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1 **Determination of salt content in hot takeaway meals in the United Kingdom**

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## 26 **Determination of salt content in hot takeaway meals in the United Kingdom**

### 27 **Highlights**

28 ► high sodium intake is associated with negative health outcomes ► pizzas had the highest salt  
29 content per portion, followed by Chinese meals ► significant differences in salt content between  
30 meals in the same category were found ► results show salt content in takeaway food is  
31 alarmingly high

### 32 **Abstract**

33 High sodium intake is associated with negative health outcomes, including an independent  
34 correlation with high blood pressure which increases the risk of cardiovascular disease. A high  
35 proportion of sodium intake in the UK is from processed and out of the home food; this includes  
36 takeaway food which is increasing in popularity. The aim of the present study was to evaluate  
37 salt levels in popular hot takeaway meals. A total of 411 samples of 23 different types of  
38 takeaway meals were analysed. Obtained results show the salt content in these kinds of foods is  
39 alarmingly high. Comparing medians (interquartile range) for different meal categories, Pizzas  
40 contained the highest salt content per portion (9.45 g (6.97-12.83)), followed by Chinese meals  
41 (8.07 g (5.47-10.99g)), Kebabs (6.21 g (4.01-8.35)) and Indian meals (4.73 g (3.61-6.10)). In  
42 addition, significant differences in the salt content between meals within the same category were  
43 reported. To enable the consumer to meet the UK's target salt intake, a significant reduction in the  
44 salt content of hot takeaway meals should be considered.

45  
46 **Key words:** takeaways; salt content; hot meals;

### 48 **Introduction**

49 High sodium intake, which is mostly consumed as sodium chloride, has been reported to  
50 be associated with increased blood pressure in many epidemiological studies (Mohan &

51 Campbell, 2009). In addition, excessive sodium consumption has been shown to be an  
52 independent risk factor of coronary heart disease and stroke (Nagata, Takatsuka, Shimizu, &  
53 Shimizu, 2004; Tuomilehto et al., 2001). Furthermore, high salt intake may also be associated  
54 with other adverse health conditions, including kidney stones, gastric cancer, asthma and  
55 osteoporosis (He & MacGregor, 2010a).

56 In the United Kingdom (UK), the Reference Nutrient Intake for sodium in adults is 1600  
57 mg per day; this is the salt equivalent of 4 g per day (Scientific Advisory Committee on Nutrition,  
58 2003). However, UK current targets are a reduction in average salt intake across the population to  
59 6 g per day per adult (Food Standards Agency, UK, 2009). This target of 6 g per day by 2015 is  
60 deemed to be achievable, rather than ideal and further reduction targets have been set to 3 g per  
61 day by 2025 (National Institute for Health and Clinical Excellence, 2010).

62 Following the 2003 report published by the Scientific Advisory Committee on Nutrition  
63 (SACN) on Salt and Health, the UK Food Standards Agency initiated a major salt campaign  
64 targeting the food industry (Food Standards Agency, UK, 2009). Recent evaluations of this  
65 campaign show a reduction of average salt intake from 9.5 g/day to 8.6 g/day, an approximate  
66 10% reduction (Wyness et al, 2011; Shankar et al, 2012). While the UK has made progress and  
67 raised consumer awareness, further reductions to reach the UK target of 6 g/day are warranted  
68 (National Institute for Health and Clinical Excellence, 2010).

69 It seems that a crucial factor for development of a proper strategy to reduce the salt intake  
70 in the UK population is identification of dietary sodium sources. It has been estimated that in UK  
71 diets about 80% of daily sodium intake comes from processed food and the catering industry,  
72 including takeaway foods (Henderson et al, 2003; Gilbert & Heiser, 2005; He & MacGregor,  
73 2010b). Eating out of home statistics show 42% of surveyed British consumers ate takeaway  
74 foods once a month or less and 32% two or three times a month (Nielson, 2005). Similarly, the

75 Food Standards Agency, UK, (2007) reported that 22% of Britons purchase foods from takeaway  
76 outlets at least once a week and 58% a few times a month.

77 Foods prepared outside the home are generally considered to be higher in salt than meals  
78 cooked at home, and it has been estimated that approximately 15% of the UK's salt intake is from  
79 foods eaten outside the home (Guthrie, Lin, & Frazao, 2002; He et al, 2010). However, the  
80 majority of previous studies have focused on fast or processed food (products bought from fast  
81 food chain outlets or supermarkets) only, not taking into account other out of home meal options  
82 such as takeaway food (Webster et al, 2010; Ni Mhurchu et al, 2011). It has been reported that  
83 ethnic cuisine, especially Chinese and Indian, is one of the most popular types of takeaway foods  
84 in the UK (Mintel Report, 2009). Furthermore, sodium intake in Northeast Asia is extremely high  
85 and ranges from 4651 mg to 6267 mg per day (11.6 – 15.7 g salt per day) depending upon region,  
86 which reflects the traditional cooking practices such as using monosodium glutamate, pickles, soy  
87 sauce and other sauces which contain sodium (Anderson et al., 2010; Brown et al, 2009). It may  
88 be expected that meals prepared in oriental takeaway outlets in the UK also contain a high level of  
89 sodium.

