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The impact of restaurant consumption among US adults: effects on energy and nutrient intakes

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Abstract

Objective: To examine the effect of fast-food and full-service restaurant consumption on adults' energy intake and dietary indicators.

Design: Individual-level fixed-effects regression model estimation based on two different days of dietary intake data was used.

Setting: Parallel to the rising obesity epidemic in the USA, there has been a marked upward trend in total energy intake derived from food away from home.

Subjects: The full sample included 12 528 respondents aged 20–64 years who completed 24 h dietary recall interviews for both day 1 and day 2 in the National Health and Nutrition Examination Survey (NHANES) 2003–2004, 2005–2006, 2007–2008 and 2009–2010.

Results: Fast-food and full-service restaurant consumption, respectively, was associated with an increase in daily total energy intake of 813·75 kJ (194·49 kcal) and 858·04 kJ (205·21 kcal) and with higher intakes of saturated fat (3·48 g and 2·52 g) and Na (296·38 mg and 451·06 mg). Individual characteristics moderated the impacts of restaurant food consumption with adverse impacts on net energy intake being larger for black adults compared with their white and Hispanic counterparts and greater for middle-income *v.* high-income adults.

Conclusions: Adults' fast-food and full-service restaurant consumption was associated with higher daily total energy intake and poorer dietary indicators.

Keywords
Fast food
Full-service restaurant
Food away from home
Energy intake
Obesity
Diet quality

The USA is one of the most obese nations in the world, with the age-adjusted prevalence of obesity at 35·5 % among adult men and 35·8 % among adult women in 2009–2010[1]. With obesity linked to diabetes, heart disease, stroke and some cancers[2], health-care spending attributed to obesity reached $US 147 billion in 2008, and the costs are projected to increase dramatically in the future[3]. Parallel to the rising obesity epidemic, there has been a marked upward trend in total energy intake derived from food away from home (FAFH). In 1977–1978, the contribution of intake from fast-food and full-service restaurants to total energy intake was 14·2 % for young adults (aged 19–39 years) and 11·5 % for older adults (aged 40–59 years)[4]. In 2007–2008, the contribution of restaurant energy to total energy intake increased to 24 % (13 % for fast-food and 11 % for full-service restaurants) for adults aged 20–64 years[5]. In addition, in 2007–2008, on a given day, 36 % and 27 % of US adults aged 20–64 years consumed foods and beverages from fast-food and full-service restaurant sources, respectively[5]. Moreover, FAFH as a share of food expenditures increased gradually from 30 % in 1977 to 43 % in 2012, although its share stagnated and declined slightly to about 42 % in the recent recession (2007–2009)[6].

A number of studies have found an association between FAFH consumption and greater total energy intake and poorer nutrient intakes among adults[7–11]. Adults who ate fast food had higher intakes of energy, total fat, saturated fat and Na, and lower intakes of vitamins, milk, fruits and vegetables than those who did not report eating fast food[7–9,12]. However, studies often focused on fast-food but not full-service restaurant consumption with the exception of one recent paper that found similar impacts of fast-food and full-service food consumption for children[13]. Moreover, some studies using cross-sectional or adjusted mean comparison analysis[8,9] often missed two important potential sources of endogeneity of consumer preferences: (i) those who eat larger or less healthy meals may prefer to eat at restaurants; and (ii) individuals might offset kilojoules eaten at restaurants by reducing energy intake at other times during the day. Thus, the positive correlation between restaurant consumption and energy intake and diet quality may be confounded by a variety of unobserved individual-level characteristics and preferences. Moreover, the differential effect of restaurant consumption on different sub-populations such as blacks compared with whites and Hispanics, low income

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compared with high income, and younger compared with older adults has not been extensively studied, although it is well known that their rates of obesity are different[14].

