Mediating Effects of Mental Health Problems in a Clinical Sample of Adolescents with Obesity

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Abstract

Introduction: The prevalence rates of obesity have increased in recent decades; despite leveling off in recent German studies among children and adolescents, obesity rates remain high. Psychosocial factors have an adverse impact on the maintenance of obesity. Hence, this study examined the mediating effects of mental health problems on the relation between the body mass index standard deviation score (BMI-SDS) and global health-related quality of life (HRQoL) among adolescent inpatients with obesity while controlling for gender and age-group. Methods: Three simple mediation analyses with gender and age-group as covariates were conducted for \( n = 313 \) adolescents with obesity (\( n_{\text{female}} = 193, 61.7\% \)) aged 12–17 (M = 14.19, SD = 1.52; BMI-SDS: M = 2.67, SD = 0.52). The adolescents were asked to report their global HRQoL at admission, and their parents estimated the children’s mental health problems at home prior to inpatient rehabilitation. Results: Emotional, peer-related, and conduct problems mediated the unfavorable effects of BMI-SDS on global HRQoL, showing high, moderate, and small effect sizes, respectively (completely standardized indirect effect of emotional problems: \( \beta = -0.09, SE = 0.03, 95\% B-CL = -0.15 \) to \(-0.04\); conduct problems: \( \beta = -0.03, SE = 0.02, 95\% B-CL = -0.06 \) to \(-0.01\); peer-related problems: \( \beta = -0.10, SE = 0.03, 95\% B-CL = -0.16 \) to \(-0.05\)). Conclusion: Mental health problems may be one salient pathway through which BMI-SDS impairs global HRQoL among adolescents with obesity. Hence, inpatient rehabilitation programs for adolescents with obesity should increase their focus more on the development of psychosocial skills. Thus, the promotion of emotion regulation and social-emotional competencies is suggested.

Introduction

The prevalence rates of obesity over the life span have increased significantly in recent decades; in the US population, rates increased from 1999 to 2016, mainly among adolescents [1]. Similarly, substantial increases in overweight and obesity were found from 1980 to 2013, espe-
of emotional problems has been reported for females only [21, 22] and prospective population-based studies [20]. In a cross-sectional population-based study, obesity was linked with a 2.5-fold increase in the risk of psychological problems [19]. To further summarize the results, more evidence has been provided for increased internalizing problems (i.e., depression and anxiety) than for externalizing problems (i.e., aggressive behavior); childhood overweight or obesity was associated with a 4-fold increase in the risk of developing late-life depression in a population-based study [20].

Moreover, research has shown close positive relations between obesity and mental health problems [17]; in a prospective study with a 2-year follow-up assessment, adolescent obesity was significantly associated with increased self-reported mental health problems [18]. Similarly, in a cross-sectional population-based study, obesity was linked with a 2.5-fold increase in the risk of psychological problems [19]. To further summarize the results, more evidence has been provided for increased internalizing problems (i.e., depression and anxiety) than for externalizing problems (i.e., aggressive behavior); childhood overweight or obesity was associated with a 4-fold increase in the risk of developing late-life depression in a population-based study [20].

Addressing the relevance of gender in the context of mental health problems, past research has provided mixed results for children and adolescents with obesity. Significant relations between obesity or increased body mass index (BMI) and higher internalizing problems have been ascertained predominately for females in cross-sectional [21, 22] and prospective population-based studies ([23, 24]; for a review, see also [25]). An increased risk of emotional problems has been reported for females only [19]. In contrast, another study among early and late adolescents ascertained a positive association with depressive mood among males, but not among females [26]. In addition, females with obesity were more likely than males to have externalizing disorders [22]. The results of age effects underscore that early adolescents with obesity seem to be very vulnerable to the development of anxiety disorders [22] and impaired global mental health [19].

Research on the association between mental health problems and HRQoL has supported an unfavorable impact of mental health problems; in a population-based study, higher levels of self-reported mental health problems were the most significant risk factor for impaired global HRQoL [27]. In sum, prior research has neglected to examine this association among children and adolescents with obesity.

