The Association Between Changes in Body Mass Index and the Risk of Depression

ABSTRACT

Objective: In recent years, the risk of depression has increased among young people, and changes in body mass index (BMI) during childhood may be important factors in their development. However, the relationship between changes in BMI during childhood and the risk of depression needs further research and exploration.

Methods: The annual health examination data were collected from Physical Examination Center of Wuhan Mental Health Center Hospital, including 1226 students. The height and weight of students at the age of 11, 14, and 17 were recorded in sequence, and at 18 years old, these students were followed up according to the Hamilton Depression Scale (HAMD) to evaluate the depression. The relationship between BMI trends and depression was analyzed through Logistic regression analysis.

Results: The growth trend of BMI was divided into normal growth, slow growth, and excessive growth. The odds ratio (OR) value for depression in the slow growth was 1.218 (95% CI, 0.995-1.493) compared to the normal growth, which was no significant difference ($P = .056$). The OR value for depression in the excessive growth was 1.982 (95% CI, 1.243-3.177) compared to the normal growth, which was significant difference ($P = .003$).

Conclusion: The rapid growth of BMI is correlated with the occurrence of depression in young individuals and may be a contributing factor to the development of depression in this demographic.

Keywords: Psychosis, depression, insulin, body mass index, longitudinal trends

Introduction

Depression is one of the diseases with the greatest impact on global public health. The main clinical feature is continuous and long-term depression, accompanied by somatization symptoms such as chest tightness and shortness of breath, which are the most important types of psychological disorders in modern people. The occurrence of depression will lead to shortened life expectancy, decreased quality of life, and increased medical costs.[1-4] So far, the etiology of depression is not very clear, but it can be confirmed that various biological, psychological, and social factors are involved in the pathogenesis of depression.[5,6] The recent relationship between body mass index (BMI) and depression has attracted everyone's attention.[7] The level of BMI is a commonly used international standard to measure the degree of obesity and health of the human body, which is also closely related to people's health levels. The BMI is related to disease mortality, disability, and psychological disorders.[8,9] Studies have shown that depression is associated with unhealthy lifestyles and diet,[10-13] which in turn affect BMI. Thus, depression is related to BMI, but its mechanisms are complex.[14] Some studies have shown that depression and BMI interact and can worsen each other. High BMI can affect the risk of depression through biological mechanisms such as hormone release, inflammation, and stress system disorders.[15,16]

In recent years, more and more studies have shown that changes in BMI during childhood may be associated with depression in adulthood, and there may be a bidirectional association.[17-19] A cross-sectional study[20] in Iran showed BMI had a positive correlation with depression in

Jian Wang[1]* ^{ID}

Hong Zhang[2]* ^{ID}

[1]Department of Trauma, Wuhan Mental Health Center, Wuhan, Hubei, China
[2]Department of Psychotherapy, Wuhan Mental Health Center, Wuhan, Hubei, China

*These authors contributed equally to this work and shared the first authorship.

Corresponding author:
Jian Wang
✉ 18120215173@163.com

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adolescents. Pine[21] conducted a prospective study on the relationship between psychopathology and obesity in male and female adolescents. The results indicated that compared to male youth, female obesity could lead to depressive symptoms. In addition, other studies have shown that increased BMI is also associated with an increased risk of depression.[22] However, these findings are inconsistent, and some studies have not found a relationship between adolescents' BMI and the risk of depression.[23,24] Therefore, by studying the relationship between changes in BMI during adolescence and the risk of depression, we aim to investigate whether changes in BMI in children are one of the risk factors for depression.

Methods

Data Collection

The annual health examination data were collected from the Physical Examination Center of Wuhan Mental Health Center Hospital, including 1226 students. These students were 11 years old in 2015, and the data on height and weight at the ages of 11, 14, and 17 were recorded in sequence. In 2022, these students were followed up at the age of 18 to assess their depression status. The included students needed continuous and complete health examination data and personal information, willing to receive follow-up and had mental health, without mental and behavioral disorders such as attention deficit hyperactivity disorder and autism. Data were collected and managed by Wuhan Mental Health Center Hospital. The study was conducted in accordance with the Declaration of Helsinki and the International Conference Guidelines for Good Clinical Practice. Approval was obtained from the Ethics Committee of Wuhan Mental Health Center Hospital (ID: 2021RO713).

