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ORIGINAL RESEARCH

Changes in body mass index and risk of adolescent psychopathology: a longitudinal cohort study

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Background. Abnormal body mass index (BMI) has been associated with development of psychopathology. This association in children is well documented, for both overweight and underweight children. However, the association between change in BMI and the development of psychopathology has been less investigated.

Aim. To investigate the association between change in BMI between childhood and adolescence and psychopathology in adolescence.

Methods. Data from the Growing Up in Ireland cohort were used. We investigated the '98 cohort (also known as the child cohort) at age 9/13. BMI, defined using internationally recognised definitions as underweight, healthy or overweight, was used as the exposure, and abnormal Strength and Difficulties Questionnaire scores were used as the outcome. Logistic regression was undertaken for the analysis. All analyses were adjusted for confounders.

Results. A change to overweight from healthy BMI was significantly associated with increased risk of psychopathology (adjusted OR 1.66; 95% CI 1.19–2.32). Both change from underweight to healthy (adjusted OR 0.12; 95% CI 0.03–0.43) or from overweight to healthy (adjusted OR 0.47; 95% CI 0.79–0.8) was associated with a significantly reduced risk of developing psychopathology.

Discussion. As a child's BMI returns to within the healthy range, their risk of adolescent psychopathology is reduced. Interventions to restore healthy BMI, in both underweight and overweight, children may reduce their risk of adolescent psychopathology.

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Key words: adolescence, body mass index, childhood, psychopathology, weight change.

Introduction

Abnormal body mass index (BMI) has been shown to be associated with psychopathology in both adults and young. For example, meta-analyses have shown that obese people have an increased risk of developing depression (Luppino *et al.* 2010; de Wit *et al.* 2010).

This apparent link is also shown to exist in children. Cross-sectional analyses (Sanders *et al.* 2015) show that obesity in childhood is associated with unfavourable mental health outcomes. Diagnostic interviews and self-report questionnaires with obese children showed that they are more likely to have a psychiatric diagnosis, as well as impaired emotional, social and/or school functioning (Schwimmer *et al.* 2003; Vila *et al.* 2004). Additionally, being underweight in childhood has been associated with higher internalising and externalising problems (Cimino *et al.* 2016).

Longitudinal analysis has shown an association between BMI and internalising symptoms (Patalay & Hardman, 2019). However, the association between change in BMI and development of psychopathology has been less investigated. To our knowledge, only three studies have investigated the association with change in BMI. The first, a longitudinal study of Australian children (Gifford Sawyer *et al.* 2011), showed that large increases in weight were associated with higher likelihood of scoring above the 'at-risk' cut-off on the Paediatric Quality of Life scale. The others showed that increasing or decreasing weight trajectories in children were associated with increased risk of adverse psychosocial outcomes (Van Grieken *et al.* 2013; Kelly *et al.* 2016). However, these papers only look at the psychological outcome in childhood and their focus does not extend to psychopathology in the adolescent. Our aim with this project is to assess whether change in BMI (both increasing or decreasing) over the period from childhood to early adolescence is associated with risk of developing psychopathology. By looking at psychopathology in early adolescence, we will be able to capture an important transition point (childhood to adolescence), during which BMI change is likely to have a particularly influential effect. Assessing the effect of change in BMI is important as weight consciousness and stigma is particularly

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prevalent in adolescence now (Canadian Paediatric Society, 2004). Meanwhile, it is becoming increasingly apparent that sustained weight loss in the overweight is hard to maintain, and that weight fluctuation between healthy and overweight is a more likely trajectory (Rothblum, 2018; Ng & Cunningham, 2020).

Importantly, this study will be the first research of its kind to use Irish nationally representative data. In Ireland, there has been concern in recent years over the increasing prevalence of overweight BMI in children, with Ireland existing amongst the countries with higher rates of prevalence (NCD Risk Factor Collaboration, 2017).

