Relationship between consumption of high fat, sugar or sodium (HFSS) food and obesity and non-communicable diseases

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ABSTRACT

The objective of this study was to investigate the relationship between high in fat, sugar or salt consumption, obesity and non-communicable diseases (NCDs) in the population in Thailand, and other associated factors. This study used data from participants age 15 years or older from the 2021 Health Behaviour of Population Survey. The final analytical sample included 74 894 respondents with complete data. Binary logistic regression analysis was used to investigate the relationship between socio-demographic characteristics, unhealthy food, NCDs and obesity. People with obesity had the significant ORs for sugar-sweetened beverages or SSB (OR 1.208; 95% CI 1.159 to 1.259), high-fat foods (OR 1.162; 95% CI 1.120 to 1.207) and snacks (OR 1.048; 95% CI 1.004 to 1.093), but had the significant protective ORs for meat products (OR 0.964; 95% CI 0.930 to 0.999), instant food (OR 0.903; 95% CI 0.865 to 0.942) and fast food (OR 0.871; 95% CI 0.831 to 0.913). People with any NCDs had the significant protective ORs for meat products (p≤0.001), instant food (p≤0.05) and fast food (p≤0.01). People with diabetes tended not to drink SSB while people with heart disease tended not to consume SSB and snacks. The findings suggest a need for prevention and control strategies such as promoting healthy snacking behaviour, modifying food environments and paying specific attention to the population most at risk of obesity and NCDs.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Consuming unhealthy foods inevitably leads to obesity and non-communicable diseases (NCDs).

WHAT THIS STUDY ADDS

⇒ The study identified the significant association between specific high in fat, sugar or salt groups and obesity and NCDs.

⇒ High consumption of sugar-sweetened beverages, high-fat foods and snacks was observed in the study population living with obesity and some NCDs.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The prevention and control of obesity and NCDs must take into account different socio-demographic characteristics, including the patient's disease.

⇒ Interventions for modification of the food environment for people at risk of obesity and NCD to encourage healthier eating habits are needed.

INTRODUCTION

Food consumption behaviour particularly foods high in fat, sugar or salt (HFSS) content is known to be associated with poor diet, obesity and diet-related non-communicable diseases (NCDs). A Canadian study found a significant correlation between liking foods high in salt and fat and lower diet quality.[1] There is considerable evidence of a significant relationship between consumption of high fat foods, meats, savoury snacks and sweets and obesity and various NCDs (eg, diabetes) and risk factors for cardiovascular disease.[2] A balanced intake of fat, sugar and salt could yield substantial savings for direct healthcare costs.[3] Evidence suggests that risk of obesity and diet-related NCDs can be reduced through changing dietary patterns by reducing HFSS food consumption and replacing it with healthier eating.[4]

Dietary risk factors are of particular concern in Thailand, where 82 of every 100 000 deaths are due to NCDs.[5] Thailand has experienced a rising prevalence of obesity and NCDs in the past 30 years.[6] NCDs remain the number one cause of premature morbidity and mortality in Thailand, and obesity is one of major risk factors of NCDs.[7] According to the National Health Examination Survey data in 2014 and 2019,[8] the prevalence of obesity has increased from 37.5% to 42.2%, cardiovascular disease from 43.8% to 56.8%, diabetes from 8.9% to 9.5% and hypertension from 24.7% to 25.4%. The increase was among all socioeconomic groups and in urban and rural populations. A concomitant increase in per capita consumption of sugar from 95 to 125 g/day,[9] total fat

supply from 67.6 to 69.0 g/day[10] and sodium on average up to 4352 g/day was observed.[11] Sugar, fat and salt intake (kilogram per capita) were significantly associated with obesity[12] and influenced the risk of developing NCDs.[13 14]

There is a concern about the impact of NCDs burden on individual and community health as well as national economies. In 2019, NCDs cost Thailand's economy more than 1.6 trillion baht (US$50 billion) annually, representing 9.7% of Thailand's gross domestic product (GDP).[15] NCDs treatment and productivity loss due to absenteeism, presenteeism or early withdrawal from the labour force accounted for the loss of 139 billion baht (approximately US$4 billion), with dramatic impact on population quality of life, socioeconomic development and long-term fiscal sustainability of public services. Investment in cost-effective health policy and clinical interventions for the prevention and control of NCDs can yield a favourable return to investment. For example, implementation of WHO's salt reduction policy package (SHAKE), for over 15 years could yield more than 10 baht return for every 1 baht invested.

