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A Systematic Cross-Sectional Analysis of British Based Celebrity Chefs' Recipes: Is There Cause for Public Health Concern?

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Abstract A comprehensive nutritional assessment was conducted on Celebrity Chefs recipes, with comparison against national healthy eating guidelines. Food preparation recipes (n=904), covering a wide range of meal types, from 26 dominant British based Celebrity Chefs were randomly sampled from literature and web sources. Recipes were blindly analysed through dietary analysis software by three trained dietetic researchers (CV 6.9%). The nutritional value of each recipe was compared against national healthy eating benchmark guidelines using a healthy eating index (HEI). Overall average energy, protein, total carbohydrate and total fat per suggested portion was 2.3MJ, 25g, 44g and 31g, respectively; with differences observed between Celebrity Chefs ($P<0.001$). The overall average recipe composition of n=22 Celebrity Chefs presented high fat, n=24 high SFA, n=17 high sugars and n=7 high salt content. Negative HEI was observed in 87% of recipes. Male and British originated Celebrity Chefs presented higher nutritional variables than Female ($P<0.001$) and International originated ($P<0.001$) Celebrity Chefs, respectively. The nutritional values of British based Celebrity Chefs recipes, in adjunct with their likely influence on food preparation habits of the public, suggest Celebrity Chefs are a likely hidden contributing factor to Britain's obesity epidemic and its associated public health issues.

Keywords Healthy Eating, Food, Recipes, Energy, Fats, Saturated Fat, Salt, Sugar, Chefs

1. Introduction

In Britain, a Celebrity Chef is described as a professional cook who uses media sources to publicise their professional cooking activities. Since the first Celebrity Chef appeared on British television in the 1940's, the number of professional cooks claiming to be a Celebrity Chef has risen substantially, exposing themselves through a plethora of multi-media sources and tagging alongside well-known food/beverage brands in collaborative marketing strategies. It has previously been suggested that Celebrity Chefs may influence food preparation habits of their targeted population. Their cookery books, television programmes and websites are accessible sources of recipe information for consumers wishing to improve their cookery knowledge and skills[1].

Even though the link between Celebrity Chefs, food preparation habits and subsequent nutritional intake of a population has not been clearly identified; exposure to food advertisement in the multi-media and unhealthy dietary behaviours has clearly been established, albeit being predominantly observed in children[2-5]. It is, however, plausible that extensive exposure to Celebrity Chef products may predispose certain individuals to adhere to Celebrity Chef culinary and nutritional messages. Indeed, anecdotal evidence has shown that 79% of a convenience sampling cohort acknowledged watching Celebrity Chef television programs frequently, whilst 74% acknowledged owning Celebrity Chef cookery books and/or accessing websites. Moreover, 60% reported using recipes from these sources frequently[6]. Interestingly, consumers respect and are widely accepting of information regarding nutrition and healthy eating messages from Celebrity Chefs, provided it is presented in an innovative and interesting manner[1]. For example, >75% of a general population cohort believe Celebrity Chefs promote healthy eating and that their divulged recipes are healthy[6]. Not only does this highlight the potential influence Celebrity Chefs have on consumers food choices and subsequent nutritional intake of the respective population, but also the capability to influence nutrition related public health issues; such as obesity and associated cardiometabolic risk factors linked with the pathophysiology of cardiovascular diseases (CVD) and type

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2 diabetes mellitus (DM)[7-9]. This may be of prime concern, considering the majority of Celebrity Chefs are not trained or qualified/registered in dietetics or nutrition, nor recruit qualified/registered nutritional professionals to support evidence based nutritional knowledge and skill transfer. Currently there are no regulations on what Celebrity Chefs can present in regards to nutrition or healthy eating messages, with the nutritional value of recipes presented through multimedia sources generally being absent. Similar attitudes are seen with food and beverage advertising on television, with aggressive promotion of sales material without giving consumers informed choice[10,11].

It is unfortunate that a systematic nutritional assessment of Celebrity Chefs' recipes is lacking. Indeed, only one report exploring this issue is currently available[12], which focused primarily on the saturated fatty acids (SFA) content of a small number of Celebrity Chefs' recipes (n=16). Nevertheless, substantially high amounts of SFA were observed in all recipes[13]. Moreover, one recent study also explored this issue, similarly using a small number of recipes (n=100), limiting the assessment to only four Celebrity Chefs, limiting meal types to selective main meals only, and the focus was on comparing recipes with supermarket ready-meals; thus not giving a thorough overview of the variety of Celebrity Chefs and meal types consumers can access[14]. Authors did however report high levels of total fat, SFA, sugars and salt in certain recipes. It is well established that the excessive intake of these nutrients are contributing factors for the development of obesity and associated cardiometabolic risk factors[15-17]. Furthermore, consumption of meals rich in total fat and SFA *per se*, not only contributes towards appetite dysregularity[18-20], but also contributes to promoting a positive energy and lipid balance, and subsequent increased adiposity, especially visceral adiposity[21-23]. This is especially relevant for sedentary populations, who have limited fat oxidative capacity[24,25]. Such tissue has the ability to release metabolic factors (e.g. increased proinflammatory profile) which are prime mechanisms in the pathophysiology of atherosclerosis, thrombosis, and insulin resistance[9,26,27]. Conversely, consuming meals rich in wholegrains, fruits, vegetables, monounsaturated fatty acids (MUFA), marine based omega-3 polyunsaturated fatty acids (PUFA), and low in total fats, SFA, trans-fats (TFA), omega-6 PUFA, added sugars and salt is recommended as part of the cardiometabolic protective diet shown to reduce risk factors that promote the development and exacerbation of processors involved in the progression of CVD and DM[28-32].

Due to the increase in obesity and its associated complications in Britain, various national healthy eating policies and initiatives have sprung, originating from the WHO 2003 '*Diet, Nutrition, and the Prevention of Chronic Disease*' report[7,33]. Current national policies/initiatives, such as, '*Choosing Health*', '*5 a Day*', '*Eat Less Salt*' and '*Change4Life*', all focus on promoting positive dietary behaviours aimed at reducing obesity rates and subsequent disease risk. It is evident that Celebrity Chefs have been involved in promoting and delivering some of these policies/initiatives and have thus attained the public's trust and confidence in regard to adhering to healthy eating behaviours. However, their recipes may portray a different story. With this in mind, the aims the current study were to analyse the nutritional composition of British based Celebrity Chefs' recipes, and compare the nutrient content of these recipes with national benchmark recommendations for certain nutrients and healthy eating guidelines.

