Nutrition Research and Practice (*Nutr Res Pract*) 2012;6(3):238-245
http://dx.doi.org/10.4162/nrp.2012.6.3.238
pISSN 1976-1457 eISSN 2005-6168

Preference and intake frequency of high sodium foods and dishes and their correlations with anthropometric measurements among Malaysian subjects

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Abstract

This study investigated the preference and intake frequency of a list of 15 commonly available high sodium Malaysian foods/dishes, discretionary salt use, and their possible association with demographics, blood pressures and anthropometric measurements among 300 Malaysian university students (114 males, 186 females; 259 ethnic Chinese, 41 Indians; 220 lean, 80 overweight). French fries and instant soup noodle were found to be the most preferred and most frequently consumed salty food, respectively, while salted fish was least preferred and least frequently consumed. Males had a significantly higher intake frequency of at least 6 of the salty foods, but the preference of most salty foods was not significantly different between genders. Ethnic Chinese significantly preferred more and took more frequently traditional and conventional Malaysian foods like *asam laksa* (a Malaysian salty-sour-spicy noodle in fish stock), salted biscuits and salted vegetable, while Indians have more affinity and frequency towards eating salty Western foods. Body Mass Index was significantly negatively correlated with the intake frequency of canned/packet soup and salted fish while waist circumference was significantly positively correlated with the preference of instant noodle. Also, an increased preference of potato chips and intake frequency of salted biscuits seemed to lead to a decreased WHR. Other than these, all the other overweight/obesity indicators did not seem to fully correlate with the salty food preference and intake frequency. Nevertheless, the preference and intake frequency of *asam laksa* seemed to be significant negative predictors for blood pressures. Finally, increased preference and intake frequency of high sodium shrimp paste (*belacan*)-based foods like *asam laksa* and *belacan* fried rice seemed to discourage discretionary salt use. In conclusion, the preference and intake frequency of the high sodium *belacan*-based dish *asam laksa* seems to be a good predictor for ethnic difference, discretionary salt use and blood pressures.

Key Words: Preference, intake frequency, obesity, high sodium, Malaysian foods and dishes

Introduction

Salt is one of human's essential food seasonings, but the Malaysian Adult Nutrition Survey (MANS) in 2003 revealed that the sodium intake by Malaysians was 2,575 mg per day [1] or 29% higher than the one teaspoon (5 g) of salt/NaCl (or 2,000 mg sodium) per day limit set by the 2010 Malaysian Dietary Guidelines [2]. However, the Malaysian sodium intake is still considered relatively lower than the averages of 3,220 - 3,680 mg/day in the USA [3], 3,700 mg/day in the UK [4] and ≥4,738 mg/day in other Asian countries [5]. The MANS survey further revealed that although there was no significant difference in the rural-urban intake among Malaysians, men consumed about 500 mg sodium more than women did, while consumption declined with age (highest in the 20-29 and 30-39 years groups to lowest in 50-59 years group) [1]. Sodium was found to be highest in the group with the highest educational level (2,734 mg/day for college/university students), and among the ethnic Chinese (2,916 mg/day) [1]. High sodium consumption is strongly linked to various health problems such as hypertension, stroke, cardiovascular diseases and obesity [6,7]. Therefore, it is thought that the high sodium consumption among Malaysians contributes to the high prevalence of hypertension among adults aged 30 years and above, which has increased to 42.6% - according to the 2006 Third Health and Morbidity Survey [8].

Most dietary sodium is consumed as common salt (sodium chloride). About 90% of salt is largely added in food processing, in restaurant food, in sauces and cooking. In industrialized countries like the UK and USA, it was estimated that about 75% of sodium intake came from processed or restaurant foods, while only 10-12% was naturally occurring and the remaining 10-15% was from added salt in home-cooking or at the table [9,10]. For example, the sodium content of a takeaway cheeseburger and French fries is estimated at 1,240 mg, while the sodium content of foods like chick peas, sweetcorn and peas, which are naturally very low in sodium, increases by 10-100-fold after processing

This project was funded by the Department of Biomedical Science, Faculty of Science, Universiti Tunku Abdul Rahman.
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Received: October 11, 2011, Revised: May 24, 2012, Accepted: May 24, 2012

reviewed in [11]. However, a different picture with regard to dietary sources of sodium is apparent in some Asian countries, where the salt added in cooking and present in sauces and seasonings represent the major sources of sodium in the diet reviewed in [11]. The salting method for processing, preservation and cooking of vegetables, tofu-derived products, seafood, poultry and eggs is common in the Chinese culture [12]. Some foods commonly consumed in Malaysia are also high in sodium; for example a bowl of curry noodle and a bowl of soup noodle available at hawker stalls contain about 2.5 g and 1.7 g sodium, respectively reviewed in [11].

