Body weight status is not a predictive factor of depressive symptoms in Polish adolescents aged 13-18 years

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ABSTRACT: Depression and unhealthy weight status are among the most common concerns in adolescent boys and girls. Research results on the relationship between depression and weight status are contradictory. The aim of the present study was to assess the association between body weight status and depressive symptoms among Polish adolescent boys and girls. The cross-sectional survey was carried out on adolescents attending lower and higher secondary schools located in three medium-sized cities and one big agglomeration in Poland. Anthropometric measurements, such as body height and weight, were performed. Beck Depression Inventory-II (BDI-II) was used to assess depressive symptoms. The total sample consisted of 624 boys and 910 girls aged 13-18 (the mean age was 16.4 ± 1.8) participated in the study. Of them, 73.3% had a healthy weight status, 12.9% were classified as thin, 11.4% were overweight and 2.5% were obese. The prevalence of depression based on BDI-II was 20.2% in boys and 34.9% in girls. The Kruskal–Wallis test revealed a lack of association between the body weight status and total scores of depressive symptoms after controlling for age ($p=0.98$ and $p=0.4$ for boys and girls, respectively). The multiple regression analysis revealed that gender and age differentiated the depressive symptoms (for gender: ß=0.19; SE=0.38; $p<0.001$ and for age: ß=0.05; SE=0.1; $p<0.05$). Age and gender explained 3.5% of the total variance of depressive symptoms. The study did not confirm the association between the body weight status and depression in adolescence.

KEY WORDS: BMI, adolescence, depression, underweight, overweight, obesity

Introduction

One of the most common problems among adolescent people living in Western societies are unhealthy weight status and depressive mood/depression. Current data indicate that the prevalence of underweight adolescents in Poland varies between 8% and 10.9% for boys and girls aged 13-18, respectively (Kaczmarek 2011). Whereas 14.1% boys and 10.5% girls were overweight and 3.7% boys and 2.4% girls were obese (Durda 2011). These observations agree well with those of others. Kułaga and colleagues (2016) found that 14.6-19.4% boys and 10.3-13.%

girls aged 13-18 were overweight and obese. Based on the WHO report for Poland, 28% boys and 16% girls were overweight at the age of 13 and 20% boys and 12% girls were overweight at the age of 15 (Currie et al. 2012). Adolescent elevated weight status, both overweight and obesity, is more common in boys than in girls, and tends to decrease with age (Inchley et al. 2016). There is also evidence for an increased tendency of the prevalence of underweight children in Poland. Grajda and colleagues' study (2011) indicates 10% boys and 13.7% girls being underweight.

Adolescence is a dynamic period of life and can be defined as a physical transition marked by the onset of puberty and the termination of physical growth. Physical maturation during puberty involving bodily changes due to significant height and weight gain (pubertal growth spurt), the distribution of body fat, acquisition of muscle mass, and the development of secondary sexual characteristics (Tanner 1962; Bogin 2005). It is also a period of cognitive and social changes to prepare for adult roles (Kapur 2015; Özdemir et al. 2016). This period of dramatic physical, hormonal and cognitive changes, exposure to high levels of stress and anxiety is often linked to depressive mood or depression. When the disease is active, signs and symptoms may include: low mood (two weeks or more), sleep difficulties, weight loss or weight gain, diminished interest or pleasure, fatigue, diminished ability to think and concentrate, feelings of worthlessness, recurrent thoughts of dead, suicidal ideation, suicidal attempt or plan (Bahls 2002; Hussain, Dubicka and Wilkinson 2018). These signs and symptoms can differentiate individually but affect the functioning in all spheres of life: at home, at school and in peer and family relationships.

Depression more often occurs at adolescence and has a tendency to continue to the next stages of ontogenesis (Birmaher et al. 1996). Depressive symptoms are associated with many behavioural problems, increased risk for substance abuse or suicide attempts (Bahls 2002, Hussain, Dubicka and Wilkinson 2018). During childhood boys are more likely to be depressed than girls, but later depression is more common in girls and this differentiation begins at the age of about 14 years (Cash and Pruzinsky, 1990; Kołodziejek 2008; Kalinowska et al. 2013).

Research on the association of body weight status and depression has so far proved inconclusive.