BMI = Weight (kg)/Height^2 (m)

Assessment Scales

We used the Hamilton Depression Scale (HAMD)[25] 25 for the follow-up of 18-year-old students to evaluate their depression status. This scale, developed by Hamilton in 1960, is the most commonly used scale in the clinical assessment of depressive status and includes 17 items. The total score is 52 points, with a score of <7 indicating no depression, 7-17 indicating possible depression, 18-24 indicating definite depression, and ≥24 indicating severe depression.[26] This scale involves 2 trained assessors conducting a joint HAMD examination on patients,

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MAIN POINTS

- *The rapid growth of BMI is associated with an increased risk of depression.*
- *There is a higher incidence of depression among young individuals.*
- *The proportion of males experiencing severe depression is higher than that of females.*

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usually through conversation and observation. After the examination is completed, the 2 assessors independently rate each patient.

Quality Control

The researchers explained the procedure and significance of the experiment in detail to the parents or guardians of the children before collecting annual health examination data for students and obtained signed the informed consent. Participants were excluded from analysis: (1) they were not suitable to continue to participate in the study due to major diseases; (2) they moved or lost contact for various reasons to move, lose contact; (3) they did not cooperate with the questionnaire evaluation; or (4) their parents or guardians reported depressive symptoms had diagnosed depression or received psychotherapy.

Statistical Analysis

We collected statistics on participants' BMI levels and then combined the records at each time point to analyze the growth trend of BMI. SPSS v27.0 software (IBM SPSS Corp.; Armonk, NY, USA) was used for statistical analysis of the data, and the height, weight, and BMI data of students were represented by the M (P_{25}, P_{75}). Latent variable mixed growth model was used to classify BMI growth trends, which was performed using Mplus 8.3. The relationship between depression and BMI growth trend was tested using logistic regression. The students with a HAMD score >17 were classified as depression, with depression as the dependent variable (depression = 1, non-depression = 0), and BMI growth trend as the independent variable for logistic regression analysis. In all analyses, a 2-tailed $P < .05$ was considered statistically significant.

Results

The BMI Situation of Student

Table 1 showed that a total of 1226 students were recorded at the median (P_{50}) height and weight at ages 11, 14, and 17 years old, including 650 boys and 576 girls. The results showed that the median height for boys, the median height at ages 11, 14, and 17 was 1.44 m, 1.65 m, and 1.72 m, respectively. The height of girls at ages 11, 14, and 17 was 1.46 m, 1.59 m, and 1.61 m. The weight of boys at ages 11, 14, and 17 was 31.12 kg, 53.66 kg, and 62.28 kg, respectively. The weight of girls at ages 11, 14, and 17 was 36.10 kg, 47.96 kg, and 51.43 kg. The median (P_{50}) BMI calculated based on height and weight is shown in Table 1, and the results showed that the BMI of boys at ages 11, 14, and 17 was 11.76 (kg/m^2), 19.66 (kg/m^2), and 20.89 (kg/m^2), respectively. For girls aged 11, 14, and 17, the BMI was 16.71 (kg/m^2), 18.65 (kg/m^2), and 20.12 (kg/m^2), respectively.

Depression in 18-Year-Old Youth

Following up on these 1226 students at the age of 18, based on the HAMD depression score in Table 2, the results showed that boys had

Table 1. Height, Weight, and Body Mass Index of Boys and Girls at Ages 11, 14, and 17, M (P_{25}, P_{75})

Items	Boys			Girls		
	11	14	17	11	14	17
Height (m)	1.44 (1.40, 1.47)	1.65 (1.61, 1.69)	1.72 (1.65, 1.77)	1.46 (1.43, 1.49)	1.59 (1.55, 1.64)	1.61 (1.58, 1.63)
Weight (kg)	37.12 (32.23, 44.53)	53.66 (49.32, 61.73)	62.28 (58.33, 69.48)	36.10 (33.00, 41.23)	47.96 (44.76, 53.73)	51.43 (49.2155.29)
Body mass index (kg/m^2)	17.67 (16.5, 18.67)	19.66 (18.5, 20.72)	20.89 (20.23, 21.66)	16.71 (15.59, 17.83)	18.65 (17.76, 19.78)	20.12 (19.34, 21.32)

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Table 2. HAMD Score at 18-Years-Old Follow-up

	HAMD Score			
Sex	< 7	7-17	18-24	> 24
Boys	156 (24%)	210 (32%)	189 (29%)	95 (15%)
Girls	141 (24%)	170 (30%)	200 (35%)	65 (11%)

HAMD, Hamilton Depression Scale.

