

Running title: BMI, BWP and suicidal ideation

Title:

Not only body weight perception but also body mass index is relevant to suicidal ideation and self-harming behavior in Japanese adolescents.

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Abstract

Purpose: Whether a low body mass index (BMI) is directly associated with high risk of suicidal ideation or self-harming behavior in adolescents is still inconclusive. This study has, therefore, evaluated the relevance of BMI to suicidal ideation and self-harming behavior after controlling for body weight perception (BWP) and other potential confounding factors.

Methods: BMI, BWP, suicidal ideation and self-harming behavior were all assessed using a self-report questionnaire administered to 18,104 Japanese adolescents. Potential confounding factors were also evaluated. The data were then analyzed using bivariate and multivariate logistic regression.

Results: Low BMI was associated with suicidal ideation and deliberate self-harm when controlling for sex, age, drug use, emotional distress and BWP.

Conclusions: Low BMI may be an independent risk factor for suicidal ideation and deliberate self-harming behavior in Japanese adolescents.

Key words: Body mass index, Body weight perception, Suicidal ideation, Adolescents, Epidemiology

Introduction

The latest annual report of vital statistics in Japan showed that suicide is the first and the third leading cause of death in 15 to 19 year-olds and in 10 to 14 year-olds, respectively (Ministry of Health, Labor and Welfare 2010). According to a systematic review (Emma et al. 2005), 30% of adolescents had considered and 10% had attempted suicide. The risk factors for suicide in adolescence that have been identified in the literature thus far include mental health problems, such as depression (Galit and James 1999;Pelkonen and Marttunen 2003), drug use (Esposito-Smythers and Spirito 2004) , and peer relationships (Fergusson et al. 2003).

In addition to these risk factors, recent studies have suggested that a low body mass index (BMI) contributes to suicidal ideation or behavior (Kaplan et al. 2007;Magnusson et al. 2006). For instance, an epidemiological study conducted by Kaplan et al (2007) revealed that for each 5kg/m² increase in body mass index the risk of suicide decreased by 18% and 24%, for adult men and women, respectively.

Nevertheless, several studies have indicated that the association between BMI and suicidal ideation or self-harming behavior can be mediated or confounded by body weight perception (BWP) in adolescents(Brausch and Gutierrez 2009;Crow et al. 2008;Kim and Kim 2009;Orbach et al. 2001) . In other words there may be no direct association or causal relationship between BMI and suicidal ideation or behavior among this generation. For example, Orbach et al.

(2001) demonstrated that adolescents who had attempted suicide reported significantly more negative attitudes towards their body than those without a suicidal history. Furthermore, Eaton et al. (2005) examined the relationship between perceived body weight, as measured by self description of body size, and actual body weight in terms of an increased risk of suicidal behavior. Using a self-report questionnaire, these researchers studied the BMI and BWP of high school students in the US, demonstrating that, when taken together, an extreme BWP, but not BMI category, was significantly associated with suicidal ideation and attempts. These results suggested a model in which BWP is mediating the association between BMI and suicidal ideation or suicide attempts.

Therefore, whether a low BMI is directly associated with risk of suicidal ideation or self-harming behavior in adolescents is still inconclusive. In such a situation, examining such an association in a large community sample of adolescents is of value. Thus, the present study aims to examine the contribution of BMI to the occurrence of suicidal ideation and self-harming behavior in adolescents.

The hypothesis we would like to examine is as follows:

Whether low BMI is associated with suicidal ideation and self-harming behavior in adolescents even after controlling for BWP and other potential confounding factors.

Methods

Study participants

In order to investigate the prevalence of psychotic-like experiences (PLEs) in Japanese adolescence and examine the associations between PLEs and mental health issues, we conducted this survey with a large community sample. In the same survey, we also collected relevant data to test the hypothesis in the present study. Between 2008 and 2009, we recruited students (7th-12th grade, ages between 12-18) from 45 public junior high schools and 28 high schools in Tsu City and Kochi Prefecture, Japan, and then conducted a cross-sectional survey of their psychopathologies. The total population of Tsu City and Kochi Prefecture is approximately 280,000 and 790,000 respectively. Tsu City is the prefectural capital of Mie, and a typical medium-sized Japanese city. Kochi prefecture has both urban and rural areas. Thus these two regions are representative of Japanese population. Attendance at junior high school is compulsory according to Japanese law, while attendance at high school is not.