To date, there is limited research on understanding how the reported high sodium intake among Malaysians (especially college/university students) is reflected by the preference and intake frequency of high sodium foods and dishes. Therefore, this study aimed to measure the preference and intake frequency of 15 types of commonly available high sodium Malaysian foods and dishes, using a 7-point hedonic scale. Discretionary salt use dietary practices were also surveyed. Demographic data, blood pressures and anthropometric measurements were taken, such as Body Mass Index (BMI), systolic blood pressure (SBP), diastolic blood pressure (DBP), waist circumference (WC), waist-to-hip ratio (WHR) and total body fat (TBF)-to investigate their possible association with salty food preference and intake frequency.

Subjects and Methods

Demographics, measurements and subject characteristics

The demographic data surveyed included age, gender and self-identified ethnicity; while measurements consisted of SBP and DBP, waist and hip circumferences, height, weight, BMI and TBF. The blood pressures were taken twice after resting for 10 minutes, on their right arm, using the automated Blood Pressure Monitor SEM-1 (Omron, Japan). Other anthropometric measurements were taken as described in our previous study [13]. Subjects with the BMI cut-off point of $\geq$ 23.0 kg/m^2 were considered as overweight [14]. The institutional board [UTAR Scientific and Ethical Review Committee, Ref: UTAR/SERC/2010(6)] approved this study, all individuals participating in this study signed informed consent forms and all samples were taken in accordance with the Declaration of Helsinki (as revised in Seoul 2008).

Hedonic ratings of salty food preference and intake frequency and discretionary salt use practices

A self-administered questionnaire on the preference and intake frequency of a list of 15 types of commonly available high sodium Malaysian foods and dishes (Table 1) was presented. These include *asam laksa* (a rice noodle dish served in a salty-sour-spicy, fish-based stock; tamarind gives the stock its sour flavour, while its salty-spicy flavour comes from shrimp and chilli paste or *sambal belacan)*, *belacan* fried rice (*belacan* is made from fresh tiny shrimps or krills, traditionally used as a food enhancer in countless Malaysian dishes and also used as a dipping condiment with chillies [17]), canned/packet soup, chicken ham, French fries, fried nuggets/balls, hotdog/sausage, instant noodle (with soup), pizza, potato chips, salted biscuits, salted fish, salted nuts, salted vegetables and spaghetti with sauce. In order to aid a better recall of the preference and intake frequency of the foods, subjects were also presented with images of the foods, with appropriate serving sizes to reflect high sodium content. Subjects were required to rate the salty foods based on their preference and how frequent they consume the foods using a 7-point hedonic scale [18]. The response alternatives for preference were 1 = very unpleasant, 2 = fairly unpleasant, 3 =

Table 1. Approximate sodium content (mg) in 15 types of salty foods in this study

Dish/food list in study	Dish/food reference and serving size [Source]	Approximate sodium content (mg)
Asam laksa	*Laksa,* Penang (1 portion or 660 g) [15]	2,653
Belacan fried rice	Fried rice (1 plate) [11]	1,465
Canned/packet soup	Soup, cream of chicken, canned, prepared with equal volume water (1 cup or 244 g) [16]	986
Chicken ham	Ham, sliced, regular (approximately 11% fat) (2 slices or 56.7 g) [16]	739
French fries	Fast foods, potato, French fried in vegetable oil (1 medium or 134 g) [16]	260
Fried nuggets/balls	Fast foods, chicken, breaded and fried, boneless pieces, plain (6 pieces) [16] *or*	840
	Fishball (4 pieces) [11]	756
Hotdog/sausage	Frankfurter, chicken (1 frank or 45 g) [16]	380
Instant noodle with soup	Mee soup (1 bowl) [11]	1,695
Pizza	Fast food, pizza chain, 14" pizza, pepperoni topping, regular crust (1 slice or 106g) [16]	670
Potato chips	Snacks, potato chips, barbecue-flavour (1 oz or 28.35 g) [16]	213
Salted biscuits	Crackers, standard snack-type, regular (4 crackers or 12 g) [16]	104
Salted fish	Fish, herring, Atlantic, pickled (3 oz or 85.05 g) [16]	740
Salted nuts	Peanuts, all types, dry-roasted, with salt (1 oz or 28.35 g) [16]	230
Salted vegetable	Salted cabbage (1 cup) [11]	2,763
Spaghetti	Pasta with meatballs in tomato sauce, canned entrée (1 cup or 252 g) [16]	1,053

slightly unpleasant, 4 = neither pleasant nor unpleasant, 5 = slightly pleasant, 6 = fairly pleasant and 7 = very pleasant [18]. Similarly, the response alternatives for frequency were 1 = never, 2 = once a month or less often, 3 = 1-2 times a month, 4 = once a week, 5 = a couple of times a week, 6 = almost everyday and 7 = at least once a day [18]. Besides, subjects were required to rate on how often they add salt/soy sauce to their food during mealtime and how often they dip their food in soy sauce mixed with chopped chilies/garlic and/or *sambal belacan*. The response alternatives were 1 = usually, 2 = sometimes and 3 = hardly ever [19].