Methods

Participants

The study population comprised the '98 cohort (child cohort) of the Growing Up in Ireland (GUI) study. This is a national longitudinal study of children and adolescents in Ireland. The cohort was recruited at age 9 and comprises 8658 children and their families. Participants were recruited from 910 primary schools (82% of those invited to participate), selected to accurately represent the school population of Ireland as a whole, with respect to location, disadvantage of pupils, gender mix, denominational status and number of 9-year-old pupils. A maximum of 40 students were recruited from each school, to minimise burden on school staff and to prevent larger schools from biasing the sample. Multiple rounds of information and consent forms were given to families to minimise refusal. Between August 2007 and May 2008, 50% of the 17 054 invited families consented to participate and provided useable data. A follow-up study (wave two) was carried out at age 13, and 7423 (87.7%) were interviewed between August 2011 and March 2012. Interviews and questionnaires were undertaken with children and primary caregivers at all ages. To account for the demographic differences between the baseline and follow-ups caused by differential attrition, the data were 'reweighted' with respect to differential response characteristics.

Ethics and consent

Written consent was obtained from all participants and their primary caregivers in the Growing Up in Ireland Study. Participants are not identifiable from the anonymised microdata file.

Exposures

At age 9/13, the child was measured (for height in cms) and weighed (kgs) to enable calculation of BMI (kgs/height).

Table 1. *Body mass index cut-offs for underweight and overweight*

9-year-olds	Underweight	Overweight
Male	<14.35	>19.1
Female	<14.28	>19.07
13-year-olds	Underweight	Overweight
Male	<15.84	>21.91
Female	<16.26	>22.58

For this paper, we defined overweight BMI according to the British Medical Journal (BMJ) worldwide standard definition, obtained by averaging the centile curves of multi-site international data (Cole *et al.* 2000). Overweight was defined as BMI over the healthy range, thus including obese.

We defined underweight BMI according to a standard definition, which determined cut-offs to define thinness in children and adolescents (Cole *et al.* 2007). These cut-offs for thinness were divided into grades 1, 2 and 3, according to increasing severity of thinness. For our paper, we decided to adopt grade 1 cut-off for underweight BMI.

The combined table of the BMJ cut-off definitions is represented in Table 1.

Outcomes

The Strengths and Difficulties Questionnaire (SDQ) (Goodman *et al.* 2000), a short behavioural screening questionnaire for age 3–16, administered to the primary caregiver at age 13, was used for the outcomes. The Total Difficulties score was used for this project, which was generated by summing the scores from the emotional problems, conduct problems and hyperactivity scales. A score of ≥17 indicates psychopathology (Goodman, 2001).

Persistent psychopathology was also used as an outcome. This was defined as SDQs scores above the threshold at both ages (i.e at both 9 and 13 years). This included both SDQ scores that remained high within the one domain (e.g. emotional problems) and those that were high in different domains over the two time points.

Confounders

Confounders were adjusted for at age 9 wave. These confounders were chosen based on the existing literature, showing them to be associated with both BMI and psychopathology. The confounding variables included were as follows:

a. *Socioeconomic status*. This was measured by investigating household income quintile (lowest quintile

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to highest). Socioeconomic status has been shown to be associated with obesity (Sobal & Stunkard, 1989; Bronner, 1996), as well as with development of psychotic episodes (Linscott & Van, 2013).

b. *Maternal education.* This was used as a proxy variable of socioeconomic status. It was measured by determining the highest level of education completed by the primary caregiver. Education received was broken down into six levels (none through to postgraduate).
c. *Physical activity.* This was defined as the number of times in the last 14 days that the child engaged in hard exercise (none through to ≥9 times). Physical activity is shown to be protective against poor mental health (Chekroud *et al.* 2018).
d. *Chronic illness.* Chronic illness has been shown to be associated with higher BMI and obesity (Anis *et al.* 2010) and with an increased risk of emotional and behavioural problems in children (Hysing *et al.* 2007). Here, we measured it as the presence or absence of any ongoing chronic physical or mental health problems in the child.
e. *Gender.* Gender has been shown to be associated with differences in risk of developing psychopathology. Women have been shown to be at increased risk of internalising problems and depression than males (Leadbeater *et al.* 1999; Sutaria *et al.* 2019). Additionally, women have been shown to be at a higher risk of obesity (Arroyo-Johnson & Mincey, 2016).
f. *Screen time.* Screen time may be associated with both psychopathology and higher BMI (Stiglic & Viner, 2019). It was measured as the average number of hours the child spends watching TV or DVDs (none through to ≥7 times) on an average day.
g. *Foreign-born.* This was measured by proxy as whether the child was born in Ireland or not, as immigration in some circumstances may be associated with increased risk of developing psychopathology (Cantor-Graae & Pederson, 2013).
h. *Childhood psychopathology.* This was included as a confounder as it is likely that psychopathology at age 9 will predispose to psychopathology at age 13.

