Saturated and Trans fatty acids in UK takeaway food

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Key words

Fast food, out of home food, non-communicable disease, consume eating patterns

Abstract

The aim of the study was to analyse the saturated fatty acid (SFA) and trans fatty acid (TFA) content of popular takeaway foods in the UK (including English, pizza, Chinese, Indian, and kebab cuisine). Samples of meals were analysed by an accredited public analyst laboratory for SFA and TFA. The meals were highly variable for SFA and TFA. English and Pizza meals had the highest median amount of SFA with 35.7 g/meal; Kebab meals were high in TFA with up to 5.2 g/meal. When compared to UK dietary reference values some meals exceeded SFA and TFA recommendations from just one meal. Takeaway food would be an obvious target to reduce SFA and TFA content and increase the potential of meeting UK recommendations. Strategies such as reformulation and smaller takeaway portion sizes warrant investigation.

Introduction

Worldwide consumer patterns over the last 10 years have led to lifestyle changes around food intake with a higher reliance on food eaten out of the home, including takeaway food (Guthrie et al., 2002; Jaworowska et al., 2013; Naska et al., 2011; Naska et al., 2015; Orfanos et al., 2007; Smith et al., 2009; Food Standards Agency (FSA), 2007). While there are no formal definitions of takeaway food we describe takeaway food as hot meals, prepared in situ, either taken away or consumed on site from non-chain, independent establishments. In the UK the FSA, UK (2007) showed 22% purchase takeaway food at least once a week. At this level of intake international dietary studies on fast food and takeaway food have shown an association with an increased risk of several non-communicable diseases (NCDs) including type 2 diabetes, coronary heart disease, some cancers, and with overweight and obesity (Bauer et al., 2013; Chandran et al., 2014; Fulkerson et al., 2011; Jiao et al., 2015; Nago et al., 2014; Odegaard et al., 2012; Smith et al., 2012).

While randomised controlled trial evidence is not available, takeaway and fast food intake is likely to be a major contributor to NCDs as increased takeaway or fast food consumption is characterised with an inadequate overall diet including higher intakes of energy, total fat, saturated fatty acids (SFA), trans fatty acids (TFA), added sugar, and sodium (Bowman & Vinyard., 2004; Jaworowska et al., 2012;

Maalouf et al., 2015; Pareatakul et al., 2003). This Western dietary pattern consists of sugar sweetened beverages, fries, snacks and convenience food from various sources including fast food chains, restaurants and other away from home establishments (Jaworowska et al., 2013). In the UK, takeaway food from independent establishments is associated with a higher body mass index (BMI) and increases the risk of obesity (Burgoine et al., 2014). These takeaway foods include traditional fish and chips, Chinese and Indian cuisine, pizzas, and kebab meals and we have previously shown that such meals have a poor nutritional profile including excessively high, but variable levels, of energy, salt, total fat, and sugar (Jaworowska et al., 2012, 2014). However, there is a dearth of data on the SFA and TFA content within the above meal types; a more detailed analysis of the type and amount of fatty acids in takeaway food will help elucidate the relationship with takeaway food and NCDs.

Considering the high prevalence of eating out of the home in the UK and the limited data regarding the quality and quantity of fat in UK takeaway meals, the current study determined the amount and concentration of SFA and TFA in popular takeaway meals in the UK.

Methods

Sampling and analysis of takeaway meals

The sampling method is available in more detail from our previous work (Jaworowska et al., 2014). Briefly, Indian, Chinese, kebab, pizza, and English takeaway meals were sampled by the continuous work of the following local authorities: Liverpool City Council Trading standards; Wirral Metropolitan Borough Council Trading Standards; and Knowsley Council Trading Standards. Takeaway meals totalled (n = 489) with 27 different types of takeaway meals, which were deemed to be popular in the UK (Leung, 2010) were sampled in singlet from Liverpool (n = 271) and Wirral (n = 150) Councils and in duplicate for Knowsley Council (n = 68). Permission from the respective councils was given to the authors to use the data for publication.

Samples were analysed by the accredited Public Analysis Laboratory (Eurofins, UK) for nutritional content. Specifically, the energy (kcal), total fat (g), SFA (g) content in the collected meals were analysed. For the analysis of TFA (g) a subsample of n = 217 meals were analysed, which were collected from the Wirral and Knowsley areas only. To determine the serving size all meals were weighed before homogenization in a blender and stored below - 18ºC prior to analysis. Total fat, energy and portion size were taken from our previous work (Jaworowska et al., 2014) and SFA and TFA were analysed with an Intellectually Protected, in-house, method (Eurofins, UK).

Statistical analysis

All statistical analysis was conducted using SPSS version 22.0 (SPSS Inc., Chicago, IL, USA). The mean value of meals was calculated for the meals collected in duplicate. Histograms, Kolmogorov-Smirnov and Shapiro-Wilk tests were employed to test the normality of distribution of analyzed variables. Due to non-normal distributions data are expressed as medians with interquartile range (25^{th} and 75^{th} percentiles). The takeaway meals were stratified to their origin into one of the following five meal categories: 1. Chinese, 2. Indian, 3. English, 4. pizzas, 5. kebabs.

Variation of the nutritional content between meal categories and between different types of meals in the same category were determined with the use of the Kruskal-Wallis test and the Mann Whitney U-Test for multiple comparisons. An adjusted significance level was used when multiple comparisons were made (see Tables 1 & 2). Median levels of all nutrients were expressed per 100 g, per portion (full meal serving size as purchased), as a percentage of the total energy of the meal, and as a percentage of total fat. The nutritional composition levels were compared with the United Kingdom Dietary Reference Values (DRVs) for SFA and TFA for men and women aged 19 – 50 years (Department of Health., 1991).