After the study was approved by the ethics committee of the Mie University School of Medicine, the principal investigators approached the schools' head-teachers about participation in the research. They then consulted with teachers and parents.

The teachers in the participating schools were instructed about the guidelines for the distribution and collection of questionnaires, and then distributed them to the students along with envelopes in which to place them after completion. The

teachers also explained: 1) that participation in the study was anonymous and voluntary, and 2) that strict confidentiality would be maintained. In addition, the students were asked to seal the completed questionnaire in the envelope they had been provided with.

Measures

The questionnaires included items regarding the following: 1) psychopathological and behavioral problems, including suicidal ideation and self-harming behavior; 2) the Japanese version of the 12-item General Health Questionnaire (GHQ-12); and 3) other variables, including demographic characteristics, height and weight. We considered the date of birth for calculation of age.

Body mass index (BMI)

The BMI (calculated as weight in kilograms divided by the height in meters squared) score was based on self-reported height and weight, since BMIs obtained from self reporting have been shown to be significantly correlated with those based on measured height and weight (Goodman et al. 2000) . In the present study, unlikely height and weight (ex. 3.0cm and 5kg) were excluded from the analyses. This procedure was done by independent two raters.

BMI percentiles for age and gender were calculated according to the standard growth charts developed from the Japanese national survey in 2000 (Kato et al. 2009) . A 5-level categorical variable was created based on the BMI percentile

for age and sex. The five categories were underweight ($\leq 5^{\text{th}}$ percentile), at risk of being underweight (5th-15th percentile), normal weight (15th-85th percentile), at risk of being overweight (85th-95th percentile), and overweight ($\geq 95^{\text{th}}$ percentile).

Body weight perception (BWP)

BWP was assessed with a question: "What do you think of your current body weight?" Response options were 'very underweight', 'slightly underweight', 'about the right weight', 'slightly overweight', and 'very overweight'.

Suicidal ideation and deliberate self-harming behavior

Questions about current suicidal ideation (in the previous month) and deliberate self-harming behavior (in the previous year) were raised in the questionnaire.

Suicidal ideation was determined by a question: "Are you currently having thoughts that your life is no longer worth living?". The response options were 'no', 'probably, no', 'possibly, yes', and 'yes'. We defined 'yes' as the presence of suicidal ideation and 'no', 'probably, no' or 'possibly, yes' as no experience.

Deliberate self-harming behavior was determined by replies to a question: "Have you intentionally hurt yourself within the past year?". The response options were 'no' or 'yes'. Respondents who answered 'yes' were also asked to provide a description of the actual act of harm. Based upon the characterization employed in a previous study, self-harm was defined as an act with a non-fatal outcome in which an individual deliberately did one or more of the following: (1) Initiated behavior (e.g. self-cutting, jumping from a height) intended to cause self harm; (2) Ingested a substance in excess of the prescribed or generally recognized

therapeutic dose; or (3) Ingested a non-ingestible substance or object. The classification of the episodes as deliberate self-harm or otherwise was based on independent ratings by two researchers using these criteria. Any disagreement between the raters was resolved following a discussion of the disputed issue.

The GHQ-12

The GHQ-12 is one of the most widely used self-report screening tools for non-psychotic psychiatric symptoms, particularly those of anxiety or depression (Goldberg et al. 1976) . The validity and reliability of the Japanese version thereof have been confirmed (Doi and Minowa 2003;Fukunishi 1990). The GHQ was originally applied to adult populations, and was then used and validated for younger groups (Arakida et al. 2003;D'Arcy and Siddique 1984;Kaneita et al. 2007;Radovanovic and Eric 1983) . A 4-point scale with binary scoring (0011), which is known as the GHQ method, was utilized for each of the questions. Responses of '1' were then added together to form the total score, with a range from 0 (best possible) to 12 (worst possible). Individuals with a total GHQ-12 score ≥ 4 were considered to have poor mental health (Arakida et al. 2003;Fuchino et al. 2003;Kaneita et al. 2007).