Several studies have indicated positive and significant relationships between BMI and depressive symptoms (de Wit et al. 2009; Rerah-Levy et al. 2011; Tashakori, Riahi and Mohammadpour 2016). They emphasized a linear nature of the relationship (Tashakori, Riahi and Mohammadpour 2016). Some other studies have found a U-shape association between BMI and depression indicating the two extremes: underweight and obese individuals are more prone to experience depression than their healthy weight peers (de Wit et al. 2009; Rerah-Levy et al. 2011; Eidsdottir et al. 2013). Some other studies have reported that there was no significant association between weight status and depression (Hallstrom and Noppa 1981; Palinkas, Wingard and Barrett-Connor 1996; Wyatt et al. 2003; Kress, Peterson and Hartzell 2006; Ohayon and Hong 2006; Askari et al. 2013). Contradictory research results suggest that the relationship between these two conditions – abnormal weight status and depression – is not a simple one and is under the influence of many factors: sociodemographic, psychosocial and cul-

tural (Askari et al. 2013). Taking into account the abovementioned statement, the main aim of the present study was to assess the association between weight status and depressive symptoms among Polish adolescent boys and girls.

Material and methods

Study design and participants

The cross-sectional survey was carried out on adolescent boys and girls attending lower and higher secondary schools located in three medium-sized cities and one big agglomeration in the Wielkopolska region of Poland. The study design and data collection procedures were approved by the Bioethics Commission of the Poznań University of Medical Sciences (no. 1016/09). The survey was carried out in compliance with the principles outlined in the Helsinki Declaration as amended (World Medical Association Declaration of Helsinki, 2001). The schools were randomly selected from government listings of secondary public schools in this region. Participation in the study was voluntary. The study was carried out subject to prior receipt of written consents of the head of the institution and the parents. The research conditions were adequate and identical for everybody. The schoolers filled in a questionnaire survey and the BDI-II scale on their own during classes and, subsequently, moved to the nurse's office in order to allow the researchers to collect anthropometric measurements.

Measurement of depression

Beck Depression Inventory-II (BDI-II) was used to assess depression. The BDI--II is one of the most widely used psychometric instruments for screening studies. This questionnaire was created in 1996 by Aaron T. Beck and based on the first version from 1961 (Beck 1961; Beck, Steer and Carbin 1988; Beck 1996; Richter 1998). BDI-II takes into account many symptoms for the diagnosis of depressive disorders by DSM-IV TR (Zawadzki, Popiel and Pragłowska 2009). The first questions assess the cognitive-affective symptoms associated with depression, the other questions are related to somatic symptoms, such as sleeping disorders, weight lost, fatigue, and loss of appetite (Neki 2013). The self-reported questionnaire consists of 21 questions and can be used by individuals who are aged at least 13 (Farinde 2013; Dolle et al. 2012). The BDI-II contains a scale from 0 to 3, maximum score is 63. Scores from 0 to 9 mean no depressive symptoms, scores from 10 to 16 indicate mild depression, scores from 17 to 29 indicate moderate depression, and scores from 30 to 63 indicate severe depression (Farinde 2013). The Cronbach's alfa for the Polish version of the questionnaire was 0.93 and 0.95 which indicates a high reliability of the tool. The questionnaire is also characterized by a high diagnostic accuracy (Zawadzki, Popiel and Pragłowska 2009). The study lasted usually 5-10 minutes.

Anthropometric measurements

Anthropometric measurements, such as body height and weight, were performed in school nursery rooms during morning hours and taken according to standard procedures (Knussmann, 1988/1992). The body weight of the subjects was measured with the use of calibrated electronic scales (measurement accuracy up to 0.1 kg). A Swiss anthropometer GMP (Gneupel Praezisions Mechanik, accuracy up to 0.1

cm) was used to measure the subjects' B-v, i.e. the distance between the vertex point and the basis (Ba) on which a given subject stood, preserving the Frankfurt plane. The data concerning body mass and height were subsequently recalculated to obtain the Body Mass Index (BMI). BMI was calculated by taking a subject's weight (kg) and dividing it by his/her height squared (m^2). Following the IOTF (International Obesity Task Force) recommendation, Cole's cut-off values were used to determine the following weight status: underweight with three categories of thinness, normal/healthy weight, overweight and obese (Cole et al. 2000; 2007). Chronological age was calculated in decimal values by subtracting the date of examination from the date of birth. The age groups were divided by years, defined in terms of the whole year, e.g. the 13-year-old group included subjects aged 13.00 to 13.99 years.