As the population in Thailand is ageing,[16] resources required for NCDs treatment will surely increase significantly in the coming years. Treating individuals with NCDs and obesity thus becomes increasingly challenging. Cost-effective solutions need to be developed to appropriately manage these individuals through changing certain behaviours such as unhealthy diets. Information about characteristics of the population living with NCDs and obesity and their food consumption is needed to inform policy decisions.

However, there is a dearth of food consumption data among people living with NCDs and obesity in Thailand at the population level. Most studies in Thailand have examined food consumption in the general population.[17] Therefore, this study investigated the relationship between HFSS consumption and obesity and NCDs in the population who are living with obesity and NCDs, and other associated factors.

METHODS
Study design and participants
This study used data from participants from the 2021 Health Behaviour of Population Survey (HBPS). The HBPS is a nationally-representative population-based household survey on health behaviours administered by the Thailand's National Statistical Office (NSO) of the Ministry of Digital Economy and Society (see online supplemental file 4).

The NSO used a stratified two-stage sampling design to obtain a nationally-representative sample of persons age 15 years or older. The population universe was stratified into four geographical regions (Central, North, Northeast and South) and Bangkok (Metropolis). This study included data from 37 provinces of Thailand (9 sampled provinces for each of the four regions and Bangkok). Within each province, a systematic sampling of 5250 enumeration areas (EA) was conducted, with 2798 EAs in urban and 2452 EAs in rural areas. Within each EA, 16 households for each EA were systematically, randomly selected. Finally, a total of 84 000 households, which comprise 44 768 and 39 232 households in urban and rural areas, respectively, were included in the survey.

This study used the data collected from the general population for assessing self-reported medical diagnosis of obesity and NCDs which mainly included hypertension, diabetes, dyslipidaemia and heart disease. The targeted population were in the age of 15 years or older. A structured questionnaire was administered in person by a trained interviewer. An interviewer training workshop was held by the NSO. The training was hands-on and focused on interviewing techniques and data collection using computer tablets. All the interviewers learnt through a step-by-step process using practical exercises and role-playing to build confidence and proficiency.

A total of 73 654 households participated in the survey during 1 February to 31 May 2021. The response rate was 95.2%, with no replacement. The final analytical sample comprised 74 894 respondents with complete data (see table 1 and online supplemental table S1).

Variables
In this study the outcome measures are obesity and NCDs, and the independent variables are unhealthy foods consisting of sugar-sweetened beverages (SSB), high-fat foods, snacks, meat products, instant food and western fast food. Covariate variables were used in the analysis such as sex, age, marital status, place of residence, education and income. This study focused on major diet-related

Table 1 Number of sampled households and respondents (age 15 years or older)

Region	Sampled households	Number of final analytical sample	
		Households	Respondents
Bangkok	4000	3242	9722
Central	26 608	22 037	22 802
North	18 048	16 298	13 510
Northeast	20 528	19 168	19 466
South	14 816	12 909	9394
Total	84 000	73 654	74 894

NCDs which are hypertension, diabetes, dyslipidaemia and heart disease.[18 19]

Measurement
Dependent variables: obesity and NCDs

Each respondent was asked 'Have you ever been diagnosed by a doctor as having any of the following non-communicable diseases (hypertension, diabetes, dyslipidemia and heart disease)?' Response options were 'yes' (1) or 'no' (0). If the response was yes, the respondent was then asked to tell the name(s) of the disease(s). Self-reported data on height and weight of each respondent was collected for Asia-Pacific body mass index (Asia-Pacific BMI) calculation. BMI is an anthropometric index that is commonly used as a simple index to classify overweight and obesity.[20] Obesity in this study was defined as a BMI=25 kg/m^2 or above.[21]

Independents variables
Unhealthy foods

Each respondent was asked that during the past 30 days, how often did s/he consume each of the following food groups: SSBs (such as soft drink, tea, coffee, energy drink, juice with sugar, beauty drink), high-fat foods (such as curry with coconut milk and baked foods such as cake, donuts, cookies), snacks (such as potato chips, fried fish strips, crispy corn, wafer, crispy seaweed), meat products (such as bacon, sausage, ham, meat balls, sour pork, pickled fish, salted fish), instant food (such as instant noodles, instant porridge) and western fast food (such as pizza, sandwich, hamburger, fried chicken)? Frequency of consumption was grouped into six categories: none, 1–3 days per month, every day, 5–6 days per week, 3–4 days per week and 1–2 days per week. This study grouped the first and second categories in 'not normally consume (0)' and the remaining categories in 'normally consume' (1).