Statistical analyses

All analyses were weighted to take account of attrition between the waves, differential response rates and missing data. The IBM SPSS Statistics Version 25 package was used to carry out the analysis. We examined demographic differences between the children of average, low and high BMI.

Logistic regression: Logistic regression was used to investigate if overweight BMI and underweight BMI in children at age 9, and separately at age 13, are associated with psychopathology at age 13. This was done firstly in a univariate analysis and then in a multivariate analysis to adjust for confounders.

Logistic regression: Change analysis logistic regression was used to assess whether a change in BMI between the waves increased the risk of developing psychopathology. The unadjusted and adjusted ORs of developing adolescent psychopathology were determined. A secondary analysis was then performed with childhood psychopathology included as a confounder.

The files were stratified by genders to analyse if the above relationships were different according to the gender.

Results

Prevalence of BMI categories

Of the children at age 9, 6.1% ($n = 431$) were underweight and 29.4% ($n = 2087$) were overweight. Of the children at age 13, 4.4% ($n = 323$) were underweight and 28.6% ($n = 2084$) were overweight.

Demographics of BMI categories

The demographics of the 9-year-olds of underweight, overweight and normal BMI are shown in Table 2.

Underweight children were more likely to be female, from a household of the lowest income quintile and to come from parents with the highest level of parental education.

Overweight children were more likely to be female, from a household of the lowest income quintile, to come from parents with the lowest level of parental education and to engage in less physical activity.

BMI and psychopathology

A total of 6.5% ($n = 489$) of 13-year-olds showed psychopathology.

The unadjusted, adjusted and gendered ORs of psychopathology are shown in Table 3.

Age 9: Being overweight at age 9 did not have a significant association with age 13 psychopathology (OR 0.9; CI 0.72–1.13) but did have a significant association with persistent psychopathology (OR 0.76; CI 0.51–0.97) when both were adjusted for confounders.

Being underweight at age 9 was not significantly associated with either age 13 psychopathology (OR 0.94; CI 0.60–1.46) or persistent psychopathology (OR 1.23; CI 0.78–1.93) when adjusted for confounders.

Age 13: Being overweight at age 13 was significantly associated with both age 13 psychopathology (OR 1.40; CI 1.13–1.74) and persistent psychopathology (OR 1.36; CI 1.08–1.71) when adjusted for confounders.

Being underweight at age 13 was not significantly associated with age 13 (OR 1.24; CI 0.77–2.01) or

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Table 2. *Demographic characteristics of 9-year-olds of underweight, overweight and healthy BMI*

Variables		Underweight % (*n*)	Normal % (*n*)	Overweight % (*n*)
Total population		6.1 (431)	64.6 (4590)	29.4 (2087)
Gender	Male	5.5 (201)	69.4 (2523)	25 (909)
	Female	6.6 (230)	59.5 (2068)	33.9 (1178)
Household income	1 (lowest)	7 (89)	62.7 (793)	30.3 (383)
	2	6.8 (91)	61.5 (819)	31.7 (422)
	3	4.8 (64)	65.5 (875)	29.7 (396)
	4	5.8 (77)	65 (861)	29.2 (386)
	5 (highest)	5.2 (72)	69 (953)	25.8 (357)
Physical exercise (hard) in last 14 days	0–2 days	6.1 (34)	57.2 (320)	36.7 (205)
	3–5 days	6.8 (87)	57.1 (728)	36 (459)
	6–8 days	63.8 (869)	5.8 (79)	30.4 (414)
	9 or more	5.9 (230)	68.3 (2673)	25.8 (1010)
Maternal education	1	<10[a] (*n* < 30)	63.5 (284)	32 (143)
	2	6.3 (104)	58.2 (968)	35.5 (590)
	3	6.2 (162)	64.8 (1698)	29 (760)
	4	5.7 (66)	66.8 (769)	27.5 (317)
	5	5.6 (44)	71.1 (558)	23.3 (183)
	6	7.9 (35)	70.9 (315)	21.2 (94)

BMI, body mass index.
[a] Value bottom coded for statistical disclosure purposes.

persistent psychopathology (OR 1.41; CI 0.86–2.34) when adjusted for confounders.

