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Nutritional composition of takeaway food in the UK

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Introduction

Over the last few decades lifestyle changes in western societies, relating to time scarcity and convenience, have resulted in an increase in food eaten out of the home (Jabs and Devine, 2006). Out of home food, such as fast food and takeaway meals, offered by food catering establishments has become a significant component of the diet for a considerable percentage of the population of the UK (Food Standards Agency, 2004; Food Standards Agency, 2007) and tends to be energy dense, higher in fat, saturated fatty acids, sugar and salt, but lower in vitamins and minerals than homemade meals (Wagner *et al*., 2008; Dunford *et al*., 2010; Rasmussen et al., 2010; Tanase *et al*., 2011; Jaworowska *et al*., 2012; Jaworowska *et al*., 2013).

Evidence from several cross-sectional and longitudinal studies indicates that frequent consumption of away from home food, including takeaway food, is associated with negative health outcomes including increased risk of hypertension, insulin resistance, diabetes, obesity, and cardio-metabolic disease (Pereira *et al*., 2005; Duffey *et al*., 2009; Krishman *et al*., 2010; Smith *et al*., 2012). To address these conditions, the UK government are campaigning to reduce national energy intake by 5 billion kcal a day (Department of Health., 2011) and considering that 22% of the UK population consume takeaway meals one or two times per week (Food Standards Agency, 2007) an awareness of the nutritional profile of out of home food is warranted. While previous studies have investigated the nutritional quality of food provided by fast food chains (Dunford *et al*., 2010; Dunford *et al*., 2012; Hearst *et al*., 2013) there is still a lack of data regarding the energy and macronutrient composition of meals purchased from small independent takeaway establishments in the UK.

We have recently reported on the salt content from a large sample of takeaway meals from independent establishments and while we found salt content to be high in certain takeaway foods, a high degree of variability was also present (Jaworowska *et al*., 2012). The study emphasised the potential risk of high salt intake from takeaway food; therefore, the purpose of this follow up investigation was to determine the nutritional profile, including energy, macronutrient, sugar and salt content of popular takeaway meals served by small, independent establishments in the UK.

Methods

Sampling and analysis of takeaway meals

Takeaway meals were purchased anonymously from small, independent takeaway establishments from the following categories: Indian, Chinese, Kebab, Pizza, and English. This took place within Liverpool by Liverpool City Council Trading standards; within the Wirral borough by Wirral Metropolitan Borough Council Trading Standards and within the Knowsley borough by Knowsley Council Trading Standards. A total of 489 samples of 27 different types of takeaway meals were purchased in singlet, except for Knowsley Council Trading Stanards where the majority of meals were sampled in duplicate, from each selected establishment as part of the Trading Standards ongoing project work to investigate the nutritional quality of foods in their area. Samples of takeaway food were collected from a random sample of 274 establishments (140, 75 and 59 from Wirral, Liverpool City, and Knowsley Councils respectively). This is an approximate 50%, 20%, and 95% representation of takeaway establishments from Wirral, Liverpool and Knowsley respectively. The category and type of takeaway food were sampled as they were considered to be popular takeaway meals in the UK (Evans, 2011; Leung, 2010). 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), protein (g), carbohydrate (g), total fat (g), salt (g), and total sugars (g) content in the collected meals were analysed. For the analysis of total sugars a subsample of 331 meals were analysed, which were collected only from the Liverpool and Knowsley areas. Meal samples were homogenized in a blender and stored below - 18ºC prior to analysis. To determine the serving size all meals were weighed. Carbohydrates were extracted with water, clarified and chromatographically separated on an amine column with an acetonitrile/water mobile phase. Extractable carbohydrates were detected using an evaporative light scattering detector and quantified with reference to calibration standards (Young, 2002). Total sugars were extracted with aqueous ethanol, the solution was clarified and sugars determined, before acid inversion for reducing sugars, and after acid inversion for total sugars, by the reducing action of glucose on copper (II). The unused copper (II) was reacted with iodide to liberate iodine. The amount of iodine and hence the amount of sugar was determined by titration with thiosulphate ((EC) No. 152/2009)). Protein content was assessed with the standard Kjeldahl procedure (International Organisation for Standardization, 1978). Total fat content was determined with the Weibull – Berntrop gravimetric method according to British Standards 4401-4 (British Standards, 1970). Briefly, the samples were acid hydrolysed with hydrochloric acid, cooled, filtered and dried. Fat was extracted from the

residue with petroleum ether and the dried fat was determined gravimetrically. Microwave acid (HNO_3) digestion followed by inductively coupled plasma optical emission spectrometry (ICP-OES) was employed to determine the concentration of sodium in takeaway food (Kira *et al*., 2004); sodium concentration was multiplied by 2.542 to calculate the total salt content. The energy value of analysed meals was calculated using the Atwater energy equivalents (Carpenter, 1994).

Statistical analysis

All statistical analysis was conducted using SPSS version 18.0 (SPSS Inc., Chicago, IL, USA) and $p < 0.05$ was considered statistically significant. The mean value of meals was calculated for the meals collected in duplicate. An adjusted significance level was used when multiple comparisons were made (see Tables 1 - 4). 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 assigned according 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. Median levels of all considered nutrients were expressed per 100 g and per portion. The nutritional composition levels were compared with the United Kingdom Estimated Average Requirements (EAR) for food energy, Dietary Reference Values (DRVs) for fat and carbohydrate; protein and salt levels were compared to Reference Nutrient Intake (RNI) for men and women aged 19 – 50 years (Department of Health, 1991).

