Monosodium glutamate is not associated with overweight in Vietnamese adults

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Abstract

Objective: To determine the prevalence of and associated factors for overweight, especially to determine the relationship between the intake of monosodium glutamate (MSG) as a seasoning and overweight in Vietnam.
Design: A cross-sectional survey was conducted of Vietnamese adults aged ≥20 years in 2008. Dietary intake was assessed by the 24 h recall method for 3 d. MSG intake was evaluated by the weighing method on three consecutive days. Physical activity was assessed based on the Global Physical Activity Questionnaire recommended by the WHO. Overweight was defined as BMI ≥ 23·0 kg/m². Other characteristics such as age and lifelong occupation were determined by a structured questionnaire.
Setting: Some rural and urban areas of Hanoi, Thua Thien Hue Province and Ho Chi Minh City, Vietnam.
Subjects: A total of 1528 adults living in surveyed areas were randomly selected by the multistage cluster sampling method.
Results: The prevalence of overweight was 27·9%, and 81·0% of participants were MSG users. Average MSG intake was 2·2 (SD 1·8) g/d. Multiple logistic regression analysis revealed that factors associated with overweight were age, region of residence, lifelong occupation, physical activity and intakes of energy, carbohydrates, saturated fat and animal protein. There was no significant association between MSG intake and overweight.
Conclusions: The study demonstrated that overweight was not associated with MSG intake in Vietnamese adults. Further longitudinal studies should be done in different populations to determine the relationship between MSG and overweight.

Even though chemical, biochemical and toxicological evaluations made by the Joint Expert Commission on Food Additives of the Codex Alimentarius Commission have shown that there is no need for establishing an Acceptable Daily Intake value for monosodium glutamate (MSG)[1,2], there is a need to conduct research on the health consequences of MSG since it has become one of the world's most widely used food additives. One of the issues of concern is weight gain related to MSG consumption. This has been a controversial problem not only in animal but also in human studies. In animal reports, it has been shown that weight gain was a result of destruction in several brain regions by high doses of MSG

by injection, without food and during the neonatal period[3,4]. However, these animal studies involved doses that people are incapable of consuming. Moreover, other animal experiments have shown that there was no brain damage[5] or any positive association between MSG and obesity[6,7]. In human studies, there have been controversial reports on the association between MSG consumption and obesity in different areas of China since 2008. The MSG intakes in these studies were found to range from a mean of 0·33 to 3·8 g/d[8–10]. At present, overweight and obesity are increasing around the world, even in developing countries[11–13]. In Vietnam, along with a growing economy, dietary patterns and lifestyles have changed profoundly. Consumption of meat and cholesterol-rich food has increased compared with previously, which would suggest that overweight and obesity have been increasing among the Vietnamese population[14–16].

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In addition, the Vietnamese people have long been familiar with the L-glutamate taste from traditional fermented seasonings, such as fish sauce and soya sauce. MSG has been also used as a food seasoning to enhance the taste of foods and meals, by shaking MSG on to foods during preparation. Since there have been controversial reports concerning the association between MSG intake and overweight/obesity[8–10], there is an urgent need to investigate this relationship in the Vietnamese population.

For these reasons, a cross-sectional survey was done to determine the prevalence of and associated factors with overweight, especially to determine the relationship between intake of MSG as a seasoning and overweight in Vietnamese adults.

Materials and methods

Setting and study participants

The study was conducted according to the guidelines laid down in the Declaration of Helsinki and it was approved by the Research and Ethical Committee of the Vietnamese National Institute of Nutrition. The survey was carried out in Hanoi, Thua Thien Hue Province and Ho Chi Minh City, which are located in the north, centre and south of Vietnam, respectively.

A multistage sampling method was used to select participants. In the first step, in each selected province/city, one commune in a rural area and one ward in an urban area were chosen randomly from the list of all communes/wards. Second, lists of all households in the selected communes/wards were established and family codes were created. From this list, a first family was selected by randomly picking a family code. Households in which all family members usually took their meals at home and had at least one member aged ≥20 years were selected for the study. All family members aged ≥20 years were invited to participate in the study. Individuals were excluded if they had any of the following factors: malformation; chronic or acute disease (such as cancer or acute infection); pregnant and lactating women; or on a special diet for weight loss, weight gain, vegetarianism, salt reduction, diabetes mellitus or other reasons.

After choosing the first family, we approached other families by using the 'random walking' method to obtain 255 adults aged ≥20 years (about eighty households) for each commune/ward. By this sampling procedure, a total of 1530 adults in six communes/wards were selected for participation in the survey. Written informed consent was obtained from all participants before conducting the survey.

Assessment of variables

Data were collected by trained researchers and doctors at the participant's home. In interviews and examinations, the doctors employed a specially designed questionnaire which included questions related to demographic variables (age, sex, region of residence and ethnic background), education, occupation, physical activities and lifestyle factors. Medical history of the participant was also requested.