Results

The levels of SFA and TFA from takeaway meals from independent establishments show varying results (Table 1 & 2; Figure 1). The Chinese category was lowest in SFA and TFA/100 g, per portion, and as a percentage energy and total fat. The pizza and English categories had more than four times the amount of SFA/100 g and per portion compared to the Chinese category ($p < 0.005$); however, there were no significant differences within pizza meals with respect to SFA or TFA but fish and chips were significantly higher in SFA and chips and curry sauce in TFA compared to other English meals (Table 1 & 2). With respect to Indian meals, chicken korma with pilau rice had the highest levels of SFA, which was significantly higher compared to some but not all of the other Indian meals (Table 1). Differences in TFA/100 g in the Indian category were unremarkable and levels were relatively low. Kebab meals on the other hand were highest for TFA variables ($p < 0.005$) than all other meal categories with TFA up to 17 times greater (Table 2). Kebab meals were analysed with and without chips; the addition of chips increased the TFA (g/100 g) ~ 2 fold, showing a significant difference between doner kebab and doner kebab with chips (Table 1 and 2, $p < 0.025$). While Chinese meals were lowest for SFA and TFA, char siu chow mein was higher in SFA/100 g and per portion compared to other Chinese meals, providing a high percentage of energy from SFA from total fat available (Table 1). Per portion and per 100 g, chicken chow mein was highest in TFA compared to other Chinese meals (Table 2).

Table 1. SFA content, concentration, and percentage of total energy and total fat.

Table 2. TFA content, concentration, and percentage of total energy and total fat.

The full range of data including outlier and extreme outlier results are also presented (Figure 1). This further emphasises the extreme range within the different categories and the specific meals are labelled on Figure 1. For example, with respect to SFA/100 g one particular doner kebab meal contained 15.75 g/100 g compared to a median of 6.18 g/100 g, whereas one meal of chicken and chips was very low with 0.72 g/100 g versus a median of 4.6 g/100 g. An extreme outlier worthy of note was one fish and chips meal with a TFA concentration of 1.45 g/100 g; this equated to 9.3 g of TFA/portion compared to a median of 0.32 g/portion.

Figure 1. SFA and TFA amount and concentration in popular takeaway meals; including outlier° and extreme outlier* results.

When comparing the meals with UK daily DRVs (Table 3), within the five categories, SFA recommendations are easily met and exceeded with 15 – 154% and 20 – 202% for men and women respectively, with English and pizza meals contributing to the highest percentages. However, a single kebab meal can provide up to 78 – 103% of TFA for males and females respectively. The range of TFA shows 2.8 – 78.0% and 3.7 – 103.0% for men and women respectively. With respect to TFA the majority of meals were low and were within the UK DRV of 2% of total energy, only the kebab category exceeded 100% for women in one meal.

Table 3. The SFA and TFA profile of all meals within the five different categories were compared to UK dietary reference values.

Discussion

The present study presents results on the SFA and TFA content of food from independent takeaway establishments in the UK. The data presented shows a wide range of these two types of "high risk" fatty acids between and within the five main meal categories (Table 1 & 2, Figure 1), and when comparing with UK daily DRVs recommendations can be easily met and exceeded with one takeaway meal (Table 3). While the intake of SFA for the risk of CVD has been questioned in recent years (Flock & Kris-Etherton., 2013; Siri-Tarino et al., 2010a, 2010b) pressure on the UK food industry to reduce SFA to enable the population to reach the target of 11% of total energy continues (Department of Health., 2011). Recent meta-analyses provide convincing evidence that replacing SFA with PUFA reduced CVD risk and coronary heart disease (CHD) events (Flock et al., 2014; Mozaffarian et al., 2010). SFA intake has recently shown a reduction in the UK population (Pot et al., 2012) but dietary recommendations have still not been met and food eaten out of the home has increased (Jaworowska et al., 2013). From the present study both the English and pizza meal categories had the highest amount of SFA with a median average of 35.7 g/portion each (Table 2). With respect to specific meals, however, kebab and chips revealed the highest median amount of SFA (47.6 g/portion). Therefore, it would be prudent to target these meals for reformulation and/or portion size options.

A recent UK study by Saunders et al (2015) on the nutritional content of takeaway food in the UK (Sandwell, West Midlands), shows several meals were comparable to the present study. For example, sweet and sour chicken had 11.0 g SFA/portion similar to the 11.7 g SFA/portion in the current study; SFA in doner kebabs and fish and chips were lower than but similar to the lower range of the present study with 25.7 g/portion vs. 26.1 – 34.9 g/portion and 34 g/portion vs. 34.8 – 48.8 g/portion respectively. High levels of SFA in meals such as fish and chips, pizza, and kebabs, but lower levels in Chinese and Indian meals have been reported elsewhere (FSA, 2004, 2014). For example, the SFA content of fish and chips were approximately 6 g/100 g or 37 g/portion, which was within the same range as the present study (4.81 – 6.64 g/100 g; 34.8 – 48.8 g/portion). The reported SFA for doner kebabs was remarkably similar with 29.7 g/portion vs 29.9 g/portion for the present study. However, evidence for pizzas is conflicting; the present study showed takeaway pizzas with a higher median SFA of 5.62 g/100 g (Table 1) compared to 4.15 g/100 g (FSA, 2004). Furthermore, an Australian study analysed meals from popular fast food chains (e.g. Pizza Hut) and revealed, out of 200 pizzas (menu labelling), the mean average SFA was 4.8 g/100 g (Dunford et al., 2010). In addition, both the present study and a recent international study across six countries, including the UK, show SFA from pizzas (from the Pizza Hut chain) are highly variable (5.0 – 6.48 g/100 g and 3.0 – 5.6 g/100 g respectively) (Ziauddeen et al., 2015). One possible explanation of the higher SFA levels found in the present study is the cooking method. The study team observed that many takeaway establishments use deep fat frying rather than oven baking and therefore increasing the overall fat content. Despite the above differences it is possible to improve the nutritional quality of pizza without effecting taste. For example, Combet et al (2014) reformulated a margherita pizza, and not only reduced the amount of SFA to 10.2% of total energy but also created a nutritionally balanced meal, with additional functional ingredients, that was acceptable for taste and appearance. The results from the present study showed the lower end of the full range of SFA (10.3% of total energy, data not shown) was similar to Combet's reformulated pizza, suggesting that reformulation to reduce SFA in pizzas from independent takeaway establishments is possible.

