

The association between relative fat mass (RFM) and suicidal ideation: A cross-sectional study

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ABSTRACT: Objective: The relative fat mass (RFM) serves as an innovative obesity indicator, offering enhanced precision in evaluating lean and fat mass. This study aims to explore the correlation between RFM and suicidal ideation among adults in the United States.

Methods: This cross-sectional study used data from the National Health and Nutrition Examination Survey (NHANES) 2007-2018. A weighted baseline description of the population was performed. Logistic analysis and smoothed curve fitting were employed to examine the relationship between RFM and suicidal ideation. Besides, subgroup analysis and interaction tests were also conducted.

Results: A total of 22,820 participants were included, with a prevalence rate of 3.81 % for suicidal ideation. In the multiple logistic regression model, compared to the lowest RFM quartile (Q1), the highest quartile (Q4) was associated with a respective increased risk of suicidal ideation (OR = 1.59, 95 % CI: 1.16 - 2.17). Smoothed curve fitting suggested a nonlinear association between RFM and suicidal ideation. Subgroup analysis sustained the uniformity of this relationship across various factors.

Conclusions: RFM levels are associated with suicidal ideation, highlighting its potential as an effective and practical metric for evaluating risks of suicide ideation.

Keywords: obesity, relative fat mass, suicidal ideation, cross-sectional study

Introduction

Suicidal ideation, recognized as a critical precursor to suicide, has emerged as a global public health concern. According to the World Health Organization, over 700,000 individuals succumbed to suicide each year^[1]. The evidence has indicated a strong link between suicidal ideation, suicide attempts, and completed suicides^[2]. It was estimated that within a single year, 60% of individuals experiencing suicidal thoughts will attempt suicide^[3]. Data also suggests that individuals who entertain suicidal thoughts are at an elevated risk of suicide completion compared to those who do not^[4-7]. However, many people who die by suicide fail to communicate their suicidal ideation with others^[8], and non-specific treatments may not be effective in addressing suicidal ideation^[9]. Consequently, understanding of the risk factors associated with suicidal ideation is essential for the devel-

opment and formulation of effective prevention strategies.

Obesity is characterized by an excessive body fat accumulation, and has a serious negative impacts on health^[10]. Obesity is not only associated with numerous physical health conditions, but also with various mental disorders, such as depression, anxiety, and bipolar disorder^[11-14]. Body mass index (BMI) is a commonly utilized metric of obesity. Nevertheless, the validity of BMI has been contested^[15, 16], given that it can not differentiate well between muscle mass, bone mass, and fat locations^[17]. Relative fat mass (RFM), a novel simple indicator, which takes waist circumference and height into account to estimate whole-body fat percentage among adult individuals^[18]. Compared to BMI, RFM has demonstrated an enhanced accuracy of body fat-defined obesity and a reduced incidence of obesity misclassification in both women and men.^[18] Researches have showed that RFM is closely related to type-2 diabetes^[19], metabolic syndrome^[20], heart failure^[21], venous thromboembolism^[22], and cardiovascular mortality^[22]. Moreover, a recent study has verified a connection between RFM and depression^[24].

However, to date, no studies have been conducted to investigate the relationship between RFM and suicidal ideation. The present study aims to explore the potential association between RFM and suicidal ideation, employing data from the National Health and Nutrition Examination Survey (NHANES) 2007-2018.

Methods

Study design and participants

NHANES is a nationally representative study designed to evaluate the health and nutritional status of the noninstitutionalized civilian population in the United States. Written informed consent was obtained from all participants before data collection, and all research protocols were approved by the National Center for Health Statistics' ethical review board (cdc.gov). NHANES data from 2007 to 2018 was gathered for our analysis. Following exclusion for age < 20 years (n = 25,072), missing data of suicidal ideation (n = 4,813), missing data of RFM (n = 1,054), and missing data of other covariates (n = 6,083), there were 22,820 participants left for data analysis, as shown in Fig.1.

Assessment of suicidal ideation

PHQ-9 is a widely used method to evaluate mental health over the past two weeks^[25]. Suicidal ideation was assessed based on Item #9 of PHQ-9: "Over the last two weeks, how often have you been bothered by the following problem: Thoughts that you would be better off dead or of hurting yourself in some way?". Response of "not at all" was defined as "without suicidal ideation", whereas response of "several days", "more than half the days", and "nearly every day" were defined as "suicidal ideation"^[26, 27].