2. Methods

After gaining local ethical approval from Coventry University's Faculty of Health and Life Sciences Ethics Committee, the nutritional composition of recipes from 26 Celebrity Chefs with multi-media exposure were analysed. A Celebrity Chef (CC) was defined as a professional cook whose recipe book/s appeared on the '*Top one hundred bestselling books of 2009*' list (www.amazon.co.uk, 2010), or who featured on the '*Good Food Channel's*' (2010) website list recognised as a '*Celebrity Chef*'. Those Celebrity Chefs who targeted their recipes at a specific population (e.g. children, elderly and/or weight management), disease state or fad diet were excluded, since the current study focused on identifying the nutritional composition of Celebrity Chefs' recipes intended for use by the general public. To comply with ethical and professional practice, maintaining the anonymity of included Celebrity Chefs was honoured by assigning a code number to each individual Celebrity Chef.

In total, 904 recipes had their nutritional content analysed, which represented 25% of total recipes from each book source and a total of 40 recipes from each selected website source. To ensure the sample was representative, stratified random sampling was used. Initially, recipes were categorised into various meal type sub-groups, namely breakfast, lunch, starter, evening meal or dessert. The required number of recipes to analyse from each meal type sub-group was calculated for the book sources by multiplying 0.25 by the total number of recipes in the particular meal type sub-group. For the website sources, it was decided a set number of recipes would be analysed (10 breakfast, 10 starter, 10 evening meal, and 10 dessert recipes) because of the wide variation in the number of recipes on each of the Celebrity Chefs' websites. Once the sample size was determined, each recipe within the meal type sub-group was numbered, based on the order of appearance in the book or on the website. A random number generator (www.randomizer.org) was used to produce sets of random numbers. The random numbers were then matched with the numbered recipes in each sub-group, identifying which recipes were to be analysed.

The total energy, protein, carbohydrate (of which complex carbohydrate, simple carbohydrate, NMES and dietary fibre), fat (of which SFA, MUFA, PUFA and TFA), sodium and salt content were determined for each recipe, by a trained dietetic researcher, who entered the ingredients list into Dietplan nutritional analysis program (v6.60, Forestfield Software, Horsham, West Sussex, UK). To improve the reliability of the dietary analysis, 10% of randomly selected Celebrity Chefs recipes were blindly analysed by two trained dietetic researchers. The overall mean inter-observer coefficiency of variation for energy and nutrient variables analysed was 6.9%.

Prior to nutritional analysis, to ensure the weight/volume of ingredients were standardised when the recipe description did not provide this information, a validated portion sizes resources was used to confirm an average weight[34]. Prior to data analysis, raw data from the nutritional analysis was coded into a spreadsheet and characteristics of the Celebrity Chefs, including their gender and nationality, were defined. Additionally, recipes from the same Celebrity Chef were grouped together and organised according to meal type sub-group.

For the purpose of the current study, a mathematical model was devised to determine a Healthy Eating Index (HEI) for each recipe, in accordance with national benchmark recommendations for food nutritional values; based on dietary guidelines aimed at the prevention and management of obesity and associated co-morbidities [33,35]. The model takes into consideration percentage deviation of total fats, SFA, sugars and salt per 100g of recipe from recommendations; with a neutral or positive index corresponding to a nutritional composition meeting or under recommendations; while a negative index corresponding to a nutritional composition over recommendations.

Healthy Eating Index (HEI)= [(((3.0 - total fats*) x 100) / 3.0) + (((1.5 - SFA*) x 100) / 1.5) + (((5.0 - sugar*) x 100) / 5.0) + (((0.3 - salt*) x 100) / 0.3)] / 4

*per 100g of recipe[35].

Nutritional variables are presented as per 100g of recipe and/or per suggested portion of recipes, as indicated. Data in text, tables, and figure are presented as mean ± standard deviation (SD), unless otherwise specified. Descriptive statistics were used to compare nutrient variables of each Celebrity Chef against national benchmark recommendations[33,35] as previously described[10,36]. Additionally, descriptive statistics were used to explore HEI within and between Celebrity Chefs. A one-way analysis of variance was used to determine significant differences in the nutrient variables between Celebrity Chefs and between different meal types. Assumptions of homogeneity were checked, with adjustments to the degrees of freedom and verification by non-parametric equivalent (Friedman) where appropriate. Significant main effects were analysed using post hoc Tukey's HSD test. An independent samples *t*-test was used to determine any significant differences between genders and nationalities of Celebrity Chefs. Where assumptions of normality were violated, Mann-Whitney U tests were applied. Significance was accepted at $P<0.05$.

3. Results

Significant differences in the energy (overall Celebrity Chef mean±SD): 2.3±0.8 MJ/portion, 786 kJ/100g, 28% of Guideline Daily Amount (GDA)[37]; $P<0.001$), protein (25±12 g/portion, 7 g/100g of recipe; $P<0.001$), total carbohydrate (44±14 g/portion, 16 g/100g of recipe, 19% of GDA; $P<0.001$) and total fat (31±12 g/portion, 11 g/100g of recipe, 44% of GDA; $P<0.001$) content per suggested portion of recipe were observed between Celebrity Chefs (Table 1). In relation to carbohydrate and fat quality, significant differences in the polysaccharide (23±10 g/portion, 8 g/100g of recipe; $P<0.001$), mono/di/oligo-saccharides (21±17 g/portion, 7 g/100g of recipe, 23% of GDA; $P<0.001$), NMES (5.0±4.7 g/portion, 2.2 g/100g of recipe, 10% of GDA; $P<0.001$), fibre (3.4±1.4 g/portion, 1.0 g/100g of recipe, 19% of GDA; $P<0.001$], SFA (12±5 g/portion, 5 g/100g of recipe, 40% of GDA; $P<0.001$), MUFA (11±9 g/portion, 4 g/100g of recipe; $P<0.001$), PUFA (7±3 g/portion, 1 g/100g of recipe; $P<0.001$) and TFA (0.5±0.2 g/portion, 0.2 g/100g of recipe; $P<0.001$) content were observed between Celebrity Chefs (Table 2). Additionally, significant differences in the sodium (859±384 mg/portion, 261 mg/100g of recipe, 36% of GDA; $P<0.001$) and salt equivalent (2.1±1.0 g/portion, 0.7 g/100g of recipe, 35% of GDA; $P<0.001$) content were also observed between Celebrity Chefs (Table 1). Of the Celebrity Chefs within the sample, per suggested portion of recipe, the highest mean content of energy, protein, total fat, SFA and TFA was observed in CC6; mono/di/oligo-saccharide and NMES in CC7; and total carbohydrate, polysaccharide, fibre, MUFA, PUFA, sodium and salt equivalent in CC26. Conversely, of the Celebrity Chefs within the sample, per suggested portion of recipe, the lowest mean content of protein, total fat, sodium and salt equivalent, fibre and PUFA was observed in CC7; mono/di/oligo-saccharide and NMES in CC10; SFA and TFA in CC16; and CC11, CC20, CC21 and CC22 presented the lowest content per suggested portion of recipe of total energy, total carbohydrate, polysaccharide and MUFA, respectively.