Stratified analysis

The stratified analyses are shown in Table 4.

Healthy BMI in childhood

Of the children with healthy BMI in childhood, 4% (*n* = 180) dropped to underweight by age 13 and 11.7% (*n* = 527) increased to overweight. An increase in overweight from healthy BMI was significantly associated with adolescent psychopathology (adjusted OR 1.66; 95% CI 1.19–2.32). This association was also significant when also adjusted for childhood psychopathology (adjusted OR 1.87; CI 1.31–2.68).

Healthy to underweight was not significantly associated with adolescent psychopathology (adjusted OR 0.74; CI 0.37–1.49).

Underweight in childhood

Of the children who were underweight in childhood, 29.7% (*n* = 125) remained underweight, 66.2% (*n* = 279) increased to healthy and 4.1% (*n* = 17) increased to overweight. Change to healthy BMI from underweight (adjusted OR 0.12; 95% CI 0.03–0.43) was associated with a significantly reduced OR of developing psychopathology.

Underweight to overweight BMI was not significantly associated with adolescent psychopathology (adjusted OR 3.1; CI 0.31–29.81).

Overweight in childhood

Of the children who were overweight in childhood, 0.2% (*n* = 5) dropped to underweight, 28.4% (*n* = 560) dropped to healthy and 71.4% (*n* = 1409) remained overweight. Change to healthy BMI from overweight (adjusted OR 0.47; 95% CI 0.79–0.8) was associated with a significantly reduced OR of developing psychopathology. The association remained significant when childhood psychopathology was also adjusted for (adjusted OR 0.55; CI 0.32–0.95).

The number of those who changed from overweight to underweight was too small for a statistical analysis to be conducted on them.

Discussion

From this large, longitudinal, nationally representative sample, we revealed that change from normal BMI to overweight between childhood and adolescence is associated with an increased risk of development of psychopathology in adolescence to those who remained normal. Our results complement existing findings (Shunk & Birch, 2004; Gifford Sawyer *et al.* 2011; Van Grieken *et al.* 2013; Carr & Jaffe, 2013). The association between overweight BMI and psychological outcome

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Table 3. *The unadjusted, adjusted and gendered ORs of psychopathology in underweight and overweight children at age 9/13*

BMI (child)	Psychopathology prevalence (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	Adjusted OR (+ child SDQ adj.)	Male only adjusted[1] OR (95% CI)	Female only adjusted[a] OR (95% CI)
Normal	6.2					
UW	6.7	1.07 (0.72–1.57)	0.94 (0.6–1.46)	1.23 (0.78–1.93)	M – 0.69 (0.34–1.43)	F – 1.23 (0.69–2.18)
OW	6.7	1.08 (0.88–1.33)	0.90 (0.72–1.13)	**0.76 (0.59–0.97)**	M – 1.03 (0.74–1.42)	F – 0.8 (0.5810–1.12)
BMI (adolescent)						
Normal	5.3					
UW	7.7	1.48 (0.96–2.27)	1.24 (0.77–2.01)	1.41 (0.86–2.33)	M – 1.74 (0.89–3.4)	F – 1.08 (0.54–2.15)
OW	8.4	**1.65 (1.35–2.02)***	**1.4 (1.13–1.74)***	**1.36 (1.08–1.71)**	M – 1.36 (1–1.84)	F – **1.49 (1.09–2.04)*****

BMI, body mass index; OR, odds ratio; CI, confidence interval; OW, overweight; UW, underweight.
[a] Adjusted for SES, maternal education, physical activity, chronic illness, gender, screen time and nationality.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

may be mediated by factors, such as social stigmatisation, isolation and victimisation (Puhl & Brownell, 2001) and through the internalising of negative perceptions towards obesity (Wang *et al.* 2004). Internalising factors (e.g. self esteem, loneliness), which have been found to mediate the association between an increase in BMI and poor school performance (Martin *et al.* 2017), may also be mediators. Explanations for the association between being underweight and psychopathology are harder but may involve body dissatisfaction and eating disorders (Ali & Lindstrom, 2005).