Assessment of relative fat mass (RFM)

The calculation equation of RFM is: $RFM = 64 - (20 \times (\text{height/waist})) + (12 \times \text{sex})$, sex=0 for male and 1 for female ^[18]. Weight and waist measurement data were collected by certified health technicians at the mobile examination center. In accordance with NHANES anthropometry procedures, height measurements required participants to remove head ornaments and braids that could impact results accuracy. For waist circumference, participants were guided to cross their arms in front of their chest, and at the end of one normal breathing, the circumference of the midpoint line between the lowest point of the rib and the two horizontal lines of the iliac crest was measured, accuracy up to 0.1 cm ^[28].

Assessment of covariates

We incorporated a set of covariates, including age (year), gender (male/female), race (Mexican American/other Hispanic/non-Hispanic White/non-Hispanic Black/other races), education level (less than high school/high school/above high school), marital status (never married/married or living with partner/widowed or divorced or separated), ratio of family income to poverty (<1.3/1.3 - 3.5/ $\geq$ 3.5). Smoking status is categorised as: never (smoked <12 cigarettes in the past year), former (formerly smoked >12 cigarettes, currently not smoking), now (smoked >12 cigarettes in the past year). Alcohol consumption is categorised as: no (<12 drinks in the past year), yes (>12 drinks in the past). Additionally, several diseases were considered as covariates, given their verified association with suicidal ideation, including hypertension, diabetes, and cardiovascular disease ^[29, 30]. The classification of hypertension, diabetes, and cardiovascular disease is based on a self-reported physician diagnosis, which is designated as either “yes” or “no.”

Statistical analysis

The data from 2007 to 2018 were weighted for baseline descriptive statistics, to explore general characteristics of the adults without or with suicidal ideation in United States. Continuous variables were expressed as mean (95% confidence interval (CI)) and categorical variables were expressed as percentages (95% CI). Three separate logistic regression models were used to explore the connection between RFM and suicidal ideation. Besides, RFM was divided into quartiles, and the lowest quartile was for reference. In model 1, no covariates were adjusted. Model 2 adjusted for age, gender, race. Model 3 adjusted for age, gender, race, education, marital status, ratio of family income to poverty, smoking status, alcohol consumption, hypertension, diabetes, cardiovascular disease. Generalized additive models and smooth curve fittings were further applied to uncover the non-linear association between RFM and suicidal ideation. Finally, subgroup analysis and interactions testing were performed for age, gender, race, education level, smoking status, drinking status, hypertension, diabetes, and cardiovascular disease. EmpowerStats (version 4.0) and R (version 4.3.2) were used

to perform data analysis. $P < 0.05$ was considered statistically significant.

Results

Baseline characteristics

The weighted baseline characteristics of 22,820 participants are shown in Table 1. 21,951 participants were defined without suicidal ideation and 869 with suicidal ideation. The incidence of suicidal ideation among all participants was 3.81%. The mean age of samples was 47.05 (95 % CI: 46.54, 47.55) years old, of whom 50.98 % were men and 49.02% were women, 7.81% were Mexican American, 5.22 % were other Hispanic, 70.07 % were non-Hispanic white, 10.19 % were non-Hispanic black, and 6.70 % were other races.

Significant differences were observed in RFM, height, BMI, race, education level, marital status, ratio of family income to poverty, smoking status, hypertension, diabetes, and cardiovascular disease between without and with suicidal ideation groups (all $P < 0.05$). In detail, participants with lower height (167.80 cm), higher BMI (29.67 m/kg²), education levels of high school (24.12 %) or below (24.59 %), never married (21.76 %) or widowed/divorced/separated (30.56%), in poverty (38.83 %), current smoking (36.64 %), hypertension (43.73 %), diabetes (16.79 %), cardiovascular disease (10.80 %) were more likely to experience suicidal ideation. Importantly, the suicidal ideation group showed a higher RFM level than non-suicidal ideation group ($P < 0.001$).

Association of RFM with suicidal ideation

The relationship between RFM and suicidal ideation is displayed in Table 2. Our findings indicated that a higher risk of suicidal ideation was connected with a higher RFM. In model 1, RFM level were positively associated with suicidal ideation risk in the highest RFM (Q4) compared with the first quartile (Q1) [odds ratio (OR) = 1.65, 95 % CI: 1.36 - 2.00, P for trend < 0.0001]. The association between RFM and suicidal ideation was still robust after adjusting for age, gender, and race in model 2 (OR = 2.00, 95 % CI: 1.48 - 2.71, P for trend < 0.0001). After further adjustment for ratio of family income to poverty, smoking, drinking, hypertension, diabetes, and cardiovascular disease based on model 2 in model 3, the association remained evident (OR = 1.59, 95 % CI: 1.16 - 2.17, P for trend = 0.003). Additionally, the continuous RFM (OR = 1.02, 95 % CI: 1.00 - 1.03) appeared a stronger correlation with suicidal ideation than the continuous BMI (OR = 1.01, 95 % CI: 1.00 - 1.02). The results of the smoothed curve fitting using fully adjusted model demonstrated the nonlinear association between RFM and suicidal ideation, as shown in Fig.2.