Controlled variables

Sex: male (0) and female (1).
Age: 15–29 (0), 30–44 (1), 45–59 (2) and 60 years or older (3).
Marital status: single (0), married (1) and widowed/divorced/separated (2).
Place of residence: rural (0) and urban (1).
Education: lower than primary school (0), primary school (1), secondary school (2) and bachelor's degree or higher (3).
Monthly baht cash income: low income (less than 3000 (0)), middle income (3000–7000 (1)), high income (7001–13 000 (2)) and highest income (13 001 or above (3)).

Statistical analysis

This study analysed the relationship between obesity and NCDs, and unhealthy food consumption in the population age 15 years or older in Thailand. Descriptive analysis was used to describe each of the independent variables. Pearson's χ^2 test was conducted to calculate the relationship between these variables. Binary logistic regression

models were created to examine the adjusted OR and its 95% CI for the association between obesity and NCDs (hypertension, diabetes, dyslipidaemia and heart disease) and unhealthy food controlled for sex, age, marital status, place of residence, education and income. Five logistic regression models were developed during the analysis for each of the five dependent variables, namely Model 1 for obesity, Model 2 for hypertension, Model 3 for diabetes, Model 4 for dyslipidaemia and Model 5 for heart disease. An observed relationship with a p value of 0.05 or less (two-tailed) was considered statistically significant.

RESULTS
Prevalence of obesity and NCDs, and link of socio-demographic characteristics and unhealthy food consumption with obesity and NCDs

Table 2 (see online supplemental table S2) presents the characteristics of respondents who had obesity or NCDs. Of the total 74 894 respondents nearly 30% were obese. Considering the type of NCDs, 20% had hypertension, 10% had diabetes, 10% had dyslipidaemia and 2% had heart disease.

Obesity and NCDs were more prevalent among respondents who were woman, older, married, lived in rural area, had primary school education and had the low income. Around 30% of respondents with obesity consumed SSB, high-fat foods, processed foods, snacks, instant food and western fast food. From 10% to 20% of respondents with NCDs consumed SSB, high-fat foods, snacks, processed foods, snacks, instant food and western fast food.

Statistically significant relationships were found between most socio-demographic variables (sex, age, marital status, education, income) and obesity and all types of NCDs. Place of residence was found to be associated only with hypertension, diabetes and dyslipidaemia. There was also a statistically-significant relationship between consumption of all unhealthy food groups and obesity and NCDs.

Association of socio-demographic characteristics and unhealthy food consumption with obesity and NCDs

Table 3 (see online supplemental table S3) shows a model for classifying variables according to the disease that the sample is to see the relationship between independent variables and disease. The results from the binary logistic regression analysis shows the adjusted OR of socio-demographic characteristics and unhealthy foods in relation to obesity and having hypertension, diabetes, dyslipidaemia and heart disease. The analysis shows that women had significant ORs for obesity (OR 1.117; 95% CI 1.080 to 1.155), hypertension (OR 1.196; 95% CI 1.146 to 1.248), diabetes (OR 1.304; 95% CI 1.235 to 1.377) and dyslipidaemia (OR 1.480; 95% CI 1.401 to 1.564) than men. People who were at age 60 years or older, were widowed/divorced/separated and lived in urban areas had significant ORs for hypertension, diabetes,

Table 2 Relationship between socio-demographic variables and unhealthy food consumption, and NCDs and obesity (N=74 894)