UK guidelines (SACN report., 2007) on TFA indicate an intake of 2% of total energy (~ 5 g/day) for men and women to reduce the risk of CVD (Thompson et al., 2008). TFA intake has recently shown a reduction in the UK population to 0.7-0.9% of energy intake for all ages, which is less than the target of 2% (Pot et al., 2012). However, very frequent consumption of takeaway food high in TFA (such as kebab meals) may exceed the recommendations of 5 g per day. The FSA, UK (2014) found similar results to the present study, out of 80 total meals sampled the TFA content ranged from 0.14 - 0.73 g/100 g compared to 0.01 – 0.84 g/100 g in the present study. For specific meals only fish and chips and kebabs were common to the present study. Fish and chips were similar with TFA 0.24 g/portion in the present study and 0.2 g/portion in the Food Standard Agency (2014) study but our study did show one outlier results of 9.3 g/portion (Figure 1). This was a meal of fish and chips and further analysis would be needed to confirm this as the majority of results for this meal show much lower levels of TFA. Doner kebabs were lower in TFA in the present study at 0.43 (0.41 – 0.55) g/100 g, the addition of chips resulted in similar levels to the FSA study 0.84 (0.53 – 0.98) g/100 g compared to 0.89 (0.2 – 1.8) g/100 g, especially when taking into account the full range from the present study (Figure 1).

Due to the potential of increased TFA consumption in Denmark in the 1990's and early 2000's the Danish government introduced a legislation of a maximum of 2% of industrial TFA in fat used for foods, resulting in a reduction in some but not all industrial TFA in popular foods (Stender et al., 2012). However, the UK have not followed with this initiative. The present study showed 100% of kebab meals were higher than this target (Table 2); but the data set from the current study is relatively small and does not separate industrial from ruminant TFA. Further detailed analysis of a larger sample is warranted to confirm this result. As part of a larger study on TFA in Turkey Karabulut (2007) analysed a small sample of doner meat (n=4), the results were higher than the present study with a mean TFA content of 1.86 ± 1.04 g/100 g vs. a median of 0.43 (0.41-0.55) g/100g for doner kebab without chips from the present study. Interestingly, the study reported TFA separate to conjugated linoleic acid (CLA) (0.97 ± 0.77 g/100 g) whereas the present study only analysed total TFA. Kebab meat consists of beef and/or lamb which are ruminant sources of TFA containing vaccenic acid (VA, t11 18:1) (50-80% of total R-TFA) and cis9,t11-CLA (Gebauer et al., 2011). CLA has been shown to confer health benefits, including reduction of body fat and reduced inflammation (Dilzer & Park., 2012) but there are concerns with respect to negative health affects as Brouwer et al (2010) reported all TFAs whether R-TFA, CLA or I-TFA increase the LDL:HDL cholesterol ratio and evidence shows positive associations with R-TFA with cardiovascular disease and cancer (Laake et al., 2012, 2013). However, evidence remains equivocal for R-TFA and CLA due to the lack of studies compared to I-TFA and a report from the

World Health Organisation suggest that R-TFA dietary intake is minimal and at these amounts there is not enough evidence for CHD risk (Uauy et al., 2009). The amount of VA and CLA from doner kebabs in the present study cannot be reported as only total TFA were analysed; beef meat has approximately 0.43 g/100 g of CLA (Gebauer et al., 2011), which is the same concentration as the median TFA from doner kebab in the present study (Table 2). However, it is unknown what additional fats during processing were used, and how the cooking methods effect the levels of TFA in the present study that may contribute to the total TFA concentration. While TFA from the majority of takeaway foods sampled are within current recommendations doner kebabs warrant further investigation with respect to the type of TFA present in the meat.

Conclusion

The present study has shown a high degree of variability with respect to SFA and TFA in takeaway food with many of the meals excessively high in SFA, and some in TFA, with regular consumption this would increase the risk of NCDs. However, the converse cannot be stated for the meals sampled with lower SFA and TFA as our previous evidence has shown that a large sample of takeaway food is exceptionality high in portion size, energy density, total fat, salt, and sugar (Jaworowska et al, 2012, 2014) and therefore could also contribute to increased risk of NCD. The wide level of variation seen in our results and others can be used as an advantage, as some meals are relatively low in SFA and TFA thus suggesting other meals can be reformulated to reach more appropriate levels of these potentially harmful fatty acids. Strategies to reformulate, and even provide functional ingredients would vastly improve the quality of food from takeaway establishments. Research on the reformulation and provision of healthier meals, coupled with innovative methods of nutritional labelling and the options of smaller portions, will help to provide a higher level of consumer choice and reduce the risk of NCDs associated with eating out of the home.

Acknowledgements

The authors acknowledge Knowsley Council/NHS and Wirral Metropolitan Borough Council for kindly providing additional data from their respective regions, and we acknowledge Jane Rawling, Wirral Metropolitan Borough Council, Trading Standards; Rachel Long, Liverpool City Council, Trading Standards and Richard Fontana, Environmental Health and Consumer Protection Service, Knowsley MBC for collection of meal samples.