Statistical analysis

The statistical analysis of the data was carried out with the use of the statistical package for social sciences IBM SPSS, version 25 and Statistica, Statsoft Polska version 12.1. That included a descriptive statistical analysis, Kolmogorov-Smirnov test for one sample, chi² test multiple regression and logistic analyses.

Results

The characteristics of our sample are presented in Table 1.

This study was performed on a sample of 1,534 adolescents aged 13 – 18 that consisted of 624 boys and 910 girls. The mean age was 16.4±1.8 (17.0±1.7 for boys and 16.0±1.8 for girls). Out of

Table 1. Characteristics of the study sample

Variable	n (%)
Age (years)[a]	16.4 ± 1.8
Gender	
Boys	624 (40.7)
Girls	910 (59.3)
Type of school	
Lower secondary school	618 (40.3)
Upper secondary school	916 (59.7)
Weight status (BMI kg/m²)	
Thinness grade 3	4 (0.3)
Thinness grade 2	26 (1.7)
Thinness grade 1	167 (10.9)
Normal weight	1123 (73.3)
Overweight	175 (11.4)
Obesity	38 (2.5)
Depressive symptoms (BDI-II)	
No depression	1090 (71.1)
Mild depression	329 (21.5)
Moderate depression	66 (4.3)
Severe depression	48 (3.1)

[a]Mean±SD
BDI-II – Beck Depression Inventory – II total scores

the total number of subjects constituting the research sample, 40.3% (42.3 boys and 38.9% girls) were lower secondary school students and 59.7% (57.7% boys and 61.1% girls) were upper secondary school students.

The distribution of the body weight status indicated that 0.3% of the adolescents (0.3% boys and 0.2 girls) were classified as thinness grade 3, 1.7% (0.6% boys and 2.4% girls) as thinness grade 2, and 10.9% (6.4% boys and 14.0% girls) as thinness grade 1. Those of the normal weight status accounted for 73.3% (73.4% boys and 73.2% girls), 11.4% (15.7% boys and 8,5% girls) were over-

weight and 2.5% (3.5% boys and 1.8% girls) were obese.

With regard to depression incidence, a large majority of the sample under study (71.1%) did not have depression, 21.5% adolescents were classified as experiencing mild depression, 4.3% as moderate and 3.1% had severe depression.

Distribution of depressive symptoms assessed using the BDI-II revealed a lack of normal distribution (Kolmogorov-Smirnov test for age-and gender specific sample, $p<0.001$). The median score obtained by the adolescents was 5.0 (4.0 for boys and 6.0 for girls) and the gender difference was statistically significant ($p<0.001$). The distribution of the depressive symptoms according to gender and weight status and the values of the Chi-square test are presented in Table 2. As shown in the table, a significantly higher fraction of boys did not have depression compared to girls (79.8% vs. 65.1%), whereas 24.9% of boys and 26.0% of girls had mild, and 3.0% of boys and 5.2% of girls had moderate depression. Severe depression was found in 2.2% of boys and 3.7% of girls (chi^2 = 38.8; $p<0.001$). The rate of depression in groups of various weight status revealed that 7.7% boys and girls classified as severe depression were very thin (thinness grade 2) and 5.1% were overweight. However, this finding is biased by a small subsample size. Almost three-quarters (70.9%) of the adolescents with healthy weight did not have depression and 78.9% of those with obesity were free from depression.

Scatterplots display total depressive symptoms scores and age, and symptoms and BMI in study sample as shown in figure 1 and 2.

There was very weak relationship between depressive symptoms and age. Pearson's correlation was r=0.022 and r=0.079 for boys and girls, respectively. However, only for girls correlation was statistically significant ($p=0.017$).

The statistical output for depressive symptoms and body weight status indicated that there was no relationship between these two variables.

The Krusal–Wallis test revealed a lack of association between body weight status and depressive symptoms after controlling for age ($p=0.98$ and $p=0.4$ for boys and girls, respectively).