90 Taking into account the high prevalence of takeaway food consumption and a lack of  
91 information regarding nutritional quality of takeaway meals, there is an urgent need to determine  
92 the nutritional content of takeaway dishes. Therefore, the aim of the present study was to evaluate  
93 salt levels in popular hot takeaway meals from small, independent outlets in the Merseyside and  
94 Wirral region, UK.

## 95 **Materials and methods**

### 96 **Collection and analyses of takeaway meals**

97 For the purpose of this study, a takeaway meal was defined as food purchased from out of  
98 home food outlets or ordered for home delivery, which was ready for immediate consumption and  
99 not eaten in outlets. Takeaway meal samples were collected between December 2005 and January

100 2006 from small, independent takeaway establishments (Indian, Chinese, Kebab Shop, Pizza  
101 Shops and Fish & Chips Shops) within the Liverpool boundary by Liverpool City Council,  
102 Trading Standards and between July and September 2008 in Wirral Borough by Wirral  
103 Metropolitan Borough Council, Trading Standards Division. As part of the Trading Standards  
104 ongoing project work to investigate the nutritional quality of foods in their area, samples of  
105 takeaway food were collected from 215 outlets (140 and 75 from Wirral and Liverpool City  
106 Councils respectively). This is an approximate 50 and 20% representation of takeaway outlets  
107 from Wirral and Liverpool respectively (Evans, 2011; Liverpool City Council, 2011 – spoken  
108 data). A total of 411 samples of 23 different types of takeaway meals were purchased, with  
109 permission recently granted to the authors to use the data for publication. All meals were  
110 purchased once from each selected outlet.

111 All samples were frozen immediately after collection and stored frozen at  $-18^{\circ}\text{C}$  until  
112 analysis. Sodium concentration was determined by microwave acid ( $\text{HNO}_3$ ) digestion followed by  
113 inductively coupled plasma optical emission spectrometry (ICP-OES) (Kira, Maio, & Maihara,  
114 2004). Salt content was calculated from sodium concentration by multiplying by 2.542. The  
115 analysis was performed at Eurofins Laboratories Ltd, Chester, UK and Eurofins Laboratories Ltd,  
116 Birkenhead, Wirral, UK for Wirral and Liverpool Trading Standards respectively.

### 117 **Statistical analyses**

118 The data were analysed using SPSS version 17.0 (SPSS Inc., Chicago, IL, USA) and  $p <$   
119  $0.05$  was considered statistically significant. The adjusted significance level of  $0.004$  was used  
120 when multiple comparisons were made. The normality of distribution of analyzed variables was  
121 checked with histograms, Kolmogorov-Smirnov and Shapiro-Wilk tests. Due to non-normal  
122 distributions, data are expressed as medians with interquartile range ( $25^{\text{th}}$  and  $75^{\text{th}}$  percentiles).  
123 The takeaway meals were classified into five groups according to their origin: 1. Chinese meals,  
124 2. Indian meals, 3. English meals, 4. Pizzas, 5. Kebabs. Differences in salt levels between meal

125 categories and between different kinds of meals in the same category were tested with the use of  
126 the Kruskal-Wallis test and the Mann Whitney U-Test. Salt levels in takeaway meals were  
127 compared with the UK target of 6 g (Food Standards agency, UK, 2009).

## 128 **Results**

129 The median salt content in takeaway meal categories is shown in Table 1. Pizzas were  
130 characterised by the highest salt content per portion (9.45 g (6.97-12.83)), followed by Chinese  
131 meals (8.07 g (5.47-10.99g)), Kebabs (6.21 g (4.01-8.35)) and Indian meals (4.73 g (3.61-6.10)).

132 Chinese meals had the highest salt density (7.4 g / 1000 kcal (5.49-10.76)) amongst all  
133 analysed takeaway meal categories ( $p < 0.001$ ). The salt content in English takeaway foods was  
134 significantly lower ( $p < 0.001$ ) than the salt content in the other categories, and this was observed  
135 for comparisons made per 100 g, per portion and per 1000 kcal.

136 In addition, significant differences in the salt content between meals in the same category  
137 were reported (Table 2) emphasising the difference between the lowest and highest salt content  
138 between meals. Results showed, an overall significant difference within Chinese, Indian, English  
139 and Kebab meals with amount of salt per meal, salt per 1000 kcal and comparison with Food  
140 Standards Agency, UK, (2006) target ( $p < 0.05$ ); Chinese, Indian and English meals also showed  
141 significant differences between meals with salt per 100 g ( $p < 0.05$ ), Chinese, Indian and Kebab  
142 meals showed significant differences between portion sizes ( $p < 0.05$ ). Mann Whitney U tests  
143 revealed remarked differences in Chinese meals; sweet and sour chicken with boiled rice  
144 contained almost four times less salt than a meal of beef, green peppers and blackbean sauce with  
145 fried rice or chicken satay with fried rice ( $p < 0.005$ ). Furthermore, some Chinese meals contained  
146 more than three times the UK salt target, e.g. a single portion of beef and black bean with fried  
147 rice contained 27 g of salt and a single portion of prawn chow mein contained 21 g of salt per  
148 portion (Figure 1). This pattern was similar for Indian takeaway meals, where a portion of chicken  
149 tikka massalla with keema rice had a salt concentration approximately 50% higher in comparison



150 with the other Indian meals ( $p < 0.005$ ); however, the salt level did not vary significantly between  
151 pizzas (regardless of the different toppings). It is important to note that the median portion size  
152 for Chinese meals was significantly higher, than English, pizza and kebab meals ( $p < 0.001$ )  
153 (Table 1, Figure 2) which could account for the higher levels of salt in the above mentioned  
154 Chinese meals.