Declaration of interest

Funding for the project was provided by Liverpool Primary Care trust to Liverpool City Council. Liverpool City Council funded Liverpool John Moores University for the analysis of the Liverpool section of data collection as part of a larger funded project to reformulate takeaway food; the funding also provided research staff and time to analyse data, the writing of reports and peer-reviewed article submissions.

References

Bauer F, Beulens JW, van der A DL, Wijmenga C, Grobbee DE, Spijkerman AM, van der Schouw YT, Onland-Moret NC. (2013). Dietary patterns and the risk of type 2 diabetes in overweight and obese individuals. European Journal of Nutrition 52(3):1127–34.

Bowman SA, Vinyard BT. (2004). Fast food consumption of U.S. adults: impact on energy and nutrient intakes and overweight status. Journal of the American College of Nutrition, 23(2):163–8.

Brouwer IA, Wanders AJ, Katan MB. (2010). Effect of animal and industrial trans fatty acids on HDL and LDL cholesterol levels in humans--a quantitative review. PloS One 5(3):e9434.

Burgoine T, Forouhi NG, Griffin SJ, Wareham NJ, Monsivais P. (2014). Associations between exposure to takeaway food outlets, takeaway food consumption, and body weight in Cambridgeshire, UK: population based, cross sectional study. BMJ 348:g1464.

Chandran U, McCann SE, Zirpoli G, Gong Z, Lin Y, Hong CC, Ciupak G, Pawlish K, Ambrosone CB, Bandera EV. (2014). Intake of energy-dense foods, fast foods, sugary drinks, and breast cancer risk in african american and European american women. Nutrition and Cancer 66(7):1187–99.

Combet E, Jarlot A, Aidoo KE, Lean ME. (2014). Development of a nutritionally balanced pizza as a functional meal designed to meet published dietary guidelines. Public Health Nutrition 17(11):2577–86.

Department of Health (1991), "Dietary reference values for food energy and nutrients for the United Kingdom", Report of the panel on the dietary reference values of the Committee on Medical Aspects of Food Policy (COMA), Report on Health and Social Subjects 41, Stationery Office, Great Britain.

Department of Health (2011). The Public Health Responsibility Deal. Available at: https://responsibilitydeal.dh.gov.uk/wp-content/uploads/2012/03/The-Public-Health-Responsibility-Deal-March-20111.pdf. Accessed 12th October 2015.

Dilzer A, Park Y. (2012). Implication of conjugated linoleic acid (CLA) in human health. Critical Reviews in Food Science and Nutrition 52(6):488–513.

Dunford E, Webster J, Barzi F, Neal B. (2010). Nutrient content of products served by leading Australian fast food chains. Appetite 55(3):484–9.

Food Standards Agency (2004). Consumer attitudes to food standards Wave 4. Available at: www.food.gov.uk/multimedia/pdfs/cas2003er.pdf. Accessed 24 September 2015.

Food Standards Agency (2007). Consumer attitudes to food standards Wave 7. Available at: www.food.gov.uk/multimedia/pdfs/cas07wa.pdf. Accessed 24 September 2015.

Food Standards Agency (2014). Analysis of trans and saturated fatty acids in fats/oils and takeaway products from areas of deprivation in Scotland. Available at: http://www.foodstandards.gov.scot/sites/default/files/854-1-1588_Report_of_Analysis_of_Trans_fatty_acids_in_fats_FINAL.pdf. Accessed 12th October 2015.

Flock MR, Fleming JA, Kris-Etherton PM. (2014). Macronutrient replacement options for saturated fat: effects on cardiovascular health. Current Opinion in Lipidology 25(1):67–74.

Flock MR, Kris-Etherton PM. (2013). Diverse physiological effects of long-chain saturated fatty acids: implications for cardiovascular disease. Current Opinion in Clinical Nutrition and Metabolic Care 16(2):133–40.

Fulkerson JA, Farbakhsh K, Lytle L, Hearst MO, Dengel DR, Pasch KE, Kubik MY. (2011). Away-from-home family dinner sources and associations with weight status, body composition, and related biomarkers of chronic disease among adolescents and their parents. Journal of the American Dietetic Association 111(12):1892–7.

Gebauer SK, Chardigny JM, Jakobsen MU, Lamarche B, Lock AL, Proctor SD, Baer DJ. (2011). Effects of ruminant trans fatty acids on cardiovascular disease and cancer: a comprehensive review of epidemiological, clinical, and mechanistic studies. Advances in Nutrition 2(4):332–54.

Guthrie JF1, Lin BH, Frazao E. (2002). Role of food prepared away from home in the American diet, 1977-78 versus 1994-96: changes and consequences. Journal of Nutrition Education and Behavior 34(3):140–50.

Jaworowska A, Blackham T, Davies IG, Stevenson L. (2013). Nutritional challenges and health implications of takeaway and fast food. Nutrition Reviews 71:310–318.

Jaworowska A, Blackham T, Stevenson L, Davies IG. (2012). Determination of salt content in hot takeaway meals in the United Kingdom. Appetite 59(2):517–22.

Jaworowska A, Blackham T, Long R, Taylor C, Ashton M, Stevenson L, Davies IG. (2014). Nutritional composition of takeaway food in the UK. Nutrition & Food Science 44(5):414–430.

Jiao J, Moudon AV, Kim SY, Hurvitz PM, Drewnowski A. (2015). Health Implications of Adults' Eating at and Living near Fast Food or Quick Service Restaurants. Nutrition & Diabetes 5:e171.

Karabulut I. (2007). Fatty acid composition of frequently consumed foods in Turkey with special emphasis on trans fatty acids. International Journal of Food Sciences and Nutrition 58(8):619–28.