Table 3. Logistic Regression of Depression and BMI Growth Trend

Item	β	SE	P	OR	95% CI
Normal growth				1	
Slow growth	0.198	0.104	.056	1.218	0.995-1.493
Excessive growth	0.684	0.241	.003	1.982	1.243-3.177

BMI, Body Mass Index; CI, Confidence Interval; OR, Odds Ratio.

the highest number of depression scores at 7-17, with 210 students (32%), and girls had the highest number of depression scores at 18-24, with 200 students (35%). Overall, the number of people with scores greater than 24 was relatively small.

The Relationship between Depression and the Trend of Body Mass Index Growth

The BMI growth trend of boys and girls showed 3 patterns: slow growth, normal growth, and excessive growth, as shown in Figure 1. The results showed that P-value of Hosmer–Lemeshow was 0.326, and the Odds Ratio (OR) value for depression in the slow growth group was 1.218 (95% CI, 0.995-1.493) compared to normal growth, which showed no significant difference ($P = .056$). The OR value for depression in the excessive growth group was 1.982 (95% CI, 1.243-3.177) compared to normal growth, which was a significant difference ($P = .003$), as shown in Table 3.

Discussion

Our study confirms a certain relationship between the rapid growth trend of BMI and the occurrence of depression. The acceptance of high BMI varies among different cultures, and this study suggests that the rapid growth of BMI in the context of Chinese culture is also related to the occurrence of depression in adolescents. These clinical results suggested that an excessive increase in BMI can affect the level of depression in youth, who are at high risk of depression. A study[27] showed that BMI and depression have a very noteworthy correlation. Pine's longitudinal study[21] showed that excessive BMI growth during adolescence was a risk factor for the development and persistence of depression. These results are consistent with those of our study. The possible mechanism of BMI changes leading

to depression was the role of neurobiology, such as the serotonin system and the hypothalamic–pituitary–adrenal axis. At the same time, the excessive or slow increase in BMI was also related to diet. Teenagers who overeat or eat very little daily were more or less affected by their emotions, which indirectly confirmed the association between body mass index and depression in adulthood. However, there is a very complex mechanism between BMI and depression, and more research is needed to elucidate the relationship between them.

Our finding of an association between chronically high BMI and depression suggests that BMI may be a risk indicator. Therefore, risk factors that contribute to the sustained increase in BMI in children should be reduced. For example, social stressors such as bullying may easily change eating behavior in adolescents,[28] the influence of estrogen may be relevant, as changes in estrogen levels are associated with depressive symptoms throughout a woman's life.[29,30] Controlling weight and improving dietary structure may also have a positive impact on mental health by maintaining a good BMI. However, it is important to note that lifestyle factors such as dietary habits and physical activity also play a significant role in the development of depression. Nevertheless, these factors were not collected and analyzed in this study, and this should be taken into consideration when interpreting the results.

Furthermore, in our study, it can be observed that the proportion of severe depression in males is slightly higher than in females (15% vs. 11%), while the proportion of moderate depression is slightly lower than in females (29% vs. 35%). Our analysis suggests that males may be relatively less inclined to seek mental health support, potentially leading to a higher likelihood of falling into severe depression without timely intervention.
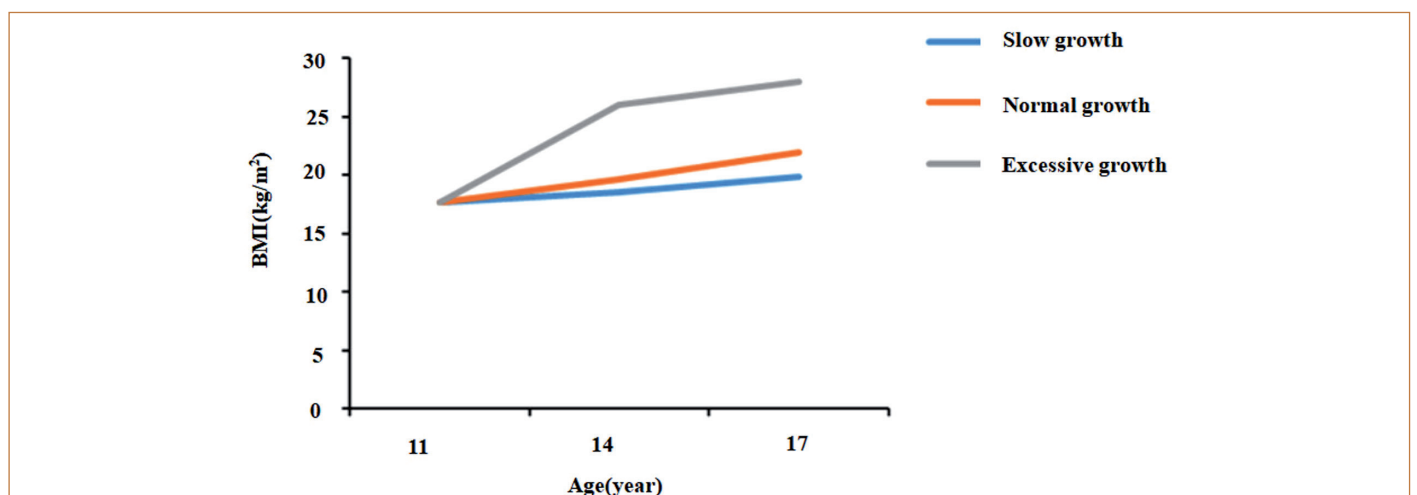