Results and Discussion

The results of the present study show that takeaway food has a highly variable nutritional profile but on the whole is largely excessive (Table 1 & Table 2).

[**Table 1** Nutritional composition of takeaway meal categories per 100 g]

[**Table 2** Nutritional composition of takeaway meal categories per portion]

When considering energy density, pizzas were highest followed by English > kebabs > Indian > Chinese (Table 1); pizzas remained the highest for energy per portion but the ranking order was slightly different: pizzas > English > Indian > Chinese > kebab (Table 2). The nutritional profile

varied considerably between the takeaway categories with pizzas higher ($p < 0.005$) in energy, energy density, all macronutrients and salt per 100 g and per portion (except total fat and total sugars) compared to most other meal categories (Table 1 & 2).

The range of energy, and energy density at the 25th - 75th percentile across the five categories was between 1125 – 1820 kcal/per meal and 140 – 283 kcal/100 g respectively (Table 1 & 2). A US study of non-chain restaurant meals (Urban *et al*., 2013) found energy for all meals ranged from 1248 – 1406 kcal per meal and 157 – 267 kcal/100 g; Chinese and Indian categories, common to the present study, were 1474 kcal/meal, 221/100 g and 1465 kcal/meal, 177 kcal/100 g respectively which compared to 1161 kcal/meal, 140 kcal/100 g, and 1391 kcal/meal, 206 kcal/100 g for Chinese and Indian meals respectively from the present study (Table 1 & 2).

Furthermore, Urban *et al*. (2013) found that non-chain restaurant food higher in energy than chain restaurants that supplied nutritional labelling.. This is in agreement with another study on fast food chains (Dumanovsky *et al*., 2011) were nutritional labelling was introduced that showed lower total energy ranges compared to the present study, suggesting nutritional labelling has an impact on energy levels in fast food. . In a Canadian study, energy density from both sit-down restaurants and fast food chains results were equivocal, 67 – 263 kcal/100 g and 52 - 281 kcal/100 g respectively but serving sizes were larger from the sit-down restaurants and were a greater predictor of total energy, resulting in meals from 61 – 2486 kcal per serving (Scourboutakos and L'Abbé., 2012). . The above evidence highlights the excessive energy provision by unregulated food establishments from the present study and internationally and while fast food chains show lower energy per meal energy density remains high and side orders and additional sugar sweetened beverages should be taken into consideration when comparing meals. Despite having the greatest portion size, Chinese meals were lowest for total fat per 100 g or per portion with a resulting lower energy density (Table 1 & 2).

However, some Chinese meals were very high in salt and relatively high in total sugars (Table 1 & Table 2), which is in agreement with our previous analysis of takeaway food (Jaworowska *et al*., 2012; Davies *et al*., 2012) and previous fast food research. For example, international studies of pizzas show salt ranges from 1.2 – 1.7 g/100 g across 7 different countries (Rasmussen *et al*., 2009; and Dunford *et al.*, 2012); similar to the results in the present study (1.26 – 1.70 g/100 g) (Table 1).

The Indian and pizza categories were highest for total sugars (Table 1 & 2); Kebab meals were lowest in portion size, energy, carbohydrate and comparatively low in total fat per portion (Table 1 & 2) but our research and others have shown kebab meals to be higher in trans fatty acids compared

to other takeaway food (Karabulut, 2007; Davies *et al*., 2012), which if consumed in excess may increase the risk of CVD (Brouwer *et al*., 2010; Laake *et al*., 2012). The present study is in agreement with Dunford *et al.* (2010) that food products served by fast food chains in Australia are energy dense with high levels of total fat, salt, and total sugars but are also highly variable. For example, the median level of energy, total fat, salt and total sugars for pizza was 283 kcal/100 g, 12.1 g/100g, 1.48 g/100g, and 2.05 g /100 g respectively (Table 1 & 2) compared to 250 kcal/100g, 10.0 g/100 g, 1.46 g/100 g, and 2.6 g/100 g respectively (Dunford *et al*., 2010). Similarly, an average meal of chips and nuggets or hot wings contained between 41 and 74 g of total fat (reviewed in Stender *et al*., 2007) comparable to the 36.9 – 79.8 g observed in takeaway food from the present study (Table 2).

Total serving size (portion size), were inconsistent across the different takeaway categories and meals from different establishments ranging from 334 – 1063 g. This difference is to be expected and has influenced some of the variation observed when comparing the nutritional profile (Table 2). For example, pepperoni pizza weighs between 639 – 855 g, contains from 1927.8 – 2597.7 kcal, 80.5 – 131 g of protein,75.3 – 130.7 g of total fat, 203.0 – 250.3 g of total carbohyrate (total sugars, 11.33 – 19.35 g), and a salt content between 5.94 – 13.70 g (Table 1 & 2). While many of the meals are excessive in portion size it is unknown whether the meals are shared; evidence on consumer estimation of fast food showed participants underestimated large high energy meals (Block *et al*., 2013) which may influence decisions on sharing practices. Further consumer studies are required to determine precise eating practices of takeaway food.

Table 3 shows how the nutritional composition of takeaway meals per portion compared to current UK DRVs (Department of Health, 1991). For males and females combined, meals varied from 44 – 93% of the EAR for energy, protein content ranged from 87 to 201% RNI, salt content ranged from 74.6 – 228.0%, and total fat levels from 37 to 106% DRV (Table 3). In some cases the consumption of one meal would be enough to provide daily energy,most macronutrient requirements and the majority of meals exceed the RNI for salt. For total sugars UK recommendations are provided as non-milk extrinsic sugars (NMES) plus intrinsic sugars and starch (Department of Health, 1991). The present study only analysed total sugars and does not differentiate between NMES and intrinsic sugars but Table 3 gives an estimate of how takeaway food compares total sugars to UK DRVs for NMES for both males and females; results ranged from 4.3 – 24.6%.