Subgroup analysis

The subgroup analysis of RFM and suicidal ideation is reported in Table 3, with stratification

factors including gender (male, female), age (20-40, 40-60, ≥ 60), education (< high school, high school, > high school), smoking (never, now, former), drinking (no, yes), hypertension (no, yes), diabetes (no, yes), cardiovascular disease (no, yes). In addition, an interaction test was also conducted. It is noteworthy that the association between RFM and suicidal ideation existed across various factors, including genders, education levels, smoking status, hypertension, diabetes, and cardiovascular disease. Compared to those without diabetes, people with diabetes have a stronger correlation between RFM and suicidal (P for interaction = 0.03). However, individuals < 60 years old and no drinking had no positive association.

Discussion

This cross-sectional study was novel in investigating the association between RFM and suicidal ideation of adults in US. There were several key findings from this study. First, the RFM level increased in those with suicidal ideation compared to those without. Second, the association between RFM and suicidal ideation was nonlinear. Third, subgroup analysis revealed that the predictive validity of RFM for suicidal ideation remained consistent across various subgroups, including genders, education levels, smoking status, hypertension, diabetes, and cardiovascular disease. These findings indicate that RFM may be a simple and effective predictor of suicidal ideation incidence.

Several studies have suggested the relationship between higher obesity levels and increased incidence of suicidal ideation, however, these studies mainly used BMI as a measure of obesity^[31-34]. Although BMI is a most accepted measure of obesity, the obesity paradox has called into question the reliability of BMI in certain cases. It has been proposed that BMI is not an accurate estimate of body fat percentage on account of its inability in differentiating between visceral and subcutaneous fat, lean and fat mass^[17]. A Korean research explored the correlation between sarcopenic obesity with suicidal ideation, revealing that BMI was without a significant connection with suicidal ideation^[35]. Besides, evidence suggested that BMI may be influenced by several demographic factors including age, gender, and racial differences^[36]. Waist circumference (WC) is another commonly employed metric for evaluating obesity. However, the reliability of the WC is compromised due to its tendency to be affected by body sizes^[37].

RFM is a novel and simple indicator of whole-body fat percentage of adults, which has been developed and validated through large cohorts^[18]. In comparison to BMI, RFM exhibited superior accuracy in evaluating whole-body fat percentage, as confirmed by dual-energy X-ray absorptiometry (DXA) results, in both genders. Moreover, RFM reduced misclassification of body fat-defined obesity among adult individuals, independent of gender and racial variations. In our study, RFM (OR= 1.02, 95 % CI: 1.00 - 1.03) showed a stronger correlation with suicidal ideation when contrasted with BMI (OR = 1.01, 95 % CI: 1.00 - 1.02). It has been demonstrated that RFM outperforms traditional metrics such as BMI and WC in distinguishing individuals with diabetes, hypertension, hospitaliza-

tions, and arthritis^[38]. Similarly, a recent study revealed a more pronounced correlation between RFM (OR = 1.033) and depression than BMI (OR = 1.023)^[24].

Regarding the mechanism between obesity and suicidal ideation, several potential explanations are involved. First, from a behavioral perspective, excessive food consumption and sedentary lifestyles are commonly linked to mental health disorders. A significant association has been proved between binge eating disorder (BED) and suicidal behaviours or ideation^[39]. This dysfunctional eating behavior may exacerbate obesity among people with mental disorders. A related hypothesis is that individuals exhibiting low intrinsic dopamine activity in brain regions associated with reward processing may try to compensate through various reinforcing activities, including heightened food intake^[40]. Physical inactivity is another factor linked to poor mental health and suicidal attempts^[41]. Second, some specific biochemical molecules may play a key role in mediating obesity and mental disorders. Elevated levels of inflammation have been found to correlate with obesity^[42, 43], which is also considered as a potential risk to the development of depression, anxiety, and other affective disorders^[44]. In obesity, macrophages in adipose tissue can release pro-inflammatory cytokines and monocyte chemoattractant protein-1, and adipocytes may secrete tumour necrosis factor-alpha, adipokines, and related hormones (e.g. increased secretion of leptin, resistin and visfatin and decreased secretion of adiponectin), which together promote inflammation^[44-46]. Cortisol, a recognized risk factor for assessing suicide risks^[47], is also associated with obesity^[48]. In short, the relationship between obesity and suicidal ideation is multifactorial, and our study showed that RFM may be an effective indicator in estimating suicidal ideation risks.