Statistical analysis

Data were analyzed by Statistical Package for Social Sciences (SPSS) Version 17.0 (SPSS Inc, Chicago, IL, USA). Descriptive statistics were used to analyze all variables such as socio-demographic characteristics, anthropometric measurements, intake of salt/soy sauce to food, salty food preference and frequency. Normality of the data was checked using Kolmogorov-Smirnov test. Means were compared by Student's *t* test or One Way ANOVA for parametric data and Mann-Whitney *U* Test or Kruskal-Wallis test for non-parametric data. In addition, partial correlations between clinical and anthropometric measurements and discretionary salt use dietary practices with preference and intake frequency of salty foods were determined after controlling for gender and ethnicity. Chi-square test was performed to determine the association between discretionary salt use practices with gender, ethnicity and BMI. The *P*-value of < 0.05 was considered as statistically significant.

Results

Subject characteristics

The subjects were the two main ethnicities of Universiti Tunku Abdul Rahman (UTAR) at its Perak campus in north Malaysia, which were ethnic Chinese and Indians. The sample were 300 healthy subjects (114 males, 186 females; 259 Chinese, 41 Indians), with the mean age of 20.90 ± 1.67 years (males - 20.67 ± 1.52 years; females - 21.05 ± 1.75 years). Majority of the subjects (73.3%) had a normal BMI, while 26.7% were overweight. SBP, DBP, WHR, WC, weight and BMI were significantly higher in males, while the opposite was true for TBF in females (Table 2).

Table 2. Demographics, clinical and anthropometric measurements of the subjects

Characteristics	Male (n = 114)	Female (n = 186)
Ethnicity		
Chinese	101 (88.6)	158 (85.0)
Indian	13 (11.4)	28 (15.0)
BMI Status		
Lean	76 (66.7)	144 (77.4)
Overweight	38 (33.3)	42 (22.6)
Clinical and anthropometric measurements (Mean ± SD)		
SBP (mmHg)	122.03 ± 12.17	107.73 ± 10.37
DBP (mmHg)	70.50 ± 8.94	66.72 ± 7.81
Pulse rate (bpm)	77.70 ± 11.30	81.48 ± 12.19
WHR	0.86 ± 0.06	0.76 ± 0.07
WC (cm)	83.32 ± 11.72	71.18 ± 8.66
Weight (kg)	66.98 ± 14.88	53.27 ± 8.20
BMI (kg/m^2)	22.38 ± 4.57	20.96 ± 3.07
TBF (%)	17.13 ± 8.34	26.37 ± 8.05

SBP, systolic blood pressure; DBP, diastolic blood pressure; WHR, waist-to-hip ratio; WC, waist circumference; BMI, body mass index; TBF, total body fat; Numbers in parenthesis are percentage of total variable of the same column; *P*-values by Student's *t* test, significant at < 0.05.

Salty food preference and intake frequency based on gender, BMI status and ethnicity

As shown in Table 3, the most preferred salty food and most frequently consumed salty dish were French fries and instant noodles (with soup), respectively; while the least preferred and least frequently consumed salty food was salted fish. Western foods and dishes such as French fries, fried nuggets/balls, hotdog/sausage, pizza and spaghetti with sauce were preferred more (around rating "5 = slightly pleasant") across genders, BMI groups and ethnicities, compared with other salty foods. However, their relatively high preference did not affect their intake frequency, when the subjects only took these foods less than once a week (less than rating "4 = once a week").

Out of the 15 foods and dishes listed, only the preference of *asam laksa* and chicken ham were significantly different between genders, where females significantly preferred more the former and males-the latter (Table 3). Meanwhile, significant differences in the intake frequency of several salty foods were found between genders, which included chicken ham, French fries, fried nuggets/balls, pizza, potato chips and salted nuts. Male subjects showed significantly higher intake frequency of these salty foods compared to females. Overall, both genders fairly preferred all the salty foods (less than the "6" rating) while their salty food intake frequency was only less than once a week (less than the "4" rating).