Previous research on potential psychological mediators has focused on the mediating effects of weight-related teasing, body dissatisfaction, or victimization. Overall, these psychological factors mediated the inverse association of BMI or obesity and global HRQoL [28], psychological well-being [29], and emotional well-being [26]. Similarly, in the only longitudinal study among adolescents, the positive association between obesity and mental health problems 2 years later was reduced but still remained significant when victimization was included as a mediating factor [18].

Some direct effects of BMI or obesity on impaired psychosocial health can be conclusively reported, with a more pronounced association among clinical samples, females, and adolescents. Nevertheless, research on potential mechanisms is scarce, and the results are contradictory. Thus, more research on mediating psychological mechanisms is needed to illuminate the potential underlying interrelations. Given the moderating effects of age and gender, consideration of these organismic variables is also recommended. Finally, the study of this relation during a vulnerable phase of development, adolescence, is particularly interesting. The developmental period of adolescence is linked to significant increases in perceived stress, maladaptive coping, and psychological maladjustment [30]. The present study aimed to close these gaps in the research by clarifying the interrelation among BMI, mental health problems, and global HRQoL in adolescent inpatients with obesity. It was hypothesized that the adverse impact of a higher BMI on global HRQoL would be mediated by mental health problems. Important implications for the modification of existing multimodal intervention programs can be drawn from the results.
Materials and Methods

Participants and Procedure

In total, \(N = 313\) adolescents with obesity \((n_{\text{female}} = 193, 61.7\%)\) aged 12–17 (\(M = 14.19, SD = 1.52\) years) were included in the convenience sample, that was recruited from an inpatient rehabilitation program. Rehabilitation is a medical program, which is intended to enable individuals with chronic impairments or diseases to (i) cope with their impairment or disease and its consequences and (ii) participate in normal life in society independently and largely independently. It contains integrated intervention modules with medical, psychological, and educational treatment elements. The participants attended 5th to 12th grade; however, the majority of them were seventh and ninth graders from junior high schools (64.2%). They had not previously participated in outpatient treatment, but it was recommended that they seek outpatient treatment after rehabilitation. The adolescents included in this study needed to have good reading and writing skills. The main diagnosis had to be obesity (BMI > 97th percentile). The mean BMI standard deviation score (BMI-SDS) was 2.67 (SD = 0.52; range: 1.17–4.40). None of the participants were diagnosed with psychiatric disorders. A minority of the parents and children declined participation in the study (5%).

This study used cross-sectional data collected from 2 research projects in inpatient rehabilitation. The adolescents completed self-reports upon admission to the inpatient rehabilitation program of a specialized rehabilitation clinic for children and adolescents of the German Pension Insurance (DRV) North in Westerland/Sylt (Germany) between 2013 and 2017. The duration of the rehabilitation program varied between 4 (50.8%) and 6 weeks (49.2%). After pre-assessment, all of the adolescents were treated with an integrated program, that adhered to current guidelines [31] and consisted of physical exercises, nutritional training, and psychosocial intervention. The parents evaluated their children’s mental health problems at home immediately before their children entered the inpatient rehabilitation program.

Measures

Body Mass Index Standard Deviation Score

Weight and height were assessed with the participants wearing light clothing and no shoes. Measurements were performed by physicians during the medical admission examination and converted into the BMS-SDS in accordance with gender- and age-specific reference scores [32].

Mental Health Problems

The parents assessed their children’s mental health problems using the German version of the Strengths and Difficulties Questionnaire (SDQ-Deu parent proxy 4–17 [33]). The 25 items of the questionnaire were rated from “not true” (0) to “certainly true” (2). Five subtests were used in the present study: emotional problems, conduct problems, hyperactivity, peer-related problems, and prosocial behavior. Subtest scores could vary between 0 and 10. The internal consistency of the SDQ-Deu parent proxy was good in previous studies [34, 35]. Scale analyses revealed Cronbach alphas from 0.63 to 0.72 (emotional problems: 0.72, conduct problems: 0.61, hyperactivity: 0.72, peer-related problems: 0.63, and prosocial behavior: 0.63). Clinical scores (cutoff values) were determined according to Woerner et al. [36] and categorized as “subclinical,” “borderline,” and “clinical.” Due to concerns regarding lower reliability scores for the self-report form of the SDQ [18], the parent proxy reports were considered in the present analyses.