Lifelong occupation was defined as the occupation that the participant engaged in most frequently in her/his life. It was classified as heavy worker (farmers, manual workers), office worker (office clerks and other sedentary jobs) or domestic work (housewife).

Education level was categorized into three groups by years of schooling: low level (≤5 years), medium level (6–8 years) and high level (≥9 years).

Body height and weight were measured while the participant was standing on a stable plane, wearing light clothing and no shoes. BMI (kg/m^2) was calculated as the ratio of weight (in kilograms) to the square of height (in metres). Waist circumference was measured at the minimum circumference between the umbilicus and iliac crest, and hip circumference was measured at the widest circumference around the buttocks. Overweight was defined as BMI ≥ 23·0 kg/m^2 based on WHO recommendations for Asian populations[17].

Physical activity was assessed according to the Global Physical Activity Questionnaire recommended by WHO[18]. Activity levels were categorized as low, moderate and high based on MET (metabolic equivalent of task) values.

Dietary intake was assessed by the 24 h recall method for three consecutive days at the participant's home, while MSG intake was evaluated by the weighing method using a precise scale on the same days. The participant was asked to eat meals prepared at home during the three survey days. On those days, a researcher came to the survey household before and after each meal. Before each meal, the researcher weighed bottles of pure MSG and any seasonings (including sauces or powder) which included MSG. After the meal, the researcher returned to the household to weigh the seasoning bottles again, and to ask the participant to recall the type and amount of any food consumed during the meal. To improve the accuracy of food descriptions, a full-size photograph album of common foods and household measures (such as bowls, cups and spoons) was used during interviews to define appropriate amounts. The participant was also asked to recall the amounts of any snacks and drinks consumed between meals.

The amount of seasonings consumed by all family members during a meal was determined by the difference between the weight of the seasoning bottles before and after the meal. The MSG content in seasonings was calculated from food labels combined with analysis. Therefore, the MSG intake of all family members was equal to the amount of seasonings multiplied by the MSG content of each seasoning. Individual MSG intake at each meal was calculated according to the MSG intake of all family members multiplied by the proportion of actual food intake of the given individual. The participant's daily

Table 1 Characteristics of the study participants: adults aged ≥20 years (*n* 1528) from rural and urban areas of Hanoi, Thua Thien Hue Province and Ho Chi Minh City, Vietnam, 2008

Variable	Urban (*n* 721)		Rural (*n* 807)	
	Mean	SD	Mean	SD
Age (years)	45·7	15·6	45·5	15·6
BMI (kg/m^2)	21·6	3·2	21·0	3·1
WHR	0·87	0·07	0·86*	0·07
Physical activity level (%)				
Low	49·9		43·0	
Moderate	18·6		16·2	
High	31·5		40·8	
Lowest education level (%)	13·4		27·0**	
Lifelong occupation heavy worker (%)	13·7		21·6**	
Energy intake (kJ/d)	8226	2134	7941*	1937
Energy intake (kcal/d)	1966	510	1898*	463
Plant protein intake (g/d)	41·5	16·3	41·4	15·0
Animal protein intake (g/d)	34·2	18·8	28·2**	18·7
MSG intake (g/d)	2·3	1·8	2·1	1·8

WHR, waist-to-hip ratio; MSG, monosodium glutamate.
Data are presented as mean and standard deviation or percentage. Values were compared between rural and urban areas by the independent *t* test or the χ^2 test.
Values were significantly different from those in urban areas: *$P<0·05$, **$P<0·01$ (two-sided).

MSG intake was calculated by totalling the amount of his/her individual MSG intake at all meals for 3 d, then dividing by three.

Statistical analysis

Data are presented as percentages or means and standard deviations. Continuous variables were log$_{10}$ transformed if not normally distributed. Student's *t* test (two-tailed) was applied to examine differences in age, BMI, waist-to-hip ratio, energy intake and MSG intake between participants according to region of residence (rural *v.* urban). The χ^2 test was used to examine differences in prevalence of physical activity level, education level and lifelong occupation of heavy worker between participants in rural and urban areas. Multiple logistic regression analysis was used to test several models for the associations between overweight and other variables. Data are presented as odds ratios and 95 % confidence intervals. Associations were considered statistically significant at $P<0·05$.

All statistical procedures were performed with the statistical software package SPSS for Windows version 10·0 (SPSS Inc.).

