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# Meal kit delivery services in the UK: An evaluation of the nutritional composition of meals

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ABSTRACT

*Objective:* To examine meals provided by meal kit delivery services (MKDS) and to evaluate their nutritional composition.
*Research Methods and Procedures:* In this cross-sectional study, the nutritional composition of meals (*n* 497) from MKDS in the UK, was considered. Energy and nutrient content were compared to dietary guidelines; meals were profiled for fat, saturated fat, total sugars, and salt content.
*Results:* There was a large range in the energy and nutrient content of meals. The levels of saturated fat per serving ranged from 0.4 to 28.0 g (Mdn = 9.0 g), and salt content ranged from 0.2 to 6.4 g (Mdn = 2.2 g). Over half of the meals were profiled as high for fat (51.3%), saturated fat (62.2%) and salt (64.4%). Notably, protein content per portion was high (Mdn = 34.0 g), and dietary fiber content was low (Mdn = 6.4 g). Meals, which had been distinguished by the providers with “health-based” descriptors or tags, had a better nutritional profile for fat, saturated fat, and salt, than other meals; nevertheless, many “health-based” meals profiled high for salt (46.5%) and saturated fat (40.4%).
*Conclusions:* Recipes from MKDS should be revised to improve their nutritional composition; specifically, reductions in salt and saturated fat content and an increase in dietary fiber are needed. Given the variation in the nutritional composition of meals, work is also needed to ascertain the main factors influencing selections made by consumers, and the relevance of guidance and information to support this.


## Introduction

Overweight- and obesity-related illness is estimated to cost the UK National Health Service £6 billion per annum [1]; 64% of adults in England [2], and more than a third of children leaving primary school are living with overweight or obesity [3]. The National Food Strategy [4] highlighted the importance of improving dietary intake, with diet acknowledged as an important modifiable risk factor of non-communicable diseases, and responsible for 74% of global deaths [5]. In particular, foremost dietary risk factors for mortality include diets low in wholegrains, fruit, nuts and seeds, vegetables, and omega-3 fatty acids, and high in sodium [6]. Moreover, the UK population’s average dietary intake exceeds recommendations for saturated fat, salt, and free sugars, and does not meet dietary recommendations for fiber, fruit and vegetables (FV), and oily fish [7].

Consuming home-cooked meals more frequently has been reported to be associated with better diet quality, greater FV consumption, and lower adiposity [8]. For working families and the increasing numbers living alone, time availability and convenience can determine tendencies toward home cooking [4,8]. A decline in home cooking and an increase in lower-cost processed food has been reported [9].

Meal kit delivery services (MKDS) are subscription-based services where consumers select a number of weekly meals (via a website or app), and then receive premeasured fresh ingredients delivered to their home, alongside straightforward recipes to follow. The MKDS market in the UK was estimated to be worth £1 billion in 2020, having seen substantial growth (from £420 million in 2017) [10]. The growth, partly attributed to the COVID-19 pandemic and the national lockdowns [11], is forecast to continue [10]. A follow-up study for the National Diet and Nutrition Survey during COVID-19 revealed 59% UK households cooking more frequently at home since the start of the pandemic [7]. Research exploring food choice during the national lockdown also found that families reported spending more time and effort on meals,

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with the place of food in the family home elevated [12]. With online ordering, a wide variety of meals intended to be straightforward to prepare, and no shopping, the convenience of MKDS presented an opportunity for growth in sales [13].

There has been limited research on the nutritional composition of a selection of MKDS meals. These include two Australian studies; Moores et al. [14] examined 346 "Classic Plan" meals from one MKDS over 1 year, and Gibson and Partridge [15] assessed 60 meals across five MKDS providers. Meals were found to be relatively high in fat and sodium [14,15]. Another study conducted with 16 families in Australia examined the impact of MKDS on family dynamics and mental health and found that MKDS reduced the mental load of food-related decisions, reduced reliance on processed convenience foods and takeaways, and also reported that most of the participants perceived meals were micronutrient dense, appropriately portioned, and in line with national dietary guidelines [16].

Despite the growth of MKDS and their potential contribution to a population's dietary intake, there is limited research in this area. This study aimed to analyze meals available from MKDS in the UK and to examine their nutritional composition.