Table 2. Distribution of depressive symptom levels (BDI-II total scores) by gender and weight status

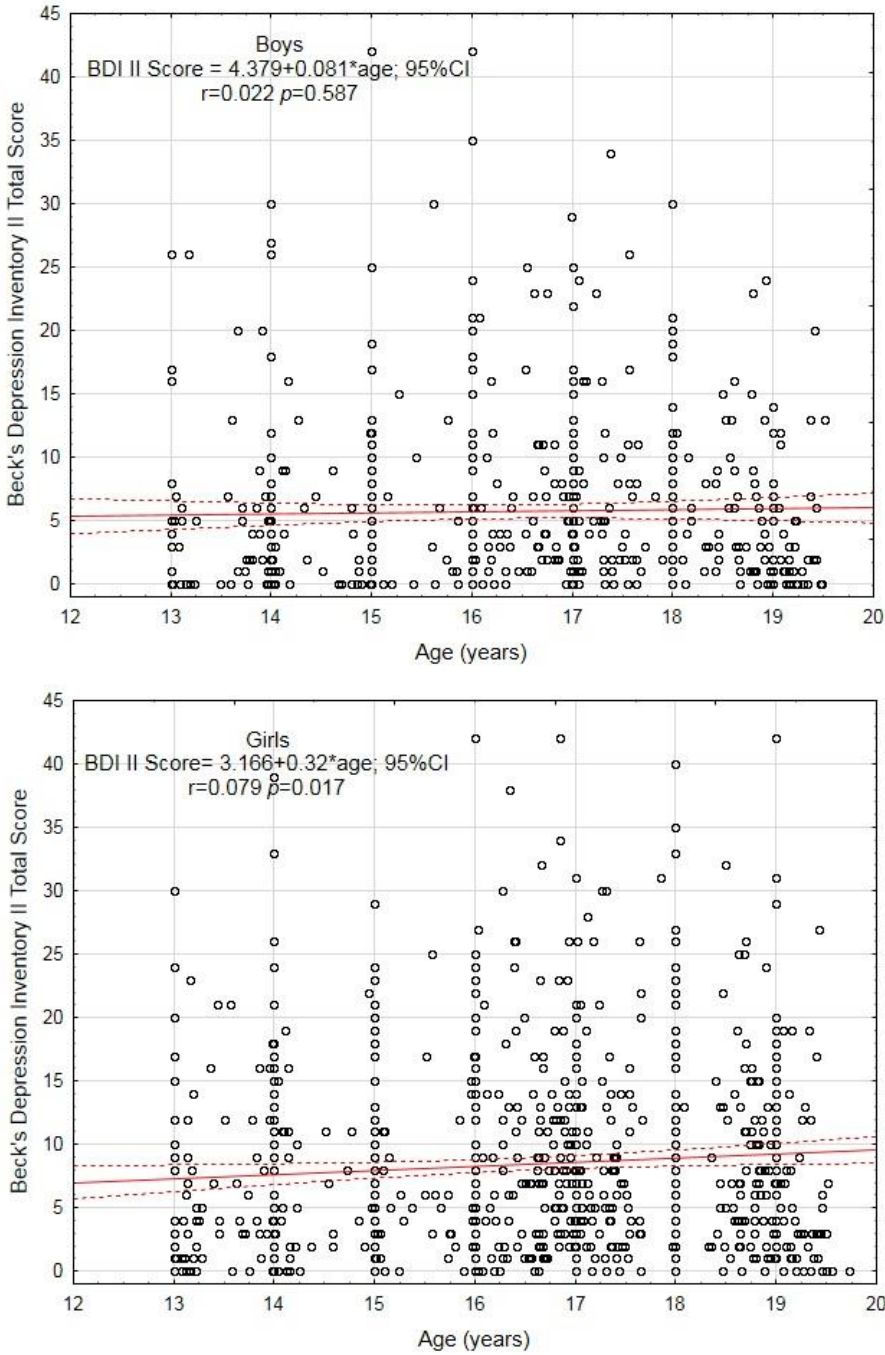| Variable	Depression n (%)				
	No	Mild	Moderate	Severe	Chi-square
Gender					
Boys	498 (79.8)	93 (14.9)	19 (3.0)	14 (2.2)	38.8;
Girls	592 (65.1)	236 (26.0)	47 (5.2)	34 (3.7)	$p<0.001$
Weight status					
Thinness grade 3	3 (75.0)	1 (25.0)	0	0	8.69; $p=0.89$
Thinness grade 2	19 (73.1)	4 (15.4)	1 (3.8)	2 (7.7)	
Thinness grade 1	119 (73.1)	39 (23.4)	5 (3.0)	4 (2.4)	
Normal weight	796 (70.9)	245 (21.8)	49 (4.4)	32 (2.9)	
Overweight	123 (70.3)	34 (19.4)	9 (5.1)	9 (5.1)	
Obesity	30 (78.9)	5 (13.2)	2 (5.3)	1 (2.6)	

