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Eating behavior and hypertension in Chinese

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ABSTRACT

Background and Objectives: The Sakata's Eating Behavior Questionnaire (SEBQ) was developed to grasp distortions and habits in eating behavior. This study aimed to validate the factor structure and psychometrics properties of the Chinese version of the SEBQ, and examine the relationship between eating behavior and hypertension. **Methods and Study Design:** Individuals were recruited from a community in Xuhui district in Shanghai. The 30-item SEBQ was used to measure eating behavior. Confirmatory factor analysis was performed to evaluate the dimensional structure, logistic regression analysis and mediating effect analysis were conducted to evaluate the relation between SEBQ with obesity and hypertension. **Results:** Cronbach's alpha coefficient was 0.81 revealed good internal reliability. The values of root mean square error of approximation [90% confidence intervals (CI)], comparative fit index and Tucker-Lewis index were 0.053 (0.050, 0.056), 0.90 and 0.89 for the original version, and 0.062 (0.045, 0.079), 0.91 and 0.86 for the 7-item short form respectively. SEBQ can be used as a predictor of general obesity [odds ratio (OR): 5.14, 95%CI: 2.91-9.08], central obesity (OR: 2.87, 95%CI: 1.86-4.42) and abdominal obesity (OR: 2.59, 95%CI: 1.67-4.01). Its effect on hypertension was mediated by obesity ($\beta=0.018$, $p=0.027$), and the percentage of mediated effect by obesity between eating behavior and hypertension was 43.9%. **Conclusions:** This study shown that SEBQ is a valid and reliable measurement tool to define obesity in Chinese as well and the associations between eating behavior and hypertension was mediated by obesity. Further validation among different populations is needed in the future study.

Key Words: Sakata's Eating Behaviour Questionnaire (SEBQ), eating behaviour, obesity, hypertension, Chinese

INTRODUCTION

The prevalence of overweight/obesity continues a relentless global rise, with over 4 million people dying each year as a result of being overweight/obese, according to the global burden of disease report of 2017.¹ Hypertension is not only a health problem in its own right, but a feature of much chronic disease, as in obesity,² diabetes,³ cardiovascular⁴ and renal disease.⁵ Behavioral factors, especially eating behavior, had already been recognized as a critical contributor to overweight/obesity.⁶ Therefore, assessment of food-related psychology and behavior is indispensable to prevent and reduce obesity. The Sakata's Eating Behavior Questionnaire (SEBQ) was developed to grasp distortions and habits in eating behavior, and

had been verified to have good reliability and factorial validity across western populations.⁷⁻⁹ A knowledge of eating behavior in Chinese populations should contribute to the understanding of how eating behavior affects, may reduce the risk and prevent the adverse outcomes of obesity. We aimed to validate the factor structure and psychometrics properties of the Chinese version of the Sakata's Eating Behavior, and examine whether eating behavior would affect hypertension which had a clear association with obesity² and eating habits¹⁰⁻¹¹ (Figure 1).

MATERIALS AND METHODS

Participants and procedure

Seven hundred ninety-nine adults were recruited from a community of Xuhui district in Shanghai after approval by the Ethics Committee of Shanghai Sixth People's Hospital (no. 2014-25) institutional review board. No specific inclusion or exclusion criteria were used. Participants were asked to respond to all the questions on the questionnaire.

Measures

Sakata's Eating Behavior Questionnaire

SEBQ consists of 50 items, and 30 of these were used to distinguish obese patients. These 30 items were classified into 7 dimensions: cognition of constitution (3 items), motivation for eating (3 items), substitute eating and drinking (6 items), feeling of satiety (5 items), eating style (3 items), meal contents (5 items), and eating rhythm abnormalities (5 items). Each item was rated on a 4-point scale ranging from 1 (there is no such thing) to 4 (absolutely), with higher scores indicating abnormal eating behavior that worsens and reinforces obesity. In the present study, we adopted 29 items (Table 1), excluding "Often drink canned soft drinks, canned coffee, sports drinks, or nutritional drinks", which is an item in the eating rhythm abnormalities area. In addition, the short version of the SEBQ, consists of 7 items, created and validated by Tayama et al.¹² were also used in our analysis.