This association between change and adverse psychological outcome could be explained by the theory that stable weight allows a stable concept of one's identity, whereas weight fluctuation means the person 'struggles between two identities: the weight they *actually* are and the weight they *believe* exemplifies who they are' (Bronner, 1996). Another theory for this association is the temporal comparison theory. The temporal comparison theory states that change to a high BMI leads a person to negatively compare themselves to their earlier self, leading to experience of social devaluation (Albert, 1977). Meanwhile, the ability to develop resistance strategies to psychological threats of stigma in those with persistent high BMI (Crocker & Major, 1989) may be a protective factor for those who do not experience weight change.

The 'change' analysis also revealed that those whose weight changes from overweight or underweight to healthy BMI had a decreased risk of developing psychopathology. The psychological benefit of weight loss in overweight or obese individuals has been documented (Lasikiewicz, Lawton, 2014; Alhalel *et al.* 2018), although it is not as well documented as the physiological benefits of weight loss (Franz *et al.* 2007). Weight loss mediated by behavioural interventions has been shown to improve self-esteem, while depressive symptoms have been shown to be alleviated by pharmacological or surgical interventions (Blaine *et al.* 2007) Therefore, our results support the hypothesis that intervening in encouraging weight loss in overweight children improves psychological well-being. Behavioural interventions are a common approach to weight loss and include forms such as attempting to understand and control eating behaviour and attitudes, maintaining good nutrition, seeking social support and exercise (Brownell & Kramer, 1998).

The literature suggesting an association between low BMI and psychopathology is not as extensive. Some studies have found low BMI to be associated with *better* mental health (Mond *et al.* 2006), while others have found an association with impaired mental health and that this was not due to higher levels of body dissatisfaction or eating disorder behaviour but other non-defined factors (Zhao *et al.* 2009; Mond *et al.* 2011).

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Table 4. *The association between change in BMI and unadjusted, adjusted and gendered ORs of psychopathology*

Change in BMI	Prevalence % (*n*)	Psychopathology % (*n*)	Unadjusted OR (95% CI)	Adjusted[a] OR (95% CI)	Adjusted[a] OR Gendered (95% CI)	Adjusted[b] OR (+ childhood SDQ) (95% CI)
Normal in childhood	*n* = 4590					
1. Dropped to UW	4 (180)	<10[c] (*n* < 30)	1.14 (0.61–2.11)	0.74 (0.37–1.49)	M – 1.09 (0.42–2.82) F – 0.58 (0.21–1.6)	0.98 (0.48–1.99)
2. Remained normal	84.3 (3782)	5.6 (210)				
3. Increased to OW	11.7 (527)	11 (58)	**2.11 (1.55–2.86)***	**1.66 (1.19–2.32)****	M – 1.41 (0.87–2.29) F – **1.95 (1.19–3.19)****	**1.87 (1.31–2.68)*****
UW in childhood	*n* = 431					
1. Remained UW	29.7 (125)	<20[3] (n < 30)				
2. Increased to normal	66.2 (279)	<10[3] (n < 30)	**0.25 (0.1–0.61)****	**0.12 (0.03–0.43)****	M – **0.02 (0.001–0.39)*** F – 0.13(0.01–1.33)	0.31 (0.0342.8)
3. Increased to OW	4.1 (17)	<20[3] (n < 30)	0.88 (0.16–4.86)	3.05 (0.31–29.81)	M – 5.03 (0.01–1906.76) F – 13.69 (0.02–8038.29)	12.01 (0.53–270.91)
OW in childhood	*n* = 2087					
1. Dropped to UW	0.2 (5)	0				
2. Dropped to normal	28.4 (560)	<10[3] (n < 30)	**0.51 (0.32–0.81)****	**0.47 (0.79–0.8)*****	M – 0.91 (0.44–1.88) F – **0.27(0.12–0.62)****	**0.55 (0.32–0.95)***
3. Remained OW	71.4 (1409)	7.3 (103)				

BMI, body mass index; OR, odds ratio; CI, confidence interval; OW, overweight; UW, underweight.
[a] Adjusted for SES, maternal education, physical activity, chronic illness, gender, screen time and nationality.
[b]Adjusted for SES, maternal education, physical activity, chronic illness, gender, screen time, nationality and childhood psychopathology.
[c]Value bottom coded for statistical disclosure.
*$p < 0.05$.
**$p < 0.01$.
***$p < 0.001$.