[**Table 3** The nutritional profile of takeaway meal categories compared to UK Dietary Reference Values (Department of Health, 1991)]

The present study supports previous research which suggests that the intake of energy and total fat may substantially increase with higher frequency of out of home eating. Studies in adult women, children and adolescents who consume out of home food show higher energy and total fat intakes (Krishnan *et al*., 2010 Bowman *et al.,*2004; Powell *et al*., 2013) and consumption of fast/takeaway food more than once a week increases the risk of being obese by 129% (Schröder *et al*., 2007) with a higher prevalence of moderate abdominal obesity (Smith *et al*., 2009). However, in 11-14 year old children fast food and takeaway food showed no association with BMI after adjustment for age and gender, which may have been due to dietary underreporting or attempts to reduce energy intake due to weight concern (Patterson et al., 2012).. Furthermore, the frequency of takeaway food consumption may increase the risk of cardio-metabolic disease; Smith *et al*. (2012) showed the intake of takeaway food in Australia twice a week or more was associated with cardio-metabolic risk but only in the presence of an elevated waist; with the association stronger in women compared to men. As the above research is equivocal and cause and effect cannot be inferredfurther investigation is warranted to assess the obesity and cardio-metabolic risk with takeaway food intake. A likely contributing factor to cardio-metabolic risk are the amount of salt and total sugars present in takeaway food; the current study showed variable results but the majority of meals exceeded the UK recommendations (Table 3) (Department of Health, 1991) for salt and some meals were excessively high in total sugars. We discussed salt content of takeaway food in our previous study (Jaworowska *et al*., 2012) but recent evidence from a large epidemiological study (n = 57, 558) in Thailand identified fast food as a contributing factor to hypertension (Thawornchaisit *et al*., 2013) and convincing evidence suggests that high dietary intake of salt is causal for hypertension, a major risk factor for CVD, and that lowering salt can reduce this risk (Campbell *et al*., 2011; Aaron and Sanders., 2013). The UK initiated a campaign to reduce salt intake to 6 g per day by 2015 with voluntary involvement from the food industry (Food Standards Agency, UK, 2006) and intake has reduced from 9.5 to 8.6 g salt per day (Shankar *et al*., 2013). Considering a large proportion of meals analysed in the present study are equal or greater than 6 g/meal with further reduction targets of 3 g per day aimed for 2025 (National Institute of Health and Clinical Excellence, 2010), and that the UK remains unregulated (Jacobson *et al*., 2013), action from the takeaway industry is necessary. . Furthermore, high intakes of dietary sugar have been associated with several metabolic abnormalities relating to obesity and cardio-metabolic disease; including, insulin resistance, hypertension, and dyslipidaemia (Johnson et al., 2009; Morenga *et al*., 2013). While the sugar content of takeaway food was not as excessive as the salt levels, on inspection of the full range of

results (including outliers) some of the meals analysed were over 35 g of sugar per meal (data not shown) and our previous study showed an outlier meal of 158 g of total sugars (Davies et al., 2012a), assuming a takeaway meal would provide 1/3 of total daily meals these levels of sugar would exceed the current UK DRV and World Health Organisations recommendations of 10% of total energy from NMES or free sugars respectively (Department of health, 1991; Mann *et al*., 2007) . Currently there are no UK initiatives to reduce dietary sugars, the majority of studies support an association with sugar sweetened beverages and obesity but there is insufficient evidence from other sources of sugar (Mann *et al*., 2013). However, considering fast food intake is associated with higher consumption of sugar sweetened beverages, added sugar, and obesity (Wilcox *et al*., 2013) in the USA studies in the UK on both fast food and takeaway food should be conducted to provide evidence on whether sugar content should be regulated.

As consumption of takeaway and fast foods has become more widespread and a regular component of the diet worldwide (Duffey *et al*., 2007; Poti *et al*., 2011), its nutritional quality is an important issue. The results of the present study indicate a general unhealthy nutritional profile compared to UK DRVs (Department of Health, 1991) with excessive portions of takeaway meals served by small, independent takeaway establishments. However, the significant variability observed across the different meal categories indicates that some meals are characterised by significantly lower energy density and a more favourable nutritional profile compared to others (Table 1 & 2); this was also found in our previous findings on the salt, sugar and trans fatty acid content of takeaway food (Jaworowska *et al*., 2012; Davies *et al*., 2012a; Davies *et al*., 2012b) and we have shown that it is possible to reduce sodium and fat content of takeaway meals by recipe reformulations without decreasing consumer acceptability (Jaworowska *et al*., 2011). Therefore, it could be possible for consumers to make informed choices when eating out and to reduce not only total energy intake, but also to select meals with a lower content of total fat and salt. However, takeaway establishments are not required to provide nutritional labelling, thus the consumer may find it very difficult to identify the nutritional value of meal options. There is evidence suggesting that the provision of nutritional labellingmay stimulate consumers to modify their food orders and to choose meals with a more favourable nutritional profile (Roberto *et al*., 2010). Therefore, it seems worthy to encourage food catering establishments to post the nutritional composition of served meals on the menu. The present study discussed the issue of portion size above and results showed variation within the takeaway meals from different establishments (Table 2) but on the whole were substantially large. Therefore, a simple reduction in served portion size or a suggestion for consumers that the meal is suitable for consumption by more than one person may significantly reduce the intake of energy, macronutrients, salt and sugar.