Outcome assessment

Hypertension was defined as having a measured systolic blood pressure (SBP) ≥ 140 mmHg or diastolic blood pressure (DBP) ≥ 90 mmHg, and/or having a self-reported diagnosis of hypertension by a physician.¹³ General obesity was defined as having a body mass index (BMI) ≥ 28 kg/m²; central obesity was defined as having a waist-to-hip ratio (WHR) $>$

0.9/0.85 for men/women; and abdominal obesity was defined as having a waist circumference (WC) ≥ 90 cm for men and ≥ 80 cm for women.¹⁴

Statistical Analysis

Continuous variables were described as means and standard deviations (SD), and categorical variables were described as the count and percentage. Correlations between variables were assessed using Spearman correlations, and internal consistency scores were measured using Cronbach's alpha. Confirmatory factor analysis (CFA) was performed to evaluate the dimensional structure of the SEBQ. The relation between obesity and hypertension with eating behaviors were evaluated by logistic regression analysis, and the mediating effects were tested using a bootstrap estimation approaches with 1000 samples. The mediating effect analysis and CFA was performed using Mplus 8.03, and other statistical analyses were implemented in SAS 9.4 (SAS Institute, Inc., Cary, NC). A two-side p -value of <0.05 was considered statistically significant.

RESULTS

Participant characteristics

A total of 799 individuals were included in the analysis. The characteristics for all individuals are shown in Table 2. Briefly, the mean age of individuals were 58 years, and 41.18% were male. The mean (SD) values for BMI, waist and hip circumference were 25.95(3.30) kg/m², 84.10(10.57) cm and 95.55(8.05) cm, respectively. About 22.4% of the participants were obese. Those with obesity had slightly higher mean scores for SEBQ total score, cognition of constitution, substitute eating and drinking, feeling of satiety, and eating style than non-obesity groups, while no significant differences in motivation for eating, meal contents and eating rhythm abnormalities.

Correlational analysis

The Cronbach's alpha coefficients for the 29-item was 0.81 revealed good internal reliability. As shown in Table 3, the seven areas were inter-correlated. The correlation coefficients between the seven dimensions with the total score of 29 item (SEBQ29) and short version of 7 item (SEBQ7) ranged from 0.42 to 0.75, and 0.34 to 0.62 respectively. And the correlation between the SEBQ29 and SEBQ7 was 0.81 ($p < 0.001$). There were positive correlations between BMI, waist and hip circumference with "Cognition of constitution", "Substitute eating and drinking", "Feeling of satiety", "Eating style", SEBQ29 and SEBQ7.

Confirmatory factor analysis of SEBQ

As shown in Table 4, CFA reports showed that the Chi-square (χ^2) value of the first and second-order model for SEBQ29 were all significant, indicating misfit, the χ^2 degrees of freedom ratio (3.24 and 3.23) were between 2.0 and 4.0, the Root Mean Square Error of Approximation (0.053) less than 0.08, and values of Comparative Fit Index (0.90) and Tucker-Lewis index (0.89) meet the acceptable standards, indicating the final model acceptable and the misfits were minor.

Relation between eating behavior and obesity

Table 5 shows the odds ratio of obesity by quartiles of eating behaviors score in individuals. Multivariable adjustment logistic regression analyses revealed significant associations between obesity defined by BMI with “cognition of constitution” [odds ratio(OR): 16.94, 95% confidence intervals (95% CI): 9.67-29.67], “substitute eating and drinking” (OR: 2.87, 95% CI: 1.52-5.43), “eating style” (OR: 2.54, 95%CI: 1.55-4.14), SEBQ29 (OR: 5.14, 95%CI: 2.91-9.08) and SEBQ7 (OR: 8.43, 95%CI: 4.14-17.13). The multivariable-adjusted OR (95%CI) for central obesity were significant in the category of “cognition of constitution” (3.92, 2.60-5.91), “substitute eating and drinking” (3.14, 1.93-5.12), “feeling of satiety” (2.38, 1.60-3.55), “eating style” (1.97, 1.32-2.94), SEBQ29 (2.87, 1.86-4.42) and SEBQ7 (2.90, 1.86-4.51). Similar results were found in abdominal obesity, “cognition of constitution” (6.41, 4.14-9.90), “substitute eating and drinking” (2.68, 1.62-4.42), “feeling of satiety” (1.76, 1.17-2.63), “eating style” (2.01, 1.33-3.05), SEBQ29 (2.59, 1.67-4.01) and SEBQ7 (2.97, 1.88-4.69).

Relation between eating behavior and hypertension

Direct, indirect, and total effects of eating behavior and hypertension are shown in table 6 and Figure 2. There was a significant indirect effect between eating behavior and hypertension that was mediated by obesity ($\beta=0.018$, $p=0.027$), and the percentage of mediated effect by obesity between eating behavior and hypertension was 43.9%. Similar results were observed for the short form of eating behavior (Table 7 and Figure 3), the percentage of mediated effect by obesity between SEBQ7 and hypertension was 31.7%.