Figure 1. The BMI growth trend pattern of student.

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The shortcomings of this study are: firstly, the clinical data adopt a holistic sampling method, and the recruitment area for participants is relatively simple, which may affect the breadth of the sample; secondly, the sample of participants only selected the age of 18 as the endpoint and did not cover the entire youth category. This group of people can be included in future studies. Thirdly, one of the symptoms of depression is rapid weight gain and loss, so more research is needed on the causal relationship between depression and the trend of BMI changes. Finally, due to the failure to collect baseline depression status from students, this may have a slight impact on our results. However, we have made every effort to exclude it, and we know that there are not many cases of depression at the age of 11. Therefore, we believe that our results are reliable.

The rapid growth of BMI is correlated with the occurrence of depression in young individuals and may be a contributing factor to the development of depression in this demographic. This provides a new perspective for the prevention and intervention of depression. Further research may help deepen our understanding of the mechanism between BMI changes and depression, thus providing more effective intervention measures for the mental health of adolescents.

References

1. Miller R, Chin S, Sedai AK. The welfare cost of late-life depression. *J Econ Behav Organ*. 2022;204:15-36. [CrossRef]
2. Freitas PHB, Meireles AL, Ribeiro IKDS, Abreu MNS, Paula W, Cardoso CS. Symptoms of depression, anxiety and stress in health students and impact on quality of life. *Rev Lat Am Enferm*. 2023;31:e3884. [CrossRef]
3. Hussenoeder FS, Jentzsch D, Matschinger H, et al. Depression and quality of life in old age: a closer look. *Eur J Ageing*. 2021;18(1):75-83. [CrossRef]
4. Sousa RD, Gouveia M, Nunes da Silva C, et al. Treatment-resistant depression and major depression with suicide risk-The cost of illness and burden of disease. *Front Public Health*. 2022;10:898491. [CrossRef]
5. Remes O, Mendes JF, Templeton P. Biological, psychological, and social determinants of depression: a review of recent literature. *Brain Sci*. 2021;11(12):1633. [CrossRef]
6. Li Z, Ruan M, Chen J, Fang Y. Major depressive disorder: advances in neuroscience research and translational applications. *Neurosci Bull*. 2021;37(6):863-880. [CrossRef]
7. Karageorgiou V, Casanova F, O'Loughlin J, et al. Body mass index and inflammation in depression and treatment-resistant depression: a Mendelian randomisation study. *BMC Med*. 2023;21(1):355. [CrossRef]
8. Amiri S, Behnezhad S. Body mass index and risk of suicide: a systematic review and meta-analysis. *J Affect Disord*. 2018;238:615-625. [CrossRef]
9. Dai H, Alsalhe TA, Chalghaf N, Riccò M, Bragazzi NL, Wu J. The global burden of disease attributable to high body mass index in 195 countries and territories, 1990-2017: an analysis of the global burden of disease study. *PLoS Med*. 2020;17(7):e1003198. [CrossRef]
10. Selvaraj R, Selvamani TY, Zahra A, et al. Association between dietary habits and depression: a systematic review. *Cureus*. 2022;14(12):e32359. [CrossRef]
11. Navarra-Ventura G, Coronado-Simsic V, Riera-Serra P, et al. Associations between unhealthy lifestyle and depression: cross-sectional results from the Spanish National Health Survey. *Span J Psychiatry Ment Health*. 2023. [CrossRef]
12. Aguilar-Latorre A, Serrano-Ripoll MJ, Oliván-Blázquez B, Gervilla E, Navarro C. Associations between severity of depression, lifestyle patterns, and personal factors related to health behavior: secondary data analysis from a randomized controlled trial. *Front Psychol*. 2022;13:856139. [CrossRef]
