



Association of Waist Circumference, Body Mass Index and Height with Depressive Symptoms in Adult Women

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Authors' contributions

This work was carried out in collaboration between all authors. Author SK designed the study, managed the literature searches. Authors MA and FL managed the field works and composing first draft of the manuscript. Author MAJ performed the statistical analysis. All authors read and approved the final manuscript.

Original Research Article

Received 15th January 2014

Accepted 13th March 2014

Published 20th March 2014

ABSTRACT

Aims: Recent evidences suggest that individuals' body composition can related to depression symptoms. We aimed to examine the relationship between depressive symptoms and waist circumference (WC), body mass index (BMI) and height.

Study Design and Methods: This study was carried out on consecutive sample of 100 adult eligible women, aged 20- 60 years attending to five randomly selected primary health care units at Tabriz, Iran. Weight, height, WC and BMI of respondents were measured and then allocated into two groups of fifty overweight or obese (case group, mean age 39.98±10.70) and fifty normal weights (control group, mean age 36.94±11.27). Moderate and severe depressive symptoms were assessed using the Beck Depression Inventory II. Chi-square and binary logistic regression models were used to explore the association between BMI, WC, height and depressive symptoms.

Results: There were positive associations between BMI, WC and depression symptoms. Participants diagnosed with overweight or obesity showed 20.21% (OR= 2.29, 95% CI 1.02 to 5.13, p= 0.03) greater depressive symptoms than those with normal weight. The

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odds of being depressed in overweight and obese women were 1.5 (95% CI 0.60 to 3.89) and 4.1 (95% CI 1.32 to 12.94, $p= 0.02$) times than women with normal weight, respectively. Women with WC > 88 cm were 2 times more likely to have depressive symptoms as compared to women with normal WC. The odds of being depressed in women with WC ≥ 110 were 6.39 (95% CI 0.68 to 59.65) times than women in reference class. There was no significant correlation between women's height and depressive symptoms.

Conclusion: These preliminary findings suggest that BMI and WC may be associated with depressive symptoms among healthy adults. Also, it warrants additional large scale studies.

Keywords: Waist circumference, body mass index, height, depression.

1. INTRODUCTION

Major depressive disorder; identified by sadness, attenuation of interest, guilty feelings, sleep disturbances, anorexia, fatigue and low energy, suicidal ideation and impaired concentration; is a common mental disorder. According to the World Health Organization (WHO), the disease is among the leading disorders causing disability and is expected to be the second global most important cause of disability in 2020 [1].

Many physical, biologic, environmental and psychological conditions are known to be associated with the depressive mood. Recently, anthropometric characteristics are suggested to be correlated with individuals' mood and prevalence of depressive disorders [2]. Obesity epidemic is one of the major worldwide public health concerns. It has been calculated that total number of patients suffering from overweight and obesity has nearly doubled since 1980 [3,4]. The prevalence of overweight (Body mass index, BMI, between 25 to 29.9) and obesity (BMI equal or greater than 30) in adults aged 20 or greater was estimated 35% and 11% during 2008, respectively [3]. It seems that increasing prevalence of both depressive disorders and obesity may induce biologic and psychologic interactions.

It is well established that obesity, especially abdominal obesity, the central distribution of adipose tissue, often tied to mental health issues and is associated with an increased risk for a number of mental disorders including depression, mania, panic attacks, anxiety, social phobia [5-7]. It appears reasonable that this may influentially augment mortality, disability, and reduced quality of life induced by the above mentioned disorders [8,9].

Increasing evidence suggests an association between waist circumference, as criteria for abdominal obesity, and depression [10-13]. However, there are inconsistent findings concerning the relationship between BMI, as a measure of overall obesity, and depression. Some studies reported positive relation between BMI and depression [14,15], while others concluded that BMI was not [16-17] or was even negatively related to the disease [17,18].

There are reports suggesting that height, as another factor that may play a role in individuals' physical and mental health, possess an inverse association with mortality, mortality risk [19]. However, others reported that taller men have a reduced risk of suicide [20]. Moreover, some others did not find any correlation between height and depression [21].

Given the high prevalence of both obesity and depression in women [3,4] and in consideration of contradictory findings and insufficiency of data available on correlation

between BMI, height and depression, the current study aimed to examine whether an increased abdominal obesity, BMI or height could predict depressive symptoms in a population-based sample of physically well-functioning women.