Variables	Prevalence of obesity — N Yes	No	% Yes	No	P value	Hypertension — N Yes	No	% Yes	No	P value	Diabetes — N Yes	No	% Yes	No	P value	Dyslipidaemia — N Yes	No	% Yes	No	P value	Heart disease — N Yes	No	% Yes	No	P value
Total	21906	52988	29.2	70.8	–	15271	59623	20.4	79.6	–	7530	67364	10.1	89.9	–	7468	67425	10	90	–	1561	73332	2.1	97.9	–
Sex																									
Male	9040	23185	28.1	71.9		5808	26416	18	82		2668	29557	8.3	91.7		2549	29675	7.9	92.1		628	31597	1.9	98.1	
Female	12866	29.803	30.2	69.8		9.463	33207	22.2	77.8		4862	37807	11.4	88.6		4919	37750	11.5	88.5		933	41735	2.2	97.8	
Pearson χ²	39.135				***	194.937				***	197.042				***	267.701				***	5.185				*
Age group (years)																									
15–29	2232	9123	19.7	80.3		68	11285	0.6	99.4		41	11314	0.4	99.6		38	11315	0.3	99.7		26	11326	0.2	99.8	
30–44	5503	12919	29.9	70.1		776	17646	4.2	95.8		418	18004	2.3	97.7		453	17.97	2.5	97.5		104	18319	0.6	99.4	
45–59	8215	15833	34.2	65.8		4642	19408	19.3	80.7		2312	21736	9.6	90.4		2250	21797	9.4	90.6		397	23651	1.7	98.3	
60 years or older	5956	15113	28.3	71.7		9785	11284	46.4	53.6		4759	16310	22.6	77.4		4727	16343	22.4	77.6		1034	20036	4.9	95.1	
Pearson χ²	789.972				***	14538.174				***	6082.034				***	5987.954				***	1247.218				***
Marital status																									
Single	3264	12208	21.1	78.9		969	14503	6.3	93.7		359	15113	2.3	97.7		502	14970	3.2	96.8		115	15356	0.7	99.3	
Married	14629	31340	31.8	68.2		9.319	36651	20.3	79.7		4.783	41187	10.4	89.6		4.607	41362	10	90		946	45024	2.1	97.9	
Widowed/ divorced/ separated	4013	9440	29.8	70.2		4.983	8469	37	63		2.388	11064	17.8	82.2		2.359	11093	17.5	82.5		500	12952	3.7	96.3	
Pearson χ²	646.393				***	4200.760				***	1910.789				***	1637.566				***	312.161				***
Place of residence																									
Urban	10.289	24826	29.3	70.7		6989	28125	19.9	80.1		3299	31815	9.4	90.6		3.35	31765	9.5	90.5		711	34403	2	98	
Rural	11617	28.162	29.2	70.8		8.282	31498	20.8	79.2		4231	35549	10.6	89.4		4.118	35660	10.4	89.6		850	38929	2.1	97.9	
Pearson χ²	0.085				–	9.594				**	31.645				***	13.777				***	1.146				
Education																									
Lower than primary school	3055	8536	26.4	73.6		4.331	7260	37.4			2136	9455	18.4	81.6		1998	9593	17.2	82.8		440	11151	3.8		
Primary school	8169	17905	31.3	68.7		7103	18972	27.2			3513	22561	13.5	86.5		3450	22624	13.2	86.8		692	25381	2.7		
Secondary school	6800	16368	29.4	70.6		2.242	20926	9.7			1122	22047	4.8	95.2		1168	21999	5	95		240	22928	1		
Bachelor's degree or higher	3.882	10179	27.6	72.4		1595	12465	11.3			759	13301	5.4	94.6		852	13209	6.1	93.9		189	13872	1.3		
Pearson χ²	119.831				***	5157.089				***	2269.974				***	1856.044				***	370.725				***
Income (baht per month)																									
Low (less than 3000)	5962	15.64	27.6	72.4		6411	15190	29.7	70.3		3276	18.325	15.2	84.8		3043	18559	14.1	85.9		696	20906	3.2	96.8	
Middle (3000–7000)	5016	12.16	29.2	70.8		3955	13222	23	77		1978	15199	11.5	88.5		1924	15253	11.2	88.8		378	16799	2.2	97.8	
High (7001–3 000)	5466	12883	29.8	70.2		2450	15899	13.4	86.6		1094	17254	6	94		1171	17177	6.4	93.6		236	18112	1.3	98.7	
Highest (13001 or above)	5462	12305	30.7	69.3		2.455	15312	13.8	86.2		1182	16586	6.6	93.4		1330	16436	7.5	92.5		251	17515	1.4	98.6	
Pearson χ²	50.156				***	2254.224				***	1232.437				***	822.031				***	233.863				***