DISCUSSION

Evaluation of the factor structure and psychometrics properties of the Chinese version of the Sakata’s Eating Behavior proved favorable for its utility in the exploration of associations

with obesity and hypertension. The structures of SEBQ29 and SEBQ7 met acceptable standards. The correlational analysis between SEBQ29 and SEBQ7 scores in our study ($r=0.81$, $p<0.001$) supports the findings of the previous study that the degree of the total eating behavior abnormality measured by the SEBQ7 had nearly the same meaning for the degree of SEBQ29 measured.¹² Furthermore, the correlation coefficients between the total score of SEBQ7 with BMI ($r=0.31$, $p<0.001$) and WC ($r=0.26$, $p<0.001$) in our study were all higher than previous reports (BMI: 0.26, $p<0.001$; WC: 0.22, $p<0.001$) which supports SEBQ7 as a reliable and valid predictor of obesity in our study as well.

In contrast to the results of each area of the original SEBQ was a risk factor of obesity except for “Eating rhythm abnormalities”,¹⁵ our findings shown that the area of “motivation for eating”, “feeling of satiety”, “meal contents” and “eating rhythm abnormalities” were not statistically significant for indicative of general obesity risk. This might be because of a different definition of general obesity, which they classified obesity according to the WHO criteria and using the cutoff value of 25 kg/m² whereas we used the cutoff value of 24 kg/m². Nevertheless, the results of a 2-year cohort study suggested that a “feeling of satiety” was the key behavior for weight gain,¹⁶ which were also significant as for central obesity [OR (95% CI): 2.38 (1.60, 3.55)] and abdominal obesity [OR (95% CI): 1.76 (1.17, 2.63)] in our results. In terms of the different area of the SEBQ, it seems more indicative of central and abdominal obesity risk, while for the total score of SEBQ29 and SEBQ7, the results were similar.

Most of the previously research on the relationship between eating behavior and hypertension were defined eating behaviors as dietary patterns^{17,18} or the consumption of single nutrients^{19,20}/food groups^{21,22} generally obtained from dietary surveys, like 3 days of 24 hours dietary recall and food frequent questionnaires. The findings have been inconsistent,^{23,24} implicating dairy, meat, nuts, coffee, pluses, alcohol, fruits and vegetables. Since nutrients are derived from food, and food is usually consumed as whole diets, the practical health relevance of studies to date has been limited or questionable. It must also be said that there are multiple interactions between the components of whole diets, and dietary patterns vary by culture and local environment. Dietary complexity, however, can be subsumed by dietary pattern as an achievable and practical measure in its own right,²⁵⁻²⁷ and food-based dietary guidelines (FBDGs) can address socio-ecological considerations.²⁸ That said, a knowledge of culturally-specific eating behavior, as in the present study of Shanghainese has policy utility, here for how hypertension might be tackled through the association of certain eating behaviors with obesity.

No significantly direct association was observed between SEBQ and hypertension in the present study, and we found obesity mediated the effect of SEBQ on hypertension. Overweight and obesity may contribute to the occurrence of hypertension through different mechanisms, and are frequently associated.² Weight loss can lower blood pressure, and blood pressure decreases in hypertensive obese patients when they reach their ideal weight.²⁹ The mean BMI in our subjects was 25.95 kg/m², and majority of the participants were overweight (50.45%) or obese (22.86%), a possible reason why a direct association was not apparent. However, the indirect effects of SEBQ on hypertension suggest that monitoring obesity with eating behavior might add advantage in the prevention of hypertension. Significantly associations reported between dietary scores with all-cause mortality, cardiovascular disease, cancer, type 2 diabetes, and neurodegenerative disease, often accompanied by hypertension, make a case for the more extensive application of SEBQ management.

A strength of our study is to explore the psychometric properties of SEBQ in Chinese population, where validation of utility provides a more convenient methodology to address the problem of disordered eating behavior. However, several limitations should be addressed. Factors like food cultural preference, biodiversity and pattern, taste, and texture are likely to influence eating behavior and, in turn, risk of hypertension,^{25,30-31} although not considered in the present analysis. The anthropometric parameters and SEBQ was self-reported, which may affect the assessment, like under-reporting weight or over-reporting height,³² while some researchers reported good agreement for self-reported and direct anthropometric measurements.³³ In our hands, both central and abdominal obesity remained similar irrespective of ascertainment method. The proportions of obesity and non-obese participants were unequal and may have skewed our findings and limited their extrapolation to other populations.