## Materials and methods

All MKDS within the UK were identified; those targeting smaller market segments (e.g., organic) and/or providing a small selection of meals (<10 meals per week) were excluded. Of the remaining MKDS, the two largest providers with national coverage and diverse offer were selected for the study. All standard-cost meals (i.e., without additional paid-for upgrades or side orders) were examined. The MKDS differed in the number of meals available each week (for consumers to select from) and so, to give a comparable number of meals for each provider (*n* 239 and *n* 258), all meals across a different number of weeks for each provider were considered.

For all meals, data relating to energy and nutrient content (protein, fat, saturated fat, carbohydrate, total sugars, salt, and dietary fiber) per meal serving and per 100 g were collected from the MKDS websites. Energy and nutrient content related to meal ingredients supplied by the MKDS (including sachets of stock and sauces) but excluded store cupboard items (listed in recipes and expected to be provided by the consumer, e.g., salt, oil, milk, butter). Serving size was available for one MKDS; for the other, serving size was deduced, that is, from energy per serving and energy per 100 g. Likewise, FV portions were stated for one MKDS, and estimated for the other provider. Estimates were based on a standard portion size of 80 g and using FV weights from ingredient lists where available (majority of cases), or if unavailable, from similar recipes in the study. Otherwise, FV portions were estimated using the FV quantity specified in the recipe and guideline portion equivalents for FV [17].

The MKDS categorized and/or tagged meals with various descriptors, including "healthy choices" and "lean in 15." These descriptors were collated, and two overarching classifications were introduced for this study: "vegetarian" or not; and "health-based" or not. Vegetarian meals were those designated as "vegetarian" and/or "plant-based" by the MKDS. Although the definition of plant-based varies [18], a review of meals assigned as "plant-based" by MKDS indicated that these meals did not contain meat, poultry, fish, or seafood. Meals categorized as "health-based" were those with descriptors that may reasonably be interpreted as health-focused, that is, "healthy choice," "lean in 15," "calorie controlled" and "under 600 calories" descriptors. Data were collected in June to August 2021, and manually input into a spreadsheet (Microsoft Excel Version 16.51) before being imported for data analysis (SPSS statistics Version 27.0).

### *Data analysis*

Data were checked for inconsistencies and outliers, with any anomalies resolved; 10% of cases (selected using a random number generator) were verified in full. Meals were profiled as low (green), medium (amber), or high (red) according to Front of Pack label guidelines [19] for fat, saturated fat, total sugars, and salt. The composition of meals was compared to government dietary recommendations [20,21] for adults aged 19–64 years (averaged where values differed by sex) and adjusted to 30% (estimated proportion for a lunch or evening meal [22]). In this way, the % of meals meeting recommendations was established. The meals were assessed on the basis that they should provide at least 30% of the recommendation for protein and carbohydrate, ≤30% of the recommendations for total fat, saturated fat, and salt, 30% of "at least 5 A Day" portions of FV, and ≥30% of the recommendations for dietary fiber [22]. Given the emphasis on overweight and obesity prevalence and reducing energy intake in the general population [23,24], meals were assessed on the basis that they should provide ≤30% of the recommended energy content.

Data were not normally distributed, and medians and interquartile ranges were considered. Profiles of meals across MKDS and meal classifications were examined using chi-squared tests, with Cramer's $V$ ($\varphi_c$) to establish strength of association. Mann–Whitney $U$ tests were used to compare the energy and nutrient content for the two providers and for meal classifications. One-sample Wilcoxon signed rank tests were conducted to compare composition against dietary recommendations (adjusted to 30% for a meal). The level of significance for all statistical tests was $P < 0.05$.

## Results

Data relating to 497 meals were collected. To reflect the meals across the study period, all occurrences of meals (including any repetitions) were included. Table 1 provides medians and interquartile ranges for the serving size, energy, nutrient, and FV content of meals from each MKDS (*n* 239 and *n* 258). The table also includes the % of meals meeting dietary recommendations (adjusted to 30% for one meal and as listed). Approximately two-fifths (*n* 198) were "health-based," and a third of meals (*n* 164) were vegetarian. For both providers, price per meal decreased as more meals per week are ordered, and this varied between £6.25 per serving for 2 meals each for 2 people and £2.98 for 4 meals each for 2 adults and 2–3 children.