Table 1. Energy, macronutrient and sodium content per suggested portion of individual Celebrity Chef (CC) recipes

Celebrity Chef	Energy (MJ)	Protein (g)	Total carbohydrate (g)	Total fat (g)	Sodium (mg)	Salt equivalent (g)
CC1	2.2±1.2[a]	30.0±25.1[a]	45.8±31.5[b]	24.5±16.9[a]	893±623[b]	2.2±1.6[b]
CC2	2.1±1.1[a]	14.8±13.0[a]	41.4±27.6[b]	29.7±20.5[a]	684±641[b]	1.7±1.6[b]
CC3	2.8±1.3[a]	33.8±18.9[a]	52.0±29.1[b]	35.4±22.3[a]	1012±592[b]	2.5±1.5[b]
CC4	2.1±0.6[a]	27.5±15.7[a]	38.4±13.6[b]	27.4±12.1[a]	600±547[b]	1.5±1.4[b]
CC5	2.6±1.4[a]	34.1±29.6[a]	39.6±22.6[b]	36.2±24.9[a]	865±442[b]	2.2±1.1[b]
CC6	4.5±2.1	52.6±33.3	68.1±39.3	66.6±34.3	1410±990[b]	3.5±2.5[b]
CC7	1.7±1.0[a]	5.6±3.5[a]	59.9±51.1	17.0±5.2[a]	290±123[b]	0.7±0.3[b]
CC8	2.8±0.8[a]	36.3±26.8	51.1±24.1[b]	35.6±19.1[a]	1132±567[b]	2.8±1.5[b]
CC9	1.6±1.0[a]	21.4±19.5[a]	32.3±22.3[b]	19.0±13.6[a]	457±481[b]	1.1±1.2[b]
CC10	1.6±0.9[a]	9.9±7.7[a]	27.4±18.5[b]	25.9±14.7[a]	819±536[b]	2.0±1.3[b]
CC11	1.4±0.7[a]	17.1±13.8[a]	27.0±26.4[b]	18.4±12.2[a]	729±604[b]	1.8±1.5[b]
CC12	2.3±1.2[a]	28.5±24.4[a]	38.4±31.0[b]	31.3±17.0[a]	1255±866[b]	3.1±2.2[b]
CC13	3.1±1.3[a]	27.3±19.7[a]	49.7±30.7[b]	49.0±29.0	604±496[b]	1.5±1.2[b]
CC14	1.7±0.8[a]	14.4±10.3[a]	37.9±23.7[b]	21.3±12.1[a]	589±529[b]	1.5±1.3[b]
CC15	2.2±1.0[a]	20.4±15.6[a]	48.7±31.1[b]	28.4±17.0[a]	882±828[b]	2.2±2.1[b]
CC16	1.9±0.8[a]	18.8±13.4[a]	46.8±30.5[b]	20.6±13.2[a]	1033±809[b]	2.6±2.0[b]
CC17	2.2±1.2[a]	23.7±21.1[a]	37.1±31.1[b]	32.8±24.7[a]	757±703[b]	1.9±1.8[b]
CC18	2.1±1.0[a]	22.8±24.7[a]	34.6±26.4[b]	29.4±18.0[a]	713±559[b]	1.8±1.4[b]
CC19	2.5±1.0[a]	26.2±21.2[a]	36.4±26.6[b]	39.7±24.1[a]	995±926[b]	2.5±2.3[b]
CC20	2.3±1.1[a]	45.3±31.6[a]	25.3±23.2[b]	28.9±16.9[a]	824±620[b]	2.1±1.5[b]
CC21	2.2±0.9[a]	23.3±19.5[a]	36.3±24.9[b]	32.2±17.8[a]	679±542[b]	1.7±1.4[b]
CC22	1.9±0.7[a]	13.6±8.1[a]	59.5±23.0	18.2±10.8[a]	751±453[b]	1.9±1.1[b]
CC23	1.9±1.0[a]	16.1±13.2[a]	39.2±26.7[b]	25.5±15.8[a]	538±463[b]	1.3±1.7[b]
CC24	1.6±1.1[a]	13.7±11.2[a]	33.8±23.8[b]	21.7±14.9[a]	689±604[b]	1.7±1.5[b]
CC25	2.0±0.7[a]	23.3±19.9[a]	34.3±24.8[b]	27.8±15.4[a]	804±686[b]	2.0±1.7[b]
CC26	4.4±0.8	47.8±15.8	88.7±28.8	56.0±24.9	2317±625	5.8±1.6

Mean±SD (n=904): [a] P<0.05 *vs.* CC6; [b] P<0.05 *vs.* CC26.