Therefore, the mechanism for the decreased psychopathology risk in children who changed from underweight to healthy BMI does not appear as straightforward. The change, nevertheless, appears to be beneficial.

We found, additionally, that being overweight in adolescence increases the risk of having psychopathology in adolescence but that no such association exists between being overweight in childhood and psychopathology in adolescence. This is supported by studies that have found that, in different child age groups, being overweight or obese increases the risk of co-occurring psychological and emotional problems at that particular age (Schwimmer *et al.* 2003; Vila *et al.* 2004; Gifford Sawyer *et al.* 2011; Sanders *et al.* 2015; Kelly *et al.* 2016). However, there appears to be less evidence to show that a higher BMI in childhood increases the risk of such problems arising later in the child's life.

This study does not out rule the possibility that the BMI change might actually be due to the psychopathology itself (e.g. an eating disorder).

Strengths and limitations

The size and representative nature of the sample used and the validity of the outcome measures strengthen the results and conclusions that can be drawn from our study and the applicability of the results to the population as a whole. Each analysis used confounders to strengthen the validity of the associations observed.

Yet, despite the large nature of the study size, the sample of underweight participants was significantly lower than that of both the normal or overweight sample. This makes the change analysis involving change to or from underweight, less reliable. In certain cases, such as change from overweight to underweight, it was not possible to conduct a meaningful statistical analysis as too few participants had such a dramatic change in BMI.

The study was reliant on parent-reported measures for outcomes, a weakness as there is some evidence that child-reported measures of psychopathology differ from parent-reported ones, especially when the child is in adolescence (Van Roy *et al.* 2010). This may lead to an underestimation of the total internalising and externalising factors reported, potentially impacted by family structure (Van Roy *et al.* 2010).

Screen time should ideally have included phone and computer use but this was not included in the GUI. The presentation of dietary data is not available in a form that allows itself to be easily used as a confounding variable. Therefore, it was not used.

Conclusions

Overall, our study has shown that change in BMI from normal to overweight increases a child's risk of developing psychopathology. Additionally, we have shown that a change in BMI from overweight or underweight back to within normal range decreases a child's risk of developing psychopathology. These effects are unlikely to be purely biological and future research into possible mediators, for example, self-esteem and peer relationships, would be an important next step. The mechanism for this improvement in BMI is worth investigating, as it may guide weight interventions, by analysing what interventions were most effective amongst the children whose weight improved (i.e. diet, exercise, social). Our study shows the need for obesity to be tackled at a societal level, as it has negative effects on both physical and mental health. The psychological benefit we observed from weight improvement is an optimistic finding, which coupled with further investigation, should educate on intervention forms for preventing psychological illness.

Conflicts of interest

Each author has no conflicts of interest to disclose.

Ethical standards

The GUI has its own designated ethics committee which approved this study. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committee on human experimentation with the Helsinki Declaration of 1975, as revised in 2008.

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References

Abarca-Gomez L, Abdeen Z, Abdul Hamid Z, Abu-Rmeileh N, Acosta-Cazares B, Acuin C, *et al.* (2017). Worldwide trends in body-mass index, underweight, overweight and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *The Lancet* **10113**(390), 2627–2642.

Albert S (1977). Temporal comparison theory. *Psychological Review* **84**, 485–503.

Alhalel N, Schueller S, O'Brien M (2018). Association of changes in mental health with weight loss during intensive lifestyle intervention: does the timing matter? *Obesity Science and Practice* **4**(2), 153–158.

Ali SM, Lindstrom M (2005). Socioeconomic, psychosocial, behavioural, and psychological determinants of BMI among young women: differing patterns for underweight

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and overweight/obesity. *European Journal of Public Health* **16**, 324–330.

Anis AH, Zhang W, Bansback N, Guh D, Amarsi Z, Birmingham C (2010). Obesity and overweight in Canada: an updated cost-of-illness study. *Obesity Reviews* **11**, 31–40.