There seemed to be an absence of association between the salty food preference and intake frequency with BMI status, as all their means were not significant different between the lean and overweight groups. Between ethnic groups, food preference and intake frequency of *asam laksa*, pizza, potato chips, salted biscuits and salted vegetable were significantly different, where Chinese significantly preferred more and took more frequently *asam laksa*, salted biscuits, salted vegetable compared with Indians. Indians seemed to prefer more Western foods like French fries, fried nuggets/balls, pizza and potato chips, and took more frequently the last two foods, compared with Chinese (Table 3).

Table 3. Means of salty food preference and intake frequency with respect to subjects' gender, BMI status and ethnicity

Variables	Gender			BMI Status			Ethnicity		
	Mean ± SD		*P*	Mean ± SD		*P*	Mean ± SD		*P*
	Male (n = 114)	Female (n = 186)		Lean (n = 220)	Overweight (n = 80)		Chinese (n = 259)	Indian (n = 41)	
Asam laksa									
Preference	3.99 ± 1.86	4.54 ± 1.85	0.008	4.45 ± 1.86	4.00 ± 1.86	0.052	4.41 ± 1.86	3.88 ± 1.91	0.044
Frequency	2.32 ± 0.98	2.54 ± 1.21	0.336	2.49 ± 1.13	2.38 ± 1.15	0.314	2.51 ± 1.14	2.16 ± 1.05	0.036
Belacan fried rice									
Preference	3.50 ± 1.59	3.50 ± 1.65	0.902	3.49 ± 1.61	3.53 ± 1.67	0.922	3.47 ± 1.57	3.65 ± 1.93	0.339
Frequency	2.29 ± 1.10	2.11 ± 1.08	0.093	2.18 ± 1.09	2.16 ± 1.10	0.777	2.18 ± 1.08	2.16 ± 1.13	0.995
Canned/packet soup									
Preference	3.65 ± 1.49	3.48 ± 1.56	0.275	3.54 ± 1.52	3.56 ± 1.57	0.997	3.53 ± 1.51	3.67 ± 1.71	0.700
Frequency	2.52 ± 1.21	2.25 ± 0.96	0.115	2.37 ± 1.08	2.30 ± 1.02	0.566	2.37 ± 1.07	2.23 ± 1.04	0.357
Chicken ham									
Preference	4.86 ± 1.38	4.40 ± 1.53	0.016	4.48 ± 1.53	4.84 ± 1.33	0.103	4.60 ± 1.42	4.44 ± 1.83	0.691
Frequency	3.21 ± 1.27	2.81 ± 1.11	0.008	2.92 ± 1.18	3.08 ± 1.19	0.320	3.03 ± 1.16	2.56 ± 1.24	0.021
French fries									
Preference	5.19 ± 1.31	5.04 ± 1.45	0.459	5.13 ± 1.37	5.01 ± 1.47	0.638	5.00 ± 1.37	5.72 ± 1.40	< 0.001
Frequency	3.66 ± 1.31	3.24 ± 1.15	0.006	3.33 ± 1.21	3.59 ± 1.26	0.100	3.37 ± 1.21	3.58 ± 1.35	0.285
Fried nuggets/balls									
Preference	5.01 ± 1.22	4.65 ± 1.57	0.073	4.79 ± 1.44	4.78 ± 1.49	0.967	4.71 ± 1.39	5.21 ± 1.75	0.004
Frequency	3.47 ± 1.32	3.12 ± 1.24	0.019	3.18 ± 1.25	3.48 ± 1.34	0.073	3.23 ± 1.22	3.42 ± 1.59	0.440
Hotdog/sausage									
Preference	5.04 ± 1.30	4.76 ± 1.51	0.224	4.87 ± 1.44	4.88 ± 1.44	0.932	4.84 ± 1.37	5.07 ± 1.78	0.041
Frequency	3.61 ± 1.46	3.36 ± 1.16	0.208	3.40 ± 1.23	3.60 ± 1.42	0.264	3.46 ± 1.27	3.42 ± 1.42	0.913
Instant noodle (with soup)									
Preference	4.35 ± 1.39	4.48 ± 1.39	0.497	4.35 ± 1.39	4.65 ± 1.38	0.117	4.38 ± 1.34	4.74 ± 1.63	0.064
Frequency	3.54 ± 1.48	3.63 ± 1.22	0.455	3.58 ± 1.33	3.63 ± 1.29	0.957	3.63 ± 1.30	3.40 ± 1.43	0.088
Pizza									
Preference	5.22 ± 1.42	5.06 ± 1.57	0.551	5.18 ± 1.47	4.98 ± 1.64	0.383	5.05 ± 1.47	5.56 ± 1.72	0.001
Frequency	2.72 ± 1.10	2.44 ± 0.84	0.025	2.47 ± 0.87	2.74 ± 1.13	0.087	2.49 ± 0.93	2.84 ± 1.07	0.007
Potato chips									
Preference	4.75 ± 1.60	4.74 ± 1.56	0.928	4.76 ± 1.56	4.68 ± 1.63	0.761	4.66 ± 1.55	5.23 ± 1.67	0.002
Frequency	3.29 ± 1.41	2.89 ± 1.10	0.029	2.96 ± 1.19	3.25 ± 1.36	0.094	2.96 ± 1.18	3.49 ± 1.49	0.012
Salted biscuits									
Preference	3.77 ± 1.60	3.74 ± 1.57	0.906	3.75 ± 1.54	3.76 ± 1.69	0.977	3.84 ± 1.52	3.21 ± 1.82	0.037
Frequency	2.87 ± 1.44	2.54 ± 1.31	0.071	2.71 ± 1.36	2.54 ± 1.40	0.253	2.75 ± 1.38	2.16 ± 1.21	0.010
Salted fish									
Preference	3.11 ± 1.47	3.12 ± 1.72	0.937	3.16 ± 1.68	2.99 ± 1.47	0.500	3.09 ± 1.58	3.23 ± 1.91	0.553
Frequency	2.24 ± 1.18	1.98 ± 0.97	0.064	2.12 ± 1.09	1.96 ± 0.96	0.305	2.07 ± 1.03	2.09 ± 1.21	0.855
Salted nuts									
Preference	3.63 ± 1.64	3.38 ± 1.61	0.248	3.52 ± 1.66	3.35 ± 1.52	0.448	3.47 ± 1.60	3.51 ± 1.79	0.649
Frequency	2.51 ± 1.29	2.11 ± 0.96	0.016	2.25 ± 1.11	2.30 ± 1.12	0.705	2.27 ± 1.10	2.21 ± 1.21	0.688
Salted vegetable									
Preference	3.10 ± 1.64	3.47 ± 1.75	0.075	3.38 ± 1.73	3.19 ± 1.67	0.394	3.42 ± 1.67	2.77 ± 1.90	0.034
Frequency	2.22 ± 1.29	2.38 ± 1.23	0.106	2.34 ± 1.27	2.26 ± 1.21	0.689	2.39 ± 1.27	1.91 ± 1.09	0.012
Spaghetti (with sauce)									
Preference	4.84 ± 1.53	4.98 ± 1.77	0.192	4.90 ± 1.70	5.00 ± 1.64	0.730	5.04 ± 1.59	4.30 ± 2.03	0.028
Frequency	3.11 ± 1.34	2.98 ± 1.22	0.393	2.96 ± 1.19	3.21 ± 1.44	0.285	3.09 ± 1.27	2.65 ± 1.21	0.068