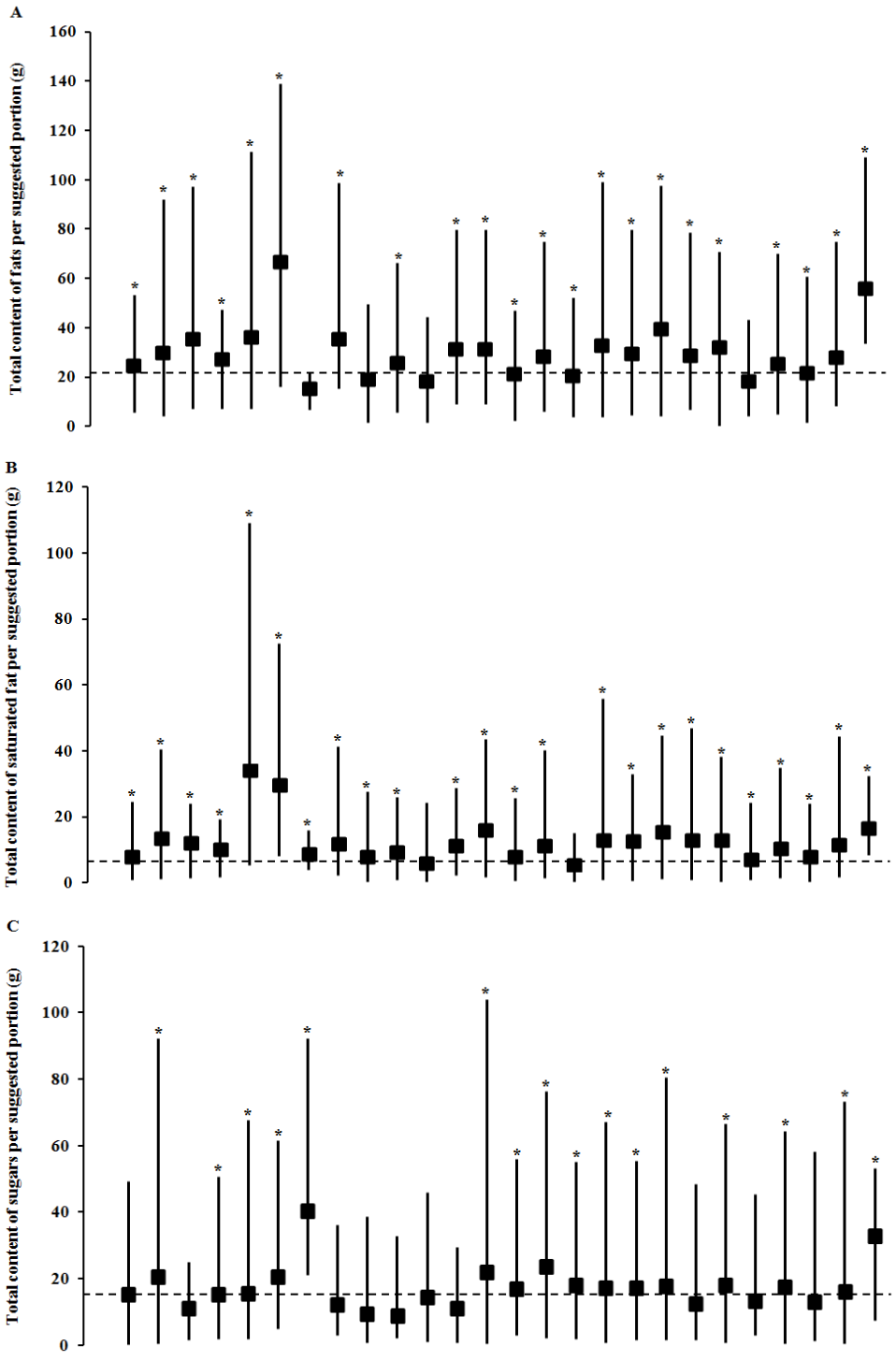
Table 2. Quality of carbohydrate and fat per suggested portion of individual Celebrity Chef (CC) recipes