The main strength of this study is the first cross-sectional investigation of the association between RFM and suicidal ideation, with a large and representative sample size of US population. Besides, RFM is a more accurate estimator of body fat percentage than BMI and a radiation-free and more practical method than DXA. Nevertheless, there are several limitations of this study. First, since it is a cross-sectional study, the causal relationship between RFM and suicidal ideation is hardly to be concluded. For causality, larger-sample prospective cohort studies are needed. Second, despite the inclusion of many relevant covariates in our model, other unknown or unmeasured covariates might affect the precision of results. Third, as the study population was limited to US adults, the findings of this study cannot be generalized among other populations.

Conclusion

RFM level was significantly associated with increased suicidal ideation. Compared to BMI, RFM displays superior predictive efficacy with regard to suicidal ideation, and maintaining RFM within the optimal range could be crucial for mitigating suicidal risks. Nevertheless, further longitudinal studies are required to validate these preliminary findings.

Data availability

Data used for this study are available on the NHANES website: <https://wwwn.cdc.gov/nchs/nhanes/>.

Ethics approval and consent to participate

The data acquisition process was governed by stringent ethical protocols, including the endorsement from the NCHS's Research Ethics Review Board and the acquisition of informed, written consent from all contributors. Documented consent to participate was obtained from participants. Details can be found on <https://www.cdc.gov/nchs/nhanes/irba98.htm>.

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Authors contribution

Yang Yang: Writing - original draft, Software, Data curation, Investigation, Methodology. Lan Luo: Writing - review and editing. Xinyi Xia: Writing - review and editing, Supervision.

Declaration of competing interest

The authors report no conflicts of interest in this work.

References

- [1] WHO. World Health Organization (2024) Suicide. <https://www.who.int/news-room/fact-sheets/detail/suicide>.
- [2] Klonsky E D, Saffer B Y, Bryan C J. Ideation-to-action theories of suicide: a conceptual and empirical update[J]. *Curr Opin Psychol*, 2018,22:38-43.
- [3] Nock M K, Borges G, Bromet E J, et al. Cross-national prevalence and risk factors for suicidal ideation, plans and attempts[J]. *Br J Psychiatry*, 2008,192(2):98-105.
- [4] van Vuuren C L, van der Wal M F, Cuijpers P, et al. Sociodemographic Differences in Time Trends of Suicidal Thoughts and Suicide Attempts Among Adolescents Living in Amsterdam, The Netherlands[J]. *Crisis*, 2021,42(5):369-377.
- [5] Power E, Coughlan H, Clarke M, et al. Nonsuicidal self-injury, suicidal thoughts and suicide attempts among sexual minority youth in Ireland during their emerging adult years[J]. *Early Interv Psychiatry*, 2016,10(5):441-445.
- [6] Yang C, Huebner E S, Tian L. Prediction of suicidal ideation among preadolescent children with machine learning models: A longitudinal study[J]. *J Affect Disord*, 2024,352:403-409.
- [7] Hubers A, Moaddine S, Peersmann S, et al. Suicidal ideation and subsequent completed suicide in both psychiatric and non-psychiatric populations: a meta-analysis[J]. *Epidemiol Psychiatr Sci*, 2018,27(2):186-198.
- [8] Hallford D J, Rusanov D, Winestone B, et al. Disclosure of suicidal ideation and behaviours: A systematic review and meta-analysis of prevalence[J]. *Clin Psychol Rev*, 2023,101:102272.
- [9] Torok M, Han J, Baker S, et al. Suicide prevention using self-guided digital interventions: a systematic review and meta-analysis of randomised controlled trials[J]. *Lancet Digit Health*, 2020,2(1):e25-e36.
- [10] Safaei M, Sundararajan E A, Driss M, et al. A systematic literature review on obesity: Understanding the causes & consequences of obesity and reviewing various machine learning approaches used to predict obesity[J]. *Comput Biol Med*, 2021,136:104754.