Continued

Table 2 Continued

Variables	Prevalence of obesity					Prevalence of NCDs Hypertension					Diabetes					Dyslipidaemia					Heart disease				
	N Yes	N No	% Yes	% No	P value	N Yes	N No	% Yes	% No	P value	N Yes	N No	% Yes	% No	P value	N Yes	N No	% Yes	% No	P value	N Yes	N No	% Yes	% No	P value
Sugar-sweetened beverages																									
Not normally consume	4549	12599	26.5	73.5		5205	11944	30.3	69.7		2815	14334	16.4	83.6		2425	14723	14.1	85.9		591	16557	3.4	96.6	
Normally consume	17357	40389	30.1	69.9		10066	47679	17.4	82.6		4715	53030	8.2	91.8		5043	52702	8.7	91.3		970	56775	1.7	98.3	
Pearson χ²	79.620				***	1358.800				***	993.966				***	430.800				***	202.200				***
High-fat foods																									
Not normally consume	6.095	16.154	27.4	72.6		5218	17031	23.5	76.5		2595	19655	11.7	88.3		2438	19811	11	89		596	21653	2.7	97.3	
Normally consume	15811	36.834	30	70		10.053	42.592	19.1	80.9		4935	47709	9.4	90.6		5030	47614	9.6	90.4		965	51679	1.8	98.2	
Pearson χ²	52.645				***	183.025				***	90.585				***	34.272				***	54.808				***
Snacks																									
Not normally consume	17133	40470	29.7	70.3		13417	44187	23.3	76.7		6523	51080	11.3	88.7		6456	51148	11.2	88.8		1410	56192	2.4	97.6	
Normally consume	4773	12518	27.6	72.4		1854	15436	10.7	89.3		1007	16284	5.8	94.2		1012	16277	5.9	94.1		151	17140	0.9	99.1	
Pearson χ²	29.366				***	1294.204				***	444.863				***	423.822				***	161.546				***
Meat products																									
Not normally consume	7491	17674	29.8	70.2		5864	19300	23.3	76.7		2715	22450	10.8	89.2		3107	22057	12.3	87.7		670	24493	2.7	97.3	
Normally consume	14415	35314	29	71		9407	40.323	18.9	81.1		4815	44914	9.7	90.3		4.362	45368	8.8	91.2		891	48839	1.8	98.2	
Pearson χ²	4.918				*	198.105				***	22.472				***	237.941				***	62.092				***
Instant food																									
Not normally consume	17508	40550	30.2	69.8		13543	44516	23.3	76.7		6652	51407	11.5	88.5		6600	51457	11.4	88.6		1401	56656	2.4	97.6	
Normally consume	4398	12438	26.1	73.9		1728	15107	10.3	89.7		878	15957	5.2	94.8		868	15968	5.2	94.8		160	16676	1	99	
Pearson χ²	102.663				***	1371.485				***	562.280				***	561.297				***	136.833				***
Western fast food																									
Not normally consume	18842	44373	29.8	70.2		13749	49465	21.7	78.3		6670	56545	10.6	89.4		6790	56424	10.7	89.3		1420	61794	2.2	97.8	
Normally consume	3064	8615	26.2	73.8		1522	10158	13	87		860	10819	7.4	92.6		678	11001	5.8	94.2		141	11538	1.2	98.8	
Pearson χ²	60.764				***	462.480				***	110.762				***	267.739				***	52.147				***

*P value≤0.05, **p≤0.01, ***p≤0.00.
NCD, non-communicable disease.

Table 3 Binary logistic regression models (OR (95% CI)) for socio-demographic characteristics and unhealthy food consumption by prevalence of NCDs and obesity (N=74894)