Health-Related Quality of Life

Using the German version of the disabled children’s quality of life measure (DISABKIDS Chronic Generic Measure; DCGM-37; [37]), HRQoL was assessed by self-report. The 5 dimensions “independence,” “limitation,” “emotion,” “inclusion,” and “exclusion” were evaluated in relation to the previous week. The dimension “medications/treatment” was not included in the study because it was irrelevant to the research question. The total score for the remaining 31 items was calculated and was used in this study. The item raw scores were transformed into percentage scores ranging from 0 to 100. High values indicate a high HRQoL. The good psychometric quality of the DCGM-37 has been proven in various studies [38, 39].

Statistical Analyses

All statistical analyses were performed using IBM SPSS Statistics 26. Mean differences in gender and age-group were determined using independent Student’s t tests, and inequality in variance was corrected by applying the Welch test. Mediation analyses were performed using the SPSS PROCESS version 3.4 macro, which uses regression analysis to test for mediation effects [40]. Simple mediation models with the 2 covariates “gender” and “age-group” were performed (gender: female = 1, male = 2; age-group: 12–14 years, i.e., early adolescents = 1, 15–17 years, i.e., late adolescents = 2). The empirically proven gender and age effects were controlled for by considering the covariates. A significance level of 5% for 2-sided tests was set.

The assumptions of the mediation analyses were tested by partial correlations between the model variables; additionally, the control variables were taken into account given that significant correlations of all model variables are a prerequisite for mediation analyses [41]. Again, a significance level of 5% for two-sided tests was applied. Linearity and homoscedasticity were given as prerequisites for the multiple linear regression analysis. Since PROCESS centers the variables, multicollinearity is reduced; thus, the results can be interpreted more accurately [42]. However, the condition indices varied from 26 to 27 and did not exceed the critical value of 30 [43]. In contrast, a normal distribution of residuals was not always given. However, this violation can be overcome by using bootstrap confidence intervals and a sufficiently large sample [40, 41].

The results of the mediation analyses were interpreted using the corrected \(R^2\) based on the number of predictors in the regression model. According to Cohen [44], the effect size \(R^2\) can be interpreted as small (0.02), medium (0.13), or large (0.26). Statistical validation of the indirect effect was performed using bootstrap confidence intervals (number of bootstrap samples: 5,000). The bootstrap confidence intervals of the unstandardized, partially standardized, and completely standardized effect sizes were considered [40, 41]; a significant mediation effect was reported if the interval between the lower limit and the upper limit of the 95% bootstrap confidence interval of all 3 effects did not contain zero. Consistent with Hayes [40], no distinction was made between partial and complete mediation in the present presentation of results.
Results

Descriptive Statistics

The distributions of clinical scores for mental health problems among the total sample of \( N = 313 \) adolescents are presented in Table 1. In contrast to the expected distribution of 80% normative scores and 10% each for borderline and clinical scores, the parents reported high clinical scores for emotional problems. Regarding gender, the male patients showed higher clinical scores for emotional problems and for hyperactivity. In terms of age-group, younger patients had higher percentages of clinical scores for conduct problems and hyperactivity than older patients did.

The ranges for the total sample indicate that the responses to HRQoL subscales were well distributed, suggesting that participants used the entire scale for their responses (Table 2). This was also true for the psychological problem subscales, with the exception of the conduct problems subscale, for which the parents used only the lower two-thirds of the response scale.

Differences in Gender and Age-Group

In independent Student’s \( t \) tests, gender effects were only ascertained for the BMI-SDS and hyperactivity; females showed a significantly higher BMI-SDS (\( t [303.2] = 2.57, p = 0.011 \)) and lower levels of hyperactivity than males (\( t [313] = -4.15, p < 0.001; \) Table 2). Moreover, age