The present study aimed to examine the relationship between fast-food and full-service restaurant consumption and energy and nutrient intakes for adults aged 20–64 years in the USA. To control for individuals' unobserved characteristics, we estimated multivariate individual-level fixed-effects regression models. Such models have previously been estimated to examine the relationship between FAFH and restaurant consumption on energy intake and diet quality[7,13,15]. Our adult sample is drawn from the nationally representative dietary recall data of the National Health and Nutrition Examination Survey (NHANES) 2003–2010. Our research focused on the effects of restaurant consumption on total energy intake and other key elements of which excessive consumption might be harmful, including saturated fat, salt, sugar and Na intakes[16–18]. We assessed the differential effects of restaurant consumption by gender, ethnicity and income sub-populations as well as by meal occasion. We also examined racial and socio-economic status differences by age group and by gender.

Methods

Data

The dietary recall data from the nationally representative NHANES 2003–2004, 2005–2006, 2007–2008 and 2009–2010 waves were used. A complete description of the data collection procedures and survey design is given elsewhere.[19] Non-pregnant individuals aged 20–64 years who completed two dietary interviews were included in our sample. Subgroup analyses by gender, race/ethnicity, income and age were conducted. Because of the relatively small sample size for the other race category, racial/ethnic subgroup analysis was focused on non-Hispanic whites, non-Hispanic blacks and Hispanics. Low-income adults were defined as individuals in families with income <130 % of the federal poverty level (FPL), middle-income adults as ≥130 % and <300 % of the FPL, and high-income adults as ≥300 % of the FPL. There were two subgroups based on age: young adults aged 20–34 years and older adults aged 35–64 years.

The NHANES included two non-consecutive 24 h dietary recalls for which respondents reported all foods and beverages consumed in the prior 24 h. The US Department of Agriculture's Automated Multiple-Pass Method was used for data collection. Day 1 interviews were conducted by trained dietary interviewers in a mobile examination centre and day 2 interviews were collected by telephone 3 to 10 d later. Over the sample period from 2003–2004 through 2009–2010, 85·5 % of dietary recalls from day 1 had day 2 dietary recall data available. Our full sample included 12 528 respondents who completed 24 h dietary recall interviews for both day 1 and day 2 in the NHANES from 2003–2004 to 2009–2010.

The survey respondents were asked about the source of each food and beverage item in terms of where it was obtained (e.g. from a store, fast-food restaurant, full-service restaurant, etc.). From this question, we constructed the following measures as dichotomous indicators of whether the individual consumed food or beverages from: (i) fast-food restaurants and (ii) full-service restaurants. Moreover, non-restaurant FAFH included all food and beverage items consumed away from home that were not sourced from a fast-food or full-service restaurant. Our analyses also controlled for whether the food or beverage items were consumed on a weekday or weekend day. Based on the reported quantity of all food and beverage items consumed, the energy and nutritional contents of each item were coded in the NHANES according to US Department of Agriculture databases[19,20].

Study design and statistical analyses

We specified an individual-level fixed-effects regression model where each individual serves as his/her own control, based on the two different days of intake data. This model removed the effects of all standard observed characteristics fixed over time such as age, gender and race, as well as the unobserved characteristics such as preferences for particular foods that affect both the incidence and food choices when eating away from home. Moreover, given the short time span between the 24 h dietary recalls of day 1 and day 2, it also removed the effects of characteristics such as marital status, education and income.

The dependent variables included the change in reported total energy intake (kilojoules/kilocalories), sugar (grams), saturated fat (grams) and Na (milligrams) throughout the surveyed day (day 1−day 2). The key independent variables of the models were whether or not any food or beverages consumed came from a fast-food or a full-service restaurant in the 24 h period. The corresponding coefficients, therefore, illustrated the change in total energy intake (sugar, saturated fat, Na, etc.) associated with fast-food or full-service restaurant food consumption. We also controlled for time-varying covariates that may be correlated with daily energy intake such as whether the intake day was a weekday *v.* a weekend day[21] and whether any consumption that day was eaten from a non-restaurant away-from-home source. We controlled for whether an individual ate away from home on day 1 *v.* day 2 due to the difference in interview methods across days. In addition, we used a second fixed-effects model specification to estimate the effect of different fast-food and full-service restaurant meal occasions (breakfast, lunch, dinner and snack) on change in total energy intake. We restricted our estimation to adults aged 20–64 years and excluded older adults aged 65 years and above to maximize the comparability of dietary intake patterns. We undertook analyses separately by age, gender, race/ethnicity and household income subgroups. We also conducted analyses by age and gender further sub-stratified

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by race and income subgroups. We performed statistical testing to compare differences in regression coefficient estimates across subgroups.