The study had several limitations, meals were collected in singlet or duplicate from the takeaway establishments sampled and therefore may not be a "true" representation of the nutritional profile; further sampling and analysis of multiple samples of the same meal from the same establishment would provide more precision. Furthermore, the variability in the data was very high, which is likely due to different establishments using different recipes and ingredients; a collection of full recipes with accurate ingredients would benefit further research but it is the authors' opinion that this would be a challenging process to obtain full agreement and cooperation needed from the takeaway establishments. While the present study analysed energy, macronutrients, total sugars, and salt further analysis of the quality of fat and carbohydrates, including type of sugars, along with micronutrients would provide a more detailed nutritional profile of takeaway food.

Conclusion

The present study has shown a largely unfavourable nutritional profile of takeaway food and regular consumption of such meals may increase the risk of non-communicable disease. Whilst the variability in the nutritional profile of the different meal categories was expected and is natural, the wide variation in similar meals from different establishments may provide an opportunity for recipe reformulation. A strategy involving recipe modifications together with the provision of nutritionalal labelling may help consumers make conscious food choices and reduce the negative health outcomes associated with eating out of the home. Considering the UK government is campaigning to reduce energy intake by 5 billion kcal per day and the increased prevalence of purchasing out of home food, improvement of takeaway and other out of the home food should be an area of intense research focus.

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Biographical Details:

Dr Agnieszka Jaworowska was a postdoctoral researcher at Liverpool John Moores University investigating the analysis, reformulation, and sensory analysis of takeaway food as part of a funded project by Liverpool City Council. Dr Jaworowska has first authored peer reviewed journal articles on takeaway food and has previously worked as a lecturer in Poland with several peer-reviewed publications relating to nutrition and obesity.

Toni Blackham was a research assistant at Liverpool John Moores University on a funded project investigating takeaway food; Toni is a Community Nutrition graduate and has co-authored peer reviewed articles relating to takeaway food. Toni is continuing research into takeaway food and will complete her PhD in the near future.

Rachel Long is an employee of Liverpool City Council; Rachel collaborated with Liverpool John Moores on a funded project investigating the reformulation of takeaway food including data collection. Rachel works for the Trading Standards department and is working with takeaway establishments in Liverpool to continue to improve the nutritional quality of the meals.

Catherine Taylor is an employee of Knowsley public health team, Knowsley Council/NHS Knowsley and has a wide interest in takeaway food including data collection for the present study and the social and health implications of takeaway food consumption. Catherine continues to work in this area and is in collaboration with Liverpool John Moores for future research.

Matthew Ashton is Director of Knowsley public health team, Knowsley Council/NHS Knowsley and has a strong interest in research involving takeaway food. Matthew continues to work in this area and is interested in projects that would provide social and health impacts relating to takeaway food .

Dr Leonard Stevenson is Director of Operations, Food & Human Nutrition Programme at Newcastle University (Singapore). Dr Stevenson has a long history with respect to research into takeaway food and Dr Stevenson initiated much of the takeaway research during his time at Liverpool John Moores University as principle investigator for a funded project on takeaway food. Dr Stevenson has a research record with several peer-reviewed journal articles in food science relating to food reformulations and continues to collaborate with Liverpool John Moores University on future research projects relating to takeaway food and other nutrition/food science projects.

Dr Ian G. Davies is a senior lecturer in nutritional science at Liverpool John Moores University. Dr Davies's primary interests are in risk of cardio-metabolic disease relating to nutritional intake with a track record of peer-reviewed journals in this area. Dr Davies took over from Dr Stevenson as principle investigator on a funded project to investigate takeaway food and is corresponding author for two previous journal articles in this area. Dr Davies continues to research in this area with future studies to investigate the effects of takeaway food on the intake of takeaway food with respect to risk of cardio-metabolic disease.