Table 1. Frequencies (\( \Sigma \)) and percentages (\% \) of adolescents for mental health problems by manifestation, stratified by gender and age-group (\( N = 313 \))

| Variable              | Scores (total sample) | Scores (\( n = 193 \) females) | Scores (\( n = 120 \) males) | Scores (\( n = 181 \) 12–14-year-olds) | Scores (\( n = 132 \) 15–17-year-olds) |
|----------------------|-----------------------|---------------------------------|-------------------------------|----------------------------------------|----------------------------------------|
|                      | sc                    | b                               | c                             | sc                                     | b                                      | c                                       |
| Emotional problems   | 226                   | 25                              | 62                            | 142                                    | 19                                     | 32                                      |
|                      | % 72.2                | 8.0                             | 19.8                          | 73.6                                   | 9.8                                    | 16.6                                    |
| Conduct problems     | 231                   | 38                              | 44                            | 145                                    | 24                                     | 24                                      |
|                      | % 73.8                | 12.1                            | 12.1                          | 75.1                                   | 12.4                                    | 12.4                                    |
| Hyperactivity        | 267                   | 24                              | 22                            | 172                                    | 13                                     | 8                                       |
|                      | % 85.3                | 7.7                             | 7.0                           | 89.1                                   | 6.7                                    | 4.1                                      |
| Peer-related problems| 213                   | 59                              | 41                            | 136                                    | 32                                     | 25                                      |
|                      | % 68.1                | 18.8                            | 13.1                          | 70.5                                   | 16.6                                    | 13.0                                    |
| Prosocial behavior   | 289                   | 13                              | 11                            | 183                                    | 7                                      | 3                                       |
|                      | % 92.3                | 4.2                             | 3.5                           | 94.8                                   | 3.6                                    | 1.6                                      |

sc, subclinical; b, borderline; c, clinical.

Table 2. M, SDs, and Min-Max for the potential mediation variables stratified by gender and age-group

| Variable               | Total (\( N = 313 \)) | Gender | Age-group | 12–14 years (\( n = 181 \)) | 15–17 years (\( n = 132 \)) |
|------------------------|------------------------|--------|-----------|-----------------------------|-----------------------------|
|                       | M         | SD      | min | max | M       | SD | M | SD | M | SD | M | SD | M | SD |
| BMI-SDS                | 2.67      | 0.52    | 1.17 | 4.40 | 2.72  | 0.57 | 2.58 | 0.41 | 2.53 | 0.41 | 2.86 | 0.58 |
| Emotional problems     | 4.00      | 2.52    | 0.00 | 10.00 | 4.02  | 2.39 | 3.98 | 2.73 | 3.88 | 2.50 | 4.17 | 2.55 |
| Conduct problems       | 2.46      | 1.80    | 0.00 | 7.00 | 2.37  | 1.77 | 2.59 | 1.84 | 2.59 | 1.86 | 2.27 | 1.70 |
| Hyperactivity          | 3.45      | 2.13    | 0.00 | 10.00 | 3.07  | 2.03 | 4.07 | 2.14 | 3.75 | 2.24 | 3.00 | 1.88 |
| Peer-related problems  | 2.89      | 2.15    | 0.00 | 10.00 | 2.78  | 2.34 | 3.65 | 2.10 | 2.87 | 2.10 | 2.92 | 2.22 |
| Prosocial behavior     | 8.11      | 1.71    | 0.00 | 10.00 | 8.30  | 1.64 | 7.79 | 1.77 | 8.04 | 1.82 | 8.20 | 1.54 |
| HRQoL                  | 62.69     | 16.61   | 11.29 | 100.00 | 62.26 | 16.86 | 63.39 | 16.24 | 62.94 | 16.07 | 62.35 | 17.36 |

M, means; SDs, standard deviations; Min-Max, ranges; BMI-SDS, body mass index standard deviation score; HRQoL, health-related quality of life.

\( a \) Female > male, \( p = 0.011 \). \( b \) Female < male, \( p < 0.001 \). \( c \) 12–14 years <15–17 years, \( p < 0.001 \). \( d \) 12–14 years >15–17 years, \( p = 0.001 \).
effects were found for the BMI-SDS and hyperactivity; the younger age-group had a significantly lower BMI-SDS than the older age-group ($t \{224.2\} = −5.63$, $p < 0.001$). Additionally, the younger age-group scored significantly higher on hyperactivity than the older age-group ($t \{313\} = 3.25$, $p = 0.001$). Hence, both variables were included in the mediation model as covariates to control for these effects.