The statistical software package Stata 11·1 (2009) was used for all estimation. The estimation accounted for the NHANES complex, multistage probability sampling design to provide representative samples of adults aged 20–64 years. The study was approved by the Institutional Review Board of the University of Illinois at Chicago.

Results

The prevalence of fast-food restaurant, full-service restaurant and non-restaurant FAFH food consumption and total energy and nutrient intakes for the full sample are presented in Table 1. On day 1, 35 % of our sample reported consumption from fast-food sources, 28 % reported eating full-service restaurant food and 61 % reported eating non-restaurant FAFH. On average, total energy intake was 9548 kJ (2282 kcal) on day 1 and 8866 kJ (2119 kcal) on day 2.

Table 2 presents the regression results examining whether fast-food and full-service restaurant food consumption was related to energy and nutrient intakes for the full sample as well as the age and gender subgroups. Fast-food and full-service restaurant consumption was associated with a net increase in daily total energy intake of 813·75 kJ (194·49 kcal) and 858·04 kJ (205·21 kcal), respectively. The additional kilojoules from restaurant consumption were equivalent to almost 10 % of total daily energy intake. Furthermore, fast-food and full-service restaurant consumption resulted in higher intakes of sugar (3·95 g and 1·91 g), saturated fat (3·48 g and 2·52 g) and Na (296·38 mg and 451·06 mg).

Table 2 shows that the effects of fast-food restaurant consumption were significantly larger for young compared with older adults (1138·38 kJ (272·25 kcal) *v.* 656·16 kJ

Table 1 Summary statistics for the full sample: respondents aged 20–64 years who completed 24 h dietary recall interviews for both day 1 and day 2 in the National Health and Nutrition Examination Survey (NHANES), 2003–2010

Consumption and nutrient intake summary statistics	Day 1	Day 2
Prevalence of consumption		
Fast-food restaurant (%)	35	32
Fast-food restaurant away from home (%)	23	21
Fast-food restaurant at home (%)	15	13
Full-service restaurant (%)	28	20
Full-service restaurant away from home (%)	23	17
Full-service restaurant at home (%)	6	4
Non-restaurant away from home (%)	61	60
Consumption on weekday (%)	59	80
Energy intake		
Total energy (kJ)		
Mean	9548	8866
SE	54	54
Total energy (kcal)		
Mean	2282	2119
SE	13	13
Dietary nutrient intakes		
Sugar (g)		
Mean	125	116
SE	1·0	0·95
Saturated fat (g)		
Mean	29	26
SE	0·3	0·3
Na (mg)		
Mean	3689	3519
SE	23·8	21·0
Socio-economic statistics	**Full sample**	
Male (%)	48·90	
Young adults aged 20–34 years (%)	31·55	
Older adults aged 35–64 years (%)	68·45	
White (%)	69·48	
Black (%)	11·49	
Hispanic (%)	13·22	
Other (%)	5·81	
Low income (%)	18·23	
Middle income (%)	25·52	
High income (%)	51·03	
Full sample size	12 528	

All summary statistics are weighted using the NHANES examination weight. Low-income adults were defined as individuals in families with income <130 % of the federal poverty level (FPL), middle-income adults as ≥130 % and <300 % of the FPL, and high-income adults as ≥300 % of the FPL.

