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Association between higher BMI and depressive symptoms in Icelandic adolescents: the mediational function of body image

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Background: Weight status and depressive affect in adolescents are positively related constructs, but the nature of this relationship is not well understood, especially in European populations. The objective of this study was to examine the interplay between body mass index (BMI) and depressive symptoms, while accounting for the possible mediational role of body image, in a sample of older adolescents in Iceland. **Method**: We utilized data from a population-based cross-sectional sample of 11 388 junior college students (16–20-year-olds) to conduct structural equation modelling to test the relationship between BMI, body image and depressive symptoms while controlling for socioeconomic status and other background variables. **Results**: Higher levels of BMI are associated with higher depressive symptoms. However, this association was mediated entirely through perceptions of body image. The association is gender dependent, with the relationship between BMI levels and depressive symptoms being significantly stronger among junior college girls than boys. **Conclusion**: Body image is a key contributor in the relationship between weight status and depressive symptoms among adolescents. Future interventions with adolescents should take this association into account and focus on such factors as physical confidence and self-esteem.

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Introduction

Although various population-based studies document that obesity is associated with depression [1–3] and that there is some evidence that obesity increases the incidence of depression,[4] findings are not consistent across studies.[1,2] Both obesity and depression have been linked to abnormal functioning of the hypothalamic-pituitary-adrenal axis and serotonin imbalances.[5,6] Another possibility is that their association may result from an interaction of psychosocial pathways that mediate the relationship. Specifically, somatic psycho-social constructs, such as body image, have been related to depression,[3,7] and studies have shown that body dissatisfaction affects depressive symptoms for some adolescents.[8] Moreover, it has been suggested that body dissatisfaction may mediate the relationship between overweight and depression.[9,10] In particular, various studies show that overweight adolescents may experience discrimination and stigma, which increase body dissatisfaction and depression,[11–13] indicating that depressive symptoms are affected through the effects of body dissatisfaction. In this light, it may not suffice in obesity prevention and treatment to merely recommend improved diet and increase in physical exercise; issues regarding body image dissatisfaction and depression may also need to be addressed. Although some studies have indicated a mediation effect of body image in the relationship between adiposity and depression outcomes among teens,[12] much still remains to be learned and confirmed about the nature of these relationships, especially in European populations.

Cultural norms about body size differ for boys and girls; hence the association between obesity and depression varies by gender. Even though body dissatisfaction may be of concern for both genders, it may have a greater consequence for girls than boys.[14] In one study of body dissatisfaction, girls were more dissatisfied with their bodies with increasing weight, whereas boys showed increased level of body dissatisfaction for being either overweight or underweight.[14] In this article, we postulate a conceptual model of the relationship between body mass index (BMI) and depressive symptoms. We propose an indirect relationship, where higher BMI levels are associated with higher depressive symptoms when there are reports of greater body dissatisfaction in a population-based sample of 16- to 20-year-old junior college students in Iceland.

Methods

Data source and participants

The data for this study came from the 2010 national survey of Icelandic adolescents, named 'Youth in Iceland'–Junior College Students. This sample includes 16–20-year-old students who were attending junior colleges in Iceland in 2010. The Youth in Iceland study series comprises cross-sectional surveys conducted to gain understanding of risk and protective factors of youth health behaviours and social well-being. The findings are used to enhance public knowledge of adolescent lifestyles and to inform programmes that can promote health and well-being of Icelandic youth. Approximately 71% of all eligible daytime junior colleges students ($N = 11\,388$, boys 48%) participated in the survey. Because of the homogeneity of the Icelandic population, with approximately 90% of the estimated 320 000 inhabitants being of Norse-Celtic decent and >80% of the population belonging to the Lutheran State Church, with no other religious institution having more than 3.0% of the population registered in their services,[15] other exogenous variables, such as race, ethnicity and religion, which are often used in research in other countries, were not included in the present analysis.

Procedure

The data collection process was guided by a strict methodological protocol,[16] conducted by the Icelandic Centre for Social Research and Analysis (ICSRA) at Reykjavik University in cooperation with the Icelandic Ministry of Education, Science, and Culture; the municipalities and all junior colleges in the country. All aspects of data collection were performed in accordance with guidelines issued by the Icelandic authority that governs the use of human subjects.