Table 1 Nutritional composition of takeaway meals per 100 g

Meal type*	*n*	Energy (kcal/100 g)	Protein (g/100 g)	Carbohydrate (g/100 g)	Total fat (g/100 g)	Salt (g/100 g)	*n*≠	Sugars (g/100 g)
Chinese (all meals)	123	140 (124 - 173)	6.9 (5.7 - 9.2)	17.4 (13.3 - 21.8)	4.9 (3.5 - 6.1)	1.07 (0.74 – 1.37)	62	1.05 (0.47 – 1.52)
Beef, Green Peppers in Blackbean Sauce with fried rice	31	147 (132 – 153) [c]	6.5 (5.4 – 7.2) [g]	17.4 (16.9 – 19.8) [c, e]	5.3 (4.0 – 6.5)	1.19 (0.91-1.50)[b]	21	1.2 (0.95 – 1.65)
Sweet and Sour Chicken with boiled rice	10	188 (168 – 196) [a, c]	6.3 (5.7 – 7.8)	28.4 (27.7 – 29.3) [a, c, e]	5.2 (3.5 – 6.1)	0.37 (0.27-0.49)[a]		n/d
Prawn Chow Mein	21	102 (93 – 124)	5.8 (5.1 – 6.7)	12.8 (11.3 – 14.0)	3.5 (2.4 – 4.4)	1.12 (0.80-1.51)[b]	21	1.2 (0.75 – 1.65)
Chicken Chow Mein	10	129 (108 - 134)	8.3 (7.2 - 9.7) [c, g]	12.0 (10.0 - 14.5)	4.1 (3.1 - 5.2)	0.96 (0.68-1.16)	10	0.32 (0.17 – 1.82)[a]
Char Siu Chow Mein	10	129 (119 – 143)	10.3 (8.2 – 14.0) [a, c, g]	9.6 (8.5 – 13.2)	5.3 (3.3 – 6.5)	1.05 (0.97-1.25)		n/d
Chicken Satay with fried rice	10	146 (130 – 157) [c]	7.4 (6.2 – 8.1)	17.8 (15.1 – 19.1) [c, e]	4.4 (4.1 – 6.1)	1.04 (0.81-1.51)		n/d
Kung Po King Prawns with boiled rice	10	126 (114 – 152)	4.1 (3.7 – 5.6)	22.5 (19.5 – 23.8) [c, d, e]	2.7 (1.8 – 4.2)	0.62 (0.39-0.85)[a, h]		n/d
Special Fried Rice	21	200 (189 - 217) [a, c, d, e, f, g]	11.5 (10.1 - 12.2) [a, b, c, f, g]	22.8 (19.1 - 26.1) [a, c, d, e]	7.3 (5.2 - 8.8) [a, c, d, g]	1.37 (1.15-1.66)[b, g]	10	0.46 (0.17 – 1.82)
Indian (all meals)	95	176 (145 - 197)[1]	6.9 (4.9 - 8.2)	17.2 (15.5 - 19.2)	8.6 (6.1 - 10.7)[1]	0.61 (0.46 – 0.79)[1]	63	1.70 (1.50 – 1.70)[1]
Chicken Korma with pilau rice	10	179 (168 – 213)[j]	7.4 (7.1 – 8.9) [j, n]	17.3 (16.9 – 19.0)	8.5 (7.6 – 11.1)[j]	0.45 (0.37-0.54)		n/d
Chicken Tikka Massalla with keema rice	21	187 (175 – 199) [j, n]	8.9 (7.3 – 10.1) [j, m, n]	16.9 (14.8 – 18.1)	9.6 (8.5 – 10.8)[j]	0.81 (0.70-0.97)[i]	21	2.60 (2.10 – 3.90)
King Prawn Rogan Josh with pilau rice	22	136 (118 – 142)	4.6 (3.9 – 5.1)[n]	17.8 (17.0 – 19.9)	4.6 (2.8 – 5.7)	0.59 (0.48-0.74)[ii]	21	1.70 (1.50 – 2.00)[b]
Lamb Rogan Josh with pilau rice	10	174 (155 – 187)[j]	7.7 (7.5 – 9.7) [j, n]	16.1 (15.0 – 17.9)	7.9 (6.8 – 9.5)	0.46 (0.37-0.57)[ii]		n/d
Lamb Bhuna with chips	22	206 (188 – 215) [j, k, n]	7.0 (6.2 – 8.0) [j, n]	18.4 (15.6 – 20.2)	11.2 (10.4 – 12.1) [j, k]	0.51 (0.38-0.65)[ii]	21	1.50 (1.25 – 1.80)[b]
Vegetable Biryani	10	151 (139 – 171)	2.8 (2.5 – 3.3)	15.4 (14.0 – 19.6)	7.9 (7.2 – 10.7)[j]	0.69 (0.55-0.78)		n/d
English (all meals)	119	224 (207 - 240)[1, 2]	6.7 (5.7 - 7.9)	24.3 (21.9 - 26.8)[1, 2, 5]	10.9 (9.3 - 12.7)[1, 2]	0.41 (0.30 – 0.59)[1, 2]	87	0.40 (0.30 – 0.80)[1, 2]
Chicken and chips	25	226 (210 - 247) [q, r]	10.9 (9.5 - 13.3) [p, q, r]	24.4 (22.6 - 27.1)[r]	9.7 (8.5 - 11.0)	0.36 (0.24-0.56)[q]	24	0.33 (0.30 – 0.40)[c]
Fish and chips	64	229 (215 – 251) [q, r]	6.7 (6.0 - 7.2) [q, r]	25.8 (23.8 - 27.7)[r]	11.1 (9.6 - 12.8) [o, q]	0.41 (0.31-0.59)	33	0.20 (0.30 – 0.55)[c]
Chips and curry sauce	9	191 (177 - 213)	2.5 (2.4 - 2.8)	24.2 (23.0 - 25.4)[r]	9 (8.0 - 10.5)	0.63 (0.46-0.81)	9	0.43 (0.31 – 0.91)[c]
Mushroom omelette and chips	21	205 (190 – 223)	6.1 (5.0 – 6.7)[q]	16.6 (15.6 – 17.8)	12.5 (10.9 – 15.1) [o, q]	0.48 (0.31-0.66)	21	0.90 (0.60 – 1.15)
Pizzas (all meals)	65	283 (259 - 304)[1, 2, 3, 5]	14.5 (13.2 - 15.7)[1, 2, 3]	28.1 (25.4 - 31.9)[1, 2, 3, 5]	12.1 (10.6 - 14.0)[1, 2, 5]	1.48 (1.26 – 1.70)[1, 2, 3]	44	2.05 (1.52 – 2.50)[1, 3]
Margherita pizza	12	301 (281 – 312) [t, u]	13.4 (12.0 – 14.7)	32.7 (30.8 – 37.0) [t, v]	12.8 (10.3 – 14.0)	1.40 (1.06-1.70)	11	2.10 (1.50 – 3.10)
Pepperoni pizza	12	304 (283 - 315) [t, u]	14.1 (13.0 - 15.3)	31.7 (27.3 - 34.4)[v]	14.3 (10.9 - 15.0)	1.62 (1.15-1.87)	12	2.20 (1.52 – 2.77)
Seafood pizza	11	253 (250 – 262)	13.9 (13.0 – 14.9)	25.4 (24.7 – 29.1)	10.7 (9.7 – 11.4)	1.32 (0.99-1.83)	11	1.80 (1.50 – 2.30)
Ham and Pineapple pizza	10	257 (247 – 280)	13.7 (12.3 – 14.6)	28.0 (25.9 – 32.7)	9.9 (8.8 – 11.5)	1.44 (1.21-1.57)		n/d
Meat pizza	20	288 (278 - 312) [t, u]	15.8 (14.7 - 18.0) [s, t, u]	26.4 (23.7 - 29.2)	12.9 (12.1 - 14.7) [t, u]	1.49 (1.39-1.71)	10	2.29 (1.99 – 2.77)