### *Serving size, energy, and nutritional composition of meals*

The serving size, energy, and nutritional composition varied across the meals. Most meals fell short of recommendations (adjusted to 30%) for saturated fat, salt, and dietary fiber. Differences between meals and the dietary recommendations (as listed in Table 1) were observed ($P < 0.01$). Figure 1 presents the distribution of energy, nutrients, and FV for all meals, including by MKDS and by "health-based" classification.

Energy content varied from 1137.0 to 4369.0 kJ per serving, with a median value of 2567.0 kJ. Almost two-thirds (65.0%) did not exceed 2835 kJ per serving (the recommended energy content adjusted to 30%). "Health-based" meals were lower in energy content per serving (Mdn = 2170 kJ) than others (Mdn = 2924 kJ), and almost all "health-based" meals (96.5%) had less than 2835 kJ.

Overall, meals had a median content of 34.0 g protein, 21.9 g fat, 9.0 g saturated fat, and 71.0 g carbohydrate. The protein content was notably high, with the overwhelming majority of meals (96.0%) containing at least 15.1 g of protein (daily guideline adjusted to a meal). Indeed, more than half of meals (*n* 308; 62.0%) contained at least double this amount of protein, and 16 meals exceeded the *daily* recommendation for protein. Saturated fat content per serving was high (Mdn = 9.0 g), and over half of meals (54.7%) exceeded 8.3 g saturated fat (recommendation adjusted to 30% for one meal). "Health-based" meals fared considerably better than others, with 69.2% compliant in terms of saturated fat content, compared to 29.4% for those not "health-based." Carbohydrate content overall was low (Mdn = 71.0 g) and ranged from 8.9 to 141.0 g. "Health-based" meals had lower carbohydrate content (Mdn = 60.6 g) compared to others (Mdn = 77.2 g); likewise non-vegetarian meals (Mdn = 69.0 g) contained less carbohydrate than vegetarian meals (Mdn = 74.7 g).

The median salt content of meals overall was 2.2 g, and almost two-thirds of meals (64.4%) exceeded 1.8 g (the recommendations adjusted to 30%). More "health-based" meals complied with salt recommendations (53.5%) compared to those that were not "health-based" (23.7%); fewer vegetarian meals (29.9%) met salt recommendations compared to non-vegetarian meals (38.4%). Median dietary fiber content was low (6.4 g per serving), and

**Table 1**
Serving size, energy, and nutritional composition of MKDS meals (per serving), presented as median (interquartile range) and % of meals meeting dietary recommendations (adjusted to 30% for one meal)