The ICSRA distributed anonymous questionnaires to all junior colleges in Iceland after written notification to parents for passive parental consent. All students who were present in school on the survey day completed their questionnaire inside their classrooms. Teachers at individual school sites assisted the students with their participation in the study, and specific contact agents supervised the distribution of surveys within each school as well as the return of the questionnaires.

Questionnaires that contained missing responses about gender, age, height or weight were excluded from the analysis, while missing values on ordinal and interval scale variables, including depressive symptoms and body image, were replaced by the respective mean score. To remove extreme outliers and answers that are possibly without foundation, respondents who reported being either below or above the 16–20-year-of-age or who reported weights greater than 170 kg, or heights under 130 cm, or above 220 cm, were excluded from the analysis. Further, because the emphasis in this study is on the relationship between increase in weight status and depressive symptoms and how this relationship is mediated through body image, underweight participants ($N = 387$) were also excluded from the analyses. After this filtering, the total number of participants numbered 8603 (75.5% of the initial sample).

Measures

Body mass index

Self-reported height and weight was used to calculate BMI (kg/m^2). For 18-year-olds and those older, BMI underweight was categorized according to the World Health Organization classification.[17] But for adolescents <18 years of age, the International Obesity Task Force-age- and gender-specific cutoff points for underweight (based on centile curves defined to pass through the BMI of 18.5 at age 18) were used.[18]

Depressive symptoms

Depressive symptoms were measured using a 10-item sub-scale from the SCL-90 outpatient assessment tool defined by Derogatis *et al.*[19]

Body image (Offer Self-Image Questionnaire)

Body image was measured using five questions derived from the body image subscale of the Offer Self-Image Questionnaire.[20] The Offer Self-Image Questionnaire instrument has been used widely in adolescent research and has high reliability[21] and moderate discriminant validity.[22]

As for control variables, we use a latent construct of parental education and parental occupation as a proximal measure for socioeconomic status (SES), and also control for age variation in our sample. A detailed description of all measures is provided in Supplementary Material.

Measurement model and data analysis

We began our analysis by testing the difference between gendered mean scores for all study variables and report effect sizes for descriptive differences.[23] We then conducted structural equation modelling (SEM) using AMOS 17.0.[24,25] SEM allowed us to explicitly model direct and indirect effects using measured and latent variables.[26] We

hypothesize that as BMI increases in the population so do depressive symptoms, but that this relationship is the product of the combined effects of BMI on body image and of body image on depression.

We specified three latent constructs for the analysis: SES based on parental education and parental work status, body image and depressive symptoms along with the observed variables BMI and age. The specification included the number of factors, the number of indicators for each factor and whether the measurement errors were allowed to correlate. Confirmatory factor analysis was used from the beginning in the construction of all latent variables, and was also used to test the fit of the hypothesized factor structure to the covariance matrix of the observed variables.

The SEM we tested may be expressed as the equation $\eta = \beta\eta + \Gamma\xi + \zeta$, where β is the matrix of regression weights interrelating the endogenous (η) variable of depression, and the mediating variable of body image. Γ is the matrix of regression weight relating the exogenous (ξ) variables, parental education and parental work status, to the endogenous (η) variable, and ζ is a vector of error terms. Hu and Bentler's[27] cutoff criteria for adequate-fit indices were adopted, with a comparative fit index of 0.950 and above and the root mean square error of approximation of below 0.050 indicating a good fit to the data. A relationship between two variables is generally considered to be mediated if it exists (or is strengthened) when a third variable is included in the putative causal pathway.[28]

When forming the measurement model, we identified a substantial correlation between the residuals (error terms) for some of the latent structure indicators, which is accounted for by the structural model. A detailed description of these correlations is contained in Supplementary Material.

To answer the question of whether there are gender-based differences in the relations between the main study variables, we had AMOS compute a table of critical ratios of differences among all pairs of free parameters. The critical ratio is the difference between the parameters divided by the estimated standard error of the difference.[25,26] Similar to the *t*-statistic, the critical ratio can be compared with a table of the standard normal distribution to test whether each pair of parameters listed in the table are equal.