Variables	Model 1 Obesity OR (95% CI)	Model 2 Hypertension OR (95% CI)	Model 3 Diabetes OR (95% CI)	Model 4 Dyslipidaemia OR (95% CI)	Model 5 Heart disease OR (95% CI)
Sex (Ref=male)					
Female	1.117 (1.080 to 1.155)***	1.196 (1.146 to 1.248)***	1.304 (1.235 to 1.377)***	1.480 (1.401 to 1.564)***	1.010 (0.906 to 1.126)
Age group (years) (Ref=15–29)					
30–44	1.483 (1.396 to 1.576)***	6.338 (4.931 to 8.146)***	5.428 (3.904 to 7.548)***	6.714 (4.793 to 9.405)***	2.072 (1.336 to 3.214)**
45–59	1.773 (1.664 to 1.888)***	29.142 (22.808 to 37.235)***	21.075 (15.287 to 29.056)***	25.207 (18.123 to 35.062)***	5.400 (3.557 to 8.198)***
60 years or older	1.491 (1.390 to 1.599)***	90.488 (70.730 to 115.766)***	50.082 (36.277 to 69.139)***	67.538 (48.494 to 94.061)***	13.881 (9.129 to 21.109)***
Status (Ref=single)					
Married	1.486 (1.415 to 1.561)***	1.245 (1.150 to 1.347)***	1.784 (1.589 to 2.003)***	1.235 (1.115 to 1.367)***	1.160 (0.942 to 1.427)
Widowed/divorced/separated	1.404 (1.320 to 1.494)***	1.592 (1.462 to 1.735)***	1.907 (1.687 to 2.156)***	1.355 (1.214 to 1.512)***	1.302 (1.042 to 1.627)*
Place of residence (Ref=rural)					
Urban	1.016 (0.983 to 1.051)	1.266 (1.213 to 1.320)***	1.128 (1.071 to 1.189)***	1.081 (1.025 to 1.139)**	1.126 (1.013 to 1.253)*
Education (Ref=lower than primary school)					
Primary school	1.208 (1.149 to 1.271)***	0.972 (0.923 to 1.023)	1.002 (0.941 to 1.066)	1.039 (0.975 to 1.107)	0.985 (0.869 to 1.117)
Secondary school	1.277 (1.205 to 1.353)***	0.772 (0.720 to 0.828)***	0.868 (0.795 to 0.948)**	0.925 (0.837 to 0.999)*	0.905 (0.756 to 1.084)
Bachelor's degree or higher	1.090 (1.019 to 1.165)*	0.705 (0.649 to 0.766)***	0.788 (0.708 to 0.877)***	0.821 (0.739 to 0.913)***	0.981 (0.794 to 1.212)
Income (baht per month) (Ref=low income (less than 3000))					
Middle (3000–7000)	1.022 (0.976 to 1.069)	0.861 (0.818 to 0.907)***	0.883 (0.829 to 0.941)***	0.938 (0.879 to 1.001)	0.829 (0.728 to 0.944)**
High (7001–13 000)	1.085 (1.035 to 1.137)**	0.793 (0.746 to 0.843)***	0.740 (0.683 to 0.800)***	0.851 (0.787 to 0.920)***	0.768 (0.654 to 0.902)**
Highest (13 001 or above)	1.134 (1.076 to 1.196)***	0.873 (0.815 to 0.934)***	0.893 (0.818 to 0.975)*	1.058 (0.971 to 1.153)	0.810 (0.677 to 0.969)*
Sugar-sweetened beverages (Ref=not normally consume)					
Normally consume	1.208 (1.159 to 1.259)***	0.998 (0.953 to 1.045)	0.824 (0.779 to 0.872)***	1.073 (1.013 to 1.137)*	0.872 (0.780 to 0.976)*
High-fat foods (Ref=not normally consume)					
Normally consume	1.162 (1.120 to 1.207)***	1.136 (1.086 to 1.188)***	1.055 (0.998 to 1.116)	1.225 (1.157 to 1.296)***	0.984 (0.881 to 1.098)
Snacks (Ref=not normally consume)					
Normally consume	1.048 (1.004 to 1.093)*	0.975 (0.917 to 1.038)	1.111 (1.028 to 1.200)**	1.109 (1.027 to 1.198)**	0.771 (0.644 to 0.923)**
Meat products (Ref=not normally consume)					

Continued

Table 3 Continued

Variables	Model 1 Obesity OR (95% CI)	Model 2 Hypertension OR (95% CI)	Model 3 Diabetes OR (95% CI)	Model 4 Dyslipidaemia OR (95% CI)	Model 5 Heart disease OR (95% CI)
Normally consume	0.964 (0.930 to 0.999)*	0.901 (0.863 to 0.942)***	1.018 (0.963 to 1.075)	0.761 (0.721 to 0.803)***	0.813 (0.730 to 0.906)***
Instant food (Ref=not normally consume)					
Normally consume	0.903 (0.865 to 0.942)***	0.855 (0.803 to 0.910)***	0.899 (0.830 to 0.974)**	0.918 (0.847 to 0.995)*	0.845 (0.709 to 1.006)
Western fast food (Ref=not normally consume)					
Normally consume	0.871 (0.831 to 0.913)***	0.908 (0.850 to 0.970)**	1.076 (0.992 to 1.167)	0.798 (0.731 to 0.871)***	0.902 (0.753 to 1.082)
Cox and Snell R^2	0.02	0.198	0.091	0.089	0.017

*P value≤0.05, **p≤0.01, ***p≤0.001.
NCD, non-communicable disease; Ref, reference.

dyslipidaemia and heart disease. People aged 45–59 years had the highest OR for obesity.

For the education variable, primary and secondary education had the highest ORs for obesity (OR 1.277; 95% CI 1.205 to 1.353), and those in secondary and bachelor and over educations had significant protective ORs for hypertension (OR 0.705; 95% CI 0.649 to 0.766), diabetes (OR 0.788; 95% CI 0.708 to 0.877) and dyslipidaemia (OR 0.821; 95% CI 0.739 to 0.913). People with low and middle incomes had significantly protective ORs against hypertension (OR 0.861; 95% CI 0.818 to 0.907), diabetes (OR 0.883; 95% CI 0.829 to 0.941) and heart disease (OR 0.829; 95% CI 0.728 to 0.944) compared with had high income. Those in the middle and highest income had significant ORs for obesity (OR 1.085; 95% CI 1.035 to 1.137; and OR 1.134; 95% CI 1.076 to 1.196, respectively). Those with middle and highest income had significant protective ORs for hypertension (OR 0.793; 95% CI 0.746 to 0.843), diabetes (OR 0.740; 95% CI 0.683 to 0.800) and dyslipidaemia (OR 0.851; 95% CI 0.787 to 0.920). There was a strong association between people who were age 45–59 years, married, had secondary school education and earned a monthly high and highest income more than 7000 baht and obesity (p≤0.001).