Celebrity Chef	Polysaccharide (g)	Mono/di/oligo-saccharide (g)	NMES (g)	Fibre (g)	SFA (g)	MUFA (g)	PUFA (g)	TFA (g)
CC1	29.5±25.4	16.3±14.8[c]	3.9±6.7[c]	3.5±3.2[b]	7. 9±7.0[a]	9.1±8.4[b]	7.2±2.1[b]	0.3±0.4[a]
CC2	18.0±18.7[b]	23.4±21.6[c]	8.8±14.6[c]	2.2±1.7[b]	13.7±10.7[a]	9.2±6.3[b]	6.2±2.1[b]	0.6±0.5[a]
CC3	37.5±29.0	14.5±5.8[c]	0.9±1.0[c]	5.0±3.3	12.1±7.2[a]	14.9±13.2[b]	7.9±3.5[b]	0.5±0.4[a]
CC4	22.3±14.6[b]	16.1±15.7[c]	1.2±2.2[c]	3.8±3.1[b]	10.2±5.2[a]	9.4±4.5[b]	7.4±2.7[b]	0.4±0.4[a]
CC5	22.8±16.0[b]	16.8±16.5[c]	1.1±2.0[c]	3.5±2.4[b]	17.6±24.9	13.3±10.1[b]	4.5±4.4[b]	0.8±0.8
CC6	38.9±25.0	29.2±16.5[c]	2.9±4.8[c]	5.7±3.7	29.7±17.1	24.1±14.3	11.7±3.9	1.1±0.9
CC7	14.7±7.1[b]	45.2±23.1	20.0±19.0	1.0±0.6[b]	8.9±3.0[a]	6.4±5.4[b]	1.2±0.9[b]	0.5±0.2[a]
CC8	32.9±22.2	18.2±7.9[c]	0.7±1.3[c]	4.1±2.2[b]	12.0±8.6[a]	16.0±9.0	7.2±2.5[b]	0.4±0.4[a]
CC9	19.6±21.2[b]	12.6±8.6[c]	0.6±0.9[c]	2.5±2.1[b]	7.9±7.1[a]	6.9±6.0[b]	3.8±2.4[b]	0.4±0.5[a]
CC10	17.9±19.8[b]	9.5±7.4[c]	0.2±0.4[c]	4.3±2.3[b]	9.4±7.7[a]	10.2±5.2[b]	5.9±3.9[b]	0.4±0.4[a]
CC11	8.1±11.7[b]	18.9±14.9[c]	0.8±1.6[c]	3.4±2.4[b]	6.0±5.4[a]	7.7±6.1[b]	4.5±1.9[b]	0.2±0.2[a]
CC12	22.1±23.8[b]	16.3±9.9[c]	1.0±1.4[c]	4.6±3.8[b]	11.4±7.9[a]	13.1±8.2[b]	6.4±2.8[b]	0.4±0.4[a]
CC13	22.6±24.7[b]	27.1±25.6[c]	10.8±18.9	3.4±2.8[b]	16.1±11.9[a]	19.9±13.8	12.4±5.9	0.6±0.7[a]
CC14	17.8±21.3[b]	20.1±15.5[c]	8.1±12.3[c]	3.0±1.8[b]	8.1±6.7[a]	7.7±4.1[b]	5.3±3.0[b]	0.2±0.3[a]
CC15	24.3±23.6[b]	24.4±23.2	9.3±13.6[c]	2.9±2.7[b]	11.5±8.9[a]	10.0±5.9[b]	6.4±1.2[b]	0.5±0.5[a]
CC16	22.4±25.2[b]	24.4±21.1[c]	3.1±3.5[c]	2.8±2.1[b]	5.5±3.8[a]	7.8±5.5[b]	7.2±3.9[b]	0.1±0.1[a]
CC17	16.9±21.0[b]	20.2±18.1[c]	2.8±4.8[c]	2.8±2.0[b]	13.1±11.6[a]	11.3±7.9[b]	7.8±3.3[b]	0.6±0.8[a]
CC18	15.3±17.0[b]	19.3±17.6[c]	4.5±6.6[c]	2.2±1.7[b]	12.9±8.5[a]	9.2±5.4[b]	6.7±2.6[b]	0.6±0.4[a]
CC19	17.2±20.7[b]	19.2±19.2[c]	6.8±11.4[c]	3.0±2.4[b]	15.7±10.8[a]	14.2±8.9[b]	9.1±2.9[b]	0.7±0.7
CC20	12.4±10.9[b]	12.9±10.9[c]	1.2±2.1[c]	3.5±2.1[b]	13.0±10.8[a]	11.0±7.2[b]	4.4±3.2[b]	0.5±0.5[a]
CC21	7.0±15.4[b]	29.3±20.7[c]	6.9±12.0[c]	2.6±1.8[b]	13.0±9.2[a]	12.4±8.9[b]	6.2±2.1[b]	0.6±0.7[a]
CC22	42.1±22.9	17.4±11.5[c]	7.5±11.3[c]	3.8±2.6[b]	7.2±5.8[a]	5.8±4.0[b]	4.9±2.2[b]	0.3±0.3[a]
CC23	17.7±17.3[b]	21.5±18.7[c]	8.8±14.2[c]	1.7±1.2[b]	10.5±9.5[a]	9.1±6.2[b]	5.4±2.5[b]	0.5±0.6[a]
CC24	18.4±20.7[b]	15.4±13.2[c]	2.5±4.0[c]	2.5±2.5[b]	8.0±5.9[a]	8.0±6.1[b]	5.3±2.1[b]	0.4±0.4[a]
CC25	17.1±16.9[b]	17.2±17.4[c]	2.9±4.8[c]	2.0±1.9[b]	11.7±9.5[a]	10.1±6.3[b]	5.5±2.1[b]	0.5±0.6[a]
CC26	50.4±26.0	38.3±13.5	11.6±9.6	7.6±2.5	16.7±9.2[a]	24.7±10.7	14.0±6.6	0.6±0.4[a]

Mean±SD (n=904): [a] P<0.05 *vs.* CC6; [b] P<0.05 *vs.* CC26; [c] P<0.05 *vs.* CC7.

The mean total fat content per suggested portion in 77% of Celebrity Chefs' recipes were above the '*high fat content*' criteria (Figure 1A). Similarly, the mean SFA content per suggested portion in 96% of Celebrity Chefs recipes' were above the '*high SFA content*' criteria (Figure 1B). Whereas, the mean overall sugars content per suggested portion in 65% of Celebrity Chefs' recipes contained more than the '*high sugar content*' criteria (Figure 1C). In addition, the mean salt content per portion in 27% of Celebrity Chefs' recipes were above the '*high salt content*' criteria (Figure 1D).

HEI for all Celebrity Chefs' recipes ranged between 73% to -874%, with mean HEI calculated at -157% (range: -71% in CC3 to -425% in CC7), suggesting that all Celebrity Chefs within the sample presented on average recipes with nutritional compositions substantially above healthy eating guidelines (Figure 2). Of all recipes analysed, 13% were calculated to indicate a neutral or positive result, while 87% were calculated to indicate a negative result.



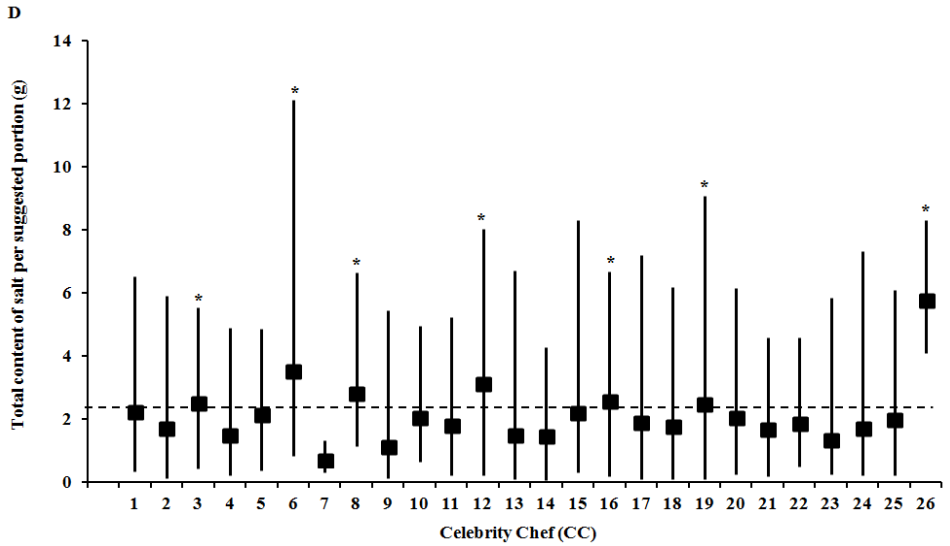


Figure 1. Total fat (A), SFA (B), sugar (C) and salt (D) content per suggested portion of individual Celebrity Chef (CC) recipes compared against national benchmark recommendations. Mean±Range (n=26 CC; n=904 recipes): * Mean exceeds '*high content*' criteria[35]