Arroyo-Johnson C, Mincey K (2016). Obesity epidemiology trends by race/ethnicity, gender, and education: national Health Interview Survey. *Gastroenterology Clinics of North America* **45**(4), 571–579.

Blaine B, Rodman J, Newman J (2007). Weight loss treatment and psychological well-being. A review and meta-analysis. *Journal of Health Psychology* **12**(1), 66–82.

Bronner Y (1996). Nutritional status outcomes for children: ethnic, cultural, and environmental contexts. *Journal of the American Dietetic Association* **96**, 891–900.

Brownell K, Kramer F (1998). Behavioural management of obesity. *Medical Clinics of North America* **73**(1), 185–201.

Canadian Paediatric Society (2004). Dieting in adolescence. *Paediatrics & Child Health* **9**, 487–491.

Cantor-Graae E, Pederson C (2013). Full spectrum of psychiatric disorders related to foreign migration: a Danish population-based cohort study. *JAMA Psychiatry* **70**(4), 427–435.

Carr D, Jaffe K (2013). The psychological consequences of weight change trajectories: evidence from quantitative and qualitative data. *Economics and Human Biology* **10**(4), 419–430.

Chekroud S, Gueorguieva R, Zheutlin A, Paulus M, Krumholz HM, Krystal JH (2018). Association between physical exercise and mental health in 1·2 million individuals in the USA between 2011 and 2015: a cross-sectional study. *Lancet Psychiatry* **5**(9), 739–746.

Cimino S, Cerniglia L, Almenara C, Stanislav J, Errie M, Tambelli R (2016). Developmental trajectories of body mass index and emotional-behavioral functioning of underweight children: a longitudinal study. *Scientific Reports* 6.

Cole T, Bellizzi M, Flegal K, Dietz W (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *British Medical Journal* **320**(7244), 1240–1243.

Cole T, Flegal K, Nicholls T, Jackson A (2007). Body mass index cut offs to define thinness in children and adolescents: international survey. *British Medical Journal* **225**, 194.

Crocker J, Major B (1989). Social stigma and self-esteem: The self-protective properties of stigma. *Psychological Review* **96**, 608–630.

de Wit L, Luppino F, van Straten A, Penninx B, Zitman F, Cuijpers P (2010). Depression and obesity: a meta-analysis of community-based studies. *Psychiatry Research* **178**(2), 230–235.

Franz MJ, Van Wormer JJ, Crain AL, Boucher J, Histon T, Caplan W (2007). Weight-loss outcomes. A systematic review and meta-analysis of weight-loss clinical trials with a minimum 1-year follow-up. *Journal of the American Dietetic Association* **10**(1), 1755–1767.

Gifford Sawyer M, Harchak T, Wake M, Lynch J (2011). Four-year prospective study of BMI and mental health problems in young children. *American Academy of Paediatrics* **128**(4), 677–684.

Goodman R (2001). Psychometric properties of the strengths and difficulties questionnaire. *Journal of the American Academy of Child & Adolescent Psychiatry* **40**(11), 1337–1345.

Goodman R, Ford T, Simmons H, Gatward R (2000). Using the strengths and difficulties questionnaire (SDQ). *The British Journal of Psychiatry* **177**(6), 534–539.

Hysing M, Elgen I, Gillberg C, Lie SA, Lundervold AJ (2007). Chronic physical illness and mental health in children. Results from a large-scale population study. *Journal of Child Psychology and Psychiatry* **48**(8), 785–792.

Kelly Y, Patalay P, Montgomery S, Sacker A (2016). BMI development and early adolescent psychosocial well-being: UK Millennium Cohort Study. *Pediatrics* **138**(6), e20160967.

Lasikiewicz N, Lawton C (2014). Psychological benefits of weight loss following behavioural and/or dietary weight loss interventions. A systematic research review. *Appetite* **72**, 123–137.

Leadbeater BJ, Kuperminc GP, Blatt SJ, Hertzog C (1999). A multivariate model of gender differences in adolescents' internalising and externalising problems. *Developmental Psychology Journal* **35**(5): 1268–1282.