Results

The age distributions of the respondents are as follows: 28% comprised 16-year-olds; 26%, 17-year-olds; 23%, 18-year-olds; 18%, 19-year-olds and approximately 5% were 20-year-olds. Most of the respondents' parents had a full- or a part-time job outside the home (84% of fathers and 75% of mothers). Similarly, almost 90% of the respondents reported parents having more than elementary education, with at least one-third holding a university degree (36% of fathers and 43% of mothers), followed by secondary school education (23% of mothers and 31% of fathers).

Table 1 shows that the average BMI score for girls (22.4) was slightly lower than boys (23.9). But they had higher depressive symptom scores (18.8 vs. 15.5) and poorer perception of their body image (13.8 vs. 15.5). The table also shows the effect size difference on depression is 0.50, which is considered large by Cohen[23]; for the questions 'I cried easily or wanted to cry' (1.04) and 'I felt sad or blue' (0.52) with the most differences. The effect size for differences on body image was 0.45. For the question, 'most of the times I find myself to be bad-looking and unattractive', the effect size differences was the least (0.45), followed by 'I'm happy with my body' (0.52). The question, 'I'm happy with the physical changes that have taken place over the last years', showed a difference of (0.53).

Tables 2 and 3 summarize the regression coefficients of the hypothesized model for boys and girls, respectively. The final SEM model had a root mean square error of approximation of 0.031 and

Table 1 Descriptive statistics for all study variables by gender

Variables	Range	Girls		Boys		Mean difference	Effect size
		Mean	**SD**	**Mean**	**SD**		
Mother's education	1–5	3.54	1.43	3.62	1.37	−0.08**	0.06
Father's education	1–5	3.45	1.33	3.54	1.43	−0.09**	0.07
Mother's work status	1–2	1.25	0.43	1.25	0.44	0.00	0.00
Father's work status	1–2	1.16	0.37	1.16	0.37	0.00	0.00
Age	16–20	17.4	1.21	17.5	1.24	−0.10**	0.08
BMI	2.87–3.81	3.12	0.14	3.14	0.14	−0.02**	0.14
Depression	10–40	18.77	6.94	15.55	5.89	3.22**	0.50
I was sad and had little interest in doing things	1–4	2.37	1.02	2.03	1.00	0.34**	0.34
I had little appetite	1–4	2.00	0.99	1.67	0.88	0.33**	0.35
I felt lonely	1–4	1.94	1.03	1.62	0.89	0.32**	0.33
I cried easily or wanted to cry	1–4	2.17	1.07	1.25	0.62	0.92**	1.04
I had sleeping problems	1–4	2.00	1.06	1.79	1.00	0.21**	0.20
I felt sad or blue	1–4	2.10	1.01	1.61	0.87	0.49**	0.52
I was not excited in doing things	1–4	1.86	0.98	1.64	0.87	0.22**	0.24
I was slow or had little energy	1–4	1.68	0.92	1.42	0.75	0.26**	0.31
The future seemed hopeless	1–4	1.49	0.86	1.35	0.76	0.14**	0.17
I thought of committing suicide	1–4	1.15	0.52	1.16	0.56	−0.01	0.02
Body image	5–20	13.79	3.93	15.50	3.89	−1.71**	0.45
When I think about how I'm going to look in the future I am happy	1–4	3.04	0.72	3.21	0.72	−0.17**	0.24
Most of the times I find myself to be bad looking and unattractive	1–4	2.80	0.85	3.17	0.80	−0.37**	0.45
I am happy with my body	1–4	2.48	0.88	2.92	0.82	−0.44**	0.52
I am happy with the physical changes that have taken place over the last years	1–4	2.62	0.86	3.07	0.82	−0.45**	0.53
I find myself to be strong and healthy	1–4	2.85	0.83	3.13	0.80	−0.28**	0.34

$*P < 0.05$, $**P < 0.01$.
Boys: $n = 3756$; Girls: $n = 4295$.