**Partial Correlations**

Table 3 presents the partial correlations between the potential mediation variables while controlling for gender and age-group. The prerequisite of significant correlations between the potential mediating variables “hyperactivity” and “prosocial behavior” and the predictor “BMI-SDS” was not given. Thus, 3 simple mediation models with the 2 covariates “gender” and “age-group” were tested:

1. The relationship between BMI-SDS and global HRQoL with emotional problems as a mediator
2. The relationship between BMI-SDS and global HRQoL with conduct problems as a mediator
3. The relationship between BMI-SDS and global HRQoL with peer-related problems as a mediator.

It was assumed that mental health problems would mediate the inverse association of the BMI-SDS with global HRQoL.

**Mediation Analyses**

In all 3 models, BMI-SDS was included as the independent variable ($X$), and global HRQoL was included as the dependent variable ($Y$). The mediators ($M$) differed in the 3 models. Emotional problems were investigated in model 1, conduct problems in model 2, and peer-related problems in model 3. The standardized coefficient ($\beta$) is reported for the 4 pathways ($a, b, c, c'$) and the indirect effect ($ab$).

A significant total and direct effect was identified for all 3 mediation models. Furthermore, mediation effects were found in all 3 models. Neither the unstandardized nor the partially or completely standardized effects of the 95% bootstrap confidence intervals included zero (Fig. 1–3). When mental health problems were included as mediators, all direct effects were reduced in magnitude but still remained significant. Moreover, both mediating pathways were also significant in all 3 models.

**Mediation Model 1**

The model illustrates that the explanation of the variance in global HRQoL increased from 7% to 28% when emotional problems were included as a mediator in the association between BMI-SDS and global HRQoL ($c$ coefficient $= −0.29$, SE $= 0.05$, $p < 0.001$, 95% CI $[−0.40; −0.17]$; $c'$ coefficient $= −0.19$, SE $= 0.05$, $p < 0.01$, 95% CI $[−0.30; −0.09]$; Fig. 1). Accordingly, the effect size increased from small to large. Thus, a higher BMI-SDS predicted higher levels of emotional problems, which subsequently predicted lower global HRQoL.

**Mediation Model 2**

The model only revealed an increase in the proportion of the explained variance in global HRQoL from 7% to 12% when conduct problems were considered a mediator in the relation between BMI-SDS and global HRQoL ($c$ coefficient $= −0.29$, SE $= 0.05$, $p < 0.001$, 95% CI $[−0.40; −0.17]$; $c'$ coefficient $= −0.26$, SE $= 0.06$, $p < 0.001$, 95% CI $[−0.37; −0.15]$; Fig. 2). Both effect sizes were small.

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**Table 3. Partial correlations of the potential mediation variables controlled for “gender” and “age-group” ($N = 313$)**

| Variable                      | BMI     | Emo    | Beh   | Hyp   | Per   | Soc   | HRQoL |
|-------------------------------|---------|--------|-------|-------|-------|-------|-------|
| BMI-SDS (BMI)                 | 1.00    |        |       |       |       |       |       |
| Emotional problems (Emo)      | 0.19*** | 1.00   |       |       |       |       |       |
| Conduct problems (Beh)        | −0.19*  | 0.34***| 1.00  |       |       |       |       |
| Hyperactivity (Hyp)           | 0.09    | 0.30***| 0.41***| 1.00  |       |       |       |
| Peer-related problems (Per)   | 0.23*** | 0.44***| 0.29***| 0.17**| 1.00  |       |       |
| Prosocial behavior (Soc)      | 0.07    | −0.17**| −0.42***| −0.25***| −0.27***| 1.00  |       |
| HRQoL                         | −0.27***| −0.50***| −0.25***| −0.23***| −0.44***| 0.19**| 1.00  |

BMI-SDS, body mass index standard deviation score; Emo, emotional problems; Beh, conduct problems; Hyp, hyperactivity; Per, peer-related problems; Soc, prosocial behavior; HRQoL, health-related quality of life. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. 

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BMI-SDS (X) Health-related quality of life (Y)

Fig. 1. Model 1: mediating effects of emotional problems on the relation between BMI-SDS and global HRQoL ($\beta$ = standardized regression coefficient, $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$). Note: simple mediation analyses using “gender (C1)” and “age-group (C2)” as covariates ($a$ = direct path of BMI-SDS; $X$ on mental health problems (M), $b$ = direct path of mental health problems on global HRQoL (Y), $c$ = path of BMI-SDS (X) on HRQoL (Y), and $c' = $ path of BMI-SDS (X) on HRQoL (Y) mediated by mental health problems (M). SE = standard error, 95% B-CI = 95% bootstrap confidence interval; BMI-SDS, body mass index standard deviation score; HRQoL, health-related quality of life.