Fig. 1. Scatter plots displaying the association between total depressive symptoms scores and age categorized by gender
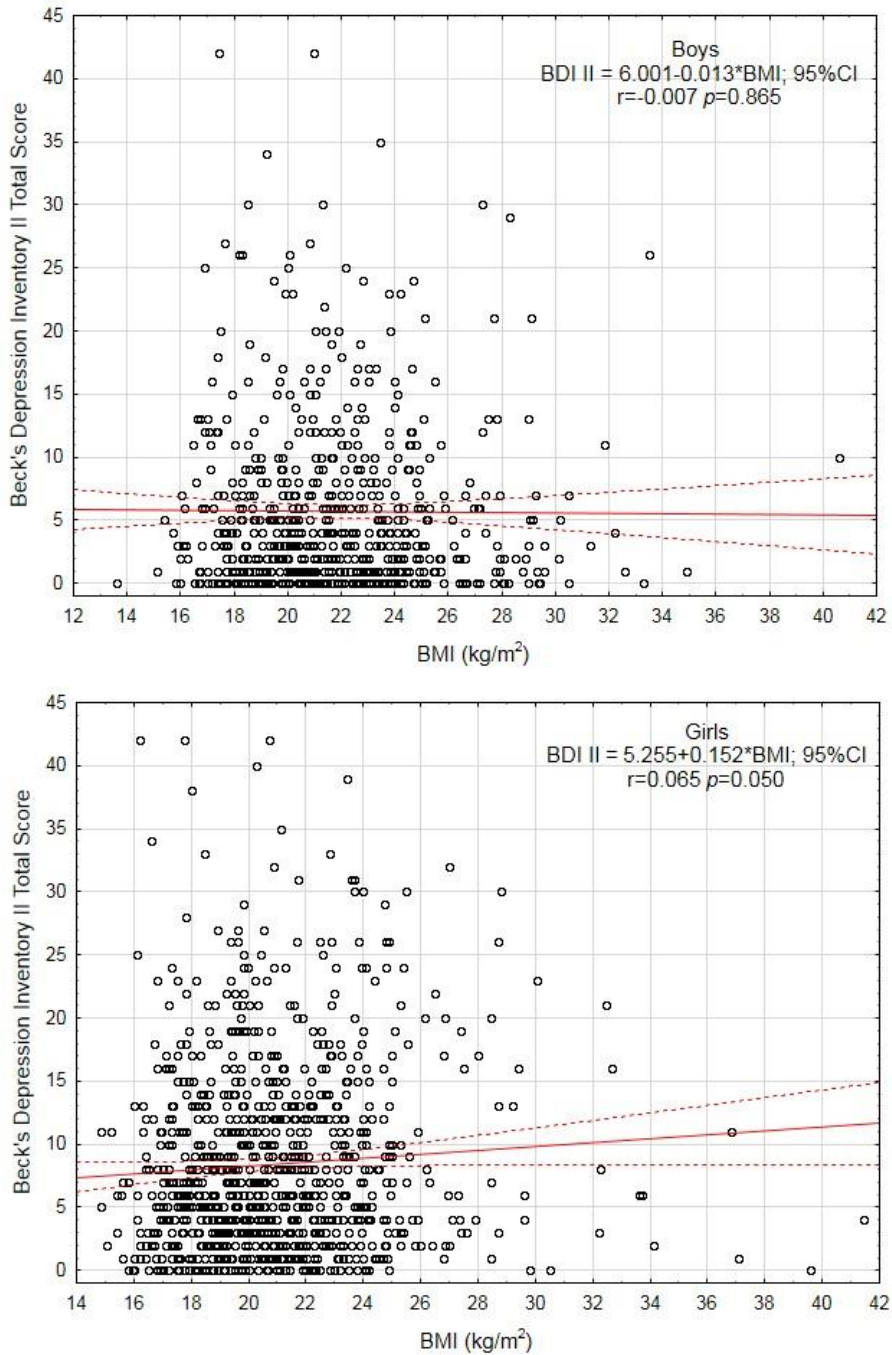
Fig. 2. Scatter plots of the association between total depressive symptoms scores and body weight status categorized by gender in adolescents aged 13-18 years