2. METHODS

2.1 Participants and Measures

The study was conducted in five randomly selected primary health care centers located at different areas of Tabriz city, Iran, during June 2012 to May 2013. The study population were physically well-functioning women (n=100, aged 20–60 years) which recruited from women attending to the centers. During the recruitment period, the opportunity to participate in the study was offered daily to all women. Interviewers were initially explained the study objectives and procedures. Subjects who agreed to participate were further interviewed and screened for inclusion criteria. Eligible individuals were enrolled in the study. Exclusion criteria included subjects with: Any underlying medical illness; history of receiving medications for mental health disorders and those with serious liver, cardiovascular, respiratory, endocrine, or metabolic disorders. Total of fifty overweight or obese (case group, mean age 39.98 ± 10.70) and fifty normal weights (control group, mean age 36.94 ± 11.27) were included in the study following a complete anthropometric assessment. The subjects were individually matched for age and menopausal condition in the two groups. Written informed consent was obtained from all the participants. The study was approved by ethical committee at Tabriz University of Medical Sciences. We excluded women who were pregnant, or with any underlying disease. Body weight was measured using a digital scale, with the examinee wearing a light gown. Height was measured barefoot using a wall-mounted stadiometer to the nearest 0.5 cm. BMI was calculated as body weight (kg) divided by the square of height (m²). According to WHO, $18.5 \leq \text{BMI} < 25 \text{ kg/m}^2$ was defined as normal weight, $25 \leq \text{BMI} < 30$ was defined as overweight and a BMI greater than or equal to 30 was considered as obesity.

WC was measured by a tape measure at the midpoint between the lower costal margin and iliac crest to the nearest 0.5 cm. WC of >88 cm was defined as abdominal obesity [22].

2.2 Depressive Symptoms

Depressive symptoms were assessed using a validated domestic version of Beck Depression Inventory II [23]. The BDI-II is a 21-item self-report questionnaire with excellent psychometric characteristics [24]. Each item is rated on a scale from 0 to 3, with 0 representing absence of symptoms and 1 to 3 representing increasing levels of severity of the symptom, yielding a total score ranging from 0 to 63. Levels of depression were classified into four categories using the scale presented in the BDI-II manual: 0–13 = minimal; 14–19 = mild; 20–28 = moderate; 29–62 = severe. Depressive symptoms defined as having moderate-to-severe depressive symptoms in this study.

2.3 Statistics

The data were presented by mean \pm SD for quantitative data and frequencies (percentage) for qualitative variables. To assess the relationship between anthropometric indices including BMI, WC, height and depression level Chi-square test was used in the univariate analysis. A binary logistic regression model was conducted to evaluate the simultaneous relation of

independent variables (anthropometric indices) on depression level as dependent variable. In this model, odds ratios (ORs) and their 95% confidence intervals (CIs) were presented. Significance level was set at $P < 0.05$. The statistical software SPSS version 21 (SPSS Inc. IL, Chicago, USA) was used for data entry and analysis.

3. RESULTS

3.1 BMI and Depressive Symptoms

A summary of descriptive statistics is given in Table 1. Association of anthropometric characteristics with depressive symptoms in the study subjects are summarized in the Table 2. On whole, there was a significant correlation between subjects' BMI and depressive symptoms ($p = 0.017$). As shown in Table 2, larger segmentation of weight categories, women diagnosed with overweight or obesity showed 20.21% greater depressive symptoms than those with normal weight (OR= 2.29, 65.31% vs. 45.10%, 95% CI 1.02 to 5.13, $p = 0.03$). As shown in finer segmentation of weight categories, increment in depressive symptoms was in proportion to BMI increment and the odds of being depressed in overweight and obese women were 1.5 (95% CI 0.60 to 3.89) and 4.1 (95% CI 1.32 to 12.94, $p = 0.02$) times higher than women with normal weight, respectively (Table 2).