155 None of the 23 analysed takeaway meal types contained less than one third of the UK salt  
156 target of 6 g per day (Food Standards Agency, UK, 2009), and the average meals provided from  
157 37 to 216% of this target (Table 2). The median salt content per 100 g of different kinds of pizzas  
158 and kebabs substantially exceeded the 2010 Food Standards Agency targets for recommended salt  
159 level of 1.2 g per 100 g for pizzas and 1 g per 100 g for kebabs (Food Standards Agency, UK,  
160 2006). Similarly, the median salt content of only one of the Chinese meals contained less than 0.6  
161 g of salt per 100 g, the UK target for meat based takeaways (Food Standards Agency, UK, 2006),  
162 but at the same time four other Chinese meals had a salt level almost 200% higher than this target.  
163 The median salt content per 100 g met the Food Standards Agency (UK, 2006) criteria for English  
164 takeaway meals only (0.5 g per 100 g); however, due to extremely large portion sizes (748 g (653-  
165 837)) (Table 2; Figure 2) meals supplied an excess amount of salt, for example chicken and chips  
166 contained 2.20 g (1.79-3.18); fish and chips 3.0 g (2.41-4.77); and mushroom omelette and chips  
167 3.77 g (2.16-5.55)).

## 168 **Discussion**

169 The results of the present study indicate a very high level of salt in hot takeaway meals in  
170 the UK. It was observed that a single portion of an average takeaway meal contained more than  
171 half of the Food Standards Agency, UK, (2009) target of 6 g per day of salt, with some meals  
172 providing more than 200%. In addition, 60% of the analysed meals were characterised by  
173 extremely high salt density, and provided about 6 g of salt per 1000 kcal. It should also be noted  
174 that chips were analysed without added salt, therefore it can be expected that the salt

175 concentration in English meals may be higher, as many people add salt to chips (North & Neale,  
176 1995).

177 Although no current data exist regarding salt content in takeaway foods purchased from  
178 small independent outlets in the UK, a high salt level in other popular out of home meals seems to  
179 be common in other countries. Lachat et al. (2009) reported in Belgium that a typical lunch  
180 purchased from various catering establishments or from university canteens contained about 3.1 g  
181 of salt. Similarly, a recent Denmark study of canteen and fast food meals found salt content  
182 ranged from 8.2 to 11.3 g per portion of pizza, and an average hot meal eaten out of home  
183 provided 4.3 g of salt (Rasmussen et al., 2010). These findings were also in agreement with the  
184 results of Johnson et al. (2010) who, based on information posted on company web sites, analysed  
185 a nutritional profile of lunchtime fast food from major US fast food chains. The average pizza  
186 contained more than 6 g of salt per portion with a mean salt density of 5 g per 1000 kcal.

187 Salt and other sodium containing seasonings are ubiquitous components of diets around  
188 the world and many people believe that salt enhances the palatability of foods (Mattes, 1997).  
189 Some studies indicated that salt may possess addictive properties, and it has been reported that  
190 salt taste preferences are highly dependent on the salt level in the diet (Tekol, 2006). It can be  
191 suggested that continuous exposure to salty foods may alter the salt taste preferences and lead to  
192 the overconsumption of sodium. Kim et al. (2009) observed that Korean adolescents who were  
193 more likely to visit fast food establishments had a significantly higher preference for salt taste.

194 Due to both high sodium concentration and high sodium density, takeaway foods may  
195 significantly contribute to daily sodium intake from just a single meal. The results of a study by  
196 Clemens et al. (1999) showed that women who reported eating out of home more than six times  
197 during the week had significantly higher sodium intake than individuals who ate away from the  
198 home less frequently. Findings were similar among US adults and children where fast food

199 consumption was associated with significantly higher sodium intake ((Paeratakul, Ferdinand,  
200 Champagne, Ryan, & Bray, 2003; Haines, Hungerford, Popkin, & Guilkey, 1992).

201 It has been reported that lowering of salt intakes by only 10% has resulted in an  
202 approximated reduction of 6000 CVD related deaths in the UK, which has had a substantial  
203 impact on the UK economy with a saving of approximately £1.5 billion per annum (NICE, 2010).  
204 However, considering that about 80% of daily salt intake comes from processed foods and food  
205 eaten away from the home (Gilbert & Heiser, 2005; He et al., 2010), personal effort to reduce the  
206 sodium level in the diet may be disrupted by high salt concentration in commercial food (Brown  
207 et al, 2009). Therefore, only limited progress in the reduction of salt intake in populations can be  
208 made without changes in the salt level in commercially produced foods. Reduction of salt content  
209 in many food products in the order of 20 – 30% can be made without affecting the sensory  
210 acceptability and can remain unnoticed by the consumer (Dötsch et al., 2009). Therefore, a  
211 strategy of repetition of small reductions may be one effective tool for reducing salt intakes. In  
212 2003, the UK Food Standards Agency began a programme to reduce the average salt intake of  
213 adults to 6 g per day by encouraging all sectors of the food industry to carry out reformulation  
214 work to reduce the salt content in their food products (Food Standards Agency, UK, 2010). The  
215 Food Standards Agency has developed targets for salt levels of various categories of food (Food  
216 Standards Agency, UK, 2006) and the revision of programme progress has shown that retailers,  
217 manufacturers, trade associations, caterers and suppliers to the catering industry have undertaken  
218 a significant amount of work to reduce the amount of salt added to foods during processing  
219 (Wyness et al, 2011; Shankar et al, 2012). While the UK's major catering chains see advantages  
220 of salt reduction and have declared collaboration, unfortunately there is no interest from small,  
221 independent catering outlets and none of them have joined the project (Food Standard Agency,  
222 UK, 2007). However, the current study showed that takeaway meals from small establishments  
223 were characterised by extremely high salt content. In addition, it seems that there are no standard