P-values obtained by Mann-Whitney U Test

Correlations of salty food preference and intake frequency with demographics, blood pressures and anthropometric measurements

Among the food list, the preference and intake frequency of *asam laksa* seemed to be a significant negative but weak predictor for blood pressures (SBP, DBP), while its preference was only significantly negative correlated with TBF (Table 4). For other overweight/obesity indicators, BMI was significantly negatively correlated with the intake frequency of canned/packet soup and

Table 4. Correlation coefficient values (*r*) of the salty food preference and intake frequency with blood pressures and anthropometric measurements

Variables	SBP	DBP	BMI	WC	WHR	TBF
Asam laksa						
Preference	-0.145*	-0.188**	-0.087	-0.029	-0.028	-0.155**
Frequency	-0.172**	-0.182**	-0.086	-0.058	0.017	-0.086
Belacan fried rice						
Preference	0.041	-0.011	-0.012	-0.009	0.046	-0.025
Frequency	0.120	-0.062	-0.055	-0.060	-0.063	-0.113
Canned/packet soup						
Preference	-0.042	0.003	-0.053	-0.014	0.030	-0.098
Frequency	-0.090	0.052	-0.118*	0.006	-0.050	-0.114
Chicken ham						
Preference	0.010	0.087	0.005	0.062	0.052	0.072
Frequency	-0.039	0.044	-0.019	0.034	0.083	-0.009
French fries						
Preference	-0.060	0.034	-0.055	-0.008	-0.014	0.022
Frequency	0.032	0.068	0.021	0.059	0.082	0.070
Fried nugget/balls						
Preference	-0.002	0.078	0.007	-0.049	0.002	-0.064
Frequency	0.030	0.090	0.068	0.018	0.004	-0.030
Hotdog/sausage						
Preference	0.046	0.117	0.003	0.027	0.076	0.002
Frequency	0.029	0.093	0.042	0.075	0.007	-0.030
Instant noodle (with soup)						
Preference	0.021	0.085	0.083	0.126*	0.073	0.036
Frequency	-0.036	0.019	0.036	0.007	-0.064	-0.047
Pizza						
Preference	-0.025	-0.061	-0.083	-0.077	-0.010	-0.043
Frequency	-0.022	-0.004	-0.007	0.004	0.046	0.007
Potato chips						
Preference	0.014	0.016	-0.057	0.025	-0.122*	-0.025
Frequency	0.041	0.027	-0.003	0.090	-0.037	0.031
Salted biscuits						
Preference	0.013	0.023	-0.041	-0.005	-0.041	-0.099
Frequency	-0.015	-0.026	-0.097	-0.099	-0.163**	-0.098
Salted fish						
Preference	-0.091	-0.006	0.005	-0.013	0.005	-0.058
Frequency	-0.107	-0.071	-0.145*	-0.017	-0.077	-0.100
Salted nuts						
Preference	0.008	0.070	0.004	0.002	0.004	-0.096
Frequency	-0.036	-0.023	-0.053	-0.013	-0.046	-0.037
Salted vegetable						
Preference	-0.019	0.019	0.013	0.020	0.013	-0.056
Frequency	-0.071	-0.004	-0.072	-0.080	-0.012	-0.056
Spaghetti						
Preference	-0.061	-0.004	-0.011	0.028	-0.011	0.029
Frequency	-0.032	0.030	0.012	0.016	0.002	0.032

