Clinical Epidemiology* 62 (10):e1–Fsue34. doi: 10.1016/j.jclinepi.2009.06.006.

Maes, M., M. Kubera, E. Obuchowiczwa, L. Goehler, and J. Brzeszcz. 2011. Depression's multiple comorbidities explained by (neuro) inflammatory and oxidative & nitrosative stress pathways. *Neuro Endocrinology Letters* 32 (1):7–24.

Mannan, M.,. A. Mamun, S. Doi, and A. Clavarino. 2016. Prospective associations between depression and obesity for adolescent males and females-a systematic review and meta-analysis of longitudinal

studies. *PloS One* 11 (6):e0157240. doi: 10.1371/journal.pone.0157240.

Mathers, C., D. M. Fat, J. T.Boerma. 2008. The Global Burden of Disease: 2004 Update. Geneva: World Health Organization.

McClure, A. C., S. E. Tanski, J. Kingsbury, M. Gerrard, and J. D. Sargent. 2010. Characteristics associated with low self-esteem among US adolescents. *Academic Pediatrics* 10 (4):238–44. doi: 10.1016/j.acap.2010.03.007.

Merikangas, A. K., P. Mendola, P. N. Pastor, C. A. Reuben, and S. D. Cleary. 2012. The association between major depressive disorder and obesity in US adolescents: Results from the 2001-2004 National Health and Nutrition Examination Survey. *Journal of Behavioral Medicine* 35 (2):149–54. doi: 10.1007/s10865-011-9340-x.

Mikkilä, V., M. Lahti-Koski, P. Pietinen, S. M. Virtanen, and M. Rimpelä. 2003. Associates of obesity and weight dissatisfaction among Finnish adolescents. *Public Health Nutrition* 6 (1):49–56. doi: 10.1079/PHN2002352.

Miller, C. T., and K. T. Downey. 1999. A meta-analysis of heavyweight and self-esteem. *Personality and Social Psychology Review* 3 (1): 68–84. doi: 10.1207/s15327957pspr0301_4.

Morrison, K. M., S. Shin, M. Tarnopolsky, and V. H. Taylor. 2015. Association of depression & health related quality of life with body composition in children and youth with obesity. *Journal of Affective Disorders* 172:18–23. doi: 10.1016/j.jad.2014.09.014.

Mühlig, Y., J. Antel, M. Föcker, and J. Hebebrand. 2016. Are bidirectional associations of obesity and depression already apparent in childhood and adolescence as based on high-quality studies? A systematic review. *Obesity Reviews* 17 (3):235–49. doi: 10.1111/obr.12357.

Ozmen, D., E. Ozmen, D. Ergin, A. C. Cetinkaya, N. Sen, P. E. Dundar, and E. O. Taskin. 2007. The association of self-esteem, depression and body satisfaction with obesity among Turkish adolescents. *BMC Public Health* 7 (1):80. doi: 10.1186/1471-2458-7-80.

Paxton, S. J., D. Neumark-Sztainer, P. J. Hannan, and M. E. Eisenberg. 2006. Body dissatisfaction prospectively predicts depressive mood and low self-esteem in adolescent girls and boys. *Journal of Clinical Child & Adolescent Psychology* 35 (4):539–49. doi: 10.1207/s15374424jccp3504_5.

Quek, Y. H., W. W. Tam, M. W. Zhang, and R. C. Ho. 2017. Exploring the association between childhood and adolescent obesity and depression: A meta-analysis. *Obesity Reviews* 18 (7):742–54. doi: 10.1111/obr.12535.

Quirk, S. E., L. J. Williams, A. O'Neil, J. A. Pasco, F. N. Jacka, S. Housden, M. Berk, and S. L. Brennan. 2013. The association between diet quality, dietary patterns and depression in adults: A systematic review. *BMC Psychiatry* 13 (1):175. doi: 10.1186/1471-244X-13-175.

Roberts, R. E., and H. T. Duong. 2015. Does major depression affect risk for adolescent obesity?. *Journal of Affective Disorders* 186:162–7. doi: 10.1016/j.jad.2015.06.030.

Roberts, R. E., and D. T. Hao. 2013. Obesity has few effects on future psychosocial functioning of adolescents. *Eating Behaviors* 14 (2): 128–36. doi: 10.1016/j.eatbeh.2013.01.008.

Sanders, R. H., A. Han, J. S. Baker, and S. Cobley. 2015. Childhood obesity and its physical and psychological co-morbidities: A systematic review of Australian children and adolescents. *European Journal of Pediatrics* 174 (6):715–46. doi: 10.1007/s00431-015-2551-3.

Sanderson, K., G. C. Patton, C. McKercher, T. Dwyer, and A. J. Venn. 2011. Overweight and obesity in childhood and risk of mental disorder: A 20-year cohort study. *The Australian and New Zealand Journal of Psychiatry* 45 (5):384–92. doi: 10.3109/00048674.2011.570309.