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Table 2 Regression estimates (β) of the effect of fast-food and full-service restaurant consumption on energy and nutrient intakes by age and gender among respondents aged 20–64 years who completed 24 h dietary recall interviews for both day 1 and day 2 in the National Health and Nutrition Examination Survey (NHANES), 2003–2010

	Energy (kJ)		Energy (kcal)		Sugar (g)		Saturated fat (g)		Na (mg)	
	β	SE	β	SE	β	SE	β	SE	β	SE
Full sample (*n* 12 528)										
Fast food	813·75***	73·76	194·49***	17·63	3·95***	1·39	3·48***	0·34	296·38***	36·74
Full service	858·04***	88·59	205·21***	21·17	1·91	1·60	2·52***	0·38	451·06***	45·17
Young adults aged 20–34 years (*n* 3967)										
Fast food	1138·38***	129·39	272·25***	30·92	6·48***	2·42	4·69***	0·56	374·64***	65·22
Full service	981·96***	155·50	234·67***	37·16	6·45**	3·05	2·26***	0·66	338·29***	77·73
Older adults aged 35–64 years (*n* 8561)										
Fast food	656·16***	89·64†	156·77***	21·43†	2·90*	1·69	2·87***	0·42†	255·09***	44·44
Full service	798·41***	107·77	190·99***	25·76	−0·26	1·87†	2·66***	0·47	503·36***	55·43†
Female (*n* 6424)										
Fast food	692·49***	83·87	165·45***	20·05	5·93***	1·63	2·67***	0·41	246·73***	41·20
Full service	782·31***	97·51	187·17***	23·31	3·80**	1·85	2·18***	0·45	388·56***	51·37
Male (*n* 6104)										
Fast food	955·60***	120·22†	228·47***	28·73†	2·36	2·23	4·33***	0·53†	352·10***	60·58
Full service	943·37***	147·08	225·52***	35·16	0·12	2·59	2·88***	0·62	515·17***	73·96

All analysis is weighted using the NHANES examination weight. Standard errors reported are robust. Control variable includes indicators for non-restaurant food away-from-home consumption, whether the recall was on a weekday *v.* a weekend day, and whether it was on day 1 *v.* day 2.
*Significant at 10 % level, **significant at 5 % level, ***significant at 1 % level.
†Significant difference between young adults *v.* older adults, or female *v.* male, at the $P \leq 0{\cdot}05$ level.

Table 3 Regression estimates (β) of the effect of fast-food and full-service restaurant consumption on energy and nutrient intakes by race and income among respondents aged 20–64 years who completed 24 h dietary recall interviews for both day 1 and day 2 in the National Health and Nutrition Examination Survey (NHANES), 2003–2010

	Energy (kJ)		Energy (kcal)		Sugar (g)		Saturated fat (g)		Na (mg)	
	β	SE	β	SE	β	SE	β	SE	β	SE
White (*n* 5768)										
Fast food	715·07***	96·94	171·06***	23·17	3·03*	1·81	3·13***	0·45	244·99***	47·37
Full service	909·87***	107·17	217·58***	25·61	1·98	1·95	2·73	0·47***	454·68	54·03***
Black (*n* 2682)										
Fast food	1241·49***	154·60†	296·43***	36·94†	5·71*	3·24	4·74***	0·64†	451·34***	73·00†
Full service	1156·69***	228·84	277·11***	54·70	13·55***	5·04†	3·48***	0·95	463·58***	103·87
Hispanic (*n* 3517)										
Fast food	756·82***	141·66§	180·83***	33·86§	7·57***	2·34	3·77***	0·60	382·91***	60·63‡
Full service	755·39***	190·29	180·68***	45·48	−0·37	3·13§	2·72***	0·81	473·93***	94·52
Low income (*n* 3486)										
Fast food	945·11***	149·94	225·87***	35·84	6·70**	2·94	3·74***	0·65	294·00***	69·45
Full service	773·92***	226·88	185·87***	54·22	3·00	4·27	1·18	0·91	324·17***	110·47
Middle income (*n* 3464)										
Fast food	1002·47***	140·86	239·61***	33·66	7·48***	2·65	4·20***	0·63	388·30***	70·84
Full service	1069·31***	178·58	255·48***	42·68	4·84	3·28	3·04***	0·79	514·27***	88·13
High income (*n* 4747)										
Fast food	653·17***	109·81§	156·10***	26·25§	1·37	2·00§	3·10***	0·51	233·10***	55·68§
Full service	804·77***	118·55	192·47***	28·34	0·05	2·12	2·56***	0·51	463·39***	61·65