Drug use

BMI, BWP, suicidal ideation and deliberate self-harming behavior among a young population might be influenced by drug use, as reported in previous studies (Esposito-Smythers and Spirito 2004;Pelkonen and Marttunen 2003). In our questionnaire we, therefore, asked whether the participants had ever used

recreational drugs at any point in their life. The items on this issue were answered either 'yes' or 'no'.

Statistical analysis

Associations between the BMI or BWP and outcomes (suicidal ideation and deliberate self-harming behavior) were analyzed using a logistic regression analysis adjusted for age, sex, drug use (use of recreational drugs), and GHQ scores. Confounding effects of BWP on the association between BMI and the outcomes were also controlled using a logistic regression analysis which included BWP as one of independent variables. In addition, confounding effects of BMI on the association between BWP and the outcomes were also controlled using a logistic regression analysis which included BMI as one of independent variables.

All statistical analyses were conducted using the Statistical Package for Social Sciences (SPSS) version 18.0 for Windows (SPSS Inc., Chicago, IL, USA). A P-value (two-tailed) of < 0.05 was considered to be statistically significant. Adjusted odds ratios (ORs) and 95% confidence intervals were calculated by logistic regression using the 15th-85th percentiles of the BMI category and the 'about the right weight' response of the BWP category as referents.

Results

Of all the students in relevant classes invited to take part ($n = 19,436$), 18,638 were approached at school (798 were absent), of whom 18,250 agreed to participate in the survey. Of these 18,250 participants, 18,104 (93.1% of all students in the relevant classes) provided analyzable responses. Of the 18,104 participants, 8992 were boys (49.7%) and 9112 were girls (50.3%). Their ages ranged from 12 to 18, with the mean age being 15.2 (SD = 1.7).

Table 1 sets out the distribution of the BMIs and BWPs. There were 2135 (11.8%) incidents of current suicidal ideation (in the previous month) and 672 (3.7%) acts of self-harm reported in the previous year. Table 2 provides the crude and adjusted ORs for suicidal ideation and deliberate self-harm by the BMI category. In terms of the adjusted ORs in this table, statistically significant difference in risk for suicidal ideation was found in the underweight ($p < 0.05$), slightly underweight ($p < 0.05$) and overweight ($p < 0.05$) groups. Table 3 presents the crude and adjusted ORs for suicidal ideation and deliberate self-harm by the BWP category. With regard to the adjusted ORs in this table, statistically significant risk for suicidal ideation was found in the overweight ($p < 0.05$) group, while risk for deliberate self-harming behavior was statistically significant in the slightly overweight ($p < 0.05$) and overweight ($p < 0.001$) groups.

Table 4 portrays the association of the BMI and BWP categories with suicide ideation or deliberate self-harm. In this table, confounding effects of BWP on the association between BMI categories and the outcomes were taken into account.

In addition, BMI was controlled for when the relation of BWP categories to the outcomes were concerned. There was no statistically significant difference between the sexes in any of the associations presented in this table.

Discussion

The present study has demonstrated that BMI is independently associated with suicidal ideation and deliberate self-harming behavior in a large, locally-representative sample of Japanese adolescents. Indeed, a low BMI (lower than the 5th percentile and between the 5th and 15th percentiles) was significantly related to suicidal ideation in the examined population. Moreover, a low BMI (lower than the 5th percentile) was significantly associated with deliberate self-harm in the same sample when controlling for sex, age, drug use, GHQ scores and BWP. There was no statistically significant difference between the sexes in this association. The prevalences of current suicidal ideation and acts of self-harm reported in the present study were comparable with those presented in our previous study in a community sample of younger adolescents (Nishida et al. 2010).

Previous research suggested a model in which BWP mediated the association between BMI and suicidal ideation or suicide attempts (Eaton et al. 2005; Kim and Kim 2009; Whetstone et al. 2007). We, therefore, conducted this study to examine if BMI is associated with suicidal ideation and self-harming behavior in adolescents even after controlling for BWP. We found that the mediating effects of BWP could not explain away the significant association between a low BMI and suicidal ideation, or deliberate self-harm, after controlling for the potential confounding factors. Indeed, in the results of the present study, both BMI and BWP were independently associated with suicidal ideation or deliberate self-harming behavior. Different distributions of BMI (more than 15% of

adolescents were low BMI in Japan, whereas less than 10% in the US) and any cultural differences between Japan and the US might be the cause of such discrepancy, although further investigations should be conducted in order to identify the type of cultural factors contributing to this inconsistency.