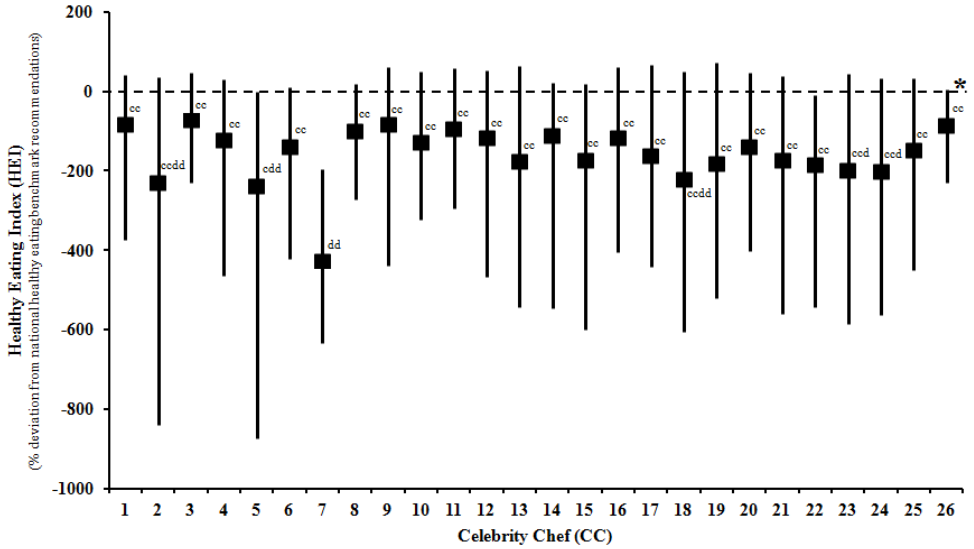


Figure 2. Health Eating Index (HEI) of individual Celebrity Chef (CC) recipes. Mean±Range (n=26 CC; n=904 recipes): $^{cc}P<0.01$ and $^{c}P<0.05$ *vs.* CC7; $^{dd}P<0.01$ and $^{d}P<0.05$ *vs.* CC3. * Healthy Eating Guidelines[35]. A neutral and positive index corresponds to a nutritional composition meeting or under national benchmark recommendations, while a negative index corresponds to a nutritional composition over national benchmark recommendations

Significant differences in the HEI were observed between Celebrity Chefs (P<0.001). CC7 presented a lower HEI compared to all other Celebrity Chefs, and CC3 presented a higher HEI compared to CC2, CC5, CC7, CC18, CC23 and CC24 (Figure 2). In regards to recipe meal type sub-groups, desserts presented a lower HEI (-284±174%; P<0.001) compared with evening meals (-99±98%), lunches (-105±165%), starters (-115±35%) and breakfasts (-140±108%). Moreover, no difference was observed in HEI between genders; while Celebrity Chefs of International origin presented a significantly higher HEI (-123±134%; P<0.001) compared with Celebrity Chefs of British origin (-167±153%).

Significant differences in the energy, protein, total carbohydrate, polysaccharide, mono/di/oligo-saccharide, NMES, fibre, total fat, SFA, MUFA, PUFA, TFA, sodium and salt content per suggested portion were observed between various meal type sub-groups (P<0.001; Table 3). Evening meal recipes contained more energy, protein, polysaccharide, MUFA, PUFA and salt per suggested portion compared to all other meal types (breakfast, lunch, starter and dessert). Lunch and evening meal recipes contained more fibre than breakfast, starter and dessert recipes. Evening meal and dessert recipes contained more SFA than breakfast, lunch and starter recipes. Dessert recipes contained the greatest amount of total carbohydrate, due to the significant amount of mono/di/oligosaccharide and NMES they presented.

Male Celebrity Chef recipes had significantly greater amounts of energy (P<0.001), protein (P<0.001), total

carbohydrate (P<0.001), polysaccharide (P=0.005), fibre (P<0.001), total fat (P<0.001), SFA (P<0.001), MUFA (P<0.001), PUFA (P<0.001), TFA (P<0.001), sodium (P<0.001) and salt (P<0.001) per suggested portion, compared with female Celebrity Chef recipes (Table 4). No differences were observed between male and female Celebrity Chef recipes regarding mono/di/oligo-saccharide (P=0.4) and NMES (P=0.7) content per suggested portion (Table 4).

British originated Celebrity Chef recipes contained significantly greater amounts of energy (P<0.001), fibre (P<0.001), total fat (P<0.001), SFA (P<0.001), MUFA (P<0.001) and TFA (P<0.001) per suggested portion when compared to International originated Celebrity Chef recipes (Table 4). No differences were observed between British and International Celebrity Chef recipes regarding protein (P=0.5), total carbohydrate (P=0.3), polysaccharide (P=0.6), mono/di/oligo-saccharide (P=0.3), NMES (P=0.2), PUFA (P=0.1), sodium (P=0.1) and salt (P=0.1) content per suggested portion (Table 4).

Table 3. Energy, macronutrient, fibre, sodium and salt content, per suggested portion, within different meal types sub-groups of Celebrity Chefs' recipes