- [11]Da C K, Salla D H, de Oliveira M P, et al. The impact of obesity-related neuroinflammation on postpartum depression: A narrative review[J]. *Int J Dev Neurosci*, 2022,82(5):375-384.
- [12]Rao W W, Zong Q Q, Zhang J W, et al. Obesity increases the risk of depression in children and adolescents: Results from a systematic review and meta-analysis[J]. *J Affect Disord*, 2020,267:78-85.
- [13]Garipey G, Nitka D, Schmitz N. The association between obesity and anxiety disorders in the population: a systematic review and meta-analysis[J]. *Int J Obes (Lond)*, 2010,34(3):407-419.
- [14]Taylor V, MacQueen G. Associations between bipolar disorder and metabolic syndrome: A review[J]. *J Clin Psychiatry*, 2006,67(7):1034-1041.
- [15]Ortega F B, Sui X, Lavie C J, et al. Body Mass Index, the Most Widely Used But Also Widely Criticized Index: Would a Criterion Standard Measure of Total Body Fat Be a Better Predictor of Cardiovascular Disease Mortality?[J]. *Mayo Clin Proc*, 2016,91(4):443-455.
- [16]Donini L M, Pinto A, Giusti A M, et al. Obesity or BMI Paradox? Beneath the Tip of the Iceberg[J]. *Front Nutr*, 2020,7:53.
- [17]Wannamethee S G, Atkins J L. Muscle loss and obesity: the health implications of sarcopenia and sarcopenic obesity[J]. *Proc Nutr Soc*, 2015,74(4):405-412.
- [18]Woolcott O O, Bergman R N. Relative fat mass (RFM) as a new estimator of whole-body fat percentage horizontal line A cross-sectional study in American adult individuals[J]. *Sci Rep*, 2018,8(1):10980.
- [19]Suthahar N, Wang K, Zwartkruis V W, et al. Associations of relative fat mass, a new index of adiposity, with type-2 diabetes in the general population[J]. *Eur J Intern Med*, 2023,109:73-78.
- [20]Kobo O, Leiba R, Avizohar O, et al. Relative fat mass (RFM) as abdominal obesity criterion for metabolic syndrome[J]. *Eur J Intern Med*, 2019,63:e9-e11.
- [21]Suthahar N, Meems L, Withaar C, et al. Relative fat mass, a new index of adiposity, is strongly associated with incident heart failure: data from PREVEND[J]. *Sci Rep*, 2022,12(1):147.
- [22]Caiano L M, Costanzo S, Panzera T, et al. Association between body mass index, waist circumference, and relative fat mass with the risk of first unprovoked venous thromboembolism[J]. *Nutr Metab Cardiovasc Dis*, 2021,31(11):3122-3130.
- [23]Wang J, Guan J, Huang L, et al. Sex differences in the associations between relative fat mass and all-cause and cardiovascular mortality: A population-based prospective cohort study[J]. *Nutr Metab Cardiovasc Dis*, 2024,34(3):738-754.
- [24]Zhu X, Yue Y, Li L, et al. The relationship between depression and relative fat mass (RFM): A population-based study[J]. *J Affect Disord*, 2024,356:323-328.
- [25]Kroenke K, Spitzer R L, Williams J B. The PHQ-9: validity of a brief depression severity measure[J]. *J Gen Intern Med*, 2001,16(9):606-613.
- [26]Cao C, Liu Q, Yang L, et al. Handgrip strength is associated with suicidal thoughts in men: Cross-sectional analyses from NHANES[J]. *Scand J Med Sci Sports*, 2020,30(1):92-99.
- [27]Huang D, Zhong S, Yan H, et al. Association between serum zinc levels and suicidal ideation in US adults: A population-based cross-sectional study[J]. *J Affect Disord*, 2023,329:359-368.
- [28]Ma W, Yan Z, Wu W, et al. Dose-Response Association of Waist-to-Height Ratio Plus BMI and Risk of Depression: Evidence from the NHANES 05-16[J]. *Int J Gen Med*, 2021,14:1283-1291.
- [29]Fan Z H, Xu J, Ge M W, et al. Suicide death, suicidal ideation and suicide attempt in patients with diabetes: A systematic review and meta-analysis[J]. *J Adv Nurs*, 2024.
- [30]Lehmann M, Kohlmann S, Gierk B, et al. Suicidal ideation in patients with coronary heart disease and hypertension: Baseline results from the DEPSCREEN-INFO clinical trial[J]. *Clin Psychol Psychother*, 2018,25(6):754-764.
- [31]Zhang M Z, Tang R, Rao W M, et al. Body mass index and the risk of suicidal ideation and suicide attempt among youth in 45 low-and middle-income countries[J]. *J Affect Disord*, 2022,298(Pt A):357-363.
- [32]Dutton G R, Bodell L P, Smith A R, et al. Examination of the relationship between obesity and suicidal idea-

tion[J]. *Int J Obes (Lond)*, 2013,37(9):1282-1286.

[33]Liu Z, Sun L, Zhang Y, et al. The prevalence of underweight and obesity in Chinese children and adolescents with major depressive disorder and relationship with suicidal ideation and attempted suicide[J]. *Front Psychiatry*, 2023,14:1130437.

[34]Stenzel C, Dalkner N, Unterrainer H F, et al. Effects of metabolic syndrome and obesity on suicidality in individuals with bipolar disorder[J]. *J Affect Disord*, 2022,311:1-7.