All analysis is weighted using the NHANES examination weight. Standard errors reported are robust. Control variable includes indicators for non-restaurant food away-from-home consumption, whether the recall was on a weekday *v.* a weekend day, and whether it was on day 1 *v.* day 2. Some subgroup observation counts do not equal the total of 12 528 because: (i) results were not reported for all race/ethnicity subgroups such as Asian and other races; and (ii) data on income were missing for some observations.
*Significant at 10 % level, **significant at 5 % level, ***significant at 1 % level.
†Significant difference between white *v.* black, or low income *v.* middle income, at the $P \leq 0{\cdot}05$ level.
‡Significant difference between white *v.* Hispanic, or low income *v.* high income, at the $P \leq 0{\cdot}05$ level.
§Significant difference between black *v.* Hispanic, or middle income *v.* high income, at the $P \leq 0{\cdot}05$ level.

(156·77 kcal)) and for males compared with females (955·60 kJ (228·47 kcal) *v.* 692·49 kJ (165·45 kcal)). Young adult and male fast-food restaurant customers also consumed more additional saturated fat than their respective counterparts. There were no statistically significant differences by age or gender in the effects of full-service restaurant consumption (except for the effect on sugar intake which was greater among young *v.* older adults).

Table 3 shows that there were a number of significant differences found by race/ethnicity and income

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sub-populations. Fast-food restaurant consumption was associated with greater additional energy intake for blacks (1241·49 kJ (296·43 kcal)) compared with whites (715·07 kJ (171·06 kcal)) and Hispanics (756·82 kJ (180·83 kcal)). In addition, fast-food consumption was associated with higher additional saturated fat and Na intakes for black (4·74 g and 451·34 mg, respectively) compared with white (3·13 g and 244·99 mg, respectively) adults and higher Na intake compared with Hispanic adults (382·91 mg). Fast-food restaurant consumption had the least adverse impacts on higher-income adults' diets. Specifically, consuming fast food had virtually no impact on high-income adults' sugar intake, and a smaller adverse impact on their total energy intake compared with their middle-income counterparts (653·17 kJ (156·10 kcal) *v.* 1002·47 kJ (239·61 kcal)). Consuming fast food also was associated with a lower increase in Na intake among high-income compared with middle-income adults (233·10 mg *v.* 388·30 mg). Similar to the findings by age and gender, there were generally no significant differences in the effect of full-service restaurant consumption by race/ethnicity or income (with the exception of differences in sugar intake by race/ethnicity).

In Table 4, we further explore the differences in total energy intake by race/ethnicity and income across age and gender. For young adults, restaurant food consumption, despite its adverse effects, had virtually no differential effects among racial and income subgroups except that Hispanics had lower additional total energy intake than black adults when eating at a fast-food restaurant. In contrast, older adult, males and females exhibited substantial differential effects of consuming fast food across racial and income subgroups. Fast-food consumption was associated with higher additional energy intake for black compared with white adults, regardless of age or gender. For example, consumption of fast food was associated with an additional 1345·18 kJ (321·51 kcal) among black male adults compared with 851·13 kJ (203·42 kcal) among white male adults. Within black adults, however, we did not observe differences in additional energy intake across age and gender groups.

As illustrated in Table 4, fast-food consumption was associated with the highest additional energy intake for middle-income males (1457·50 kJ (348·35 kcal)) compared with high-income (763·99 kJ (182·60 kcal)) and low-income males (782·48 kJ (187·02 kcal)). However, fast-food restaurant consumption was associated with the highest additional energy intake among low-income females (1061·28 kJ (253·65 kcal)) compared with their middle-income (538·63 kJ (128·74 kcal)) and high-income (565·38 kJ (135·13 kcal)) counterparts. Fast-food consumption also was associated with lower additional energy intake for high-income older adults compared with their middle-income counterparts (550·48 kJ (131·57 kcal) *v.* 922·46 kJ (220·47 kcal)).