Laake I, Carlsen MH, Pedersen JI, Weiderpass E, Selmer R, Kirkhus B, Thune I, Veierød MB. (2013). Intake of trans fatty acids from partially hydrogenated vegetable and fish oils and ruminant fat in relation to cancer risk. International Journal of Cancer. Journal International Du Cancer 132(6):1389–403.

Laake I, Pedersen JI, Selmer R, Kirkhus B, Lindman AS, Tverdal A, Veierød MB. (2012). A prospective study of intake of trans-fatty acids from ruminant fat, partially hydrogenated vegetable oils, and marine oils and mortality from CVD. The British Journal of Nutrition 108(4):743–54.

Leung G. (2010). Ethnic foods in the UK. Nutrition Bulletin 35(3):226–234.

Maalouf J, Cogswell ME, Yuan K, Martin C, Gunn JP, Pehrsson P, Merritt R, Bowman B. (2015). Top sources of dietary sodium from birth to age 24 mo, United States, 2003-2010. The American Journal of Clinical Nutrition 101(5):1021–8.

Mozaffarian D, Micha R, Wallace S. (2010). Effects on coronary heart disease of increasing polyunsaturated fat in place of saturated fat: a systematic review and meta-analysis of randomized controlled trials. PLoS Medicine 7(3):e1000252.

Nago ES, Lachat CK, Dossa RA, Kolsteren PW. (2014). Association of out-of-home eating with anthropometric changes: a systematic review of prospective studies. Critical Reviews in Food Science and Nutrition 54(9):1103–16.

Naska A, Katsoulis M, Orfanos P, Lachat C, Gedrich K, Rodrigues SS, Freisling H, Kolsteren P, Engeset D, Lopes C, Elmadfa I, Wendt A, Knüppel S, Turrini A, Tumino R, Ocké MC, Sekula W, Nilsson LM, Key T, Trichopoulou A; HECTOR Consortium. (2015). Eating out is different from eating at home among individuals who occasionally eat out. A cross-sectional study among middle-aged adults from eleven European countries. British Journal of Nutrition 113(12):1–14.

Naska A, Orfanos P, Trichopoulou A, May AM, Overvad K, Jakobsen MU, Tjønneland A, Halkjær J, Fagherazzi G, Clavel-Chapelon F, Boutron-Ruault MC, Rohrmann S, Hermann S, Steffen A, Haubrock J, Oikonomou E, Dilis V, Katsoulis M, Sacerdote C, Sieri S, Masala G, Tumino R, Mattiello A, Bueno-de-Mesquita HB, Skeie G, Engeset D, Barricarte A, Rodríguez L, Dorronsoro M, Sánchez MJ, Chirlaque MD, Agudo A, Manjer J, Wirfält E, Hellström V, Shungin D, Khaw KT, Wareham NJ, Spencer EA, Freisling H, Slimani N, Vergnaud AC, Mouw T, Romaguera D, Odysseos A, Peeters PH. (2011). Eating out, weight and weight gain. A cross-sectional and prospective analysis in the context of the EPIC-PANACEA study. International Journal of Obesity (2005) 35(3):416–26.

Odegaard AO, Koh WP, Yuan JM, Gross MD, Pereira MA. (2012). Western-style fast food intake and cardiometabolic risk in an Eastern country. Circulation 126(2):182–8.

Orfanos P, Naska A, Trichopoulos D, Slimani N, Ferrari P, van Bakel M, Deharveng G, Overvad K, Tjønneland A, Halkjaer J, Santucci de Magistris M, Tumino R, Pala V, Sacerdote C, Masala G, Skeie G, Engeset D, Lund E, Jakszyn P, Barricarte A, Chirlaque MD, Martinez-Garcia C, Amiano P, Quirós JR, Bingham S, Welch A, Spencer EA, Key TJ, Rohrmann S, Linseisen J, Ray J, Boeing H, Peeters PH, Bueno-de-Mesquita HB, Ocke M, Johansson I, Johansson G, Berglund G, Manjer J, Boutron-Ruault MC, Touvier M, Clavel-Chapelon F, Trichopoulou A. (2007). Eating out of home and its correlates in 10 European countries. The European Prospective Investigation into Cancer and Nutrition (EPIC) study. Public Health Nutrition 10(12):1515–25.

Paeratakul S, Ferdinand DP, Champagne CM, Ryan DH, Bray GA. (2003). Fast-food consumption among US adults and children: dietary and nutrient intake profile. Journal of the American Dietetic Association 103(10):1332–8.

Pot GK, Prynne CJ, Roberts C, Olson A, Nicholson SK, Whitton C, Teucher B, Bates B, Henderson H, Pigott S, Swan G, Stephen AM. (2012). National Diet and Nutrition Survey: fat and fatty acid intake from the first year of the rolling programme and comparison with previous surveys. The British Journal of Nutrition 107(3):405–15.

SACN (2007). Update on trans fatty acids and health: Position statement by the Scientific Advisory Committee on Nutrition. Available at: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/339359/SACN_Update_on_Trans_Fatty_Acids_2007.pdf. Accessed 12th October 2015.

Saunders P, Saunders A, Middleton J. (2015). Living in a “fat swamp”: exposure to multiple sources of accessible, cheap, energy-dense fast foods in a deprived community. The British Journal of Nutrition 113(11):1828–34.

Siri-Tarino PW, Sun Q, Hu FB, Krauss RM. (2010a). Meta-analysis of prospective cohort studies evaluating the association of saturated fat with cardiovascular disease. The American Journal of Clinical Nutrition 91(3):535–46.

Siri-Tarino PW, Sun Q, Hu FB, Krauss RM. (2010b). Saturated fat, carbohydrate, and cardiovascular disease. The American Journal of Clinical Nutrition 91(3):502–9.