224 procedures of food preparation in the small outlets as variability in the salt level across the same  
225 kind of meals have been found to be very high. As takeaway meals from these types of outlets are  
226 increasing in popularity (Mintel, 2009) and may be an important contributor to daily sodium  
227 intake for a substantial percentage of the population, a different government programme to  
228 encourage the reduction of salt levels in food prepared in the private catering sector is needed. As  
229 voluntary guidelines regarding salt reduction do not result in adequate changes, some statutory  
230 regulation to lower salt concentration in takeaway foods should be considered. The fact that salt is  
231 a cheap ingredient which can make food palatable at a very small cost may be one of reasons why  
232 the private catering sector are reluctant to cooperate (Food Standard Agency, UK, 2010). It also  
233 seems to be a fundamental issue in that small takeaway outlets should be provided training to  
234 improve food preparation procedures and nutritional knowledge of staff. Additionally, a possible  
235 strategy is the introduction of convenient and clear labels indicating salt content in takeaway  
236 meals. However, labelling the food products or menu with only the amount of nutrients and  
237 without any explanation leaves the responsibility of choosing the proper food products with the  
238 consumer and relies on their nutritional knowledge. Therefore, nutritional labelling may not  
239 always be associated with desirable dietary changes. For example, Hoefkens et al. (2011) found  
240 that posting of nutrition information in university canteens did not effectively improve the  
241 nutritional quality of chosen meals. Similarly, the EATWELL project (Interventions to Promote  
242 Healthy Eating Habits: Evaluation and Recommendations) reported that posting point of purchase  
243 nutrition information had no effect on food choice (Brambila-Macias et al., 2011; Bhavani et al.,  
244 2012).

245 A different approach of labelling has been issued in Finland (Pietinen, Valsta, Hirvonen, &  
246 Sinkko, 2007). Food products must contain a 'high salt product' warning if salt content exceeds a  
247 maximum limit. If the salt level meets a set low salt limit, products may be voluntary marked as  
248 'low salt product'. This approach makes it easier for the consumer to make proper choices even if

249 they are not sure about recommended daily salt intake, as they may use only ‘low salt product’ or  
250 ‘high salt product’ information.

251 The most effective strategy to reduce salt intake in populations should involve changes in  
252 the food environment, recipe reformulations, altering the food preparation process and consumer  
253 education. Recent studies from Australia (Grimes, Riddell, & Nowson, 2009) and UK (Food  
254 Standard Agency, UK, 2007) indicated that less than 50% of participants were concerned about  
255 the amount of salt in their diet and only 5% of them were able to correctly identify the current  
256 recommended daily salt intake (Grimes, Riddell, & Nowson, 2009).

### 257 **Conclusion**

258 The present study is one of the first designed to evaluate the salt content in hot takeaway  
259 meals from small independent outlets in the UK, and obtained results show that salt concentration  
260 in these kinds of food is alarmingly high. To enable the UK population to meet the recommended  
261 daily salt intake a significant reduction in the salt content of hot takeaway meals should be  
262 considered.

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267

### 268 **References**

269 Anderson, C. A., Appel L. J., Pkuda N, Brown I. J., Chan Q., Zhao L., et al. (2010). Dietary  
270 sources of sodium in China, Japan, the United Kingdom, and the United States, women and men  
271 aged 40 to 59 years: the INTERMAP study. *Journal of the American Dietetic Association*, 110(5),  
272 736–745.