Kebabs (all meals)	87	206 (155 - 257)[1, 2]	13.5 (9.5 - 16.2)[1, 2, 3]	17.8 (12.4 - 22.5)	9.9 (4.9 - 14.0)[1]	1.17 (0.91 – 1.58)[2, 3, 4]	75	1.08 (0.60 – 1.50)[2, 3, 4]
Donner kebab with chips	32	254 (224 – 306) [y, z]	8.6 (7.6 – 12.7)	22.9 (21.9 – 25.0) [x, y, z]	13.3 (11.2 – 18.1) [y, z]	1.07 (0.84-1.22)[x]	21	0.60 (0.25 – 0.90)
Donner kebab	12	277 (223 - 325) [y, z]	13.4 (11.3 - 16.6) [w]	18.2 (14.8 - 19.7) [y]	15.6 (12.5 - 20.4) [y, z]	1.90 (1.61-2.16)	12	2.00 (1.06 – 3.12)[d]
Chicken kebab	22	147 (135 – 184)	15.2 (11.4 – 17.1) [w]	11.8 (9.9 – 12.9)	5.6 (3.7 – 8.4)	1.15 (0.91-1.42)[x]	22	1.30 (0.80 – 1.65)[d]
Shish kebab	21	155 (139 – 164)	15.0 (13.6 – 17.2) [w]	13.8 (12.1 – 17.0) [y]	4.0 (2.8 – 5.3)	1.17 (0.91-1.51)[x]	21	1.20 (0.95 – 1.60)[d]

n=number of meals, $n^{\neq}$=number of meals for total sugars, n/d=no data; *data presented as median (interquartile range); 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 $p < 0.001$; 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]Donner kebab with chips; [x]Donner kebab; [y]Chicken kebab; [z]Shish kebab.