[35]Cho Y, Shin S Y, Shin M J. Sarcopenic obesity is associated with lower indicators of psychological health and quality of life in Koreans[J]. *Nutr Res*, 2015,35(5):384-392.

[36]Jackson A S, Stanforth P R, Gagnon J, et al. The effect of sex, age and race on estimating percentage body fat from body mass index: The Heritage Family Study[J]. *Int J Obes Relat Metab Disord*, 2002,26(6):789-796.

[37]Ross R, Neeland I J, Yamashita S, et al. Waist circumference as a vital sign in clinical practice: a Consensus Statement from the IAS and ICCR Working Group on Visceral Obesity[J]. *Nat Rev Endocrinol*, 2020,16(3):177-189.

[38]Cichosz S L, Rasmussen N H, Vestergaard P, et al. Is predicted body-composition and relative fat mass an alternative to body-mass index and waist circumference for disease risk estimation?[J]. *Diabetes Metab Syndr*, 2022,16(9):102590.

[39]Aguiar P V, Dionisio W, Souza E, et al. Binge eating, depressive symptoms and suicidal ideation in obese candidates for bariatric surgery[J]. *Eat Weight Disord*, 2023,28(1):12.

[40]Comings D E, Blum K. Reward deficiency syndrome: genetic aspects of behavioral disorders[J]. *Prog Brain Res*, 2000,126:325-341.

[41]Grasdalsmoen M, Eriksen H R, Lonning K J, et al. Physical exercise, mental health problems, and suicide attempts in university students[J]. *BMC Psychiatry*, 2020,20(1):175.

[42]Poynter M E, Mank M M, Ather J L. Obesity-associated inflammatory macrophage polarization is inhibited by capsaicin and phytolignans[J]. *Am J Physiol Regul Integr Comp Physiol*, 2024,326(5):R370-R382.

[43]Freitas R, Vasques A, Da R F G, et al. Gut bacterial markers involved in association of dietary inflammatory index with visceral adiposity[J]. *Nutrition*, 2024,122:112371.

[44]Capuron L, Miller A H. Immune system to brain signaling: neuropsychopharmacological implications[J]. *Pharmacol Ther*, 2011,130(2):226-238.

[45]Capuron L, Miller A H. Immune system to brain signaling: neuropsychopharmacological implications[J]. *Pharmacol Ther*, 2011,130(2):226-238.

[46]Lago F, Dieguez C, Gomez-Reino J, et al. Adipokines as emerging mediators of immune response and inflammation[J]. *Nat Clin Pract Rheumatol*, 2007,3(12):716-724.

[47]O'Connor D B, Gartland N, O'Connor R C. Stress, cortisol and suicide risk[J]. *Int Rev Neurobiol*, 2020,152:101-130.

[48]Russell E, Koren G, Rieder M, et al. Hair cortisol as a biological marker of chronic stress: current status, future directions and unanswered questions[J]. *Psychoneuroendocrinology*, 2012,37(5):589-601.

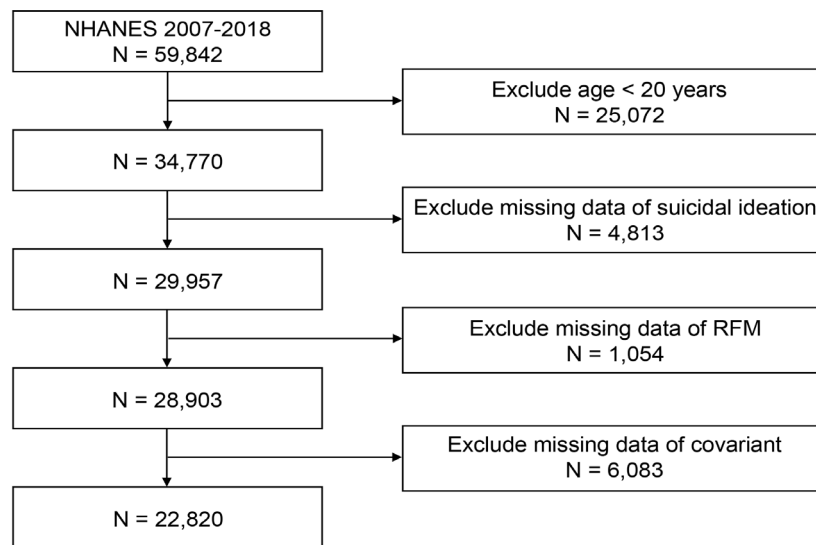


Fig. 1. Flowchart of participants selection. NHANES, National Health and Nutrition Examination Survey