There was a statistically significant association between consumption of some unhealthy foods and obesity and having hypertension, diabetes, dyslipidaemia and heart disease. A significant association was observed between consumption of all unhealthy foods and obesity. People with obesity had significant ORs of consuming SSB, high-fat foods and snacks, but had significant protective ORs for meat products, instant food and western fast food.

People with NCDs had significant ORs for SSB and high-fat foods (p≤0.001), and significant protective ORs for meat products, instant food and western fast food (p≤0.001). Those with hypertension had significant ORs for high-fat foods (OR 1.136; 95% CI 1.086 to 1.188), but had significant protective ORs for meat products (OR 0.901; 95% CI 0.863 to 0.942), instant food (OR 0.855; 95% CI 0.803 to 0.910) and western fast food (OR 0.908; 95% CI 0.850 to 0.970). Those with diabetes had significant protective ORs for SSB (OR 0.824; 95% CI 0.779 to 0.872) and instant food (OR 0.899; 95% CI 0.830 to 0.974), but had significant OR for snacks (OR 1.111; 95% CI 1.028 to 1.200). Those with dyslipidaemia had the highest ORs for SSB (OR 1.073; 95% CI 1.013 to 1.137), snacks (OR 1.109; 95% CI 1.027 to 1.198) and fat (OR 1.225; 95% CI 1.296) while they had significant protective ORs for meat (OR 0.761; 95% CI 0.721 to 0.803), instant foods (OR 0.918; 95% CI 0.847 to 0.995) and western foods (OR 0.798; 95% CI 0.731 to 0.871). Those with heart disease had significant protective ORs for SSB (OR 0.872; 95% CI 0.780 to 0.976), snacks (OR 0.771; 95% CI 0.644 to 0.923) and meat products (OR 0.813; 95% CI 0.730 to 0.906).

DISCUSSION

Analysis of data from a national, cross-sectional study of food consumption found statistically-significant associations between HFSS consumption and obesity and NCDs in the population in Thailand. Prevalence of obesity and NCDs varied with different socio-demographic characteristics. To the best of our knowledge, this is the first study to analyse the relationship between obesity and NCDs and consumption of different HFSS groups using the largest-scale population-based survey data in Thailand.

Overall prevalence of obesity in Thailand was 29.2% while overall prevalence of major NCDs—hypertension, diabetes, dyslipidaemia and heart disease were 20.4%, 10.1%, 10.0% and 2.1%, respectively. Thailand had the higher prevalence of obesity and diabetes than in many countries in Southeast Asia such as Bangladesh (25.9% and 8.3%, respectively) and Nepal (28.8% and 5.8%, respectively).[22] However, Thailand had low prevalence of hypertension, dyslipidaemia and heart disease compared with the two countries.[23] The differing results among countries may be due to demographic and/or socio-cultural differences as well as methodological differences such as differences of time or differences of sampling.

The relationship between unhealthy diet and obesity has been well-established. However, to our knowledge, this is the first study to analyse the influence of consumption of specific food groups on people with diet-related illnesses in Thailand. This analysis indicates that people with obesity had the high significant ORs for SSB, high-fat foods and snacks and had the significant protective ORs for meat products, instant food and western fast food. This finding may be explained by the definition of snacking behaviour in the survey, as consumption of foods and drinks between meals.[24] Some studies confirmed the role of snacking in obesity. Individuals with obesity were found to consume snacks more frequently than people without obesity.[25] Snacking was also linked with skipping a meal, which often includes foods with meat products, instant food and western fast food. Several studies found that people with higher snacking frequency tended to skip meals or have less frequent consumption of meals.[26–29] Therefore, there is a need for modification of food environments of people at risk of obesity to encourage healthier eating behaviour. It is also important to take into account that obesity is highly complex. There are many physiological adaptions that happen in obesity leading the body to fight weight loss. Obesity cannot simply be resolved alone by advising people to 'eat less and exercise more'. Multicomponent policies and actions for tackling this complex disease are thus needed.