	Breakfast	Lunch	Starter	Evening Meal	Dessert
Energy (MJ)	1.8±0.9§	2.1±1.0§	1.5±1.0§	2.9±1.3	2.1±0.9§
Protein (g)	15.4±10.4§	21.6±16.3§	15.1±12.1§	41.0±22.2	7.4±4.2§
Total carbohydrate (g)	43.2±25.6$^{\infty}$	43.1±24.2$^{\infty}$	24.1±21.4$^{\infty}$	47.7±30.8$^{\infty}$	54.8±26.1
Polysaccharide (g)	24.9±12.6§	23.4±23.7§	13.3±17.1§	32.5±25.5	13.8±12.6§
Mono/di/oligosaccharide (g)	18.3±15.9$^{\infty}$	19.7±6.0$^{\infty}$	10.8±10.0$^{\infty}$	15.2±10.6$^{\infty}$	41.0±19.6
NMES (g)	4.5±8.1$^{\infty}$	0.8±2.9$^{\infty}$	1.2±5.0$^{\infty}$	1.6±4.4$^{\infty}$	14.6±14.4
Fibre (g)	2.9±2.4$^{¥}$	4.0±2.6	2.7±2.3$^{¥}$	4.1±2.9	1.9±1.4$^{¥}$
Total fat (g)	21.9±15.8§	26.5±19.8§	23.5±20.4§	38.2±22.9	28.0±18.0§
SFA (g)	8.4±6.7§	9.4±9.1§	7.8±8.5§	15.9±14.4	14.8±10.3
MUFA (g)	7.2±5.6§	10.5±9.0§	9.4±9.1§	15.2±9.8	8.5±5.6§
PUFA (g)	6.0±2.7§	6.3±3.7	6.1±3.6	6.5±3.3	4.0±2.1§
TFA (g)	0.3±0.4$^{\infty}$	0.3±0.5$^{\infty}$	0.2±0.4$^{\infty}$	0.6±0.6	0.7±0.6
Sodium (mg)	642±583§	956±592	797±604§	1174±741	223±170§
Salt equivalent (g)	1.6±.5§	2.4±1.5	2.0±1.5§	2.9±1.9	0.6±0.4§

Mean±SD (n=904): $^{¥}$ P<0.05 *vs.* Lunch; § P<0.05 *vs.* Evening meal; $^{\infty}$ P<0.05 *vs.* Dessert.

Table 4. Energy, macronutrient, fibre, sodium and salt content per suggested portion of Celebrity Chefs' (CC) recipes based on gender and country of origin

	Male CC	Female CC	British CC	International CC
Energy (MJ)	2.5±1.3†	1.9±1.0	2.3±1.3‡	2.0±1.0
Total protein (g)	26.1±22.8†	19.2±17.0	23.3±20.9	22.2±20.1
Total carbohydrate (g)	44.8±30.3†	38.7±26.4	42.7±29.4	40.5±27.3
Polysaccharide (g)	24.8±23.0†	19.5±20.9	22.6±22.1	21.8±22.5
Mono/di/oligosaccharide (g)	20.0±17.5	19.2±16.8	20.1±17.5	18.7±16.5
NMES (g)	4.7±9.8	4.5±9.6	4.9±10.3	4.0±8.2
Fibre (g)	3.5±2.7†	2.7±2.3	3.3±2.7‡	2.8±2.2
Total fat (g)	34.4±23.5†	23.8±16.1	32.0±22.7‡	24.3±16.1
SFA (g)	14.8±13.7†	9.3±7.6	13.7±12.8‡	9.2±7.6
MUFA (g)	13.1±9.9†	8.6±6.8	12.0±9.6‡	8.9±6.6
PUFA (g)	5.9±3.6†	5.5±2.8	5.8±3.5	5.8±2.7
Trans fatty acids (g)	0.6±0.6†	0.4±0.4	0.5±0.6‡	0.4±0.4
Sodium (mg)	920±738†	661±596	826±699	749±665
Salt equivalent (g)	2.3±1.8†	1.7±1.5	2.1±1.7	1.9±1.7

Mean±SD (n=904): † P<0.05 *vs.* Female CC; ‡ P<0.05 *vs.* International CC.

4. Discussion

The study aimed to determine the nutritional composition of Celebrity Chefs' recipes and to compare the nutrient content of these recipes with national healthy eating benchmark recommendations for certain nutrients focused on prevention and management of obesity and associated non-communicable diseases. This novel investigation was the first to systematically and comprehensively assess the nutritional composition of Celebrity Chefs' recipes and suggests the majority of recipes, irrespective of source, meal type, gender or country of origin are generally considered unhealthy in accordance with benchmark recommendations[11,35,37]. The results demonstrate that all Celebrity Chefs promote recipes that contain undesirable levels of certain nutrients (e.g. total fat, SFA, sugars and salt) associated with obesity and cardiometabolic risk factors[7]. Even though it was not feasible to analyse all publicly available Celebrity Chef recipes, the stratified randomisation sampling method used provides a representative snap-shot of current public exposure. When these results are considered in the light of previous research[1], indicating the British public feel Celebrity Chefs are a valuable source of culinary information, nutritional knowledge and promote healthy eating; there is cause for concern that Celebrity Chefs may potentially be a hidden and unknown contributory factor to current public health issues.

Total energy content of recipes analysed ranged from 0.2 to 9.6 MJ/portion. It must however be highlighted that 20% of recipes analysed presented an energy content ≥3.4 MJ/portion; with certain Celebrity Chefs consistently promoting high energy dense recipes (CC3 39%, CC6 70%, CC13 47% and CC26 92% of total recipes analysed ≥3.4 MJ/portion), predominantly due to high fat content. The average total fat (range: 0.2 to 139 g/portion) and SFA (range: 0.2 to 109 g/portion) content of a suggested portion of recipe contributed to 40% and 44% GDA, respectively. Moreover, n=22 and n=24 of Celebrity Chefs had average total fat and SFA contents of recipes above healthy eating benchmark recommendations, respectively. SFA was the predominant fat in recipes (39% of total fat content), compared with MUFA (37%) and PUFA (23%). However, some Celebrity Chefs suggest the use of olive oil, resulting in a reasonable MUFA presence. This is a positive attribute, taking into account the beneficial effects of MUFA on cardiometabolic risk factors, including reducing blood pressure, total and LDL cholesterol levels, improving insulin sensitivity and reducing inflammatory and oxidative stress[38-41]. The omega 3 PUFA content (especially EPA and DHA) of recipes was negligible, since very few Celebrity Chefs presented recipes that included using oily fish. This is disappointing, since current recommendations of increasing the consumption of oily fish is associated with reduced risk of CVD, linked to improving blood lipid profile, improving arterial elasticity and function, and reduced arthrogenic and thrombogenic activity[28,30,42,43].