Table 1. Descriptive statistics of variables used in the analysis (Mean \pm SD)

| | Control | | Case | |
|------------------|-------------------|-------------------|--------------------|-------------------|
| | N= 51 | Overweight N= 27 | Obese N= 22 | Total N= 49 |
| Weight | 64.36 \pm 7.14 | 76.15 \pm 6.54 | 88.82 \pm 14.14 | 81.84 \pm 12.30 |
| Height | 171.78 \pm 8.51 | 165.37 \pm 6.29 | 162.23 \pm 8.30 | 163.96 \pm 7.35 |
| BMI ^a | 21.79 \pm 1.64 | 27.82 \pm 1.34 | 33.61 \pm 3.55 | 30.42 \pm 3.86 |
| WC ^b | 82.69 \pm 4.45 | 95.41 \pm 4.77 | 106.09 \pm 10.19 | 100.20 \pm 9.30 |
| BDI ^c | 21.22 \pm 12.08 | 22.15 \pm 12.73 | 27.00 \pm 11.65 | 24.33 \pm 12.37 |

^a body mass index, ^b waist circumference, ^c Beck's Depression Inventory

3.2 Waist Circumference and Depression Symptoms

There was a remarkable but statistically non-significant correlation between participants' WC and depressive symptoms ($p = 0.05$). As shown in Table 2, in large segmentation, participants with WC higher than 88 cm were 2 times (95% CI 0.94 to 4.65) more likely to have depressive symptoms compared to women with normal WC (<88). As shown in finer segmentation of WC, increment in depressive symptoms was in proportion to WC increment and the odds of being depressed in women with WC ≥ 110 were 6.39 (95% CI 0.68 to 59.65) times than women in reference class (Table 2).

3.3 Height and Depression Symptoms

As shown in Table 2, there was no significant correlation between women's height and depressive symptoms, but the odds of being depressed in women with short height (150-159 cm) were 1.44 (95% CI 0.47 to 4.39) times than women in reference class.

Table 2. Association of anthropometric characteristics (BMI¹, WC² and height) with depressive symptoms in adult women

| Anthropometric status | | | Number | % of women with depression symptoms (no.) | Odds Ratio | 95% C.I. | P value |
|-----------------------|----------------------------|--------------------------------|--------|---|------------|-------------|---------|
| Weight categories | Larger segmentation | Favorable weight (18.5≤BMI<25) | 51 | 45.10 (23) | 1.00 | Reference | 0.03 |
| | | Unfavorable weight (BMI≥25) | 49 | 65.31 (32) | 2.29 | 1.02- 5.13 | |
| | Finer segmentation | Normal weight (18.5≤ BMI <25) | 51 | 45.10 (23) | 1.00 | reference | |
| | | Overweight (25≤ BMI <30) | 27 | 55.55 (15) | 1.52 | 0.60- 3.89 | |
| Waist circumference | Larger segmentation | Obese (BMI≥30) | 22 | 77.27 (17) | 4.14 | 1.32- 12.94 | 0.02 |
| | | Normal WC (≤88 cm) | 50 | 46.00 (23) | 1.00 | reference | |
| | Finer segmentation | WC > 88cm | 50 | 64.00 (32) | 2.09 | 0.94- 4.65 | 0.05 |
| | | WC≤79 cm | 10 | 60.00 (6) | 1.92 | 0.47- 7.83 | 0.34 |
| | | 80≤WC≤89cm | 41 | 43.90 (18) | 1.00 | reference | |
| | | 90≤WC≤99cm | 23 | 56.52 (13) | 1.66 | 0.59- 4.65 | 0.33 |
| | | 100≤WC≤109cm | 20 | 65.00 (13) | 2.37 | 0.79- 7.18 | 0.13 |
| WC≥ 110 cm | 6 | 83.33 (5) | 6.39 | 0.68- 59.65 | 0.10 | | |
| Height categories | Short height (150-159 cm) | | 18 | 61.11 (11) | 1.44 | 0.47- 4.39 | 0.53 |
| | Medium height (160-169 cm) | | 44 | 52.27 (23) | 1.00 | reference | |
| | Long height (≥170 cm) | | 38 | 55.26 (21) | 1.10 | 0.47- 2.70 | 0.79 |

¹Body Mass Index
²Waist Circumferenc

4. DISCUSSION

The present study examined whether anthropometric indices could predict existence of depressive symptoms in a community-based sample of women. There are accumulative evidences that increased abdominal obesity is strongly associated with variety of mental disorders including depression. For instance, Zhao et al. concluded that waist circumference or abdominal obesity among overweight and obese American adults, was remarkably associated with increased occurrence of moderate-to-severe major depressive disorders [10]. Also, Grossniklaus et al. found that depressive symptoms were more frequently observed in those with high waist circumference [25]. We found that abdominal obesity was weakly associated with depressive symptoms in women. The finding could be attributed to sample size variation, population difference, in the measure of depression used and cut-off points used for WC assessment.