In Table 5, we show the results of the effects of fast-food and full-service restaurant consumption by meal occasion. Fast-food consumption as a snack was associated with the highest additional energy intake (1091·98 kJ (260·99 kcal)) followed by fast-food consumption for dinner (818·57 kJ (195·64 kcal)) and lunch (701·41 kJ (167·64 kcal)). Fast-food consumption for breakfast was associated with the least additional energy intake (354·44 kJ (84·71 kcal)). Similarly, full-service restaurant consumption as a snack was associated with the highest additional energy intake (979·91 kJ (234·20 kcal)) followed by consumption for dinner (903·02 kJ (215·83 kcal)), breakfast (611·21 kJ (146·08 kcal)) and lunch (480·74 kJ (114·90 kcal)).

Discussion and conclusion

Based on multivariate individual-level fixed-effects models, the present study shows that both fast-food and full-service restaurant food consumption among adults were associated with significant increases in energy, sugar, saturated fat and Na intakes. Previous research suggested that on days that adults consume from restaurant sources, they consumed 2410 kJ (576 kcal) from fast-food restaurants (31 % of total energy intake) and 2858 kJ (683 kcal) from full-service restaurants (34 % of total energy intake)[4]. In our research, restaurant consumption was associated with an additional total daily energy intake of 813·75 kJ (194·49 kcal) for fast-food and 858·04 kJ (205·21 kcal) for full-service restaurants. Restaurant food consumption as a snack was associated with particularly high additional energy intake (1091·98 kJ (260·99 kcal) for fast-food and 979·91 kJ (234·20 kcal) for full-service restaurants). Therefore, the evidence suggests that adults do not sufficiently reduce non-restaurant intake to compensate for additional energy intake on days consuming at restaurants. Further, in terms of nutrient intakes, both fast-food and full-service restaurant consumption increased intakes of saturated fat (3·48 g and 2·52 g, respectively), sugar (3·95 g and 1·91 g, respectively) and Na (296·38 mg and 451·06 mg, respectively).

Our results are consistent with previous studies that examined adult restaurant food consumption. Evidence from earlier studies based on cross-sectional analysis and mean comparisons using the Continuing Survey of Food Intakes by Individuals (CSFII) 1994–1996 showed that adults who reported eating fast food had higher intakes of energy, total fat, saturated fat, Na and carbonated soft drinks, and lower intakes of vitamin A, vitamin C, Ca, milk, fruits and vegetables than those who did not report eating fast food[8,9], and that meals consumed at both fast-food and full-service restaurants were associated with higher energy intake[10]. Assessing FAFH, two studies using within-person estimation based on NHANES 2003–2004 data and the CSFII data found that FAFH increased adults' daily energy intake and reduced diet quality from a classification of fair to poor[7,12]. While the conclusion is similar, our study with more recent waves of NHANES data and explicit specifications of fast-food and full-service restaurant consumption found larger adverse effects.

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Table 4 Regression estimates (β) of the effect of fast-food and full-service restaurant consumption on energy intake by gender, race and socio-economic status for young (aged 20–34 years) and older (aged 35–64 years) adults, and male and female adults, among respondents aged 20–64 years who completed 24 h dietary recall interviews for both day 1 and day 2 in the National Health and Nutrition Examination Survey (NHANES), 2003–2010