Even though the average sugars content (range: 0.1 to 104 g/portion) of a suggested portion of recipe contributed to 23% GDA, in sweet recipes (e.g. desserts) this value increased to ≥50% GDA. Over half of Celebrity Chefs (n=17) had average content of sugars above healthy eating benchmark recommendations. This is of particular concern due to the cardiometabolic risk factors including insulin resistance and dyslipidaemia associated with high intakes of sugar[15]. Average fibre content (range 0.0 to 14.9 g/portion) of suggested portion of recipe contributed to 18% GDA. These results suggest recipes had less fibre than would be ideal, which is not surprising taking into account the generally low use of wholegrain and pulses, and the small portions of fruits and vegetable observed within recipes. Regular use of Celebrity Chefs' recipes could exacerbate the already inadequate dietary fibre intake of the British population[44]. This is worrying given the many positive effects a fibre-rich diet previously reported on obesity and cardiometabolic risk factors[45,46]. On the other hand, given that excessive dietary salt intakes have been associated with hypertension, heightening cardiometabolic risk[29], it is also worrying that the average salt content (range: 0.1 to 12.1 g/portion) of recipes contributed to 35% GDA. However, during dietary analysis only foods listed in the ingredients section were used. It is a common practice for Celebrity Chefs to add a substantial amount of salt during the recipe preparation procedure. Therefore, the current figure is potentially under reported. On a practical standpoint the nutritional composition of Celebrity chefs' recipes is comparable to the nutritional composition of fast food outlets and ready-made meals, which have previously been implicated as contributing factors for Britain's obesity epidemic[14,47-49]. Based on the result of the current study, it is feasible to suggest that frequent preparation and consumption of Celebrity Chef s' recipes will potentially contribute to a positive energy and lipid balance, and high intakes of sugars and salt. In light of Britain's ever-growing sedentary behaviour[50], such dietary compositions have been acknowledged in the pathophysiological mechanisms of obesity and associated cardiometabolic risk factors[22,49].

There were large variations in the nutritional composition between Celebrity Chefs. The variations observed likely reflect origin, interests, personality, culinary speciality traits, and links to the target audience. Clearly, if a Celebrity Chef's interest was in savoury dishes, high levels of fat and salt were observed; whilst if desserts were favoured, high levels of sugars were observed. Additionally, evening meal recipes were the most common type of recipe to find in Celebrity Chefs recipe books and websites. It is particularly concerning that evening meal recipes contained substantially more total fat and SFA (as well as more TFA and salt) than other meal types; indicating consumers that use these culinary resources could be at greater risk of consuming undesirable amounts of these nutrients, compared to those who choose other meal types.

It was interesting that on average male Celebrity Chef recipes contained substantially more energy, macronutrients (except simple sugars and NMES), sodium and salt per portion than female Celebrity Chef recipes. This could be due to male Celebrity Chefs suggesting larger portion sizes. It would be beneficial for male Celebrity Chefs to consider reducing their suggested portion sizes; as people are more likely to overeat when presented with larger portions of food, an acknowledged contributing factor for the current obesity epidemic[51,52]. Moreover, the International Celebrity Chefs included in this study were of American, Australian, Chinese, Indian and Afro-Caribbean heritage. American and Australian diets are quite similar to British diets[53]. Traditional Indian, Chinese and Afro-Caribbean diets contain less meat (for Indian and Chinese groups only) and dairy foods, resulting in a reduced intake of total fat and SFA[54]. This probably explains why recipes from International Celebrity Chefs contained less energy, total fat, SFA and TFA. It is however interesting that recipes from British Celebrity Chef contained more fibre than recipes from International Celebrity Chef. Culinary habits from Indian, Chinese and Afro-Caribbean backgrounds commonly favour greater inclusion of wholegrains, fruits and vegetables compared to Western culinary habits[53,54]. Possibly, Indian, Chinese and Afro-Caribbean Celebrity Chef recipes were higher in fibre, but this was masked by the lower fibre content of the American and Australian Celebrity Chef recipes.

Healthy eating guidelines have previously been developed to encourage appropriate dietary practices and help overcome obesity and related co-morbidities[7,33]. In the current study a HEI was devised to determine deviations of total fats, SFA, sugars and salt per 100g of recipe from national benchmark recommendations for healthy eating[33,35]. This index highlighted that 87% of recipes analysed were substantially above health eating guidelines, indicating only 13% of recipes used ingredients that presented an overall nutritional composition considered healthy. Additionally, all Celebrity Chefs presented an average HEI (range: -71 to -425) in a negative value; suggesting Celebrity Chefs predominantly promote recipes that are not in accordance with healthy eating recommendations. It was worrying to observe that Celebrity Chefs that have previously been recruited by government health bodies to promote '*Healthy Eating*' initiatives[33], actually produced recipes with some of the lowest HEI scores and nutritional compositions not in accordance with the aims and objectives of these initiative. This highlights the need for Celebrity Chefs to be consistent with their health messages to consumers.

There is clearly evidence that Celebrity Chefs need to improve the nutritional composition of their recipes, to fit with healthy eating guidelines. Since the British public value them as a source of cookery information and nutritional knowledge, it is essential and indeed a professional responsibility that Celebrity Chefs improve their recipes to encourage healthier eating practices[1]. It is advisable that Celebrity Chefs work collaboratively with qualified dietetic and nutritional professionals to enhance the nutritional quality of their recipes whilst maintaining the visual appeal and palatability[55]. To help promote healthy eating it is important that Celebrity Chefs ensure their recipes are quick and easy to make, as time constraints are a prime reason why the British population do not often cook food from raw ingredients[56]. Finally, further exploration of the nutritional composition of Celebrity Chefs' recipes would be useful, especially for those Celebrity Chefs who target their recipes at different population groups (e.g. children, university students, vegetarians, weight management or those with medical conditions such as diabetes mellitus and celiac disease), or specialist recipes (e.g. Christmas, Easter, different seasons, dinner parties, easy preparation and time-saving, targeted healthy eating, country specific).

5. Conclusions

In conclusion, it was found that although variation in the nutritional composition of recipes existed between Celebrity Chefs, there was still a general trend whereby excessive amounts of total fat, SFA, sugars and salt were evident. The majority of recipes analysed had unhealthy nutritional compositions in accordance with national healthy eating benchmark recommendations, and therefore Celebrity Chefs could potentially be a hidden contributory factor to current public health nutrition issues, through exacerbating Britain's already unbalanced dietary intake. By working alongside qualified and registered dietetic and nutritional professionals to improve the nutritional quality of their recipes and promoting more appropriate and healthier eating habits, Celebrity Chefs could easily reverse their potential negative impact.

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