Implications for research and practice

An SEBQ with a seven-factor structure and its 7-item short form, can provide risk evaluation for general obesity, central obesity and abdominal obesity. In turn, hypertension may be mediated by obesity in a Shanghainese community screening for aberrant eating habits and behaviors may allow a reduction in the pathway that leads to hypertension through over fatness.

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AUTHOR DISCLOSURE

The authors declare no conflict of interest.

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Table 1. Items of eating behaviors in the SEBQ

Dimension	Items
Cognition of constitution	Tend to gain weight more easily than others Gain weight just by drinking water Have eaten a lot since childhood
Motivation for eating	When buying food, am not content unless I buy more than necessary When making food, am not content unless I make a lot When eating out or getting home delivery, I always order a lot
Substitute eating and drinking	Eat together if others are eating Always have a bowl of fruit or sweets out If fruit or sweets are out, I always eat some If given food, I eat it all because I don't want to waste it Always gain weight on consecutive holidays or the New Year and O-bon holidays
Feeling of satiety	Eat to get rid of irritability Do not feel satisfied unless I eat until full If it is food I like, I can eat more after meals Often cautioned by others about eating too much Feel regret after eating too much If food is left over, I eat it so as not to waste it
Eating style	Eat fast Chew food very little Cannot chew well
Meal contents	Like noodles Prefer strong tastes Like oily foods Often eat fast food Often eat snack foods
Eating rhythm abnormalities	Eat at all different times Do not have time to eat leisurely Eat daytime snacks Snack after dinner

Table 2. Characteristics for the individuals

	All n=799	Obesity n=179	Non-obesity n=620	p-value
Age, years	58.41±6.85	59.38±6.57	58.13±6.90	0.031
Sex, male	329 (41.18%)	65 (36.31%)	264 (42.58%)	0.133
BMI, Kg/m ²	25.95±3.30	30.46±2.23	24.62±2.20	<0.001
Waist, cm	84.10±10.57	93.38±9.00	81.42±9.41	<0.001
Hip, cm	95.55±8.05	102.99±7.05	93.40±6.97	<0.001
Education				0.003
Elementary school	404 (50.56%)	109 (60.89%)	295 (47.58%)	
Secondary school	328 (41.05%)	62 (34.64%)	266 (42.90%)	
Senior school	67 (8.39%)	8 (4.47%)	59 (9.52%)	
Occupation				0.002
Worker	237 (29.66%)	33 (18.44%)	204 (32.90%)	
Farmer	208 (26.03%)	58 (32.40%)	150 (24.19%)	
Housework	154 (19.27%)	41 (22.91%)	113 (18.23%)	
Other	200 (25.03%)	47 (26.26%)	153 (24.68%)	
Smoking	163 (20.40%)	24 (13.41%)	139 (22.42%)	0.008
Drinking alcohol	146 (18.27%)	27 (15.08%)	119 (19.19%)	0.210
Exercise				0.566
Regular	256 (32.04%)	59 (32.96%)	197 (31.77%)	
Irregular	212 (26.53%)	42 (23.46%)	170 (27.42%)	
Never	331 (41.43%)	78 (43.58%)	253 (40.81%)	
BP	552 (69.09%)	139 (77.65%)	413 (66.61%)	0.005
SEBQ 29	46.63±10.30	50.19±10.40	45.61±10.05	<0.001
Cognition of constitution	5.37±2.54	7.40±2.90	4.78±2.08	<0.001
Motivation for eating	3.60±1.11	3.65±1.08	3.58±1.11	0.437
Substitute eating and drinking	9.44±2.92	10.06±3.00	9.26±2.87	0.001
Feeling of satiety	7.99±2.90	8.38±3.11	7.88±2.82	0.042
Eating style	5.60±2.17	6.08±2.24	5.46±2.13	0.001
Meal contents	8.57±2.44	8.63±2.48	8.55±2.43	0.709
Eating rhythm abnormalities	6.08±2.05	5.98±1.92	6.10±2.08	0.484
SEBQ7	11.45±3.17	12.92±3.03	11.03±3.09	<0.001