| | Dietary recommendations[*] | All meals n 497 | MKDS | | Vegetarian or not | | "Health-based"[‡] or not | |
|---|---|---|---|---|---|---|---|---|
| | | | MKDS1 n 239 | MKDS2 n 258 | Vegetarian n 164 | Not vegetarian n 333 | "Health-based" n 198 | Not "health-based" n 299 |
| Serving size (g) | — | 473.0 (406.5–552.6) | 499.0 (426.2–583.0) | 454.5[‖] (391.8–521.8) | 488.8 (420.3–582.1) | 467.0[¶] (402.8–539.8) | 456.6 (398.7–532.5) | 481.6[#] (414.2–562.0) |
| Energy (kJ) | 2835 | 2567.0[§] (2113.5–3039.5) | 2752.0 (2352.0–3188.0) | 2407.0[‖] (1982.5–2864.3) | 2561.5 (2044.8–2957.0) | 2567.0 (2149.0–3095.0) | 2170.0 (1894.3–2434.3) | 2924.0[#] (2552.0–3257.0) |
| | | *65.0%* | *55.2%* | *74.0%* | *70.7%* | *62.2%* | *96.5%* | *44.1%* |
| Protein (g) | 15.1 | 34.0[§] (26.0–42.0) | 35.0 (28.0–42.0) | 33.3 (24.4–41.3) | 24.4 (17.9–32.3) | 38.9[¶] (31.0–44.6) | 30.4 (22.0–40.0) | 36.0[#] (28.0–42.8) |
| | | *96.0%* | *97.9%* | *94.2%* | *87.8%* | *100.0%* | *91.9%* | *98.7%* |
| Fat (g) | 26.3 | 21.9[§] (13.7–30.2) | 25.0 (16.0–32.0) | 18.3[‖] (11.3–26.6) | 21.0 (13.9–28.0) | 22.0 (13.7–31.0) | 15.0 (10.3–21.6) | 26.0[#] (18.2–33.0) |
| | | *65.6%* | *56.1%* | *74.4%* | *73.2%* | *61.9%* | *87.4%* | *51.2%* |
| Saturated fat (g) | 8.3 | 9.0[§] (5.0–13.0) | 10.0 (6.0–14.0) | 8.2[‖] (3.5–11.1) | 8.8 (5.0–14.0) | 9.0 (4.8–13.0) | 5.3 (2.9–9.0) | 11.6[#] (7.0–15.0) |
| | | *45.3%* | *39.7%* | *50.4%* | *44.5%* | *45.6%* | *69.2%* | *29.4%* |
| Carbohydrate (g) | 90.0 | 71.0[§] (56.0–84.5) | 75.0 (57.0–86.0) | 67.4[‖] (55.8–80.9) | 74.7 (59.9–89.0) | 69.0[¶] (54.5–82.0) | 60.6 (49.2–73.2) | 77.2[#] (65.9–89.5) |
| | | *16.7%* | *19.7%* | *14.0%* | *23.2%* | *13.5%* | *5.1%* | *24.4%* |
| Total Sugars (g) | — | 13.0 (9.9–20.0) | 15.0 (11.0–21.0) | 12.7[‖] (9.3–17.2) | 14.8 (11.0–21.5) | 12.9[¶] (9.0–19.0) | 12.9 (9.8–19.0) | 13.0 (9.9–20.0) |
| Salt (g) | 1.8 | 2.2[§] (1.5–2.8) | 2.5 (1.8–3.4) | 1.9[‖] (1.3–2.5) | 2.3 (1.7–3.0) | 2.0[¶] (1.4–2.8) | 1.7 (1.2–2.4) | 2.4[#] (1.8–3.1) |
| | | *35.6%* | *23.8%* | *46.5%* | *29.9%* | *38.4%* | *53.5%* | *23.7%* |
| Dietary fiber (g) | 9.0 | 6.4[§] (5.0–9.0) | 5.0 (4.0–7.0) | 7.6[‖] (5.9–9.9) | 8.8 (6.4–11.0) | 6.0[¶] (4.0–7.4) | 6.7 (5.0–9.0) | 6.3 (5.0–9.0) |
| | | *26.0%* | *15.1%* | *36.0%* | *48.2%* | *15.0%* | *25.8%* | *26.1%* |
| FV (portions) | 1.5[†] | 2.0[§] (1.3–2.6) | 2.0 (1.5–3.1) | 2.0[‖] (1.0–2.0) | 2.0 (2.0–3.7) | 2.0[¶] (1.0–2.0) | 2.0 (1.7–2.9) | 2.0[#] (1.0–2.4) |
| | | *72.4%* | *75.3%* | *69.8%* | *86.6%* | *65.5%* | *81.8%* | *66.2%* |

FV, fruit and vegetables; MKDS, Meal Kit Delivery Services.
[*]Dietary recommendations for adults (19–64 years) adjusted to 30% for one meal [22].
[†]"At least 5 A Day" portions of fruits and vegetables recommendation adjusted to 30% for one meal [22].
[‡]"Health-based" meals were those meals assigned descriptors "healthy choice," "lean in 15," "calorie controlled" and "under 600 calories" by the MKDS.
[§]Significantly different ($P < 0.01$) from corresponding value for dietary recommendations.
[‖]Significantly different ($P < 0.05$) from corresponding value for MKDS1.
[¶]Significantly different ($P < 0.05$) from corresponding value for vegetarian meals.
[#]Significantly different ($P < 0.05$) from corresponding value for "health-based" meals.