Results

Characteristics of participants

Two persons refused to complete all the procedures for the study. Thus, data for 1528 adults, including 706 males and 822 females, were analysed for the present report. The mean age of participants was 45·6 (SD 15·6) years. As shown in Table 1, there were no significant differences in age and BMI between urban and rural areas. Waist-to-hip ratio and energy intake in rural areas were significantly lower than in urban areas ($P<0·05$). Prevalence of participants with the lowest education level was higher in rural areas than in urban areas ($P<0·01$), as was the prevalence of participants with a lifelong occupation of heavy worker ($P<0·05$).

Table 2 Prevalence of overweight/obesity (%) by sex and region of residence: adults aged ≥20 years (*n* 1528) from rural and urban areas of Hanoi, Thua Thien Hue Province and Ho Chi Minh City, Vietnam, 2008

	Males	Females	Total
Urban	31·1	32·4	31·8
Rural	22·1	26·4	24·4*
Total	26·2	29·4	27·9

Data are presented as percentage. Values were compared between males and females, rural and urban areas by the χ^2 test.
Value was significantly different from that in urban areas: *$P<0·05$.

All participants took their meals at home during the survey period, of whom 81·0 % were MSG users. Average MSG seasoning intake was 2·2 (SD 1·8) g/d. Therefore, glutamate (GLU) from MSG was estimated as 1·9 (SD 1·5) g/d. Average animal and plant protein intakes were 31·0 (SD 19·0) g/d and 41·4 (SD 15·2) g/d, respectively. Thus, GLU from food was estimated to be equal to 14·7 (SD 6·7) g/d. There was no significant difference between rural and urban areas with regard to MSG intake as seasoning. There were significant differences in energy intake ($P<0·05$) and animal protein intake ($P<0·01$) between rural and urban areas (Table 1).

Prevalence of overweight

Table 2 shows that there was no significant difference in overweight prevalence between males and females. The prevalence was 26·2 % and 29·4 % in males and females, respectively. The prevalence in rural areas (24·4 %) was significantly lower than that in urban areas (31·8 %, $P<0·05$).

Table 3 Odds ratios and 95 % confidence intervals of predictors for overweight: adults aged ≥20 years (*n* 1528) from rural and urban areas of Hanoi, Thua Thien Hue Province and Ho Chi Minh City, Vietnam, 2008

	OR	95 % CI	*P* value
Region of residence			
Urban	1·00	Ref.	–
Rural	0·77	0·60, 0·98	<0·05
Sex			
Female	1·00	Ref.	–
Male	0·87	0·68, 1·11	NS
Age (per 1 quartile increment)	1·26	1·12, 1·43	0·001
Lifelong occupation			
Office worker	1·00	Ref.	–
Heavy worker	0·45	0·29, 0·68	<0·001
Housewife	1·14	0·83, 1·57	NS
Physical activity level			
High	1·00	Ref.	–
Moderate	1·20	0·91, 1·58	NS
Low	1·50	1·08, 2·09	<0·05
Energy intake (per 1 tertile decrement)	0·64	0·47, 0·85	<0·01
Saturated fat intake (per 1 quartile increment)	1·53	1·33, 1·75	<0·001
Carbohydrate intake (per 1 tertile increment)	1·65	1·28, 2·12	<0·001
Animal protein intake (per 1 quartile increment)	1·20	1·06, 1·35	<0·001
MSG intake			
Non-user	1·00	Ref.	–
1st quartile	1·15	0·80, 1·65	NS
2nd quartile	0·87	0·56, 1·35	NS
3rd quartile	0·69	0·47, 1·00	NS
4th quartile	0·88	0·63, 1·22	NS

MSG, monosodium glutamate; Ref. referent cetagory.
OR and 95 % CI from multiple logistic regression analysis, model was adjusted for education level and smoking.

Associated factors for overweight

Table 3 shows results of the multiple logistic regression model applied to analyse associations between overweight and related variables. It reveals that age, region of residence, lifelong occupation, physical activity level and intakes of energy, carbohydrates, saturated fat and animal protein acted as significant predictors for overweight. There was no significant association between overweight and the intake of MSG as food seasoning. The model was adjusted for education level and smoking. Increased age was positively related to the risk of overweight ($P<0·001$). Participants living in rural areas ($P<0·05$) and those whose lifelong occupation was heavy work ($P<0·001$) had a significantly reduced risk of overweight. Participants who did physical activity at low levels had an overweight prevalence 1·5 times higher than those who did so at high levels ($P<0·05$).

Reduced energy intake was associated with a significantly reduced risk of overweight ($P<0·01$). Increased intakes of carbohydrates, saturated fat and animal protein were separately related to a higher risk of overweight ($P<0·001$ for all).

Discussion

The present report demonstrates that the prevalence of overweight was 27·9 % in a large sample of adults living in three different regions of Vietnam. This is lower than the prevalence in Western countries and China, which ranges

from 48 to 73 %[19–21], but similar to that in other Asian countries, which ranges from 17 to 26 %[22–25]. Concerning overweight in urban areas, the prevalence in the three regions in the current study was 31·1 % and 32·4 % in males and females, respectively. These prevalences are similar to those in 2004 in Ho Chi Minh City, the largest city of Vietnam. This shows that overweight is a noteworthy problem in Vietnam, especially in urban areas.