- 273 Bhavani, V., W., Pérez-Cueto, F., Koziół-Kozakowska, A., Piorecka, Beata., Niedzwiedzka, B.,  
274 D'Addesa, D., et al. (2012). Policies to promote healthy eating in Europe: A structured review of  
275 instruments and their effectiveness. *Nutrition Reviews*, 70(3), 188-200.
- 276 Brambila-Macias, J., Shankar, B., Capacci, S., Mazzocchi, A., Perez-Cueto, A., Verbeke W., et al.  
277 (2011). Policy interventions to promote healthy eating: A review of what works, what does not,  
278 and what is promising. *Food and Nutrition Bulletin*. 32(4), 365-375.
- 279 Brown, I. J., Tzoulaki, I., Candeias, V., & Elliott, P. (2009). Salt intakes around the world:  
280 implications for public health. *International Journal of Epidemiology*, 38(3), 791-813.
- 281 Clemens, L. H., Slawson, D. L., & Klesges, R. C. (1999). The effect of eating out on quality of  
282 diet in premenopausal women. *Journal of the American Dietetic Association*, 99(4), 442-444.
- 283 Dötsch, M., Busch, J., Batenburg, M., Liem, G., Tareilus, E., Mueller, R., et al. (2009). Strategies  
284 to reduce sodium consumption: a food industry perspective. *Critical reviews in food science and*  
285 *nutrition*, 49(10), 841-851.
- 286 Evans, E. (2011) Takeaway food a briefing paper. Heart of Mersey, UK.
- 287 Food Standard Agency. (2006). Salt reduction Targets. Accessed 27 July 2011. Available at  
288 <http://www.food.gov.uk/multimedia/pdfs/salttargetsapril06.pdf>
- 289 Food Standard Agency. (2007). Consumer attitudes to food standards. Accessed 27 July 2011.  
290 Available at <http://www.food.gov.uk/science/socsci/surveys/foodsafety-nutrition-diet/eighthcas>
- 291 Food Standards Agency. (2009). Agency publishes 2012 salt reduction targets. Accessed 27 July  
292 2011. Available at <http://www.food.gov.uk/news/newsarchive/2009/may/salttargets>
- 293 Food Standard Agency. (2010) UK salt reduction initiatives. Accessed 27 July 2011. Available at  
294 <http://www.food.gov.uk/multimedia/pdfs/saltreductioninitiatives.pdf>
- 295 Gilbert, P. A., & Heiser, G. (2005) Salt and health: the CASH and BPA perspective. *Nutrition*  
296 *Bulletin*.30, 62-69.

- 297 Grimes, C. A., Riddell, L. J., & Nowson, C. A. (2009). Consumer knowledge and attitudes to salt  
298 intake and labelled salt information. *Appetite*, 53(2), 189-194.
- 299 Guthrie, J. F., Lin, B. H., & Frazao, E. (2002) Role of food prepared away from home in the  
300 American diet, 1977-78 versus 1994-96: changes and consequences. *Journal of Nutrition*  
301 *Education Behaviour*, 34(3), 140-150.
- 302 Haines, P. S., Hungerford, D. W., Popkin, B. M., & Guilkey, D. K. (1992). Eating patterns and  
303 energy and nutrient intakes of US women. *Journal of the American Dietetic Association*, 92(6),  
304 698–704.
- 305 Henderson, L., Irving, K., Gregory, J., Bates, Ch. J., Prentice, A., Perks, J. et al. (2003) *National*  
306 *Diet and Nutrition Survey: Adults Aged 19 to 64 Years. Volume 3: Vitamin and Mineral Intake*  
307 *and Urinary Analytes*. The Stationery Office, London.
- 308 He, F. J., & MacGregor, G. A. (2010a) Reducing population salt intake worldwide: from evidence  
309 to implementation. *Progress in Cardiovascular Diseases*, 52(5), 363-382.
- 310 He, F. J., & MacGregor, G. A. (2010b) WASH-world action on salt and health. *Kidney*  
311 *International*, 78(8), 745-753.
- 312 Hoefkens, C, Lachat, C., Kolsteren, P., Van Camp, J., & Verbeke, W. Posting point-of-purchase  
313 nutrition information in university canteens does not influence meal choice and nutrient intake.  
314 *American Journal of Clinical Nutrition*, 94(2), 562-70.
- 315 Johnson, C. M., Angell, S. Y., Lederer, A., Dumanovsky, T., Huang, C., Bassett, M. T. et al.  
316 (2010) Sodium content of lunchtime fast food purchases at major US chains. *Archives of Internal*  
317 *Medicine*, 170(8), 732-734.
- 318 Kim, G. H., & Lee, H. M. (2009) Frequent consumption of certain fast foods may be associated  
319 with an enhanced preference for salt taste. *Journal of Human Nutrition and Dietetics*, 22(5),  
320 475—480.

- 321 Kira, C., S., Maio, F., D., & Maihara, V., A. (2004). Comparison of partial digestion procedures  
322 for determination of Ca, Cr, Cu, Fe, K, Mg, Mn, Na, P, and Zn in milk by inductively coupled  
323 plasma-optical emission spectrometry. *Journal of AOAC International*, 87(1), 151-156.
- 324 Lachat, C. K., Huybregts, L. F., Roberfroid, D. A., Van Camp, J., Remaut-De Winter, A. M.,  
325 Debruyne, P., et al. (2009). Nutritional profile of foods offered and consumed in a Belgian  
326 university canteen. *Public Health Nutrition*, 12(1), 122-128.
- 327 Mattes, R. D. (1997). The taste for salt in humans. *American Journal of Clinical Nutrition*, 65(2  
328 Suppl), 692S-697S.
- 329 Mintel Report. (2009). Ethnic Cuisine – UK. Accessed 27 July 2011. Available at  
330 [http://academic.mintel.com/sinatra/oxygen\\_academic/search\\_results/show&/display/id=393883](http://academic.mintel.com/sinatra/oxygen_academic/search_results/show&/display/id=393883)
- 331 Mohan, S., & Campbell, N. R. (2009). Salt and high blood pressure. *Clinical Science (London,*  
332 *England:1979,)* 117(1), 111.
- 333 Nagata, C., Takatsuka, N., Shimizu, N., & Shimizu, H. (2004). Sodium intake and risk of death  
334 from stroke in Japanese men and women. *Stroke*, 35(7), 1543-1547.
- 335 National Centre for Social Research and Medical Research Council. (2008). *An assessment of*  
336 *dietary sodium levels among adults (19-64) in the U.K. General Population in 2008 Based on*  
337 *Analysis of 24 hour Urine Samples*. London: TSO.
- 338 National Institute for Health and Clinical Excellence (2010) Prevention of Cardiovascular Disease  
339 at Population Level. NICE Public Health Guidance 25. Accessed 20 April 2012. Available at  
340 <http://guidance.nice.org.uk/PH25>
- 341 Ni Mhurchu, C., Capelin, C., Dunford, E. K., Webster, J. L., Neal, B. C., & Jebb, S. A. (2011).  
342 Sodium content of processed foods in the United Kingdom: analysis of 44,000 foods purchased  
343 by 21,000 households. *American Journal of Clinical Nutrition* 93(3), 594-600