	Young adult		Older adult		Male		Female	
Energy (kJ)	β	SE	β	SE	β	SE	β	SE
White (*n* 5768)								
Fast food	1112·02***	180·73	548·43***	114·45†	851·13***	156·00	602·39***	110·33†
Full service	951·04***	199·10	886·43***	127·03	1014·44***	176·95	810·83***	119·41
Black (*n* 2682)								
Fast food	1376·52***	285·75	1157·67***	176·59‡	1345·18***	259·85‡	1160·27***	186·91‡
Full service	1641·42***	412·41	829·35***	264·80†	1630·11***	370·12	698·16**	271·74†
Hispanic (*n* 3517)								
Fast food	784·42***	212·01§	756·89***	189·32	1032·09***	229·07	475·82***	162·86§,†
Full service	937·64***	298·35	608·45**	245·01	698·03**	323·62§	825·26***	194·32
Low income (*n* 3486)								
Fast food	1283·71***	230·04	707·78***	195·92†	782·48***	268·28	1061·28***	164·78
Full service	1183·76***	356·48	454·90	286·01	775·00**	392·14	778·91***	244·03
Middle income (*n* 3464)								
Fast food	1114·69***	238·14	922·46***	171·47	1457·50***	219·83‡	538·63***	168·28‡,†
Full service	989·17***	292·85	1104·76***	226·22‡	937·77***	294·06	1163·35***	203·45
High income (*n* 4747)								
Fast food	972·10***	219·66	550·48***	126·84§,†	763·99***	176·30§	565·38***	124·59‖
Full service	925·59***	227·79	758·00***	138·94	988·37***	195·38	630·13***	128·19§
	Young adult		Older adult		Male		Female	
Energy (kcal)	β	SE	β	SE	β	SE	β	SE
White (*n* 5768)								
Fast food	265·78***	43·19	131·08***	27·35†	203·42***	37·28	143·97***	26·37†
Full service	227·30***	47·59	211·86***	30·36	242·46***	42·29	193·79***	28·54
Black (*n* 2682)								
Fast food	329·00***	68·30	276·69***	42·21‡	321·51***	62·11‡	277·31***	44·67‡
Full service	392·31***	98·57	198·22***	63·29†	389·61***	88·46	166·86**	64·95†
Hispanic (*n* 3517)								
Fast food	187·48***	50·67§	180·90***	45·25	246·68***	54·75	113·72***	38·92§,†
Full service	224·10***	71·31	145·42**	58·56	166·83**	77·35§	197·24***	46·44
Low income (*n* 3486)								
Fast food	306·81***	54·98	169·16***	46·83†	187·02***	64·12	253·65***	39·38
Full service	282·92***	85·20	108·72	68·36	185·23**	93·72	186·16***	58·32
Middle income (*n* 3464)								
Fast food	266·42***	56·92	220·47***	40·98	348·35***	52·54‡	128·74***	40·22‡,†
Full service	236·42***	69·99	264·04***	54·07‡	224·13***	70·28	278·05***	48·63
High income (*n* 4747)								
Fast food	232·34***	52·50	131·57***	30·32§,†	182·60***	42·14§	135·13***	29·78‖
Full service	221·22***	54·44	181·17***	33·21	236·23***	46·70	150·60***	30·64§

All analysis is weighted using NHANES examination weight. Standard errors reported are robust. Control variable includes indicators for non-restaurant food away-from-home consumption, whether the recall was on a weekday *v.* a weekend day, and whether it was on day 1 *v.* day 2. Some subgroup observation counts do not equal the total of 12 528 because: (i) results were not reported for all race/ethnicity subgroups such as Asian and other races; and (ii) data on income were missing for some observations.
**Significant at 5 % level, ***significant at 1 % level.
†Significant difference between young adults *v.* older adults, or female *v.* male, at the $P \leq 0{\cdot}05$ level.
‡Significant difference between white *v.* black, or low income *v.* middle income, at the $P \leq 0{\cdot}05$ level.
§Significant difference between black *v.* Hispanic, or middle income *v.* high income, at the $P \leq 0{\cdot}05$ level.
‖Significant difference between white *v.* Hispanic, or low income *v.* high income, at the $P \leq 0{\cdot}05$ level.

The present study provides new evidence for adults on the differential effects across racial and income subgroups. Similar to a recent study for children[13], we found that fast-food consumption was associated with fewer additional total kilojoules and lower sugar and Na intakes for high-income adults. Further, fast-food consumption was associated with greater additional energy, saturated fat and Na intakes for black compared with white adults, which was similarly found in adolescents[13]. Overall, individual characteristics moderated the impacts of restaurant food consumption on adults' diets. The study also documents the racial and income differences between young *v.* older adults, and for male *v.* female adults. Fast-food consumption resulted in lower additional energy intake for high-income older adults (compared with middle-income older adults). By gender subgroup, middle-income male adults and low-income female adults were the two groups with the highest additional energy intake associated with fast-food consumption.