Previous researches suggested that depression might result in abdominal obesity and vice versa. Some hypothesis have been proposes to explain the mechanism by which depression provides a platform for obesity. It has been suggested that in depressed persons, dysregulation of the hypothalamic-pituitary-adrenal axis leads to high levels of cortisol which in turn promotes accumulation of visceral fat by activating lipoprotein lipase and inhibiting lipid mobilization [26,27]. Besides, dysregulation of the hypothalamic-pituitary-gonadal axis leads to low levels of sex steroid hormones which facilitate lipid mobilization. This can trigger the accumulation of fat around the abdomen [28]. It is proposed that "appearance concern" is key trigger from obesity to depression whereby women become more vulnerable to MDD through subsequent induction of stigma and body image dissatisfaction (BID) [29]. There is good evidence that obese people may regularly experience repeated perception of discrimination and mistreatment from strangers, acquaintances and intimates, leading to BID and impairment of self-esteem [30,31].

BMI is another anthropometric indicator that its positive relation to depression has been shown in some studies [14-15, 32]. It should be mentioned that an absent or even an inverse relationship has also been reported by others [16, 18]. However, in the present study, we found a significant positive association between BMI and depressive symptoms. The population used for the study in terms of culture, sex, race and age is one of the factors that may lead to inconsistent results from the previous studies. It has been generally accepted that women are more concerned about obesity as compared to men. This implies presence of more stigma among obese and overweight females which may induce depressive mood leading to variety of depressive disorders. Thus, interaction between obesity and depression is thought to be more profound for women than men. Interestingly, several surveys have observed positive associations between obesity and depression among women [14,33] and either negative or no associations among men [33,34].The relationship between the depressive mood and obesity may also be dependent upon age and race. Heo *et al.* have reported that young obese Hispanic women were much prone to depressive mood than those with normal weight [35]. Also, significant associations between depression and obesity was observed in Caucasians in the US and Canada [36]. Cultural aspects may also influence the association between obesity and depression. In some communities, higher weight is considered as a positive social norm. Therefore, in such communities little risk for development of depressive symptoms is expected [37,38]. In a study conducted by Li et al. in China, it was found that both obese elderly men and women were less likely to suffer from depressive symptoms than those of normal weight. They argued that traditional Chinese subjective norms and a positive social attitude towards obesity may impede development of depressive symptoms [38]. On the contrary, in communities where a higher weight has not

been preferred, stigma toward being obese leads to low self-esteem and ultimately depression.

Although, a few studies suggested short height linked to an increased mental disorders such as suicidal attempts [20,21], to our best knowledge there is no study to report a possible relationship between height and depression. However, in the current study we found no association between height and depressive symptoms which is in harmony with previous researches [21].

The main limitation of the present study might be its low sample size. Besides, this work was conducted in a local set up which may impede generalization of the findings to different ethnic and geographic locations. Thus, additional study with a larger sample size and more diverse ethnic and social status may lead to more reliable results.

5. CONCLUSION

In this study, we replicated findings from America/Europe in the Iranian context. The results demonstrated that BMI and WC were associated with an increased likelihood of having depressive symptoms among overweight and obese women. It is hypothesized that anthropometric indices, in particular BMI and WC can be considered as assessment tools to predict occurrence of depressive disorders in the population. This study confirmed previous findings of the association of BMI/WC and depressive symptoms.

CONSENT

All authors declare that a written informed consent was obtained from all the study participants.

ETHICAL APPROVAL

All authors hereby declare that specific national laws were followed where applicable. All experiments have been examined following a study proposal approved by the ethics committee of the Tabriz University of Medical Sciences, Tabriz, Iran.

COMPETING INTERESTS

The authors declare that they have no financial or non-financial competing interests.

REFERENCES

1. Murray CJN, Lopez AD. Alternative projections of mortality and disability by cause 1990–2020: Global Burden of Disease Study. *Lancet*. 1997;349(9064):1498–1504.
2. Ahlberg AC, Ljung T, Rosmond R, McEwen B, Holm G, Akesson HO, Björntorp P. Depression and anxiety symptoms in relation to anthropometry and metabolism in men. *Psychiatry Res*. 2002;112(2):101-10.
3. Obesity - World Health Organization. Available: www.who.int/topics/obesity/en/ Accessed on 20/07/2013.