Smith KJ, Blizzard L, McNaughton SA, Gall SL, Dwyer T, Venn AJ. (2012). Takeaway food consumption and cardio-metabolic risk factors in young adults. European Journal of Clinical Nutrition 66(5):577-84.

Smith KJ, McNaughton SA, Gall SL, Blizzard L, Dwyer T, Venn AJ. (2009). Takeaway food consumption and its associations with diet quality and abdominal obesity: a cross-sectional study of young adults. Int J Behav Nutr Phys Act 6:29.

Stender S, Astrup A, Dyerberg J. (2012). A trans European Union difference in the decline in trans fatty acids in popular foods: a market basket investigation. BMJ Open 2(5).

Thompson AK, Shaw DI, Minihane AM, Williams CM. (2008). Trans-fatty acids and cancer: the evidence reviewed. Nutrition Research Reviews 21(2):174–88.

Uauy R, Aro A, Clarke R, Ghafoorunissa, L'Abbé MR, Mozaffarian D, Skeaff CM, Stender S, Tavella M (2009). WHO Scientific Update on trans fatty acids: summary and conclusions. European Journal of Clinical Nutrition 63(S2):S68–S75.

Ziauddeen N, Fitt E, Edney L, Dunford E, Neal B, Jebb SA. (2015). Variability in the reported energy, total fat and saturated fat contents in fast-food products across ten countries. Public Health Nutrition 1–8.

Table 1. SFA content, concentration, and percentage of total energy and total fat.

n=number of meals, *data presented as median (interquartile range)

Meal type*	*n*	SFA (g/100 g)	SFA (g/portion)	SFA % Energy Total meal	SFA % Energy Total fat
Chinese (all meals)	123	0.93 (0.59 – 1.50)	7.97 (4.35 – 11.70)	5.9 (4.0 – 8.0)	19.4 (15.4 – 27.4)
Beef, Green Peppers in Blackbean Sauce with fried rice	31	0.97 (0.7 – 1.30)	9.11 (6.3 – 12.34)	5.7 (4.6 – 7.8)	19.7 (15.2 – 22.9)
Sweet and Sour Chicken with boiled rice	10	1.55 (0.82 – 2.34)	11.70 (6.35 – 19.20)	8.7 (3.9 – 10.6)	33.3 (15.5 - 48.6)
Prawn Chow Mein	21	0.60 (0.40 – 0.80)	3.77 (3.12 – 5.34)[a,b]	4.6 (3.5 – 6.6)	17.1 (14.0 - 22.3)
Chicken Chow Mein	10	0.54 (0.41 – 0.62)[a,c]	3.92 (2.99 – 4.49)[a]	4.1 (3.6 – 4.4)	14.5 (10.5 - 17.7)
Char Siu Chow Mein	10	1.93 (1.43 – 2.34)[a,d]	14.59 (9.56 – 18.90)[b,c,d]	12.3 (10.2 – 15.5)[a,c,d]	40.7 (28.3 - 44.6)[a,c,d]
Chicken Satay with fried rice	10	0.72 (0.55 – 0.98)[e]	6.17 (4.69 – 10.10)[e]	4.4 (3.5 – 6.0)[e,e]	15.3 (11.9 - 17.4)[e]
Kung Po King Prawns with boiled rice	10	0.51 (0.33 – 0.80)[e]	4.74 (2.95 – 6.17)[a,b,e]	3.6 (2.4 – 4.3)[e]	18.5 (15.6 – 22.0)[e]
Special Fried Rice	21	1.59 (1.39 – 1.90)[a,c,d,f,g]	11.07 (9.10 – 14.39)[c,d,f,g]	7.3 (6.1 – 8.4)[d,e,f,g]	22.1 (19.4 - 27.5)[d,e,f,g]
Indian (all meals)	95	2.3 (1.7 – 3.2)[1]	18.4 (11.80 – 26.30)[1]	11.3 (9.1 – 15.5)[1]	28.1 (21.1 – 39.1)[1]
Chicken Korma with pilau rice	10	3.93 (3.24 – 4.97)	34.53 (27.5 – 45.05)	18.9 (16.9 – 24.1)	44.1 (39.2- 51.2)
Chicken Tikka Massalla with keema rice	21	3.00 (2.25 – 4.10)	22.74 (18.88 – 31.54)	15.3 (11.4 – 18.9)	30.9 (27.2 - 38.2)[i]
King Prawn Rogan Josh with pilau rice	22	1.20 (0.87 – 1.80)[i,ii]	9.32 (6.70 – 15.18)[i,ii]	9.2 (6.3 – 11.6)[i,ii]	38.5 (22.7 - 43.2)
Lamb Rogan Josh with pilau rice	10	1.91 (1.71 – 2.09)[i,ii]	15.20 (12.41 – 17.65)[i,ii]	9.8 (8.5 – 10.6)[i,ii]	21.9 (19.3 - 27.8)[i]
Lamb Bhuna with chips	22	2.50 (2.17 – 2.62)[i,j]	18.28 (15.03 – 20.25)[i,j]	10.7 (9.7 – 11.7)[i,ii]	21.5 (18.7 - 24.1)[i,ii,j]
Vegetable Biryani	10	2.17 (1.27 – 2.92)[i]	17.22 (9.77 – 28.45)[i]	12.3 (8.4 – 17.9)	24.0 (16.0 - 33.1)[i]
English (all meals)	119	4.9 (3.9 – 5.98)[1,2]	35.71 (27.21 – 43.68)[1,2]	19.9 (16.8 – 22.9)[1,2]	48.3 (42.7 – 51.3)[1,2]