The multiple regression analysis, shown in table 3, revealed that two variables, i.e. gender (ß=0.185 (95%CI: 0.135;0.234), SE=0.025; $p<0.001$) and age (ß=0.051 (95%CI: 0.008;0.101), SE=0.025; $p<0.05$) differentiated the depressive symptoms scored with the use of the BDI-II. Age and gender explained 3.5% of the total vari-ance of depressive symptoms. Body weight status described in terms of BMI did not reveal statistically significant association with depressive symptom scores (ß=0.03; SE=0.06; $p=0.29$).

As shown in Table 4, girls were two times more likely than boys to develop depression (OR=2.10; 95%CI 1.66;2.68;

Table 3. Association between depressive symptoms and potential predictive variables in adolescents using multiple regression analysis

Potential predictive variable	Outcome variable Beck Depression Inventory – II total scores				
	β	95%CI	SE	t	*p*-value
Constant	-1.720	-5.672;2.232	2.015	-0.854	0.393
Sex (Boys; Girls)	0.185	0.135;0.235	0.025	7.309	<0.001
Age (13-18 years)	0.051	0.0008;0.101	0.025	1.993	0.046
BMI (kg/m^2)	0.027	-0.023;0.078	0.026	1.059	0.289

Adjusted R^2 = 0.035; 95%CI – 95% confidence interval

Table 4. Adjusted associations between depressive symptoms and predictive variables: results of multiple logistic regression models with backward elimination procedure

Predictive variable	Initial model[a]		Final model[b]
	n	OR (95%CI)	OR (95%CI)
Gender			
Boys (Ref.)	624	1	1
Girls	910	2.14 (1.68;2.73)	2.10 (1.66;2.68)
p-value for trend		<0.0001	<0.0001
Age (years)			
13 (Ref.)	140	1	1
14, 15, 16, 17	972	1.09 (1.02;1.17)	1.10 (1.03;1.18)
18	422	1.74 (1.15;2.62)	1.80 (1.20;2.70)
p-value for trend		0.008	0.004
Weight status (BMI kg/m^2)			
Thinness grade 3 (Ref.)	4	1	
Thinness grade 2	26	1.08 (0.91;1.30)	
Thinness grade 1	167	1.18 (0.83;1.69)	
Healthy/Normal weight	1123	1.29 (0.76;2.20)	
Overweight	175	1.41 (0.69;287)	
Obesity	38	1.54 (0.63;3.73)	
p-value for trend		0.343	

[a]Adjusted for gender, age and weight status (BMI); Constant -4.010;Wald=35.683; $\chi2$=48.869; df=3; $p < 0.0001$.
[b]Adjusted for gender and age; Constant -3.714; Wald=38.46; $\chi2$ =47.901; df = 2; $p < 0.0001$.

p<0.0001) and the probability of having this condition was increased by 1.10 times for each single year. Adolescents aged 18 years were 1.7 times more likely to be depressed (OR=1.80; 95%CI 1.20;2.70; *p*=0.004).

Discussion

Adolescence is known to be a demanding and critical period of life. It has been documented that the prevalence of major depression in adolescence is much greater than in childhood - 3.3%-12.4%, even up to 20.0% vs. 0.4-3.0% (Bahls 2002; Hussain, Dubicka and Wilkinson 2018); in Poland it is 2-15% vs. 0.2-2% and at the age of 18, as many as 20% of adolescents had at least one depressive episode (Kołodziejek 2008; Kalinowska et al. 2013). In the presented study based on adolescents aged 13-18 years, the prevalence of depression based on BDI--II was 20.2% in boys and 34.9% in girls. Depression is therefore a significant problem among Polish young girls and boys. Adolescent depression is a serious health care problem not only in Western countries, but also in developing countries, such as Kenya (prevalence is around 26.4%) and Nigeria (prevalence between 12.6 and 16.3%) (Oderinde et al. 2018).