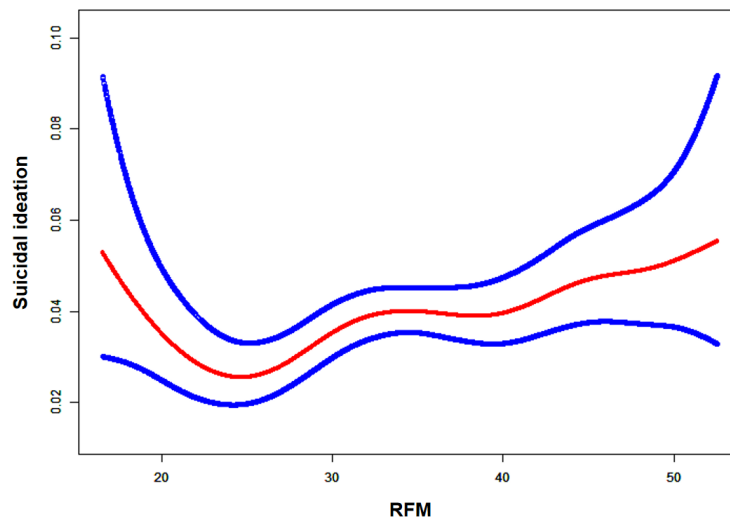


Fig. 2. Nonlinear relationship between the RFM and suicidal ideation. The red line represents the smooth curve fit between variables. Blue lines represent the 95 % CI from the fit. RFM: relative fat mass.

Table 1. Weighted baseline characteristics of participants without or with suicidal ideation.

Variables	Overall (N=22,820)	Without suicidal ideation (N=21,951)	With suicidal ideation (N=869)	P-value
Age (year)	47.05 (46.54 ,47.55)	47.04 (46.52 ,47.55)	47.35 (45.85 ,48.85)	0.698
RFM	35.08 (34.91 ,35.26)	35.04 (34.86 ,35.22)	36.38 (35.68 ,37.08)	<0.001
Weight (kg)	83.64 (83.13 ,84.15)	83.64 (83.13 ,84.16)	83.60 (81.83 ,85.37)	0.963
Height (cm)	169.33 (169.13 ,169.53)	169.38 (169.18 ,169.58)	167.80 (167.02 ,168.59)	<0.001
BMI (m/kg ²)	29.09 (28.91 ,29.27)	29.07 (28.89 ,29.26)	29.67 (29.10 ,30.25)	0.047
Gender (%)				0.085
Male	50.98 (50.25 ,51.70)	51.10 (50.36 ,51.85)	47.19 (42.86 ,51.57)	
Female	49.02 (48.30 ,49.75)	48.90 (48.15 ,49.64)	52.81 (48.43 ,57.14)	
Race (%)				<0.0001
Mexican American	7.81 (6.53 ,9.32)	7.78 (6.51 ,9.28)	8.65 (6.43 ,11.54)	
Other Hispanic	5.22 (4.39 ,6.20)	5.08 (4.28 ,6.03)	9.39 (7.17 ,12.21)	
Non-Hispanic White	70.07 (67.38 ,72.64)	70.28 (67.59 ,72.83)	64.14 (59.13 ,68.86)	
Non-Hispanic Black	10.19 (8.91 ,11.63)	10.18 (8.90 ,11.63)	10.38 (8.45 ,12.69)	
Other Race	6.70 (6.03 ,7.44)	6.68 (6.01 ,7.42)	7.44 (5.31 ,10.33)	
Education (%)				<0.0001
<High school	13.70 (12.61 ,14.88)	13.34 (12.23 ,14.52)	24.59 (20.63 ,29.02)	
High school	22.72 (21.51 ,23.98)	22.68 (21.47 ,23.93)	24.12 (20.52 ,28.12)	
>High school	63.57 (61.59 ,65.51)	63.99 (62.01 ,65.92)	51.30 (46.38 ,56.18)	
Marital status (%)				<0.0001
Never married	18.00 (16.77 ,19.30)	17.88 (16.62 ,19.21)	21.76 (18.88 ,24.94)	
Married/Living with partner	63.85 (62.35 ,65.32)	64.40 (62.89 ,65.87)	47.69 (43.12 ,52.30)	
Widowed/Divorced/Separated	18.15 (17.33 ,19.00)	17.73 (16.93 ,18.56)	30.56 (26.96 ,34.40)	
Ratio of family income to poverty (%)				<0.0001
<1.3	19.95 (18.59 ,21.38)	19.31 (17.96 ,20.73)	38.83 (34.46 ,43.38)	
1.3 - 3.5	35.00 (33.68 ,36.35)	34.97 (33.63 ,36.34)	35.97 (32.19 ,39.94)	
≥3.5	45.05 (42.99 ,47.13)	45.72 (43.66 ,47.79)	25.20 (20.77 ,30.22)	
Smoke at least 12 cigarettes per year (%)				<0.0001
Never	51.58 (50.14 ,53.02)	52.04 (50.60 ,53.49)	37.90 (33.57 ,42.42)	
Now	21.39 (20.29 ,22.52)	20.87 (19.79 ,21.99)	36.64 (32.09 ,41.44)	
Former	27.03 (25.95 ,28.14)	27.08 (25.99 ,28.20)	25.46 (22.07 ,29.19)	
At least 12 drinks per year (%)				0.369
No	8.85 (8.04 ,9.75)	8.82 (8.02 ,9.68)	9.92 (7.36 ,13.25)	
Yes	91.15 (90.25 ,91.96)	91.18 (90.32 ,91.98)	90.08 (86.75 ,92.64)	
Hypertention (%)				0.003
No	62.56 (61.39 ,63.71)	62.77 (61.61 ,63.92)	56.27 (51.64 ,60.80)	
Yes	37.44 (36.29 ,38.61)	37.23 (36.08 ,38.39)	43.73 (39.20 ,48.36)	
Diabetes (%)				<0.001
No	87.65 (86.97 ,88.30)	87.80 (87.12 ,88.45)	83.21 (80.18 ,85.87)	
Yes	12.35 (11.70 ,13.03)	12.20 (11.55 ,12.88)	16.79 (14.13 ,19.82)	
Cardiovascular disease (%)				<0.001
No	93.49 (93.03 ,93.91)	93.63 (93.16 ,94.08)	89.20 (85.69 ,91.93)	
Yes	6.51 (6.09 ,6.97)	6.37 (5.92 ,6.84)	10.80 (8.07 ,14.31)	