Linscott, R, Van OJ (2013). An updated and conservative systematic review and meta-analysis of epidemiological evidence on psychotic experiences in children and adults: on the pathway from proneness to persistence to dimensional expression across mental disorders. *Psychological Medicine* **43**(6), 1133–1149.

Luppino FS, de Wit LM, Bouvy PF, Stijnen T, Cuijpers P, Penninx BW, *et al.* (2010). Overweight, obesity, and depression: a systematic review and meta-analysis of longitudinal studies. *Archives of General Psychiatry* **67**(3), 220–229.

Martin A, Booth JN, McGeown S, Niven A, Sproule J, Saunders DH, Reilly JJ (2017). Longitudinal associations between childhood obesity and academic achievement: systematic review with focus group data. *Current Obesity Reports* **6**(3), 297–313.

Mond JM, Robertson-Smith G, Vitere A (2006). Stigma and eating disorders: is there evidence of negative attitudes towards individuals suffering from anorexia nervosa? *Journal of Mental Health* **15**, 519–532.

Mond J, Rodgers B, Hay P, Owen C (2011). Mental health impairment in underweight women: do body dissatisfaction and eating-disordered behaviour play a role? *BioMed Central Public Health* **11**, 547.

NCD Risk Factor Collaboration (2017). Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults. *Lancet* **390**, 2627–2642.

Ng CD, Cunningham S (2020). In, out and fluctuating: obesity from adolescence to adulthood. *Annals of Epidemiology* **41**, 14–20.

https://doi.org/10.1017/ipm.2020.28 Published online by Cambridge University Press

Patalay P, Hardman C (2019). Comorbidity, codevelopment, and temporal associations between body mass index and internalizing symptoms from early childhood to adolescence. *Journal of the American Medical Association Psychiatry* **76**(7), 721–729.

Puhl RM, Brownell KD (2001). Bias, discrimination, and obesity. *Obesity Research* **9**, 788–905.

Rothblum E (2018). Slim chance for permanent weight loss. *Archives of Scientific Psychology* **6**, 63–69.

Sanders RH, Han A, Baker JS, Cobley S (2015). Childhood obesity and its physical and psychological co-morbidities: a systematic review of Australian children and adolescents. *European Journal of Pediatrics* **174**(6), 715–746.

Schwimmer JB, Burwinkle TM, Varni JW (2003). Health-related quality of life of severely obese children and adolescents. *Journal of the American Medical Association* **289**(14), 1813–18191.

Shunk JA, Birch LL (2004). Girls at risk for overweight at age 5 are at risk for dietary restraint, disinhibited overeating, weight concerns, and greater weight gain from 5 to 9 years. *Journal of the American Dietetic Association* **104**, 1120–1126.

Sobal J, Stunkard AJ (1989). Socioeconomic status and obesity: a review of the literature. *Psychological Bulletin* **105**(2), 260–275.

Stiglic N, Viner R (2019). Effects of screentime on the health and well-being of children and adolescents: a systematic review of reviews. *British Medical Journal* **9**(1), e023191.

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

Van Grieken A, Renders C, Wijtzes A, Hirasing R, Raat H (2013). Overweight, obesity and underweight is associated with adverse psychosocial and physical health outcomes among 7-year-old children: the 'be active, eat right' study. *Public Library of Science One* **8**(6).

Van Roy B, Groholt B, Heyerdahl S, Clench-As J (2010). Understanding discrepancies in parent-child reporting of emotional and behavioural problems: effects of relational and socio-demographic factors. *BioMed Central Psychiatry* **10**(1), 56–68.

Vila G, Zipper E, Dabbas M, Bertrand C, Robert JJ, Ricour C, *et al.* (2004). Mental disorders in obese children and adolescents. *Psychosomatic Medicine* **66**(3), 387–394.

Wang SS, Brownell KD, Wadden TA (2004). The influence of the stigma of obesity on overweight individuals. *International Journal of Obesity and Related Metabolic Disorders* **28**, 1333–1337.

Zhao G, Ford ES, Dhingra S, Li C, Strine TW, Mokdad AH (2009). Depression and anxiety among US adults: associations with body mass index. *International Journal of Obesity* **33**, 257–266.

https://doi.org/10.1017/ipm.2020.28 Published online by Cambridge University Press