SBP, systolic blood pressure; DBP, diastolic blood pressure; WHR, waist-to-hip ratio; WC, waist circumference; BMI, body mass index; TBF, total body fat; Values are *r* by partial correlation analysis after controlling for gender and ethnicity; *Correlation is significant at the 0.05 level (2-tailed); **Correlation is significant at the 0.01 level (2-tailed).

salted fish while WC was significantly positively correlated with the preference of instant noodle. Lastly, an increased preference of potato chips and intake frequency of salted biscuits seemed to lead to a decreased WHR.

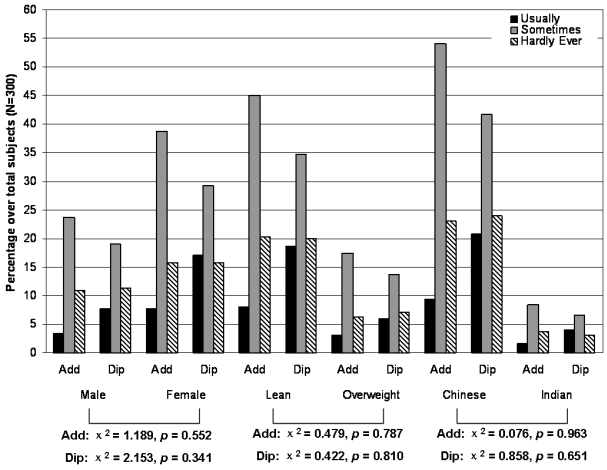

Fig. 1. Prevalence of discretionary salt use dietary practices, which include adding salt/soy sauce to food (add) and dipping food with soy sauce with chilies/garlic or with *sambal belacan* (dip) - according to gender, BMI status and ethnicity. Bars are percentages over the total number of subjects (n = 300). χ^2 and *P*-values between gender, BMI status and ethnicity are by Pearson's Chi-square test.

Discretionary salt use dietary practices

Fig. 1 shows the prevalence of adding salt/soy sauce to food with respect to subjects' gender, BMI status and ethnicities. Majority of the subjects practised usual and occasional adding salt/soy sauce to food and dipping food in soy sauce mixed with chopped chilies/garlic and/or *sambal belacan*, with more subjects preferred usual dipping rather than adding additional sodium to food. No association was found between these dietary practices with gender, BMI and ethnicity.

Correlations of salty food preference and intake frequency with discretionary salt use dietary practices

The intake frequency of all salty foods and dishes were significantly negatively correlated with the practice of adding salt/soy sauce to food, except for *asam laksa*, canned/packet soup and salted biscuits (Table 5). This indicates that the more frequent the subjects take these salty foods, the less likely they will add additional sodium to their food. Meanwhile, both the preference and intake frequency of *asam laksa*, *belacan* fried rice and salted vegetable were significantly negatively correlated with the practice of dipping food with additional sodium, indicating that increased preference and intake frequency of these high sodium and aromatic *belacan*-based foods will cause the subjects less likely to dip their food with chillies/garlic-infused soy sauce or with *sambal belacan*.