- 344 Nielsen AC (2005) Consumers in Europe – Our Fast Food / Takeaway Consumption Habits, 2nd  
345 Half, October 2004. AC Nielsen Online Consumer Survey, AC Nielson. Available at:  
346 <http://ie.nielsen.com/pubs/documents/EuroFastFoodDec04.pdf>
- 347 North, S. L., & Neale, R. J. (1995). Knowledge, attitudes and eating habits of teenagers with  
348 respect to salt in their diet. *British Food Journal*, 97(5), 3-11.
- 349 Paeratakul, S., Ferdinand, D. P., Champagne, C. M., Ryan, D. H., & Bray, G. A. (2003) Fast-food  
350 consumption among US adults and children: dietary and nutrient intake profile. *Journal of the*  
351 *American Dietetic Association*, 103(10), 1332–1338.
- 352 Pietinen, P., Valsta, L.M., Hirvonen, T., & Sinkko, H. (2007). Labelling the salt content in foods:  
353 a useful tool in reducing sodium intake in Finland. *Public Health Nutrition*, 11(4), 335–340.
- 354 Rasmussen, L. B., Lassen, A. D., Hansen, K., Knuthsen, P., Saxholt, E., & Fagt S. (2010). Salt  
355 content in canteen and fast food meals in Denmark. *Food and Nutrition Research*, 54, doi:  
356 10.3402/fnr.v54i0.2100.
- 357 Scientific Advisory Committee on Nutrition. (2003). *Salt and health*. London: TSO
- 358 Tekol, Y. (2006) Salt addiction: a different kind of drug addiction. *Medical Hypotheses*. 67(5),  
359 1233-1244.
- 360 Shankar B, Brambila-Macias J, Traill B, Mazzocchi M, Capacci S (2012). An evaluation of the  
361 UK Food Standard Agency’s salt campaign. *Health Economy*. doi: 10.1002/hec.2772. [Epub  
362 ahead of print]
- 363 Tuomilehto, J., Jousilahti, P., Rastenyte, D., Moltchanov, V., Tanskanen, A., Pietinen, P., et al.  
364 (2001) Urinary sodium excretion and cardiovascular mortality in Finland: a prospective study.  
365 *Lancet*, 357(9259), 848-851.
- 366 Webster, J. L., Dunford, E. K., Neal, B. C. (2010). A systematic survey of the sodium contents of  
367 processed foods. *American Journal of Clinical Nutrition*, 91(2), 413-420.

368 Wyness, L. A., Butriss, J. L., Stanner, S. A. (2011). Reducing the population's sodium intake: the  
 369 UK Food Standards Agency's salt reduction programme. *Public Health Nutrition*, 15(2), 254-261.

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373 Table 1 Salt content in analyzed take away meals by meal category

Meal Category*	Weight <sup>†</sup>	Salt <sup>†</sup>	Salt <sup>†</sup>	Salt <sup>†</sup>	Salt <sup>†</sup>
	g per meal	g per 100g	g per meal	g per 1000 kcal	%FSA <sup>†</sup>
Chinese (n=92)	852 (728-947) <sup>c,d,e</sup>	0.99 (0.70-1.37) <sup>b,c,d</sup>	8.07 (5.47-10.99) <sup>b,c</sup>	7.40 (5.49-10.76) <sup>b,c,d</sup>	134 (91-183) <sup>b,c</sup>
Indian (n=95)	803 (731-864) <sup>d,e</sup>	0.61 (0.46-0.79) <sup>a,c,d,e</sup>	4.73 (3.61-6.10) <sup>a,c,d</sup>	3.61 (2.59-4.85) <sup>a,c,d,e</sup>	79 (60-102) <sup>a,c,d</sup>
English (n=95)	748 (653-837) <sup>a,e</sup>	0.41 (0.30-0.59) <sup>a,b,d,e</sup>	3.01 (2.23-4.48) <sup>a,b,d,e</sup>	1.86 (1.33-2.79) <sup>a,b,d,e</sup>	50 (37-75) <sup>a,b,d,e</sup>
Pizzas (n=54)	676 (559-781) <sup>a,b,e</sup>	1.47 (1.17-1.70) <sup>a,b,c,e</sup>	9.45 (6.97-12.83) <sup>b,c,e</sup>	5.28 (4.04-6.08) <sup>a,b,c</sup>	157 (116-214) <sup>b,c</sup>
Kebabs (n=75)	505 (436-711) <sup>a,b,c,d</sup>	1.09 (0.89-1.40) <sup>b,c,d</sup>	6.21 (4.01-8.35) <sup>c,d</sup>	5.08 (3.98-7.99) <sup>a,b,c</sup>	103 (67-139) <sup>c,d</sup>

374 n = total number of meals; \* data presented as median (interquartile range).