Table 3. Correlation matrix of the SEBQ

	EB1	EB2	EB3	EB4	EB5	EB6	EB7	SEBQ29	SEBQ7
EB1	1.00								
EB2	0.23***	1.00							
EB3	0.44***	0.29***	1.00						
EB4	0.34***	0.28***	0.41***	1.00					
EB5	0.25***	0.14***	0.37***	0.25***	1.00				
EB6	0.19***	0.19***	0.25***	0.29***	0.19***	1.00			
EB7	0.17***	0.24***	0.40***	0.34***	0.15***	0.38***	1.00		
SEBQ29	0.62***	0.42***	0.75***	0.69***	0.54***	0.57***	0.59***	1.00	
SEBQ7	0.55***	0.34***	0.58***	0.47***	0.62***	0.48***	0.38***	0.81***	1.00
Age	-0.07	-0.15***	-0.14***	0.01	-0.10**	-0.05	-0.05	-0.12***	-0.09**
BMI	0.41***	0.02	0.16***	0.08*	0.15***	0.04	-0.01	0.22***	0.31***
Waist	0.30***	0.03	0.09*	0.12***	0.18***	0.05	-0.05	0.18***	0.26***
Hipline whr	0.30***	0.05	0.08*	0.08*	0.15***	0.06	0.00	0.17***	0.23***
SBP	0.09*	-0.07	-0.01	0.03	0.03	-0.07*	-0.08*	-0.01	0.03
DBP	0.07	-0.04	0.06	0.02	0.07*	0.00	-0.06	0.03	0.07*
Education	0.01	0.07*	0.08*	-0.01	0.09*	-0.01	-0.01	0.04	-0.01
Occupation	0.03	0.02	0.08*	-0.11**	-0.06	-0.10**	-0.08*	-0.06	-0.02

EB1: Cognition of constitution; EB2: Motivation for eating; EB3: Substitute eating and drinking; EB4: Feeling of satiety; EB5: Eating style; EB6: Meal contents; EB7: Eating rhythm abnormalities.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Table 4. Goodness of fit indices for the structure of SEBQ

Model	χ^2	df	TLI	CFI	RMSEA (90%CI)
First-order SEBQ	1141.165	352	0.890	0.904	0.053 (0.050, 0.056)
Second-order SEBQ	1182.217	366	0.890	0.901	0.053 (0.049, 0.056)
SEBQ -7 item	56.596	14	0.862	0.908	0.062 (0.045, 0.079)

[†]Japanese, Thai, Korean, Philippine.

[‡]Defined as having three of three policies in place.

RMSEA: Root mean square error of approximation; TLI: Tucker-Lewis index; CFI: Comparative fit index.

Table 5. Adjusted OR and 95%CI between obesity and eating behaviors[†]

	25-50 th	50-75 th	75-100 th
Obesity			
Cognition of constitution	2.09 (0.98, 4.45)	2.37 (1.33, 4.21)	16.94 (9.67, 29.67)
Motivation for eating	1.63 (0.96, 2.79)	1.53 (0.80, 2.91)	1.32 (0.75, 2.32)
Substitute eating and drinking	1.66 (0.87, 3.17)	1.95 (1.03, 3.68)	2.87 (1.52, 5.43)
Feeling of satiety	1.23 (0.68, 2.22)	0.92 (0.56, 1.52)	1.53 (0.96, 2.44)
Eating style	1.36 (0.70, 2.62)	1.41 (0.87, 2.30)	2.54 (1.55, 4.14)
Meal contents	1.46 (0.83, 2.58)	1.06 (0.65, 1.71)	1.25 (0.76, 2.05)
Eating rhythm abnormalities	1.41 (0.86, 2.30)	1.24 (0.72, 2.15)	1.06 (0.68, 1.67)
SEBQ29	2.03 (1.11, 3.70)	3.33 (1.88, 5.91)	5.14 (2.91, 9.08)
SEBQ7	2.17 (1.00, 4.68)	4.62 (2.20, 9.73)	8.43 (4.14, 17.13)
Central obesity			
Cognition of constitution	1.30 (0.80, 2.11)	1.41 (0.98, 2.02)	3.92 (2.60, 5.91)
Motivation for eating	1.32 (0.82, 2.13)	1.52 (0.86, 2.69)	1.42 (0.88, 2.30)
Substitute eating and drinking	1.64 (1.03, 2.63)	1.69 (1.06, 2.70)	3.14 (1.93, 5.12)
Feeling of satiety	1.49 (0.91, 2.43)	1.17 (0.79, 1.75)	2.38 (1.60, 3.55)
Eating style	0.97 (0.58, 1.64)	1.23 (0.84, 1.80)	1.97 (1.32, 2.94)
Meal contents	1.06 (0.66, 1.72)	1.03 (0.69, 1.53)	1.13 (0.75, 1.70)
Eating rhythm abnormalities	1.06 (0.70, 1.60)	1.07 (0.68, 1.70)	0.99 (0.68, 1.43)
SEBQ29	1.14 (0.76, 1.72)	1.46 (0.97, 2.20)	2.87 (1.86, 4.42)
SEBQ7	1.26 (0.81, 1.98)	1.54 (0.97, 2.44)	2.90 (1.86, 4.51)
Abdominal obesity			
Cognition of constitution	1.80 (1.09, 2.99)	1.47 (1.00, 2.16)	6.41 (4.14, 9.90)
Motivation for eating	1.72 (1.05, 2.83)	1.60 (0.89, 2.86)	1.21 (0.74, 1.96)
Substitute eating and drinking	1.53 (0.94, 2.50)	1.56 (0.96, 2.53)	2.68 (1.62, 4.42)
Feeling of satiety	1.51 (0.91, 2.50)	1.11 (0.84, 1.68)	1.76 (1.17, 2.63)
Eating style	0.92 (0.54, 1.58)	1.23 (0.83, 1.83)	2.01 (1.33, 3.05)
Meal contents	1.05 (0.64, 1.72)	0.71 (0.47, 1.06)	1.18 (0.77, 1.79)
Eating rhythm abnormalities	1.36 (0.89, 2.09)	1.15 (0.72, 1.85)	0.90 (0.62, 1.32)
SEBQ29	1.15 (0.75, 1.76)	1.64 (1.07, 2.51)	2.59 (1.67, 4.01)
SEBQ7	1.38 (0.86, 2.21)	1.56 (0.96, 2.53)	2.97 (1.88, 4.69)