RFM: relative fat mass; BMI: body mass index.

Table 2. Association between RFM and suicidal ideation.

OR (95 % CI) p-value	Model 1	Model 2	Model 3
BMI	1.02 (1.01, 1.03)	1.02 (1.01, 1.03)	1.01 (1.00, 1.02)
RFM	1.02 (1.01, 1.03)	1.03 (1.02, 1.04)	1.02 (1.00, 1.03)
RFM quartiles			
Q1 (<29.14)	Reference	Reference	Reference
Q2 (29.14-34.62)	1.29 (1.05, 1.58)	1.30 (1.05, 1.61)	1.31 (1.06, 1.63)
Q3 (34.62-41.87)	1.23 (1.00, 1.51)	1.40 (1.09, 1.80)	1.30 (1.00, 1.68)
Q4 (≥41.87)	1.65 (1.36, 2.00)	2.00 (1.48, 2.71)	1.59 (1.16, 2.17)
P for trend	<0.0001	<0.0001	0.003

RFM: relative fat mass.

Model 1: No covariates were adjusted.

Model 2: Adjust for age; gender; race.

Model 3: Adjust for age; gender; race; education; marital status; ratio of family income to poverty; smoking status; alcohol consumption; hypertension; diabetes; cardiovascular disease.

Table 3. Subgroup analysis of the relationship between RFM and suicidal ideation.

Subgroup	Number	OR (95% CI)	P for interaction
Gender			0.583
Male	12024	1.02 (1.00, 1.04)	
Female	10796	1.04 (1.02, 1.06)	
Age (year)			0.524
20-40	8189	1.01 (0.99, 1.03)	
40-60	7847	1.01 (0.99, 1.04)	
≥60	6784	1.04 (1.00, 1.07)	
Education			0.477
<High school	4877	1.03 (1.02, 1.05)	
High school	5267	1.01 (1.00, 1.03)	
>High school	12676	1.01 (1.00, 1.03)	
Smoke at least 12 cigarettes per year			0.880
Never	11409	1.01 (1.00, 1.03)	
Now	5270	1.03 (1.02, 1.04)	
Former	6141	1.03 (1.01, 1.05)	
At least 12 drinks per year			0.739
No	2049	1.00 (0.97, 1.03)	
Yes	20771	1.02 (1.01, 1.03)	
Hypertention			0.589
No	13169	1.02 (1.01, 1.03)	
Yes	9651	1.02 (1.01, 1.03)	
Diabetes			0.030
No	19014	1.01 (1.00, 1.02)	
Yes	3806	1.04 (1.02, 1.06)	
Cardiovascular disease			0.117
No	20940	1.02 (1.01, 1.02)	
Yes	1880	1.05 (1.03, 1.08)	

RFM: relative fat mass. Adjusted for age; gender; race; education; marital status; ratio of family income to poverty; smoking status; alcohol consumption; hypertension; diabetes; cardiovascular disease except the stratification factor itself.