The association between a low BMI and suicidal ideation or deliberate self-harming behavior may be explained by other physiological or psychological factors. For example, low serum cholesterol was shown to be associated with suicide attempt (Asellus et al. 2010). Conceivably, reduction in serum cholesterol caused by weight loss elevates suicidal ideation and risk of deliberate self-harming behavior. In addition, increased impulsivity caused by poor nutritional state may mediate the relationship (Mukamal et al. 2010). Indeed, more empirical support would be needed to confirm these speculations.

The findings of our study document the important fact that not only the cognition that one is overweight but also a low BMI is a crucial risk factor for suicidal ideation and deliberate self-harm in adolescents. In other words, detection, and intervention aimed at targeting issues related to BMI and BWP, may be valuable when it comes to reducing suicidal ideation and deliberate self-harming behavior in adolescents.

The prevalences of current suicidal ideation and acts of self-harm in the sample of the present study were consistent with those reported in previous studies.

There are several limitations with this research. Firstly, our survey was cross-sectional, meaning that it was impossible to demonstrate an actual causal relationship. In other words, the results of our study might be interpreted in a way which suggests that the presence of suicidal ideation and deliberate self-harming behavior is predictive of both a low BMI and the BWP of being very overweight. Nevertheless, in the questionnaire used in our survey, experiences of suicidal ideation in the previous month were asked about, while incidents of deliberate self-harm in the previous year were the concern. This design of questionnaire could increase the possibility that the BMI and BWP of each participant were established before the emergence of suicidal ideation and deliberate self-harming behavior. Secondly, history of suicide attempt was not assessed in the survey and its relationship to BMI and BWP could not be analyzed, though suicide attempt rather than suicide ideation is an important predictor for suicide. Thirdly, as this was a school-based survey, we could not obtain answers from students who were absent. This is relevant because suicidal ideation and/or acts of deliberate self-harm may be more prevalent among those who are frequently absent or have been off for a long time. Furthermore, participants with a low BMI or an extreme BWP (very underweight or overweight) may be more likely to miss school. Accordingly, the associations evaluated in this study might be under or overestimated. However, the very large sample size (n=18,250) and an exceptionally high response rate (93.1%) should have minimized this sampling bias. Fourthly, because the current study was a secondary analysis of data from the survey, as described in the Methods part, we could not include a number of relevant factors (i.e. unhealthy weight control

behaviors and parent and peer relationship) in the potential confounding factors. Though these factors have been demonstrated to be important predictors of suicidal ideation in people with low BMI (Cook et al. 2007; Crow et al. 2008; Kim and Kim 2009), no assessment was done with regard to these variables in our survey. Fifthly, reliability and validity of the questionnaire used to assess the BWP is yet to be confirmed, though the questionnaire is commonly used and seems to have good face validity.

Conclusions

A low BMI may predict suicidal ideation in adolescents. Similarly, a low BMI can be risk factors for deliberate self-harm in the population studied. Additionally, BWP also contributes to these problematic outcomes. Therefore, issues of both BMI and BWP should be targeted before they lead to harmful behaviors. Further investigations, preferably of a prospective and controlled nature, should be conducted to provide a clear picture of the mechanism which links BMI and BWP with suicidal ideation and acts of self-harm in adolescents.

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Table 1. Sample distribution among categories of BMI and BWP (n = 18 104)

	Underweight (%)	Slightly Underweight (%)	Normal weight (%)	Slightly Overweight (%)	Overweight (%)
Classification of BMI percentile for age group;					
Whole sample	5.3	10.0	64.1	4.9	3.1
Male	4.8	9.2	69.5	6.1	4.2
Female	5.8	10.8	58.8	3.7	2.1
BWP answered by the students;					
Whole sample	4.0	11.4	30.7	34.0	17.0