Chicken and chips	25	4.60 (3.75 – 5.00)	31.20 (25.20 – 36.78)	17.4 (15.4 – 18.8)	45.5 (42.6 - 47.7)
Fish and chips	64	5.53 (4.81 – 6.64)[o]	41.99 (34.79 – 48.77)[o]	21.9 (19.6 – 24.3)[o]	50.7 (48.5 – 52.0)[o]
Chips and curry sauce	9	4.21 (3.96 – 5.11)[p]	21.04 (17.01 – 27.82)[p]	21.2 (20.5 – 22.4)[o]	28.2 (25.3 - 30.7)
Mushroom omelette and chips	21	3.40 (3.20 – 3.90)[o,p]	26.51 (23.37 – 33.15)[p]	15.5 (14.6 – 16.6)[p]	48.0 (46.4 - 50.7)[o,p,q]
Pizzas (all meals)	65	5.62 (5.0 – 6.48)[1,2,3,5]	35.70 (27.84 – 43.33)[1,2]	17.7 (16.5 – 19.5)[1,2,3]	46.9 (41.9 – 52.0)[1,2]
Margherita pizza	12	6.20 (4.72 – 7.22)	37.20 (29.07 – 52.77)	18.1 (15.3 – 21.6)	49.5 (43.1 - 55.9)
Pepperoni pizza	12	5.85 (5.02 – 7.17)	37.83 (32.90 – 59.13)	17.2 (15.5 – 20.5)	45.4 (40.1 - 50.0)
Seafood pizza	11	4.80 (4.60 – 5.10)	39.60 (31.74 – 49.52)	16.6 (16.4 – 17.7)	45.1 (41.3 - 54.0)
Ham and Pineapple pizza	10	5.36 (4.62 – 5.69)	28.10 (22.87 – 31.85)	18.2 (16.8 – 19.2)	53.3 (48.8 - 57.7)
Meat pizza	20	5.91 (5.36 – 6.52)[t]	33.14 (26.61 – 40.64)	18.4 (17.6 – 19.5)	46.4 (41.7 - 47.6)
Kebabs (all meals)	87	4.0 (1.1 – 6.0)[1,4]	19.20 (4.42 – 41.10)[1,3,4]	13.7 (6.8 – 21.6)[1,3]	38.6 (27.8 – 45.0)[1,2,3,4]
Doner kebab with chips	32	5.95 (5.10 – 7.57)	47.62 (34.73 – 55.16)	21.4 (19.8 – 23.9)	46.5 (40.7 – 51.0)
Doner kebab	12	6.18 (5.47 – 8.87)	29.92 (26.08 – 34.95)[w]	23.7 (20.5 – 24.5)	43.3 (40.3 - 44.3)
Chicken kebab	22	1.05 (0.67 – 1.60)[w,x]	4.93 (3.00 – 7.75)[w,x]	6.7 (4.2 – 8.1)[w,x]	22.2 (15.2 - 27.3)[w,x]
Shish kebab	21	1.40 (0.85 – 1.90)[w,x]	3.35 (4.41 – 8.15)[w,x]	7.1 (5.6 – 10.8)[w,x]	35.0 (30.3- 37.5)[w,x,y]

Significant difference of paired comparisons between meal categories ($p < 0.005$ Kruskal-Wallis test; $p < 0.005$ Mann-Whitney's test with Bonferroni adjustment: [1]Chinese; [2]Indian; [3]English; [4]Pizza; [5]Kebabs. Significant difference between meal types within the same meal category (Bonferoni adjustments: Chinese $p < 0.001$; Indian $p < 0.003$; English $p < 0.008$; Pizzas $p < 0.005$; Kebabs $p < 0.008$; Mann Whitney's test):

[a]Beef green pepper in black bean sauce with fried rice; [b]Sweet and sour chicken with boiled rice; [c]Prawn chow mein; [d]Chicken chow mein; [e]Char siu chow mein; [f]Chicken satay with fried rice; [g]Kung po king prawns with boiled rice; [h]Special fried rice; [i]Chicken Korma with pilau rice; [ii]Chicken tikka Massalla with keema rice; [j]King Prawn Rogan Josh with pilau rice; [k]Lamb Rogan Josh with pilau rice; [m]Lamb Bhuna with chips; [n]Vegetable Biryani; [o]Chicken and

chips, [p]Fish and chips, [q]Chips and curry sauce, [r]Mushroom omelette and chips; [s]Margherita pizza, [t]Seafood pizza, [u]Ham and Pineapple pizza, [v]Meat pizza; [w]Doner kebab with chips; [x]Doner kebab; [y]Chicken kebab; [z]Shish kebab.

Table 2. TFA content, concentration, and percentage of total energy and total fat.

n=number of meals, *data presented as median (interquartile range)