Factors contributing to overweight and obesity have been given great attention and studied extensively[21,26–28]. Similar to previous studies, our data also found that increasing age and less physical activity are predictors of overweight[21,26,27]. Participants who had a lifelong occupation as heavy workers had less risk of overweight than those who did not. In addition, our study confirmed the previous findings that increased intakes of energy, carbohydrates, saturated fat and animal protein were separately associated with increased risk of overweight[28,29]. We observed that the prevalence of overweight in urban areas was significantly higher than in rural areas. This can be explained by the fact that most of the participants in rural areas were farmers who had lifelong occupation as heavy workers and had energy intakes lower than those in urban areas, so they had less risk of overweight than participants in urban areas.

The present survey is the first one done in Vietnam concerning the intake of MSG as seasoning, and its major strengths are that we selected a large number of participants representative of three ecological regions of the country and that we chose an appropriate method for

MSG measurement. The noteworthy finding was that our results contrast with those from the studies by He et al.[8,10]. Even though we used nearly same method as He et al. in the latter study[10], we could not find any significant association between MSG seasoning intake and overweight. In our survey, participants had their meals at home and the intake of MSG as seasoning was measured by the weighing method for every meal during three consecutive days; this may be a more reliable method than that used by He et al., since they assessed the amount of MSG seasoning intake by 24 h recall[10] or asked users to demonstrate the amount of MSG seasoning added during food preparation[8]. Because overweight is a multi-influenced phenotype which is related to lifestyle, environment and genome, the relationship between MSG and overweight should be considered and studied not only in China and Vietnam, but also in different populations and ethnicities.

The question whether the MSG-enhanced taste of foods can lead to increased total energy intake, thus increasing overweight, is still controversial. It is well known that Asian countries have a higher intake of seasonings rich in MSG; however, these countries do not show higher BMI, while in Western countries the MSG intake is lower but the prevalence of overweight and obesity is higher[24,25,30]. In our participants, the prevalence of overweight was higher in urban areas, while MSG seasoning intake was not significantly different between rural and urban areas. Our literature reviews also found that several studies performed with animal models show either that MSG promotes over-weight[31] or that it has no effect[32]. In addition, a recent study with human volunteers has shown that the subjective assessment of neither hunger nor fullness was affected by MSG supplementation[33]. Regarding to physiology of GLU, 'Glutamate salts such as MSG dissociates in the neutral area so that independent from origin and salt species free GLU is formed'. Also, GLU in food and GLU from MSG are similarly metabolized in the human body[1]. Beyreuther et al.[1] have shown that total intake of GLU from food in European countries was 5–12 g/d, while GLU in seasoning was only about 0·4 g/d. Our study also found that GLU in season-ing was 1·9 g/d, while GLU in food was estimated to be equal to 14·7 g/d. This means that GLU from MSG is indeed small when compared with GLU in food. For these reasons, we cannot say that only MSG (but not GLU in food) causes overweight/obesity. In our study, it is not likely due to chance that we found significant associations between overweight and intakes of energy, carbohydrate, saturated fat and animal protein separately, but not between overweight and MSG seasoning intake.

Our results also support the findings from the study carried out 5 years ago by Shi et al.[9], which found that there was no association between obesity and MSG seasoning intake in the Chinese population. However, in their study, the cut-off for overweight was BMI $\geq 25\cdot0\,\text{kg/m}^2$, while in the present study the cut-off was BMI $\geq 23\cdot0\,\text{kg/m}^2$,

as defined by the WHO to identify risks of an undesirable state of health that warrants a public health or clinical intervention[17].

Despite being carried out in a large number of Vietnamese adults from three different areas (north, central and south), our study has several limitations. First, the survey was done in autumn and winter; therefore, dietary and MSG seasoning intake may not represent the full picture of the four seasons in Vietnam. Second, the participants in our study had meals at home; hence, adults who have meals away from home may have different characteristics from those presented in the current report. Third, due to the cross-sectional design, longitudinal studies using the same method of MSG measurement are needed to confirm our findings.

Conclusions

The present study demonstrates that the prevalence of overweight in Vietnam is relatively high compared with nearby countries. These findings suggest that overweight is becoming an alarming problem in Vietnam which requires great efforts to prevent. The associations between overweight and risk factors were assessed by using multiple logistic regression modelling. Although MSG intake was relatively high, we could not find a relationship between MSG intake and overweight. It is suggested that further longitudinal studies should be done in different populations and ethnicities to determine the association between MSG and overweight.

Acknowledgements

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