Fig. 2. Model 2: mediating effects of conduct problems on the relation between BMI-SDS and global HRQoL ($\beta$ = standardized regression coefficient, $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$). SE = standard error, 95% B-CI = 95% bootstrap confidence interval; BMI-SDS, body mass index standard deviation score; HRQoL, health-related quality of life.

Fig. 3. Model 3: mediating effects of peer-related problems on the relation between BMI-SDS and global HRQoL ($\beta$ = standardized regression coefficient, $^*p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$). SE = standard error, 95% B-CI = 95% bootstrap confidence interval; BMI-SDS, body mass index standard deviation score; HRQoL, health-related quality of life.
Mediation Model 3

The explained variance in HRQoL increased from 7% to 22% when peer-related problems were included in the mediation model as a mediator (c: coefficient = −0.29, SE = 0.05, \( p < 0.001 \), 95% CI [−0.40; −0.17]; \( c' \): coefficient = −0.18, SE = 0.05, \( p < 0.001 \), 95% CI [−0.29; −0.08]; Fig. 3). Accordingly, the effect size increased from small to moderate.

Moderating Effects

No gender effects could be ascertained. In contrast, a significant correlation was indicated for the covariate “age-group” in mediation model 2. The parents reported more conduct problems among adolescents aged 12–14 years than among adolescents aged 15–17 years (\( f_2 \): coefficient = −0.24, SE = 0.12, \( p < 0.05 \), 95% CI [−0.48; −0.01]; Fig. 2).

Discussion

The present study provided results regarding the relations among BMI-SDS, parent proxy-reported mental health problems, and self-reported global HRQoL in adolescent inpatients with obesity, and these findings are of important clinical relevance. First, BMI-SDS significantly predicted global HRQoL. Second, emotional, conduct, and peer-related problems mediated the associations between BMI-SDS and global HRQoL. Moderating effects of gender and age-group were exclusively found for conduct problems, indicating that conduct problems are increased among early adolescents compared with late adolescents. Research on age effects in population-based studies revealed rather inconclusive results, showing increased conduct problems in early adolescents compared with late children [45] and enhanced conduct problems among children and early adolescents than among late adolescents [46].

In bivariate partial correlation analyses, BMI-SDS was negatively associated with emotional, conduct, and peer-related problems, which is consistent with prior results showing an adverse impact of obesity and BMI on mental health problems [18–20]. In contrast, BMI-SDS was not significantly linked with hyperactivity or prosocial behavior. Past research has provided inconclusive results regarding the relation of attention-deficit hyperactivity disorder (ADHD) with obesity, studies have both shown that childhood ADHD does not predict adult BMI when the analyses are controlled for conduct disturbance symptoms [47] and suggested that ADHD has predictive value for obesity [48]. However, the use of a screening instrument versus a clinical interview seems to weaken the association [48]. Consistent with earlier cross-sectional studies with population-based samples, mental health problems were inversely associated with global HRQoL [15, 27].

The present results extend the research on the mediating role of mental health problems in the association between BMI-SDS and global HRQoL. As expected, BMI-SDS was positively linked with emotional, conduct, and peer-related problems, and these mental health problems were subsequently inversely associated with global HRQoL. Interestingly, the mediating value of emotional problems was clinically significant, showing an increase from a small to a large effect size. The mediating effect of peer-related problems had a somewhat decreased association, with moderate clinical significance. In contrast, conduct problems had low clinical significance. As cited above, when the direct effects of BMI on mental health problems were investigated in a population-based study, the same association was found for self-reported peer-related problems [19]. Moreover, these authors also reported weaker associations for conduct and emotional problems, which exhibited a 1.90- and 1.55-fold increased risk among adolescents with obesity, respectively. Furthermore, gender effects on emotional problems were found in this substudy of the KiGGS; multivariate analyses yielded significant effects on emotional problems for females, but not males, with obesity. In contrast, moderating effects of gender were not be found in the present mediation model. Variable methods and factors, such as the type, size, and age range of the sample, as well as the type of informant (parental- or self-report), may account for the different effects.