4. Stevens GA, Singh GM, Lu Y, Danaei G, Lin JK, Finucane MM, Bahalim AN, McIntire RK, Gutierrez HR, Cowan M, Paciorek CJ, Farzadfar F, Riley L, Ezzati M. Global Burden of Metabolic Risk Factors of Chronic Diseases Collaborating Group (Body Mass Index). National, regional and global trends in adult overweight and obesity prevalences. *Popul Health Metr.* 2012;10(1):22.
5. Zhao G, Ford ES, Dhingra S, Li C, Strine TW, Mokdad AH. Depression and anxiety among US adults: Associations with body mass index. *Int J Obes.* 2009;33:257-266.
6. Petry NM, Barry D, Pietrzak RH, Wagner JA. Overweight and obesity are associated with psychiatric disorders: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. *Psychosom Med.* 2008;70(3):288-97.
7. Mather AA, Cox BJ, Enns MW, Sareen J. Associations of obesity with psychiatric disorders and suicidal behaviors in a nationally representative sample. *J Psychosom Res.* 2009;66(4):277-85.
8. Birnbaum HG, Kessler RC, Kelley D, Ben-Hamadi R, Joish VN, Greenberg PE. Employer burden of mild, moderate, and severe major depressive disorder: Mental health services utilization and costs and work performance. *Depress Anxiety.* 2010;27:78-89.
9. Moussavi S, Chatterji S, Verdes E, Tandon A, Patel V, Ustun B. Depression, chronic diseases, and decrements in health: Results from the World Health Surveys. *Lancet.* 2007;370:851-858.
10. Zhao G, ESF, Li C, et al. Waist circumference, abdominal obesity and depression among overweight and obese US. Adults: National Health and Nutrition Examination Survey 2005–2006. *BMC.* 2011;11:130.
11. Luppino FS, De Wit LM, Bouvy PF, et al. Overweight, obesity and depression: A systematic review and meta-analysis of longitudinal studies. *Arch Gen Psychiatry.* 2010;67:220–229.
12. Vogelzangs N, Kritchevsky SB, Beekman AT, et al. Obesity and onset of significant depressive symptoms: Results from a prospective community-based cohort study of older men and women. *J Clin Psychiatry.* 2009;71:391–399.
13. Van Reedt Dortland AK, Giltay EJ, Van Veen T, Zitman FG, Penninx BW. Longitudinal relationship of depressive and anxiety symptoms with dyslipidemia and abdominal obesity. *Psychosom Med.* 2013;75(1):83-9.
14. Pan A, Sun Q, Czernichow S, Kivimaki M, Okereke OI, Lucas M, Manson JE, Ascherio A, Hu FB. Bidirectional association between depression and obesity in middle-aged and older women. *Int J Obes.* 2012;36(4):595-602.
15. Simon GE, Von Korff M, Saunders K, Miglioretti DL, Crane PK, Van Belle G, Kessler RC. Association between obesity and psychiatric disorders in the US adult population. *Arch Gen Psychiatry.* 2006;63(7):824-30.
16. Pagoto SL, Ma Y, Bodenlos JS, Olendzki B, Rosal MC, Tellez T, Merriam P, Ockene IS. Association of depressive symptoms and lifestyle behaviors among Latinos at risk of type 2 diabetes. *J Am Diet Assoc.* 2009;109(7):1246-50.
17. Rivenes AC, Harvey SB, Mykletun A. The relationship between abdominal fat, obesity, and common mental disorders: Results from the HUNT study. *J Psychosom Res.* 2009;66:269-275.
18. Ho RC, Niti M, Kua EH, Ng TP. Body mass index, waist circumference, waist-hip ratio and depressive symptoms in Chinese elderly: A population-based study. *Int J Geriatr Psychiatry.* 2008;23:401-408.
19. Song YM, Sung J. Adult height and the risk of mortality in South Korean women. *Am J Epidemiol.* 2008;168(5):497-505.