Male	7.0	19.0	39.6	23.2	8.9
Female	1.1	4.0	21.8	44.7	25.0

BMI: body mass index, BWP: body weight perception

Table 2. Association between BMI and suicidal ideation and deliberate self harm

BMI category	Suicidal ideation		Deliberate self-harm	
	Crude OR (95%CI)	Adjusted OR# (95%CI)	Crude OR (95%CI)	Adjusted OR# (95%CI)
Underweight	1.80 (1.35, 2.39)**	1.57 (1.15, 2.16)*	1.45 (1.07, 1.97)*	1.11 (0.80, 1.55)
Slightly underweight	1.41 (1.11,1.79)*	1.35 (1.05, 1.74)*	1.10 (0.85, 1.42)	0.93 (0.70, 1.22)
Normal weight	1.00	1.00	1.00	1.00
Slightly overweight	1.50 (1.10, 2.06)*	1.35(0.95, 1.90)	1.17(0.82,1.65)	1.13 (0.78,1.63)
Overweight	1.79 (1.25, 2.56)*	1.58 (1.07, 2.33)*	1.27 (0.84,1.92)	1.33 (0.86,2.05)

Odds ratio adjusted for sex, age, drug usage, and GHQ total score.

*p < 0.05, **p < 0.001

In each section, the sample size ranged between 11 921 and 13 370 depending on the data that have been included in the statistical

analyses.

BMI: body mass index, OR: odds ratio, CI: confidence interval, GHQ: general health questionnaire

Table 3. Association between BWP and suicidal ideation and deliberate self harm

BWP categories	Suicidal ideation		Deliberate self-harm	
	Crude OR (95%CI)	Adjusted OR# (95%CI)	Crude OR (95%CI)	Adjusted OR# (95%CI)
Underweight	1.66 (1.14, 2.42)*	1.00 (0.66, 1.53)	0.95 (0.53, 1.70)	0.74 (0.38, 1.45)
Slightly underweight	0.97 (0.71, 1.31)	0.90 (0.65,1.25)	0.94 (0.64, 1.37)	1.09 (0.73, 1.64)
Normal weight	1.00	1.00	1.00	1.00
Slightly overweight	1.34 (1.09, 1.64)*	0.95 (0.76,1.19)	2.35 (1.87, 2.95)**	1.33 (1.04,1.69)*
Overweight	2.92 (2.38, 3.58)**	1.40 (1.10, 1.79)*	4.47 (3.54, 5.65)**	1.71 (1.32, 2.22)**

Odds ratio adjusted for sex, age, drug usage, and GHQ total score.

*p < 0.05, **p < 0.001

In each section, the sample size ranged between 6135 and 11 661 depending on the data that have been included in the statistical

analyses.

BWP: body weight perception, OR: odds ratio, CI: confidence interval, GHQ: general health questionnaire

Table 4. Associations between BMI and BWP and suicidal ideation or deliberate self-harm

	Adjusted OR (95%CI)#	Adjusted OR (95%CI)#
	suicidal ideation	deliberate self-harm
BMI category		
Underweight	2.03 (1.42, 2.90)**	1.57 (1.08,2.27)*
Slightly Underweight	1.58 (1.20, 2.08)*	1.13 (0.85,1.51)
Normal weight	1.00	1.00
Slightly Overweight	1.07 (0.74, 1.54)	0.91 (0.62, 1.34)
Overweight	1.26 (0.83, 1.91)	1.06 (0.62, 1.82)
BWP		
underweight	0.98 (0.61, 1.56)	0.90 (0.45, 1.81)
Slightly underweight	0.93 (0.65, 1.31)	1.16 (0.76, 1.77)
About right	1.00	1.00
Slightly overweight	0.98 (0.76, 1.26)	1.27 (0.97, 1.66)
overweight	1.40 (1.01, 1.95)*	1.83 (1.31, 2.55)**

Odds ratio adjusted for sex, age, drug usage and GHQ total score. When odds ratios for BMI categories were calculated, we included BWP as a covariate. When those for BWP categories were calculated, we included BMI as a covariate.

*p < 0.05, **p < 0.001

In each section, the sample size ranged between 5812 and 10 398 depending on the data that have been included in the statistical analyses.

BMI: body mass index, BWP: body weight perception, OR: odds ratio,

CI: confidence interval, GHQ: general health questionnaire