Table 5. Correlation coefficient values (*r*) of salty food preference and intake frequency with dietary practices of adding additional sodium to food

Variables	Adding salt/soy sauce to food	Dipping food with soy sauce+chillies/garlic or *sambal belacan*
Asam laksa		
Preference	-0.043	-0.217**
Frequency	-0.048	-0.207**
Belacan fried rice		
Preference	-0.040	-0.197**
Frequency	-0.116*	-0.145*
Canned/packet soup		
Preference	0.024	-0.005
Frequency	-0.085	-0.045
Chicken ham		
Preference	-0.048	0.044
Frequency	-0.202**	-0.047
French fries		
Preference	-0.014	0.061
Frequency	-0.214**	-0.175**
Fried nugget/balls		
Preference	-0.014	-0.017
Frequency	-0.195**	-0.124*
Hotdog/sausage		
Preference	-0.025	0.072
Frequency	-0.157**	-0.081
Instant noodle (with soup)		
Preference	-1.000	-0.022
Frequency	-0.217**	-0.098
Pizza		
Preference	-0.032	0.033
Frequency	-0.174**	-0.038
Potato chips		
Preference	-0.020	-0.020
Frequency	-0.168**	-0.017
Salted biscuits		
Preference	-0.095	-0.031
Frequency	-0.042	-0.015
Salted fish		
Preference	-0.084	-0.097
Frequency	-0.171**	-0.108
Salted nuts		
Preference	-0.016	-0.103
Frequency	-0.115*	-0.090
Salted vegetable		
Preference	-0.059	-0.122*
Frequency	-0.156**	-0.145*
Spaghetti		
Preference	0.047	0.034
Frequency	-0.131*	-0.033

Values are *r* by partial correlation analysis after controlling for gender and ethnicity. *Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

Discussion

As the sodium intake by Malaysians was 29% higher than the limit set by the Malaysian Dietary Guidelines 2010 [1], we therefore sought to investigate the patterns of preference and intake frequency of a list of specific high sodium content Western and Malaysian foods among Malaysians (particularly college/university students and ethnic Chinese), discretionary salt use practices and how they might correlate with blood pressures and anthropometric measurements indicative of overweight/obesity.

The Malaysian Food Regulations 1985 and Food Act 1983 defines low salt, very low salt and salt-free foods as foods with a sodium concentration of up to 120 mg/100 g, 40 mg/100 g and 5 mg/100 g, respectively [20], while the 2010 Malaysian Dietary Guidelines has indicated moderate and high salt foods as containing 120-480 mg/100 g and more than 480 mg/100 g, respectively [2]. Therefore, from the list of 15 foods and dishes, Malaysian foods such as a bowl of noodles with soup, a plate of fried rice and four pieces of fishballs have extremely high sodium contents, containing up to 1,695, 1,465 and 756 mg sodium, respectively reviewed in [11]. In this study, French fries and instant noodles (with soup) were found to be the most preferred salty food and most frequently consumed food, respectively. This is possibly due to the former being flavourful and having a more favourable crispy texture (as they are deep-fried), while the latter is a quick, cheap and convenient food option especially among university students. Salted fish was least preferred and least frequently consumed (less than 1-2 times a month), which could be due to the fact that majority of the subjects were ethnic Chinese, a group who reportedly consume significantly more shellfish and less processed fish compared to other ethnic groups [21]. Consistent with our finding, another study found that salted fish was hardly ever eaten daily across households of different ethnicities-weekly was a moderate frequency and less than weekly was most common [22].

The students had an ambiguous preference towards *belacan*-based foods like *asam laksa* and *belacan* fried rice, while they consumed these foods less than 1-2 times a month. This is in contrast with another Malaysian study with a student majority (20-29 years) and a more reflective ethnic composition, which found that most of the subjects consumed dishes with *belacan* 2-3 times a week (34.1%) and 2-3 times a month (26.7%) [17]. In the same study, *belacan* fried rice was found to be the third most favourite dish with *belacan*, after *sambal belacan* and *kangkung belacan* (stir fried water convolous with *belacan*). Meanwhile, Western foods and dishes were preferred more by the students and this is not unexpected, as Malaysia is also facing nutrition transition towards a more Westernized one [23,24]-facilitated by food imports and mushrooming of fast food centres. However, the relatively infrequent intake of these foods may be due to their relatively higher costs compared to the more commonly available Malaysian foods/dishes.

From our study, male subjects had a significantly higher intake

frequency of at least 6 of the salty foods, but the preference of the salty foods (except *asam laksa* and chicken ham) was not significantly different between genders. Although we did not quantitatively measure daily sodium intake, the higher sodium intake among men is supported by the 2003 MANS survey which found that men consumed more sodium than women did [1], as well as other worldwide studies reviewed in [11,19]. Also, in contrast with our finding, a similar food frequency and preference questionnaire survey among the Japan Colloborative Cohort found women reported less preference of salty foods than men [25]. Meanwhile between ethnic groups, Chinese significantly preferred more and took more frequently traditional and conventional Malaysian foods like *asam laksa*, salted biscuits and salted vegetable, while Indians have more affinity and frequency towards Western foods.