Sjöberg, R. L., K. W. Nilsson, and J. Leppert. 2005. Obesity, shame, and depression in school-aged children: A population-based study. *Pediatrics* 116 (3):e389–e392. doi: 10.1542/peds.2005-0170.

Smolak, L., and Levine, M. P.2004. Body Image in Children. In *Body image, eating disorders, and obesity in youth: Assessment, prevention, and treatment*. Washington: American Psychological Association. 41–66.

Stice, E., K. Presnell, H. Shaw, and P. Rohde. 2005. Psychological and behavioral risk factors for obesity onset in adolescent girls: A prospective study. *Journal of Consulting and Clinical Psychology* 73 (2): 195–202. doi: 10.1037/0022-006X.73.2.195.

Su, S.-C., M.-T. Sun, M.-J. Wen, C.-J. Lin, Y.-C. Chen, and Y.-J. Hung. 2011. Brain-derived neurotrophic factor, adiponectin, and proinflammatory markers in various subtypes of depression in young men. *International Journal of Psychiatry in Medicine* 42 (3):211–26. doi: 10.2190/PM.42.3.a.

Sutaria, S.,. D. Devakumar, S. S. Yasuda, S. Das, and S. Saxena. 2019. Is obesity associated with depression in children? Systematic review and meta-analysis. *Archives of Disease in Childhood* 104 (1):64–74. doi: 10.1136/archdischild-2017-314608.

Swallen, K. C., E. N. Reither, S. A. Haas, and A. M. Meier. 2005. Overweight, obesity, and health-related quality of life among adolescents: The National Longitudinal Study of Adolescent Health. *Pediatrics* 115 (2):340–7. doi: 10.1542/peds.2004-0678.

Sweeting, H., C. Wright, and H. Minnis. 2005. Psychosocial correlates of adolescent obesity, 'slimming down' and 'becoming obese' . *The Journal of Adolescent Health: Official Publication of the Society for Adolescent Medicine* 37 (5):409e409-409. e417. doi: 10.1016/j.jadohealth.2005.01.008.

Tanofsky-Kraff, M., M. L. Cohen, S. Z. Yanovski, C. Cox, K. R. Theim, M. Keil, J. C. Reynolds, and J. A. Yanovski. 2006. A prospective study of psychological predictors of body fat gain among children at high risk for adult obesity. *Pediatrics* 117 (4):1203–9. doi: 10.1542/peds.2005-1329.

Ting, W.-H., C.-Y. Huang, Y.-K. Tu, and K.-L. Chien. 2012. Association between weight status and depressive symptoms in adolescents: Role of weight perception, weight concern, and dietary restraint. *European Journal of Pediatrics* 171 (8):1247–55. doi: 10.1007/s00431-012-1753-1.

Viner, R., M. Haines, S. Taylor, J. Head, R. Booy, and S. Stansfeld. 2006. Body mass, weight control behaviours, weight perception and emotional well being in a multiethnic sample of early adolescents. *International Journal of Obesity* 30 (10):1514–21. doi: 10.1038/sj.ijo.0803352.

Wake, M., L. Salmon, E. Waters, M. Wright, and K. Hesketh. 2002. Parent-reported health status of overweight and obese Australian primary school children: A cross-sectional population survey. *International Journal of Obesity* 26 (5):717–24. doi: 10.1038/sj.ijo.0801974.

Wang, F., and P. Veugelers. 2008. Self-esteem and cognitive development in the era of the childhood obesity epidemic . *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity* 9 (6):615–23. doi: 10.1111/j.1467-789X.2008.00507.x.

Wang, F., T. Wild, W. Kipp, S. Kuhle, and P. Veugelers. 2009. The influence of childhood obesity on the development of self-esteem. *Health Reports* 20 (2):21–7.

Wardle, J., S. Williamson, F. Johnson, and C. Edwards. 2006. Depression in adolescent obesity: Cultural moderators of the association between obesity and depressive symptoms. *International Journal of Obesity (2005)* 30 (4):634–43. doi: 10.1038/sj.ijo.0803142.

Wells, G. A., B.Shea, D.O'connell, J.Peterson, V.Welch, M.Losos, and P.Tugwell. 1999. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses. Ottawa: The Ontario Health Research Institute, University of Ottawa.

Wisse, B. E. 2004. The inflammatory syndrome: The role of adipose tissue cytokines in metabolic disorders linked to obesity. *Journal of the American Society of Nephrology* 15 (11):2792–800. doi: 10.1097/01.ASN.0000141966.69934.21.

Zakeri, M., M. Sedaghat, M. E. Motlagh, R. T. Ashtiani, and G. Ardalan. 2012. BMI correlation with psychiatric problems among 10-18 years Iranian students. *Acta Medica Iranica* 50 (3):177–184.