20. Magnusson PK, Gunnell D, Tynelius P, Davey Smith G, Rasmussen F. Strong inverse association between height and suicide in a large cohort of Swedish men: Evidence of early life origins of suicidal behavior? *Am J Psychiatry*. 2005;162(7):1373-5.
21. Bjerkeset O, Romundstad P, Evans J, Gunnell D. Association of adult body mass index and height with anxiety, depression, and suicide in the general population: The HUNT study. *Am J Epidemiol*. 2008;15;167(2):193-202.
22. Zhang C, Rexrode KM, Van Dam RM, Li TY, Hu FB. Abdominal obesity and the risk of all-cause, cardiovascular and cancer mortality: Sixteen years of follow-up in US women. *Circulation*. 2008;117:1658-1667.
23. Ghassemzadeh H, Mojtabai R, Karamghadiri N, Ebrahimkhani N. Psychometric properties of a Persian-language version of the beck depression inventory-second edition: BDI-II-PERSIAN. *Depress Anxiety*. 2005;21(4):185-192.
24. Beck AT, Steer RA. *Manual for the Revised Beck Depression Inventory 1*. San Antonio, TX: Psychological Corporation; 1987.
25. Grossniklaus DA, Dunbar SB, Gary R, Tohill BC, Frediani JK, Higgins MK. Dietary energy density: A mediator of depressive symptoms and abdominal obesity or independent predictor of abdominal obesity? *Eur J Cardiovasc Nurs*. 2012;11(4):423-31.
26. Deuschle M, Weber B, Colla M, Depner M, Heuser I. Effects of major depression, aging and gender upon calculated diurnal free plasma cortisol concentrations: A re-evaluation study. *Stress*. 1998;2(4):281–287.
27. Chrousos GP, Gold PW. The concepts of stress and stress system disorders. Overview of physical and behavioral homeostasis. *JAMA*. 1992;267(9):1244–1252.
28. Morsink LF, Vogelzangs N, Nicklas BJ, et al. Associations between sex steroid hormone levels and depressive symptoms in elderly men and women: Results from the Health ABC study. *Psychoneuroendocrinology*. 2007;32(8):874–883.
29. Markowitz S, Friedman MA, Arent SM. Understanding the relation between obesity and depression: Causal mechanisms and implications for treatment. *Clin Psychol Sci Pract*. 2008;15(1):1–20.
30. Kessler RC, Mickelson KD, Williams DR. The prevalence, distribution and mental health correlates of perceived discrimination in the United States. *J Health Soc Behav*. 1999;40(3):208-230.
31. Carr D, Friedman MA. Is obesity stigmatizing? Body weight, perceived discrimination, and psychological well-being in the United States. *J Health Soc Behav*. 2005;46(3):244-259.
32. Olszanecka-Glinianowicz M, Zahorskamarkiewicz B, Kocelak P, Semik-Grabarczyk E, Dabrowski P, Gruszka W, Wikarek T. Depression in obese persons before starting complex group weight-reduction programme. *Int J Soc Psychiatry*. 2009;55(5):407-413.
33. Carpenter KM, Hasin DS, Allison DB, Faith MS. Relationships between obesity and DSM-IV major depressive disorder, suicide ideation, and suicide attempts: Results from a general population study. *Am J Public Health*. 2000;90(2):251-7.
34. Onyike CU, Crum RM, Lee HB, Lyketsos CG, Eaton WW. Is obesity associated with major depression? Results from the Third National Health and Nutrition Examination Survey. *Am J Epidemiol*. 2003;158(12):1139-47.
35. Heo M, Pietrobelli A, Fontaine KR, Sirey JA, Faith MS. Depressive mood and obesity in US adults: comparison and moderation by sex, age and race. *Int J Obes*. 2006;30(3):513-9.
36. Jasienska G, Ziomkiewicz A, Gorkiewicz M, Pajak A. Body mass, depressive symptoms, and menopausal status: An examination of the “Jolly Fat” hypothesis. *Womens Health Issues*. 2005;15:145–51.

37. Yu NW, Chen CY, Liu CY, Chau YL, Chang CM. Association of body mass index and depressive symptoms in a Chinese community population: Results from the health promotion knowledge, attitudes and performance survey in taiwan. *Chang Gung Med J.* 2011;34(6):620-7.
38. Li ZB, Ho SY, Chan WM, Ho KS, Li MP, Leung GM, Lam TH. Obesity and depressive symptoms in Chinese elderly. *Int J Geriatr Psychiatry.* 2004;19(1):68-74.

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