[†]Adjusted for age, sex, educational level, occupation, smoking, drinking alcohol and exercise.

Table 6. Standardized direct, indirect, and total effects for eating behaviors to hypertension[†]

	Estimate	SE	t	p-value
SEBQ29→BP	0.023	0.038	0.598	0.550
SEBQ29→Obesity→BP	0.018	0.008	2.216	0.027
SEBQ29→Obesity	0.204	0.036	5.744	<0.001
Obesity→BP	0.087	0.035	2.479	0.013

[†]Adjusted for age, sex, educational level, occupation, smoking, drinking alcohol and exercise.

Table 7. Standardized direct, indirect, and total effects for short form of EBQ to hypertension[†]

	Estimate	SE	t	p-value
SEBQ7→BP	0.043	0.039	1.100	0.271
SEBQ7→Obesity→BP	0.020	0.010	2.040	0.041
SEBQ7→Obesity	0.243	0.034	7.139	<0.001
Obesity→BP	0.081	0.036	2.214	0.027

[†]Adjusted for age, sex, educational level, occupation, smoking, drinking alcohol and exercise.

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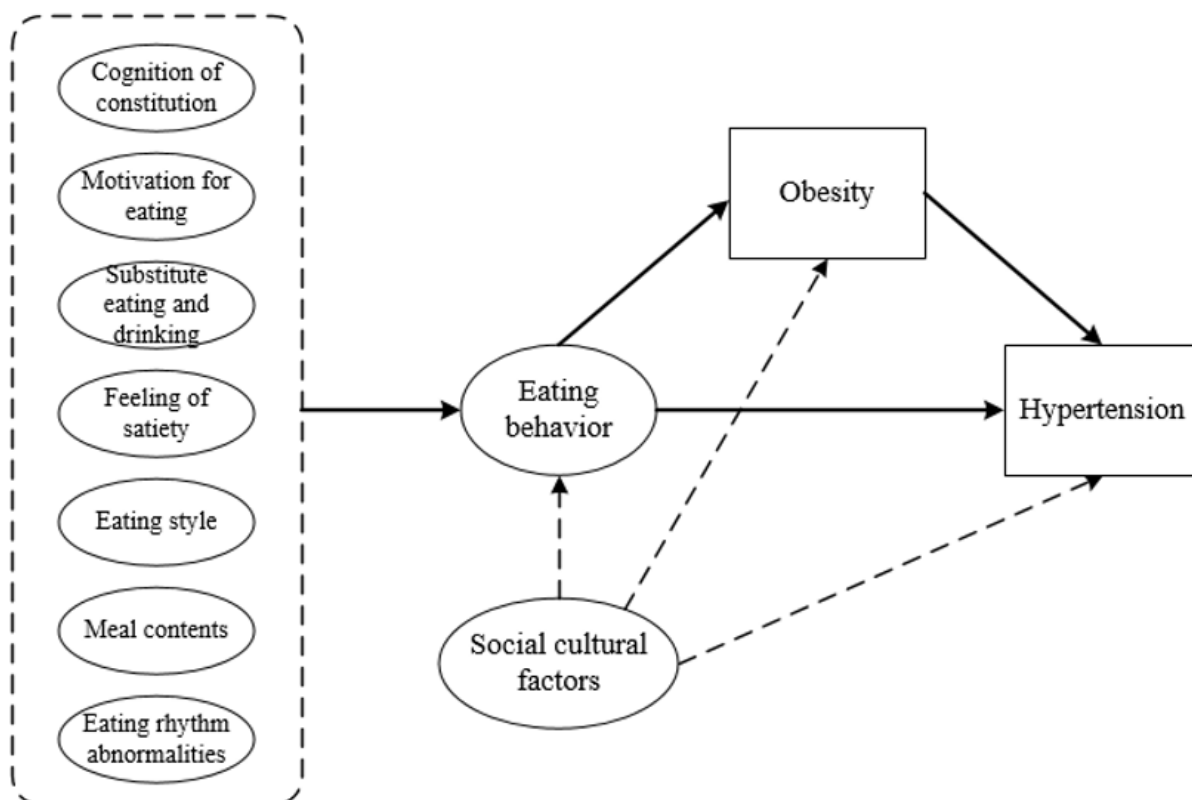