Table 2 Nutritional composition of takeaway meals per portion

Meal type*	*n*	Weight of meal (g)	Energy (kcal/portion)	Protein (g/portion)	Carbohydrate (g/portion)	Total fat (g/portion)	Salt (g/portion)	*n*≠	Sugars (g/portion)
Chinese (all meals)	123	821 (683 – 915)[3, 4, 5]	1161 (932 - 1452)	58.2 (44.2 - 72.5)	145.2 (96.2 - 184.8)[5]	36.9 (25.6 - 52.7)	6.43 (4.37-8.92)[2,3,4]	62	8.89 (4.10 – 11.61)
Beef, Green Peppers in Blackbean Sauce with fried rice	31	915 (871 – 1013) [c, e, h]	1386.2 (1170.4 – 1559.3) [c, d]	62.4 (48.5 – 70.5) [c, g]	167.0 (148.8 – 189.5) [c, d, e]	48.0 (36.9 – 63.6) [c, g]	10.72 (8.13-13.88)	21	10.96 (8.88 – 15.78)
Sweet and Sour Chicken with boiled rice	10	766 (744 – 868)	1501.0 (1415.0 – 1618.5) [c]	51.5 (44.6 – 62.3)	225.3 (214.1 – 246.3) [a, c]	41.6 (30.8 – 47.6)	3.13 (1.83-3.76)[a]		n/d
Prawn Chow Mein	21	679 (584 – 834)	724.6 (650.8 – 883.7)	40.5 (37.3 – 45.3)	93.1 (71.5 – 106.6)	24.5 (17.3 – 31.5)	7.88 (5.58-9.99)[b]		n/d
Chicken Chow Mein	10	690 (567 - 873)	838.5 (697.4 - 1023.7)	56.4 (50.2 - 65.1) [c]	81.6 (69.9 - 105.7)	27.9 (17.1 - 41.8)	6.23 (4.50-7.45)[a, b]	10	2.06 (0.89 – 6.64)[a]
Char Siu Chow Mein	10	716 (680 – 848)	1095 (805.5 – 1159.0)	78.4 (56.8 – 105.8) [c, g]	72.1 (58.9 – 93.9)	45.5 (22.9 – 53.7)	8.07 (7.18-8.46)[b]		n/d
Chicken Satay with fried rice	10	891 (781 – 1063)	1247.3 (1095 – 1726.8) [c]	61.4 (55.1 - 75.0) [c]	152.9 (136.0 – 183) [c, d, e]	35.8 (32.6 – 59.2)	10.3 (7.53-13.38)[b]		n/d
Kung Po King Prawns with boiled rice	10	882 (794 – 931)	1097.7 (983.8 – 1318.3) [c]	37.8 (31.8 – 46.4)	181.3 (172.9 – 199.8) [c, d, e]	24.8 (14.2 – 31.6)	5.54 (3.51-7.37)[a]		n/d
Special Fried Rice	21	686 (604 - 742)	1367.0 (1234.5 - 1546.8) [c, d, e]	78.2 (66.7 - 88.7) [c, g]	156.0 (127.0 - 183.7) [c, d, e]	50.0 (37.7 - 62.5) [c, g]	9.41 (7.17-12.33)[b]	10	3.34 (1.19 – 11.57)
Indian (all meals)	95	803 (731 – 864)[3, 4, 5]	1391 (1170 – 1585)[1, 5]	56.0 (35.4 – 67.3)	138.0 (119.8 – 156.0)[5]	69.6 (50.4 – 86.3)[1]	4.70 (3.61-5.96)[1,3,4,5]	63	13.96 (10.89 – 19.37)[1]
Chicken Korma with pilau rice	10	869 (819 – 923)	1594.5 (1458.5 – 1743.8) [j]	67.3 (58.2 – 72.6) [j, n]	156.5 (143.9 – 168.5)	75.9 (66.2 – 96.5)[j]	3.81 (3.18-4.35)		n/d
Chicken Tikka Massalla with keema rice	21	808 (746 – 872)	1479.8 (1331.2 – 1688.5)[j]	69.7 (61 – 77.3) [j, m, n]	138.0 (117 – 152.3)	73.3 (67.0 – 91.6)[j]	6.68 (5.64-8.18)[i]	21	22.57 (18.61 – 31.68)
King Prawn Rogan Josh with pilau rice	22	772 (701 – 828)	1027.2 (838.3 – 1154.5)	33.9 (29.6 – 38.9) [n]	135.1 (125.7 – 163.2)	32.1 (18.7 – 44.2)	4.20 (3.44-6.08)[ii]	21	13.57 (11.24 – 16.07)[b]
Lamb Rogan Josh with pilau rice	10	758 (719 – 857)	1356 (1246.3 – 1479.3)[j]	64.4 (53.5 – 77.1) [j, n]	120.6 (114.2 – 148.0)	66.5 (50.0 – 70.7)[j]	3.49 (2.78-5.23)[ii]		n/d
Lamb Bhuna with chips	22	745 (714 – 830)	1521.5 (1378.9 – 1765.1)[j]	53.8 (48.5 – 62.3) [j, n]	134.1 (114.2 – 155.4)	84.5 (76.1 – 92.9)[j, k]	4.12 (3.10-5.14)[ii]	21	11.73 (10.00 – 14.23)[b]
Vegetable Biryani	10	834 (747 – 910)	1310.6 (1102.3 – 1519.2)	22.8 (20.3 – 26.8)	134.3 (112.7 – 154.6)	71.7 (50.8 – 90.6)[j]	5.63 (4.77-6.47)[i]		n/d
English (all meals)	119	716 (638 - 830)[4, 5]	1606 (1431 - 1881)[1, 2, 5]	48.4 (42.0 - 61.8)	174.2 (135.1 - 204.1)[1, 2, 5]	79.8 (65.7 - 94.0)[1, 2, 5]	2.65 (1.82-3.80)[1,2,4,5]	87	2.98 (1.67 – 5.62)[1, 2]
Chicken and chips	25	694 (606 - 828) [q]	1575.3 (1320.0 - 1858.1) [q]	81.7 (68.5 – 88.8) [p, q, r]	169.5 (129.2 - 197.6) [r]	66.2 (53.9 - 79.4) [q, r]	2.18 (1.68-3.23)	24	2.56 (1.73 – 2.98)[c]
Fish and chips	64	749 (656 – 827) [q]	1657.9 (1515.3 – 1967.5) [q]	47.7 (44.1 – 56.4) [q]	193.0 (169.7 – 214.3) [q, r]	82.8 (71.6 – 96.7) [o, q]	2.90 (2.32-4.47)	33	2.50 (1.48 – 4.82)c
Chips and curry sauce	9	487 (459 - 548)	1052.7 (830.4 - 1123.9)	13.1 (11.5 - 13.5)	130.3 (105.4 - 142.5)	45.5 (38.6 - 57.0)	3.31 (1.88-4.55)	9	2.74 (1.47 – 4.97)[c]
Mushroom omelette and chips	21	783 (662 – 917) [q]	1568.1 (1376.4 – 1920.3) [q]	42.9 (33 – 55.9) [q]	127.5 (112.9 – 151.5)	92.3 (79.9 – 114.3) [o, q]	2.15 (3.77-5.55)	21	6.70 (4.66 – 9.40)
Pizzas (all meals)	65	637 (538 - 768)[5]	1820 (1469 - 2152)[1, 2, 3, 5]	90.3 (73.5 - 107.5)[1, 2, 3, 5]	186.9 (149.9 - 223.1)[1, 2, 5]	74.9 (56.5 - 96.4)[1, 5]	9.12 (6.78-11.96)[1,2,3,5]	**44**	12.58 (10.65 – 17.81)[1, 3]
Margherita pizza	12	674 (575 – 740)	1985.5 (1712.4 – 2270.0) [u]	90.6 (68.9 – 100.2)	222.7 (208.6 – 256.4) [v]	83.4 (59.6 – 103.6)	8.83 (6.63-10.81)	11	12.05 (11.11 – 22.11)
Pepperoni pizza	12	750 (639 – 855)	2137.4 (1927.8 – 2597.7) [u, v]	99.0 (80.5 - 131.0)	219.7 (203.0 - 250.3) [v]	95.4 (75.3 - 130.7) [u]	12.87 (5.94-13.70)	12	13.62 (11.33 – 19.35)
Seafood pizza	11	765 (690 – 971) [u, v]	2004 (1697.4 – 2514.9) [u]	108.8 (97.1 – 135.9) [u]	217.0 (170.4 – 244.7) [v]	91.8 (66.9 – 109.5) [u]	11.09 (8.66-13.62)	11	12.80 (11.88 – 18.36)
Ham and Pineapple pizza	10	558 (497 – 605)	1468.5 (1261.0 – 1526.3)	77.2 (62.3 – 86.2)	170.2 (122.1 – 188.5)	55.3 (45.3 – 59.1)	7.72 (5.37-9.75)		n/d
Meat pizza	20	550 (462 - 646)	1563.2 (1323.1 - 2007.8)	88.8 (73.6 - 101.5)	147.1 (118.8 - 166.1)	75.1 (55.9 - 92.1)	8.20 (6.93-9.81)	10	10.53 (8.30 – 14.34)
Kebabs (all meals)	87	491 (418 - 636)	1125 (690 - 1673)	64.4 (54.6 - 76.2)[a, b, c]	74.1 (52.2 - 134.1)	58.9 (22.3 - 93.3)	6.62 (4.27-8.48)[2,3,4]	75	5.26 (2.98 – 8.28)[1, 2, 3, 4]