13. Lazarevich I, Irigoyen Camacho ME, Velázquez-Alva MC, Flores NL, Nájera Medina O, Zepeda Zepeda MA. Depression and food consumption in Mexican college students. *Nutr Hosp*. 2018;35(3):620-626. [CrossRef]
14. Konttinen H, van Strien T, Männistö S, Jousilahti P, Haukkala A. Depression, emotional eating and long-term weight changes: a population-based prospective study. *Int J Behav Nutr Phys Act*. 2019;16(1):28. [CrossRef]
15. Fu X, Wang Y, Zhao F, et al. Shared biological mechanisms of depression and obesity: focus on adipokines and lipokines. *Aging (Albany NY)*. 2023;15(12):5917-5950. [CrossRef]
16. Reyes-Martínez S, Segura-Real L, Gómez-García AP, et al. Neuroinflammation, microbiota-gut-brain axis, and depression: the vicious circle. *J Integr Neurosci*. 2023;22(3):65. [CrossRef]
17. Perry BI, Stochl J, Upthegrove R, et al. Longitudinal trends in childhood insulin levels and body mass index and associations with risks of psychosis and depression in Young adults. *JAMA Psychiatry*. 2021;78(4):416-425. [CrossRef]
18. Badillo N, Khatib M, Kahar P, Khanna D. Correlation between body mass index and depression/depression-like symptoms among different genders and races. *Cureus*. 2022;14(2):e21841. [CrossRef]
19. Gibson-Smith D, Halldorsson TI, Bot M, et al. Childhood overweight and obesity and the risk of depression across the lifespan. *BMC Pediatr*. 2020;20(1):25. [CrossRef]
20. Rostampour N, Naderi M, Kheiri S, Safavi P. The relationship between body mass index and depression, anxiety, body image, and eating attitudes in adolescents in Iran. *Adv Biomed Res*. 2022;11:51. [CrossRef]
21. Pine DS, Goldstein RB, Wolk S, Weissman MM. The association between childhood depression and adulthood body mass index. *Pediatrics*. 2001;107(5):1049-1056. [CrossRef]
22. Kraus C, Kautzky A, Watzal V, et al. Body mass index and clinical outcomes in individuals with major depressive disorder: findings from the GSRD European Multicenter Database. *J Affect Disord*. 2023;335(335):349-357. [CrossRef]
23. Singh D, Dobrowolny H, Kapogiannis D, Steiner J. Canonical insulin signaling is not significantly impaired in early stages of depression. *Eur Arch Psychiatry Clin Neurosci*. 2023;273(1):283-286. [CrossRef]
24. Cha DS, Best MW, Bowie CR, et al. A randomized, double-blind, placebo-controlled, crossover trial evaluating the effect of intranasal insulin on cognition and mood in individuals with treatment-resistant major depressive disorder. *J Affect Disord*. 2017;210:57-65. [CrossRef]

25. Hamilton M. A rating scale for depression. *J Neurol Neurosurg Psychiatry*. 1960;23(1):56-62. [CrossRef]

26. He S, Ke XJ, Wu Y, et al. The stigma of patients with chronic insomnia: a clinical study. *BMC Psychiatry*. 2022;22(1):449. [CrossRef]

27. Khan QU, Zaffar S, Rehan AM, Rashid RR, Ashraf H, Hafeez F. Relationship of major depression with body mass index and salivary cortisol. *Cureus*. 2020;12(1):e6577. [CrossRef]

28. Lee KS, Vaillancourt T. Longitudinal associations among bullying by peers, disordered eating behavior, and symptoms of depression during adolescence. *JAMA Psychiatry*. 2018;75(6):605-612. [CrossRef]

29. Albert KM, Newhouse PA. Estrogen, stress, and depression: cognitive and biological interactions. *Annu Rev Clin Psychol*. 2019;15(15):399-423. [CrossRef]

30. Lewis G, Ioannidis K, van Harmelen AL, et al. The association between pubertal status and depressive symptoms and diagnoses in adolescent females: a population-based cohort study. *PLoS One*. 2018;13(6):e0198804. [CrossRef]