Table 2 SEM summary table for boys showing standardized and unstandardized regression weights ($N = 3756$)

Variable relationships	Standardized coefficient (b)	Unstandardized coefficients	Standard errors	Critical ratios
Hypothesized relationships				
BMI → body image	−0.223**	−0.660	0.062	−10.583
BMI → depression	−0.096**	−0.197	0.036	−5.539
Body image → depression	−0.490**	−0.337	0.020	−16.469
Control relationships				
SES → BMI	−0.086**	−0.013	0.003	−4.026
Age → BMI	0.171**	0.020	0.002	10.650
Age → body image	0.040*	0.014	0.007	1.997
SES → body image	0.079**	0.035	0.011	3.068
Age → depression	0.088**	0.021	0.004	5.284
SES → depression	−0.018	−0.006	0.006	−0.001
SES → mother's education	0.703	1.000		
SES → father's education	0.630**	0.860	0.110	7.802
SES → father's work	−0.122**	−0.047	0.009	−5.372
SES → mother's work	−0.142**	−0.064	0.011	−6.083

$*P < 0.05$ (two-tailed), $**P < 0.01$ (two-tailed).

Table 3 SEM summary table for girls showing standardized and unstandardized regression weights ($N = 4295$)

Variable relationships	Standardized coefficient (b)	Unstandardized coefficients	Standard errors	Critical ratios
Hypothesized relationships				
BMI → body image	−0.359**	−1.232	0.067	−18.486
BMI → depression	−0.152**	−0.246	0.028	−8.718
Body image → depression	−0.564**	−0.266	0.015	−18.150
Control relationships				
SES → BMI	−0.171**	−0.024	0.003	−8.235
Age → BMI	0.152**	0.017	0.002	10.167
Age → body image	0.094**	0.037	0.007	5.547
SES → body image	0.120**	0.058	0.011	5.330
Age → depression	0.041**	0.008	0.003	2.725
SES → depression	−0.034	−0.008	0.004	−1.783
SES → mother's education	0.687	1.000		
SES → father's education	0.655**	0.885	0.078	11.321
SES → father's work	−0.099**	−0.037	0.007	−4.983
SES → mother's work	−0.162**	−0.071	0.009	−7.786

$*P < 0.05$ (two-tailed), $**P < 0.01$ (two-tailed).

a comparative fit index of 0.952. The model fits resulted in $\chi 2 = 3041$, $df = 348$ and $P = 0.000$, as expected with large samples.[25]

As shown in table 2, we observe a very strong inverse relationship between body image and depression (standardized $\beta = -0.49$) for boys, and a moderate inverse relationship between BMI and body image (standardized $\beta = -0.22$). Further, the direct relationship between BMI and depression is moderate and negative (standardized $\beta = -0.10$). This appears odd at first glance but on further observation, shown in table 4, we see that the net indirect relationship between BMI and depression is 0.11. This results in the total relationship between BMI and depression being positive among boys and suggests that the relationship between BMI and depression is ultimately explained by mediation through body image.

We identify similar results for girls, shown in table 3. A strong inverse relationship between body image and depression (standardized $\beta = -0.56$) is observed for girls, and an inverse relationship between BMI and body image (standardized $\beta = -0.36$). Similar to the boys, we observe the direct relationship between BMI and depression being moderate and negative ($\beta = -0.15$) among girls. However, the net indirect relationship between BMI and depression is 0.20, as shown in table 4. This results in the total relationship between BMI and depression being positive, albeit small. As explained for the boys, this indicates that the relationship between BMI and depression is indirect and ultimately explained by the mediating variable; body image.

The relationship between BMI and body image is significantly stronger among girls than boys in our model (critical ratio: −6.26),

Table 4 Standardized parameter estimates of BMI on depression mediated through body image for boys and girls

Gender	Direct	Indirect	Total
Boys	−0.096	0.109	0.013
Girls	−0.150	0.200	0.050

but the relationship between BMI and depression is not (critical ratio: −1.08). Then again, the relationship between body image and depression is significantly stronger for girls than boys in our model (critical ratio: −2.83).

Discussion

This study confirms a model portraying the relationship between body weight, body image and depressive symptoms. Consistent with previous studies,[12,29,30] and our central hypothesis, higher BMI levels were associated with depressive symptoms entirely through a psychosocial factor; negative body image. This means that as BMI increases in the population so do depressive symptoms, but that this relationship is the product of the effect of BMI on body image and the effect of body image on depression.