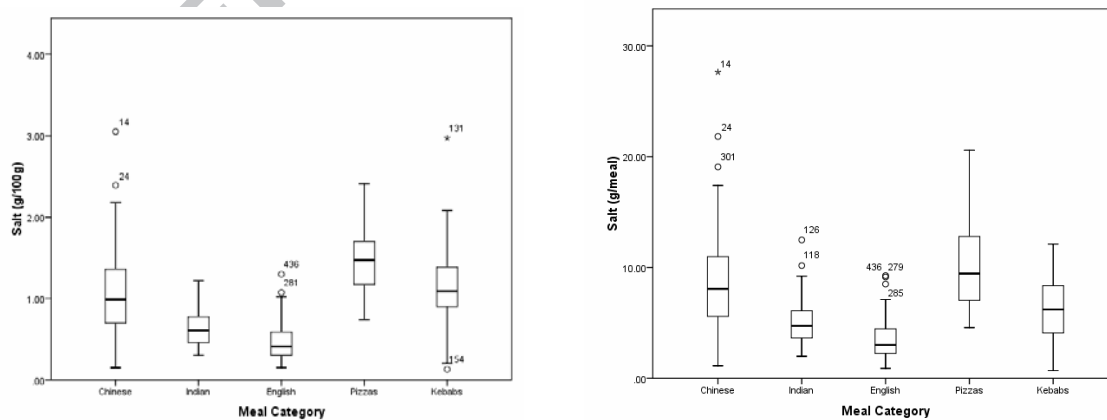
375 <sup>†</sup> Significant difference between all meal categories ( $p < 0.001$ ; Kruskal-Wallis test).

376 Significant difference ( $p < 0.001$ ; Mann-Whitney's test) of paired comparison of meal categories <sup>a</sup> Chinese; <sup>b</sup> Indian; <sup>c</sup> English; <sup>d</sup>  
 377 Pizzas; <sup>e</sup> Kebabs.

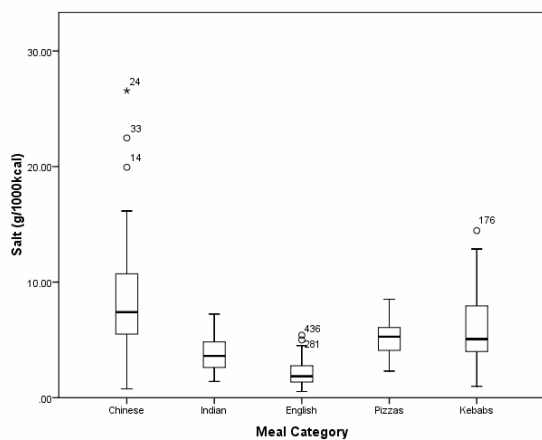
378 <sup>†</sup> FSA target, 6 g salt per day (Food Standards Agency, UK, 2009)

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380 Figure 1 Variation in salt content in different meal categories

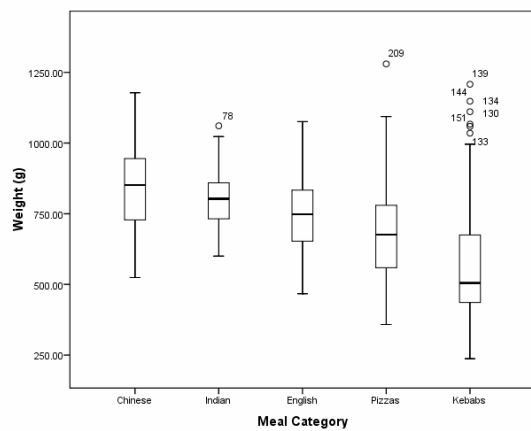


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383 Figure 2 Variation in portion size for different meal categories



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Table 2 Salt content in different types of takeaway meals