Figure 1. Hypothetical pathways by which eating behaviour may contribute to hypertension.

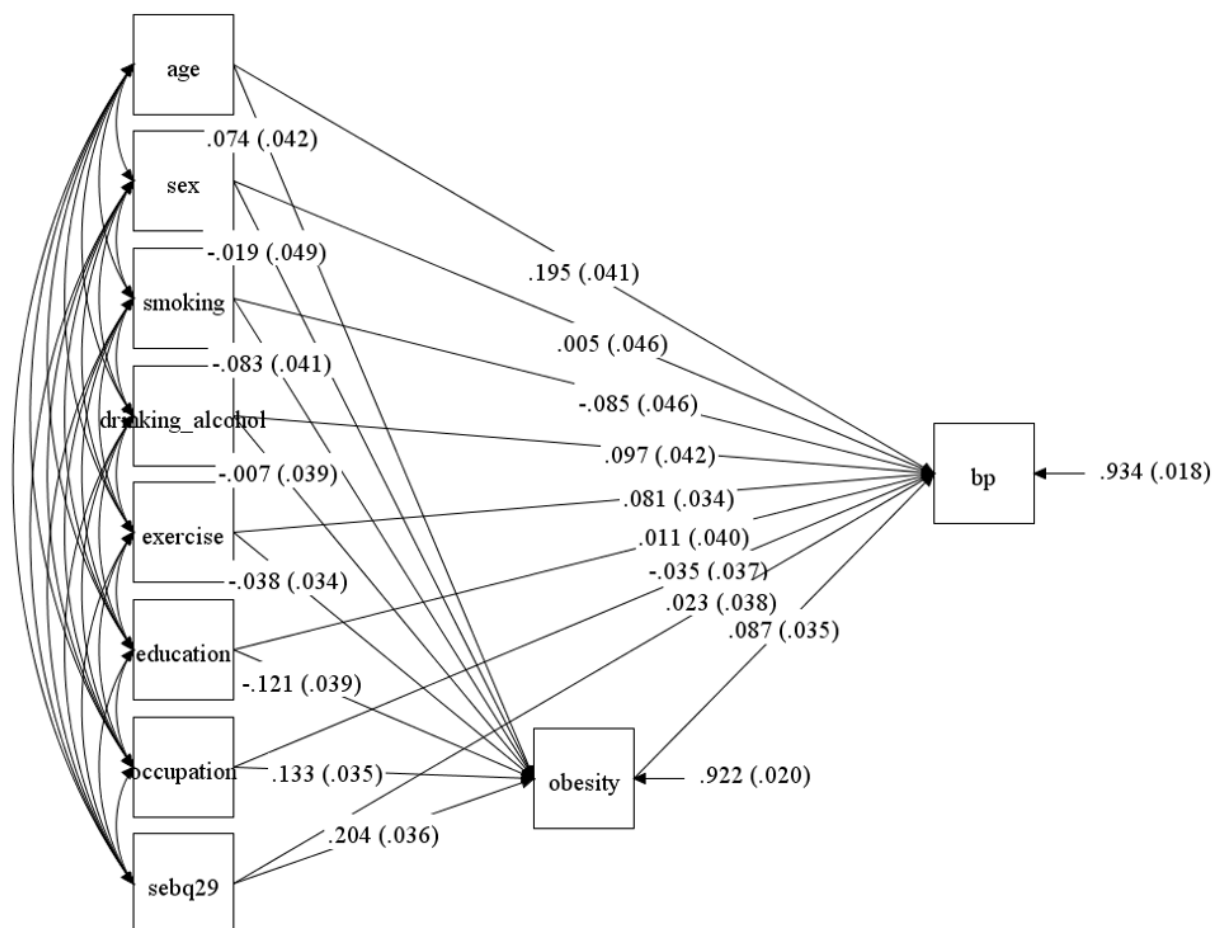


Figure 2. Path model for relationships among