Many studies have indicated a positive association between depression and weight status. Adolescents with obesity had a 40.0% higher risk of depression than their normal weight counterparts (Mannan et al. 2016). Brewis and Bruening (2018) carried out a systematic review and meta-analysis of longitudinal studies and found a prospective association between depression and obesity for adolescents (n=1443). Students who were classified as overweight or obese and had body shame had higher mean depression scores than those who had overweight or obesity and did not have body shame (2.53 ± 0.85 vs. 1.88 ± 0.66; *p*<0.05) (Brewis and Bruening 2018).

Tashakori and colleagues (2016) reported that the prevalence of major depression among obese females was 86.2% and 13.8% for moderate depression. Rerah-Levy and colleagues (2011) examined 39,542 adolescents at the age of 17 and found significant association between BMI and depression both for boys and girls. Moreover, they found a U-shape association for boys, for girls the association showed inverted convexity for high levels of BMI and the prevalence of depression was higher among overweight girls than obese girls.

There was some evidence indicating a significant positive relation between obesity and low levels of anxiety and depression among adults. This association was named 'the jolly fat hypothesis' (Crisp and McGuiness 1976). Unfortunately, other studies have not confirmed it (Dearborn, Robbins and Elias 2018).

In the same time, there are a lot of studies that have indicated no link between depressive symptoms and a weight status. Askari and colleagues (2013) investigated 400 individuals aged 16-50 of whom 200 were obese and indicated no differences in the level of depression between the healthy and obese groups of the body weight status. Our study did not reveal the association between total scores of BDI-II and weight status (Final model: ß=0.03; SE=0.06; *p*=0.29). Roberts and Duong (2013) in their two-way prospective cohort study of adolescent girls and boys aged 11-17 (initial sample consisted of 4,175 individuals) did not confirm the relationship between depression and a weight status; however, depression was found to increase the risk of future obe-

sity more than twofold. Depressed boys had a sixfold increased risk for obesity (Roberts and Duong 2013; Wilson and Goldfield 2013). Interestingly, depressive symptoms during adolescence may be a risk factor for obesity in the later stages of life (Mooreville et al. 2014).

The relationship between depression and obesity might be explained through (1) behavioral mechanisms, such as dieting, (2) cognitive mechanisms, such as body image and self-esteem, and (3) social mechanism, such as stigma (Neki 2013). Various factors may influence the relationship between depression and weight status, e.g. gender, age, socioeconomic status (SES), eating behaviours, physical activity, and stress (Stunkard, Fairth and Alison 2003; Askari et al. 2013, Neki 2013).

Some studies have shown a positive association between depression and obesity only for women, not for men, with younger women being at a risk group for both obesity and depression (Neki 2013). The association between a higher level of BMI and depression is significantly stronger among adolescent girls than boys and this association has been mediated entirely through perceptions of body image (Eidsdottir et al. 2013). In the present study, we did not find any differences between boys and girls in the relationship between depressive symptoms and weight status, but girls differed significantly from boys in terms of depressive symptoms.

Study limitations

Although this study has reached its aim, it could have been affected by some unavoidable limitations. The weak point of this study may lie in its cross-sectional design. According to several suggestions, it would be better if it was done longitudinally. However, longitudinal design is usually carried out on the account of sample size. Cross-sectional design and large sample size that were examined in this study may enhance the generalizability of our findings. It seems to be the strength of this study.

Conclusions

The study revealed null relationship between body weight and depression in adolescence. The main predictors of this condition were age and gender. Further in-depth research is needed to find other factors of depression during adolescence and their potential impact on this condition later in life.

Acknowledgments

Authors' contributions

ST-O conceived of the study and participated in its design and coordination, collected data, conceived a paper, conducted a literature search, performed some statistical analysis, interpreted data, and drafted the manuscript; AK designed, organized and supervised the course of the study; IS-K collected the data, conducted a literature search, interpreted data; MK designed and supervised the course of the study, performed some statistical analysis, interpreted data, and drafted the manuscript. All authors discussed

the results, read and approved the final manuscript.

Conflict of interest

The authors declare that there is no conflict of interests associated with this publication.

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