Meal type*	<i>n</i>	Weight g per meal	Salt g per 100g	Salt g per meal	Salt g per 1000 kcal	Salt %FSA <sup>†</sup>
<b>Chinese</b> <sup>i,ii,iii,iv,v</sup>						
Beef green peppers and blackbean sauce with fried rice	31	915 (871-1013) <sup>a</sup>	1.19 (0.91-1.50) <sup>a,b</sup>	10.72 (8.13-13.88) <sup>a,b</sup>	7.88 (6.04-10.8) <sup>a,b</sup>	179 (136-231) <sup>a,b</sup>
Prawn chow mein	21	679 (584-834)	1.12 (0.80-1.51) <sup>a,b</sup>	7.88 (5.58-9.99) <sup>a</sup>	11.97 (7.65-14.99) <sup>a,b</sup>	131 (93-167) <sup>a</sup>
Sweet and sour chicken with boiled rice	10	766 (744-868)	0.37 (0.27-0.49)	3.13 (1.83-3.76)	2.19 (1.65-2.52) <sup>b</sup>	52 (31-63)
Char siu chow mein	10	716 (680-848)	1.05 (0.97-1.25) <sup>a</sup>	8.07 (7.18-8.46) <sup>a</sup>	8.29 (6.37-10.37) <sup>a</sup>	134 (120-141) <sup>a</sup>
Chicken satay with fried rice	10	891 (781-1063)	1.04 (0.81-1.51) <sup>a,b</sup>	10.3 (7.53-13.38) <sup>a,b</sup>	7.12 (6.04-10.39) <sup>a</sup>	172 (125-223) <sup>a,b</sup>
Kung po king prawns with boiled rice	10	882 (794-931)	0.62 (0.39-0.85)	5.45 (3.51-7.37)	5.42 (3.14-6.63) <sup>a</sup>	91 (59-123)
<b>Indian</b> <sup>i,ii,iii,iv,v</sup>						
Lamb bhuna with chips	22	745 (714-830)	0.51 (0.38-0.65) <sup>c</sup>	4.12 (3.10-5.14) <sup>c</sup>	2.53 (1.84-3.37) <sup>c,d</sup>	69 (52-86) <sup>c</sup>
King prawn rogan josh with pilau rice	22	772 (701-828)	0.59 (0.48-0.74) <sup>c</sup>	4.20 (3.44-6.08) <sup>c</sup>	4.93 (3.57-5.97)	70 (57-101) <sup>c</sup>
Chicken tikka massalla with keema rice	21	808 (746-872)	0.81 (0.70-0.97)	6.68 (5.64-8.18)	4.22 (3.75-5.68)	111 (94-136)
Lamb rogan josh with pilau rice	10	758 (719-857)	0.46 (0.37-0.57) <sup>c</sup>	3.49 (2.78-5.23) <sup>c</sup>	2.81 (2.05-3.16) <sup>c,d</sup>	58 (46-87) <sup>c</sup>
Chicken korma with pilau rice	10	869 (819-923)	0.45 (0.37-0.54) <sup>c,d</sup>	3.81 (3.18-4.35) <sup>c,d</sup>	2.54 (1.98-2.95) <sup>c,d</sup>	64 (53-72) <sup>c,d</sup>
Vegetable biryani	10	834 (747-910)	0.69 (0.55-0.78)	5.63 (4.77-6.47)	4.11 (3.55-5.62)	94 (79-108)
<b>English</b> <sup>ii,iii,iv,v</sup>						
Chicken and chips	22	714 (641-847)	0.35 (0.22-0.44)	2.20 (1.79-3.18)	1.47 (0.98-1.99)	37 (30-53)
Fish and chips	52	745 (654-793)	0.43 (0.33-0.63)	3.00 (2.41-4.77)	1.90 (1.51-2.86)	50 (40-80)
Mushroom omelette and chips	21	783 (662-917)	0.48 (0.31-0.66)	3.77 (2.16-5.55)	2.51 (1.53-3.16)	63 (36-92)
<b>Pizzas</b> <sup>f</sup>						
Pepperoni pizza	11	770 (646-864)	1.65 (1.14-1.88)	12.94 (7.26-13.82)	5.79 (3.85-6.20)	216 (121-230)
Seafood pizza	11	765 (690-971)	1.32 (0.99-1.83)	11.09 (8.66-13.62)	5.28 (3.87-7.29)	185 (144-227)
Margherita pizza	12	674 (575-740)	1.40 (1.06-1.70)	8.83 (6.63-10.81)	4.75 (3.43-5.58)	147 (110-180)
Ham and pineapple pizza	10	558 (497-605)	1.44 (1.21-1.57)	7.72 (5.37-9.75)	5.39 (4.48-6.15)	129 (89-163)
Meat pizza	10	641 (554-767)	1.46 (1.26-1.57)	8.59 (7.44-10.57)	5.14 (4.41-5.55)	143 (124-176)
<b>Kebabs</b> <sup>i,iii,iv,v</sup>						
Donner kebab and chips	32	751 (561-979)	1.07 (0.84-1.22)	7.50 (5.90-9.71)	4.02 (3.48-4.75)	125 (98-162)
Chicken kebab	22	481 (436-539) <sup>c</sup>	1.15 (0.91-1.42)	5.94 (3.95-7.27)	7.55 (5.19-9.31) <sup>e</sup>	99 (66-121)
Shish kebab	21	386 (334-478) <sup>c</sup>	1.17 (0.91-1.51)	4.27 (3.47-5.99) <sup>c</sup>	7.12 (5.61-8.95) <sup>e</sup>	71 (58-100) <sup>e</sup>

*n* = number of meals; \* data presented as median (interquartile range).

Significant difference within meal categories ( $p < 0.05$ ; Kruskal Wallis test):

<sup>i</sup>Weight (g per meal); <sup>ii</sup>salt (g per 100 g); <sup>iii</sup>salt (g per meal); <sup>iv</sup>salt (g per 1000 kcal); <sup>v</sup>salt %FSA.

Significant difference between meal types within the same meal category ( $p < 0.004$ ; Mann-Whitney's test):

Chinese: <sup>a</sup>Sweet and sour chicken with boiled rice; <sup>b</sup>Kung po king prawns with boiled rice; Indian; <sup>c</sup>Chicken tikka massalla with keema rice; <sup>d</sup>Vegetable biryani; Kebabs: <sup>e</sup>

Donner kebab and chips (only statistically significant results were marked)

<sup>†</sup> target, 6 g salt per day (Food Standards Agency, UK, 2009)

## Determination of salt content in hot takeaway meals in the United Kingdom

### Highlights

► high sodium intake is associated with numbers of negative health outcomes ► pizzas had the highest salt concentration per portion, followed by Chinese meals ► significant differences in salt content between meals in the same category were found ► results show that salt concentration in takeaway food is alarmingly high

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