Donner kebab with chips	32	751 (561 – 979) [x, y, z]	1864.5 (1577.4 – 2221.1) [x, y, z]	68.8 (58.7 – 81.7)	167.9 (128.9 – 224.4) [x, y, z]	100.5 (83.6 – 118.3) [x, y, z]	7.50 (5.90-9.71) [z]	21	4.41 (2.10 – 6.57)
Donner kebab	12	447 (338 - 503)	1163.5 (1121.4 - 1354.5) [y, z]	56.0 (47.2 - 74.2)	76.3 (68.1 - 85.8) [y, z]	71.8 (63.1 - 82.1) [y, z]	7.98 (6.64-9.72) [y, z]	12	6.41 (3.93 – 15.27)
Chicken kebab	22	481 (436 – 539) [z]	725.8 (649.5 – 818.9) [z]	74.5 (56.2 – 90.7)	52.9 (49.8 – 61.3)	26.9 (20.3 – 40.4)	5.94 (3.95-7.27)	22	6.28 (3.61 – 8.42)
Shish kebab	21	386 (334 – 478)	603.5 (508.9 – 709.2)	60.5 (51.5 – 68.3)	52.2 (44.5 – 58.1)	16.2 (10.2 – 22.2)	4.27 (3.47-5.99)	21	4.60 (2.88 – 7.04)

n=number of meals, $n^{\neq}$=number of meals for total sugars, n/d=no data; *data presented as median (interquartile range); 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 $p < 0.001$; 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]Donner kebab with chips; [x]Donner kebab; [y]Chicken kebab; [z]Shish kebab.

Table 3 The nutritional profile of takeaway meal categories compared to UK Dietary Reference Values (Department of Health, 1991)

Meal type	*n*	Energy (% EAR)		Protein (% RNI)		Carbohydrate (% DRV)		Total fat (% DRV)		Salt (% RNI)	$n^{\neq}$	NMES (% DRV)*	
		men	women	men	women	men	women	men	women	Adults		men	women
Chinese	123	46 (37 - 57)	60 (48 - 75)	105 (80 - 131)	129 (98 - 161)	43 (28 - 54)	56 (37 - 71.4)	37 (26 - 53)	49 (34 - 70)	203.2 (145.2 – 273.8)	62	13.1 (6.0-17.1)	17.2 (7.9-22.4)
Indian	95	55 (46 - 62)	72 (60 - 81)	101 (64 - 122)	124 (80 - 150)	41 (35 - 46)	53 (46 - 60)	70 (52 - 87)	92 (69 - 114)	118.2 (90.3 – 152.5)	63	20.5 (16.0-28.5)	27.0 (21.0-37.4)
English	119	63 (56 - 74)	82 (73 - 97)	87 (75 - 110)	107 (92 - 136)	51 (40 - 60)	67 (52 - 79)	80 (66 - 94)	106 (86 - 124)	74.6 (52.5 – 109..7)	87	4.4 (2.5-8.3)	5.8 (3.2-10.8)
Pizzas	65	70 (57 - 85)	93 (75 - 111)	163 (133 - 194)	201 (163 - 239)	55 (44 - 66)	72 (58 - 86)	76 (57 - 97)	99 (75 - 128)	228.0 (169.6 – 299.0)	44	18.5 (15.7-26.2)	24.3 (20.6-34.4)
Kebabs	87	44 (27 - 65)	58 (36 - 86)	115 (98 - 137)	142 (121 - 168)	22 (15 - 39)	29 (20 - 52)	59 (23 - 94)	78 (30 - 123)	165.5 (106.8 – 211.9)	75	7.7 (4.3-12.2)	10.2 (5.7-16.0)

The nutritional profile of all meals within the five different ccategories were compared to UK dietary reference values; however, total sugars were compared to non-milk extrinsic sugars as the UK does not have a dietary reference value for total sugars.

n = total number of meals $n^{\neq}$=number of meals for total sugars. Meals presented per portion, * percentage of UK DRV for NMES (UK recommendations are 10% of total energy, for males and females age 19-49 energy recommendations are 2550 and 1940 kcal per day respectively.