In this study, there was absence of association between salty food preference and intake frequency with BMI status, and preference and intake also seemed to be not or negative predictors for BMI. In contrast, another study showed that for both sexes, dietary intake of sodium decreased progressively with increasing quintiles of BMI; however, this was due to the relative underreporting of dietary sodium intake by subjects with a higher BMI [26]. A Mongolian study showed that individuals practising a 'transitional' diet pattern (high in processed meat, vegetables, potato, cheese, beef, mutton and cookies) had significantly greater risk of abdominal obesity [27], suggesting that a high sodium diet will in part lead to overweight/obesity. In support of this, a Japanese study showed that a 'healthy' dietary pattern (high intakes of vegetables, mushrooms, seaweeds, potatoes, fish and shellfish, soy products, processed fish, fruit and salted vegetables) was significantly associated with a lower risk of obesity, while 'Japanese traditional' (high intakes of rice, miso soup and soy products) and 'Western' (high intakes of meats, fats and oils, seasonings, processed meats and eggs) dietary patterns increased the risk of obesity [28]. In this study, the intake frequency of canned/packet soup showed a weak negative correlation with BMI, but not WHR, TBF and WC. Similarly, another study by Kuroda *et al*. [29] found that frequency of soup intake was negatively correlated with obesity-related physical parameters in Japanese men. Last but not least, our current study fails to fully support data from epidemiological studies that demonstrate that increased sodium intake will lead to increased blood pressures [6,7], as SBP and DBP were weakly negatively correlated with the preference and intake frequency of only one food item, *asam laksa*. The reason behind the phenomenon of increased preference and intake frequency of *asam laksa* leading to decreased blood pressures is currently unknown and needs further investigation. Nevertheless, we speculate that the high tamarind content in this dish might mask the direct effect of sodium towards blood pressure, since dried and pulverized pulp of tamarind (*Tamarindus indica)* fruit orally administered to human subjects for 4 weeks was found to cause significant reduction of at least DBP [30].

Limitations to the study include the validity of the salty food preference and intake frequency survey, as there may be under-reporting due to responder fatigue, memory recall and interviewer and subject bias. Quantitative methods such as 7-day weighed record, 24-h dietary recall, duplicate portions of food, and collection of 24-hour, overnight or spot (single) urine collection reviewed in [11] can be used as more accurate estimations of sodium intake in the future. We are also aware of the imbalance in the distribution of the subjects, where the number of females almost twofold outnumbered males and also the ethnicities were just limited to Chinese and Indians. There was also an imbalance of the male: female ratio among ethnicities, causing direct comparison solely due to ethnicity to be difficult. As we only focused on college students for convenience, findings in this study might not be applicable to other age groups. Future larger studies encompassing ethnic Malays and other East Malaysian ethnic groups and other age groups too are needed to validate our findings to be more reflective of the Malaysian population. It will be also interesting to examine the association between salty food preference and intake frequency with taste phenotypes like perceived bitterness of propylthiouracil (PROP) and number of taste fungiform papillae [19].

In conclusion, French fries and instant noodles (with soup) were found to be the most preferred salty food and most frequently consumed food, respectively, while salted fish was least preferred and least frequently consumed. For salty food preference, only *asam laksa*, a Malaysian salty-sour-spicy noodle in fish stock, was significantly different between subjects' genders and ethnicities. In this study, male subjects had a significantly higher intake frequency of at least 6 of the salty foods, but the preference of the salty foods (except *asam laksa* and chicken ham) was not significantly different between genders. Meanwhile between ethnic groups, Chinese significantly preferred more and took more frequently traditional and conventional Malaysian foods like *asam laksa*, salted biscuits and salted vegetable, while Indians have more affinity and frequency towards salty Western foods. There was absence of association between salty food preference and intake frequency with BMI status, and preference and intake also seemed to be not or negative predictors for BMI. Nevertheless, the preference and intake frequency of *asam laksa* seemed to be significant negative predictors for blood pressures. Discretionary salt use dietary practices did not associate with subjects' demographics; however, increased preference and intake frequency of high sodium *belacan*-based foods like *asam laksa* and *belacan* fried rice seemed to discourage discretionary salt use practices. Taken together, the preference and intake frequency of the high sodium *belacan*-based dish *asam laksa* seems to be a good predictor for ethnic difference, discretionary salt use and blood pressures. Understanding the preference and intake frequency of list of specific high sodium foods and dishes common available in Malaysia can help to plan for sodium reduction strategies in our diet, in order to prevent the detrimental health and economic burdens of high sodium intake.

Acknowledgments

We gratefully acknowledge all the volunteers who have participated in this study.

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