Meal type*	*n*	TFA (g/portion)	TFA (g/100 g)	TFA % Energy Total meal	TFA % Energy Total fat
Chinese (all meals)	81	0.29 (0.16 – 0.57)	0.03 (0.02 – 0.10)	0.20 (0.10 – 0.42)	1.20 (0.46 – 2.20)
Sweet and Sour Chicken with boiled rice	10	0.18 (0.16 – 0.25)	0.02 (0.02 – 0.03)	0.11 (0.09 – 0.19)	0.57 (0.38 – 0.80)
Chicken Chow Mein	10	0.69 (0.57 – 0.87)[a]	0.10 (0.10 – 0.10)[a]	0.70 (0.67 -0.83)[a]	2.44 (1.95 - 3.28)[a]
Char Siu Chow Mein	10	0.19 (0.13 – 0.42)[b,d]	0.02 (0.02 – 0.06)[b,d]	0.17 (0.10 – 0.40)[b]	0.46 (0.28 – 1.21)[d]
Chicken Satay with fried rice	10	0.08 (0.06 – 0.12)[a,b,d]	0.01 (0.01 – 0.01)[a,b,e]	0.06 (0.05 – 0.07)[a,b]	0.19 (0.16 – 0.22)[a,b]
Kung Po King Prawns with boiled rice	10	0.36 (0.09 – 0.46)[b,d]	0.04 (0.01 – 0.05)[b]	0.32 (0.14 – 0.42)[b,d]	1.82 (0.29 – 2.90)[d]
Special Fried Rice	21	0.53 (0.21 – 0.70)[d]	0.10 (0.03 – 0.10)[d]	0.40 (0.14 – 0.42)[b,d]	0.95 (0.44 – 1.34)[b,d]
Indian (all meals)	30	0.79 (0.50 – 0.88)[1]	0.09 (0.06 – 0.1)[1]	0.48 (0.33 – 0.53)[1]	0.99 (0.73 – 1.28)
Chicken Korma with pilau rice	10	0.83 (0.59 – 0.92)	0.09 (0.07 – 0.10)	0.50 (0.37 – 0.51)	0.97 (0.80 – 1.25)
Lamb Rogan Josh with pilau rice	10	0.73 (0.62 – 0.84)	0.10 (0.09 – 0.10)	0.49 (0.43 – 0.54)	1.13 (0.94 – 1.47)
Vegetable Biryani	10	0.76 (0.22 – 0.88)	0.10 (0.03 – 0.10)	0.50 (0.20 – 0.56)	0.84 (0.38 – 1.26)
English (all meals)	54	0.31 (0.16 – 0.64)[2]	0.07 (0.02 – 0.1)	0.24 (0.09 – 0.41)[2]	0.55 (0.22 – 0.95)[2]
Chicken and chips	3	0.32 (0.20 – 0.36)	0.10 (0.10 – 0.10)	0.30 (0.28 – 0.39)	0.72 (0.56 – 3.03)
Fish and chips	42	0.24 (0.15 – 0.67)	0.03 (0.02 – 0.10)	0.12 (0.08 – 0.38)	0.28 (0.18 – 0.87)
Chips and curry sauce	9	0.49 (0.46 – 0.55)[k]	0.10 (0.10 – 0.10)	0.47 (0.42 – 0.51)[j,k]	1.11 (0.95 – 1.25)[k]
Pizzas (all meals)	30	1.01 (0.80 – 1.56)[1,2,3]	0.18 (0.15 – 0.26)[1,2,3]	0.58 (0.46 – 0.79)[1,2,3]	1.70 (1.13 – 2.16)[1,2,3]
Ham and Pineapple pizza	10	0.98 (0.77 – 1.71)	0.18 (0.15 – 0.30)	0.60 (0.43 – 0.78)	1.97 (1.39 – 3.03)
Meat pizza	20	1.03 (0.80 – 1.49)	0.18 (0.14 – 0.26)	0.57 (0.43 – 0.78)	1.50 (1.01 – 2.04)
Kebabs (all meals)	22	2.67 (1.85 – 4.45)[1,2,3,4]	0.53 (0.41 – 0.89)[1,3,4]	1.87 (1.43 – 2.38)[1,2,3,4]	3.37 (2.65 – 4.41)[1,2,3,4]
Doner kebab with chips	10	4.47 (2.69 – 5.22)	0.84 (0.53 – 0.98)	2.43 (1.84 – 2.60)	4.50 (3.78 – 4.94)
Doner kebab	12	1.99 (1.82 – 2.79)[o]	0.43 (0.41 – 0.55)[o]	1.50 (1.41 – 1.90)[o]	2.78 (2.55 – 3.38)[o]

Significant difference of paired comparisons within meal categories ($p < 0.005$ Kruskal-Wallis test $p < 0.005$; Mann-Whitney's test with Bonferroni adjustment: [1]Chinese; [2]Indian; [3]English; [4]Pizza; [5]Kebabs. Significant difference between meal types within the same meal category (Bonferoni adjustments: Chinese $p < 0.008$; Indian $p < 0.017$; English $p < 0.017$; Pizzas $p < 0.025$; Kebabs $p < 0.025$; Mann Whitney's test):

[a]Sweet and sour chicken with boiled rice; [b]Chicken chow mein; [c]Char siu chow mein; [d]Chicken satay with fried rice; [e]Kung po king prawns with boiled rice; [f]Special fried rice; [g]Chicken Korma with pilau rice;; [h]Lamb Rogan Josh with pilau rice; [i]Vegetable Biryani; [j]Chicken and chips, [k]Fish and chips, [l]Chips and curry sauce, [m]Ham and Pineapple pizza, [n]Meat pizza; [o]Doner kebab with chips; [p]Doner kebab.

Table 3. The SFA and TFA profile of all meals within the five different categories were compared to UK dietary reference values.

n = total number of meals n$^{\neq}$=number of meals for TFA

Meal type	*n*	SFA (% DRV)		$n^{\neq}$	TFA (% DRV)	
		men	women		men	women
Chinese	123	28 (15 – 41)	37 (20 – 54)	81	5.1 (2.8 – 10)	6.7 (3.7 – 13)
Indian	95	65 (42 – 93)	85 (55 – 122)	30	14 (8.7 – 15)	18 (11.6 – 20)
English	119	126 (96 – 154)	165 (126 – 202)	54	5.4 (2.8 – 11)	7.1 (3.7 – 15)
Pizzas	65	126 (98 – 153)	165 (129 – 201)	30	18 (14 – 27)	23 (19- 36)
Kebabs	87	68 (16 – 145)	89 (20 – 190)	22	47 (32 – 78)	62 (43 – 103)

Meals presented per portion; UK recommendations: as percentages of total energy SFA = 10%, and TFA = 2% of total energy, for males and females age 19-49 energy recommendations are 2550 and 1940 kcal per day respectively.