hypertension, obesity and eating behaviour.

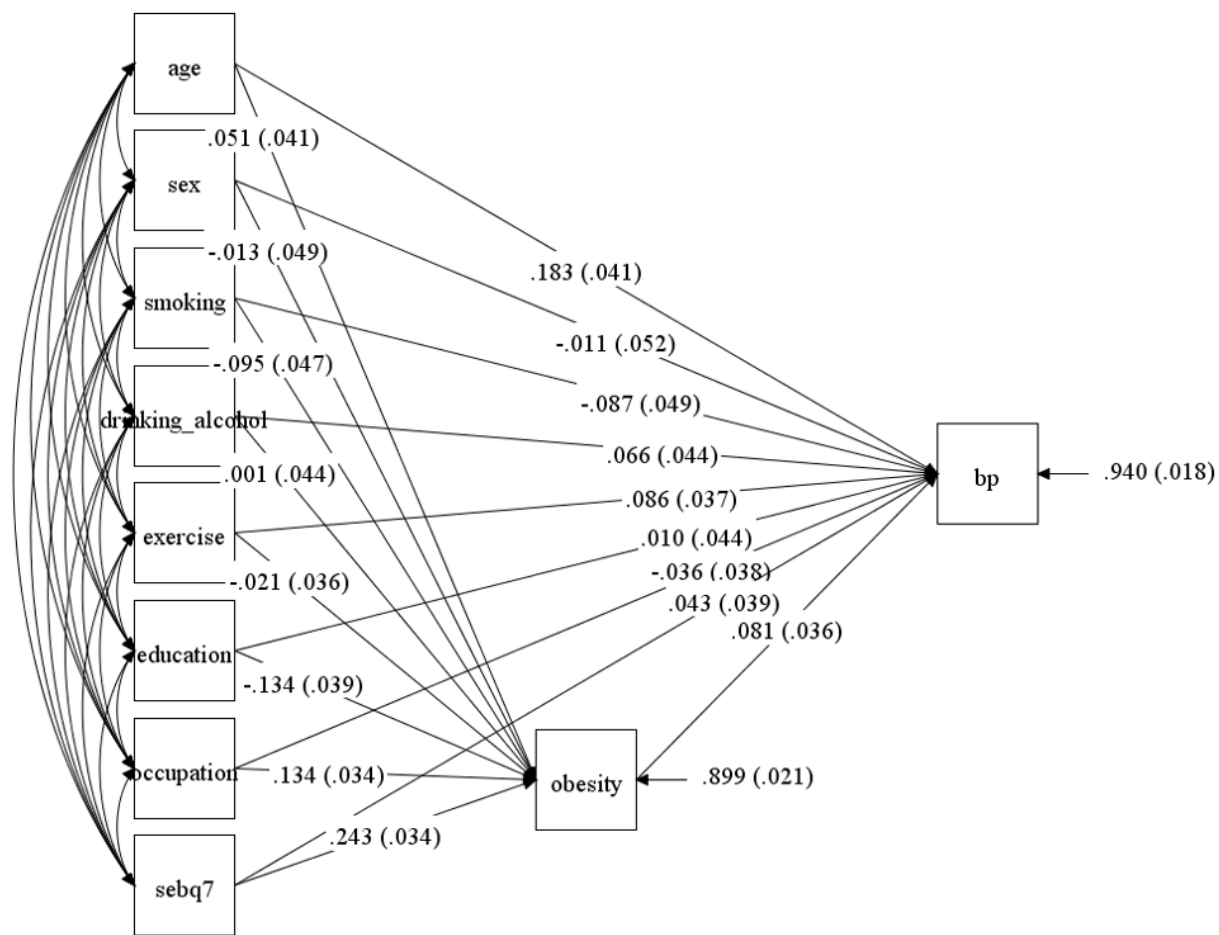


Figure 3. Path model for relationships among hypertension, obesity and short form of SEBQ.