Unhealthy diet is considered as one of major risk factors of NCDs.[30] Overall in this study, a statistically-significant association was found between HFSS consumption and NCDs. This is not surprising. There is clear evidence regarding the contribution of unhealthy consumption to an occurrence of metabolic syndrome which includes hypertension, dyslipidaemia and disturbed metabolism of glucose or insulin[31] which can lead to increased risk of developing diabetes and cardiovascular disease, as well as chronic respiratory diseases and cancer.[32 33] The present study confirms this finding that people with obesity and some NCDS had the significant protective OR for some certain HFSS products. People with obesity and hypertension, for example, had the protective ORs for meat products, instant food and western fast foods. These HFSS are rich in highly processed meat and refined carbohydrate, sodium and fat which can lead to increased risks of obesity and hypertension.[34 35] Therefore, dietary modification such as low-fat foods, and small quantities or reduced consumption of red meat, high sodium foods, high-energy dense foods, is commonly recommended for people with those diseases. The Dietary Approach to Stop Hypertension diet, for example, is one among recommended treatments for NCDs by increasing consumption of fruits, vegetables, low-fat dairy products, whole grains, lean meats and fish and reducing consumption of sugar sweetened desserts and beverages.[36] However, the study population with certain NCDs tended to consume more SSB, snacks and high-fat foods. This highlights that unhealthy snacking may be a common dietary behaviour among this population. The findings suggest a need for limiting unhealthy snacking to reduce and control risk of NCDs, together with promotion of healthy snacking, taking into consideration context, such as socio-demographic characteristics, convenience and price.

Obesity and NCDs varied according to socio-demographic characteristics of the sample population. Obesity was observed in people who were woman, aged 45–59 years, married, had a higher level of education and had a higher income. This could be partly due to an unhealthy labour/working environment that can cause late working hours or overwork, perhaps contributing to unhealthy daily routines such as eating on the run, sedentary behaviour or inadequate sleep.[37] Having higher socioeconomic status and greater risk of obesity may be explained by increased access to surplus/excess foods, and/or a lower level of engagement in manual labour occupations.[38] By contrast, people living with any of the study NCDs tended to be woman, age 60 years or older, widowed/divorced/separated, had a lower education and had a lower monthly income. This may be explained by the nature of NCDs which are commonly slow in progression, and, thus, more prevalent later in life.[39] NCDs can cause a significant burden, especially those with low socio-economic status.[40] Those in low socioeconomic status have higher risk in accessing or affording preventative services and treatment as compared with their counterparts in high socioeconomic status. This can cause a delay in seeking care and lead to late diagnosis, further aggravating their economic vulnerability and a cycle of poverty and illness. The findings suggest that obesity and NCDs deserve closer attention by the Thailand government, particularly through a perspective of health equity and social determinants of health.

There are some limitations of this study. First, misclassification of food groups consumed may have occurred

due to the nature of self-reported data. NCDs were also self-reported based on previous diagnoses. Respondents may exaggerate diseases or consumption in order to make them seem worse, or they may under-report diseases or consumption due to social desirability bias. Respondents might also simply be mistaken or misremember the questions in the survey. Individual height and weight were also self-reported, and thus could have influenced BMI values. Therefore, this self-report could have reduced the validity and reliability of the survey tools, and then have biased the results. Second, validity of the tool in this study was assessed through consultative meetings with experts and the pretest process of the NSO to review its clarity, comprehensibility and appropriateness for the population. Reliability of the tool was not assessed, which is a major limitation. Many validated food frequency questionnaires had a formal assessment to test both content validity and reliability before data collection. Third, the food categories in the study were considered less healthy or unhealthy as they are often high in sugar, fat and sodium according to the Department of Health's recommendation. However, it is possible that respondents could have reported that they consumed certain items that fell into one of the 'unhealthy or less healthy' categories even though the items they were referring to could be considered 'healthy' (eg, lean meat products, unprocessed nutrient-dense snack foods). Therefore, careful consideration is needed to interpret the results accurately. Fourth, the results of this study may have been insufficient to provide concrete evidence on the direct effect of HFSS consumption on obesity and NCDs. Future research using a longitudinal design or a cohort study is needed to elucidate any causal relationships. A strength of this study is that it used data from a population-based survey, which can be considered nationally-representative of the population in Thailand.

CONCLUSIONS

The prevalence of obesity and NCDs is fairly high in the population in Thailand, and varies with socio-demographic characteristics. This may warrant special attention from the government for specific subpopulations. The study identified the strong association between specific HFSS groups and obesity and NCDs. High consumption of SSB, high-fat foods, and snacks was observed in the study population living with obesity and some NCDs. This suggests the need for interventions related to snacking behaviour by limiting unhealthy snacking and promoting healthier snacking, such as through modification of the food environment. Prevention and control strategies should also consider the population most exposed to obesity and NCDs, taking into account different socio-demographic characteristics. However, additional research is needed to confirm direct effect of HFSS consumption on obesity and NCDs.

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