However, past research has underscored the crucial impact of internalizing problems on obesity (e.g., [22]) and on HRQoL (e.g., [15]). Other studies have added to the growing evidence of the crucial role of mental health problems in the onset and maintenance of obesity (e.g., [17]). Hence, the mediation results of this study have important implications for research and practice, suggesting that mental health problems may play a key role in the relation of BMI-SDS and HRQoL. Existing multimodal intervention programs for adolescents with obesity, which focused on a combination of diet, physical activity, and behavioral components and displayed short-term intervention effects [49], can be modified accordingly with the aim of extending the effects of such interventions in the long-term. First, the finding of adverse influences of emotional, conduct, and peer-related

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problems underlines the importance of emotion regulation training to improve adolescents’ maladaptive adjustment to their increased perceived stress. Based on a framework of a stress-obesity relationship in which emotion regulation is assumed to be the missing link, an inpatient program has been developed [50]. An ongoing evaluation study will provide important results for the future. Second, the moderate mediation effect of peer-related problems may reflect the increased perceived interpersonal stress among adolescents with obesity, especially the experience of weight-related teasing and victimization, which has been shown to be a significant mediator in the relation between BMI or obesity and psychosocial health [18, 26, 28, 29]. Similarly, the importance of addressing weight stigma “as a psychosocial contributor to obesity” in improving the success of weight management programs was emphasized in a current study [51]. Thus, the implementation of elements aimed at improving social-emotional competencies is recommended.

Some limitations of this study should be noted. First, when a clinical sample is used in a study, uncontrolled selection effects cannot be excluded. However, the main intention of the present study was to identify significant psychological mediating factors, that can be addressed in future intervention programs. Nonetheless, the increased odds of mental health problems among adolescent patients with obesity should be compared with those of age- and gender-matched healthy controls in the future. Second, based on the findings of bidirectional associations between BMI or obesity and psychosocial health, the cross-sectional design of the study must be discussed. Although conclusions about the direction of associations cannot be drawn, increasing consensus in the literature suggests that BMI or obesity predicts psychosocial health among children and adolescents rather than the reverse [25]. Nevertheless, future studies should examine these relations using a prospective study design. A third limitation refers to the use of single informants; mental health problems were not measured by self-reports in the first research project due to concerns about the restricted reliability of the SDQ-S [18]. Although the SDQ-S was integrated into the second research project, which had a sample of \( N = 142 \), the internal consistencies were insufficient, and these self-reports could not be used in further analyses. However, some research has indicated good agreement between self- and parent proxy-reported emotional problems and total scores based on independent Student’s \( t \) tests [52]. HRQoL was only assessed by a self-report measure. However, studies indicate that parents overestimate the impact of obesity on the HRQoL of their children [12, 53].

Conclusions

The present study extends previous evidence of the significant association between obesity and psychosocial factors among adolescents. Mental health problems may be one salient pathway through which BMI-SDS impairs global HRQoL in adolescents with obesity. Hence, early diagnosis of mental health problems is recommended, and early interventions should be applied to identified risk groups. In agreement with current treatment guidelines, the present findings support the notion that in the conceptualization of multimodal interventions, increased attention to psychosocial factors is warranted. Thus, the promotion of emotion regulation and social-emotional competencies is advised. However, due to the crucial impact of social factors, such as weight-related stigmatization in society, self-management programs should be supplemented by setting-based interventions to better prevent the onset and maintenance of obesity and comorbid mental health problems in adolescents.

Statement of Ethics

The analyzed data combined data sets from 2 research projects that received full approval from the Ethical Review Board of the “Ärztekammer SH” (approval no. 083/12) and the German Psychological Society (DGPs; approval no. PH_112015) and was conducted in accordance with the 1964 Helsinki Declaration and its later amendments. Written informed consent was obtained from the parents and adolescents included in the study.

Conflict of Interest Statement

The authors have no conflicts of interest to declare.

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Author Contributions
R. Stachow collected the data, and P. Hampel analyzed the data and wrote the paper. J. Wienert provided essential support during the writing process and collaborated on 1 of the 2 studies. All authors agreed to publish the paper.

Data Availability Statement
The data sets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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