The results suggest that there were differences across racial and income groups by gender and age on energy

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Table 5 Regression estimates (β) of the effect of fast-food and full-service restaurant consumption on energy intake by meal occasion among respondents aged 20–64 years who completed 24 h dietary recall interviews for both day 1 and day 2 in the National Health and Nutrition Examination Survey (NHANES), 2003–2010

	Energy (kJ)		Energy (kcal)	
Sample (*n* 12 528)	β	SE	β	SE
Fast food: Breakfast	354·44***	0·57	84·71***	0·14
Fast food: Lunch	701·41***	0·36†	167·64***	0·09†
Fast food: Dinner	818·57***	0·37‡,§	195·64***	0·09‡,§
Fast food: Snack	1091·98***	0·59‖,¶,††	260·99***	0·14‖,¶,††
Full service: Breakfast	611·21***	0·71	146·08***	0·17
Full service: Lunch	480·74***	0·45†	114·90***	0·11†
Full service: Dinner	903·02***	0·40‡,§	215·83***	0·10‡,§
Full service: Snack	979·91***	0·71‖,¶,††	234·20***	0·17‖,¶,††

All analysis is weighted using NHANES examination weight. Standard errors reported are robust. Control variable includes indicators for non-restaurant food away-from-home consumption, whether the recall was on a weekday *v.* a weekend day, and whether it was on day 1 *v.* day 2.
***Significant at 1 % level.
†Significant difference between breakfast *v.* lunch at the $P \leq 0{\cdot}05$ level.
‡Significant difference between dinner *v.* lunch at the $P \leq 0{\cdot}05$ level.
§Significant difference dinner *v.* breakfast at the $P \leq 0{\cdot}05$ level.
‖Significant difference between snack *v.* dinner at the $P \leq 0{\cdot}05$ level.
¶Significant difference between snack *v.* lunch at the $P \leq 0{\cdot}05$ level.
††Significant difference between snack *v.* breakfast at the $P \leq 0{\cdot}05$ level.

intake and diet outcomes, which may lead to potential health disparities. Fast-food restaurant consumption had a consistently greater adverse effect on energy intake among black adults compared with white and Hispanic adults, for older adults and both male and female adults. This finding that blacks have greater adverse effects from consuming fast food is even more concerning given other evidence that they consume a higher percentage of their total energy from fast-food restaurants than their white and Hispanic counterparts[22].

There are several limitations to the present study. First, the data were self-reported based on 24 h dietary recalls. Validation studies have reported the tendency towards overestimation of portion size by those who eat smaller portions and underestimation by those who eat larger portions[23]. A study that used NHANES III suggested that 28 % of the women and 18 % of the men were classified as under-reporters, with under-reporting of energy intake highest in individuals who were older, overweight or trying to lose weight[24,25]. Second, our individual fixed-effects model was able to account for some but not all of the bias and under-report issues. Third, due to data limitations, the regression analyses could not incorporate the level of physical activity on the interview day or other unobserved time-varying factors that might affect food preferences and food demand day to day. Despite these limitations, the fixed-effects regression estimation was able to control for individuals' unobserved time-constant characteristics and preferences.

There is a rising interest in potential FAFH policy interventions to alleviate factors related to the obesity epidemic, including prohibitions on new fast-food restaurants' opening, increasing the relative costs of restaurant food purchases, and mandatory posting of energy (calories) on menus in chain restaurants[26,27]. Consistent with previous study findings for children and adolescents, our research results for adults suggest that given that full-service and fast-food restaurant consumption were similarly related to excess energy intake and a number of poorer dietary outcomes, policies intended to limit access to unhealthy foods and beverages should apply to both full-service and fast-food restaurants[13]. In addition, given that larger adverse effects on energy intake and diet quality were found for some lower socio-economic and minority populations, policies aimed at improving diet and reducing energy intake from restaurant sources will help to reduce racial and socio-economic disparities in Americans' diets.

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