In accordance with previous studies,[12,29,30] our findings also highlight the importance of gender differences in these relationships. Both relationships between BMI and body image and between body image and depression were significantly stronger for girls than boys in our model. Thinness as a criterion of perceived beauty is conceived as being of greater importance to girls than boys.[11,29] Boys may place greater value on the capacity to gain muscle mass, thus body weight may not translate to the same extent to body dissatisfaction as in girls. In addition, it has been posited that girls have more risk factors for depression than boys.[11] According to Stice et al.,[11] elevated body mass leads to body dissatisfaction, as being overweight is presently not perceived as socially desirable by and among girls. This body dissatisfaction may in turn be directly conducive to depression, because in Western societies, appearance is perceived to be an important and a culturally relevant evaluative dimension among females. Furthermore, body dissatisfaction may also contribute to dietary restraint, which in turn has been shown to lead to subsequent depression among girls.[11] In a recent Icelandic study among 18–79-year-old adults, the prevalence of body dissatisfaction was so prominent among Icelandic female adults, for all age groups, that it was labelled as 'normative discontent' in the population.[31] Among the overweight participants, 64% of females were dissatisfied with their body weight compared with only 37% of their male counterparts. Similarly, more females than males also felt the need to lose weight. Strikingly, in the normal BMI category, close to 64% of the females and only 19% of men felt the need to lose weight.[31]

Our study confirms that while BMI was lower among girls than boys (22.4 vs. 23.9), girls had higher depressive scores and were less satisfied with their body. The average score for depressive symptoms was 18.8 in comparison with 15.5 for boys, and the body image score was 13.8 for girls vs. 15.5 for boys. This difference underlines the perceived normative cultural pressure on girls to be thin over and above what is experienced by boys. In addition, when looking at the effect size differences on body image, the questions demonstrating the greatest differences were those that asked about current body satisfaction: 'most of the times I find myself to be bad-looking and unattractive', 'I am happy with my body' and 'I am happy with the physical changes that have taken place over the last years'. While the questions 'I find myself to be strong and happy' is health focused, and 'when I think of how I am going to look in the future I am happy' did not reveal as much difference because the girls may have the intention to change their diet. That is, they are not content with their current state, but they may be more optimistic as they plan to go on a diet to lose weight in the near future.

There are some limitations of the study. First, the cross-sectional nature of the study design precludes us from making definitive statements about causality and the direction of the effects beyond the theory used to develop the model. For example, given that depression among adolescents has been shown to predict increase in weight in adulthood in longitudinal studies,[5,32] a plausible alternative explanation could be that depressive symptoms influence weight gain. Thus, it could be that increases in body dissatisfaction lead to depression, which in turn may promote subsequent obesity in adulthood. Second, given our preferred technique of analysis in this study, we are unable to account for a possible non-linear relationship between BMI and body image. A recent study by Calzo et al.[33] indicates that the relationship between BMI levels and body dissatisfaction among adolescents differs by BMI categories at the 50th percentile for girls and the 75th percentile among boys. Their results suggest a non-linear association between BMI and body image measures. The findings by Calzo et al.[33] therefore call for a confirmation of our findings in this present study by stratifying the samples based on BMI percentiles. Third, although BMI is generally accepted as a valid indicator of body composition for purposes of population-level assessment,[34] using BMI as an index of adiposity can be problematic.[35] Fourth, the use of self-reported height and weight data in the calculation of BMI can be problematic because some adolescents may over-report their height and underreport their weight.[36] Despite these limitations, the large population-based representative sample and high response rate are strengths not to be overlooked. Moreover, our use of SEM allowed us to simultaneously evaluate multiple relationships and enabled us to identify latent variables such as body image and depression. Finally, the data encompass 71% of the junior college student population in Iceland.

In conclusion, our findings demonstrate that depressive symptoms in overweight and obese adolescents should be assessed, and obesity prevention and treatment should integrate components aimed at helping adolescents promote positive body image.

Supplementary data

Supplementary data are available at *EURPUB* online.

Funding

Key points

- Among 16- to 20-year-old junior college students in Iceland, higher levels of BMI are associated with higher depressive symptoms. However, this association was mediated entirely through perceptions of body image.
- The association is gender dependent, with the relationship between BMI levels and depressive symptoms being significantly stronger among junior college girls than boys.
- The study shows that body image is a key contributor to the depressive symptoms for adolescents with higher levels of BMI.

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