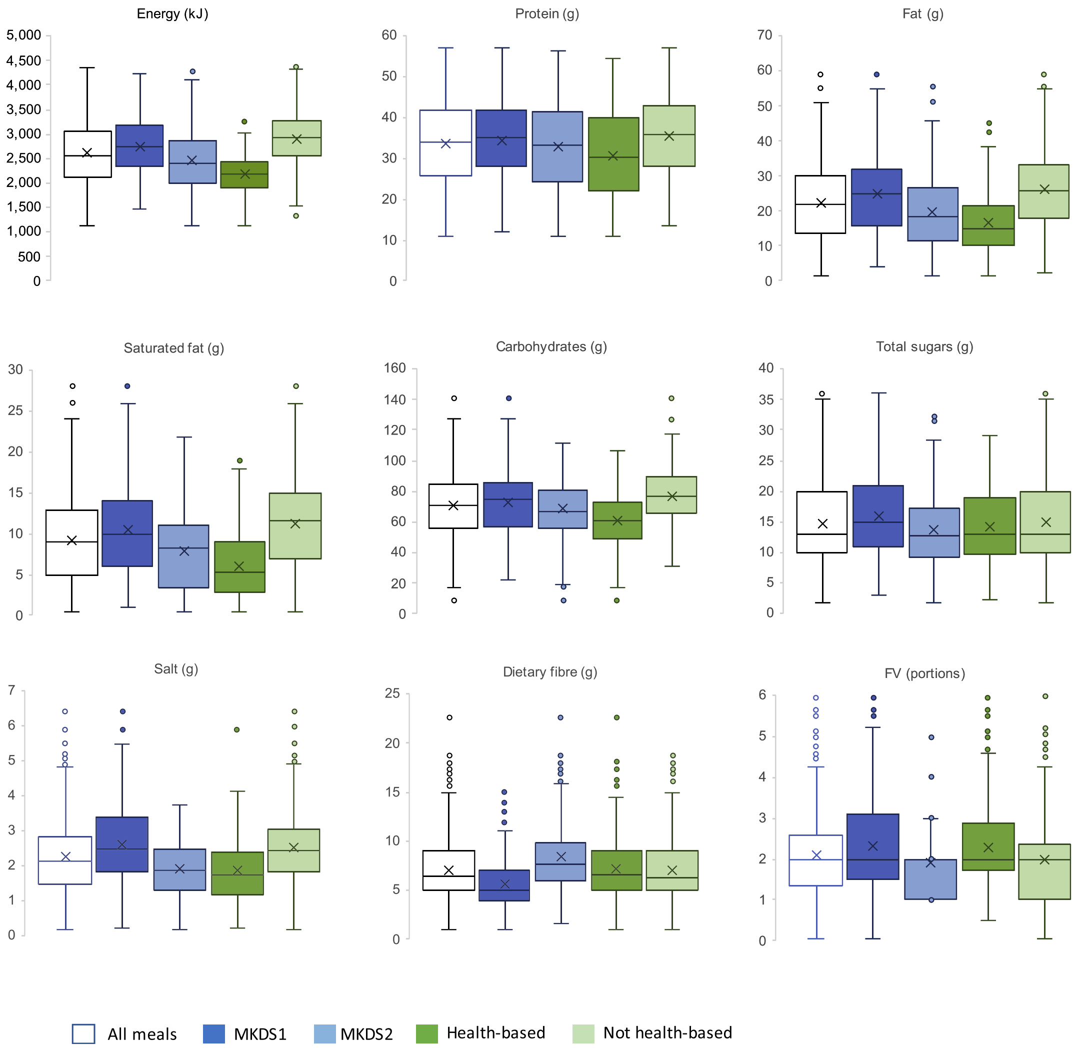


**Fig. 1.** Energy content and nutritional composition for all MKDS meals, across providers, and "health-based" classification.

approximately a quarter (26.0%) met the dietary reference value adjusted to 30% for a meal, that is, 9.0 g—with almost half of vegetarian meals (48.2%) doing so. Meal servings contained a median of 2.0 portions FV. Almost three-quarters (72.4%) had at least 1.5 portions—with vegetarian and "health-based" meals performing the best overall (86.6% and 81.8%, respectively, meeting the guideline).

With the exception of protein content, meals from the different MKDS differed in their nutritional composition. Effect sizes however were small apart from that observed for dietary fiber ($U$ = 16436.0, $P < 0.001$, $r$ = 0.40). Regarding vegetarian and non-vegetarian meals, differences were apparent for all variables considered, apart from energy, fat, and saturated fat content. The largest effect sizes were observed for protein, where non-vegetarian meals had higher content (Mdn = 38.9 g) than vegetarian meals (Mdn = 24.4 g), $U$ = 9066.5, $P < 0.001$, $r$ = 0.54; and fiber, where vegetarian meals had higher content (Mdn = 8.8 g) than non-vegetarian meals (Mdn = 6.0 g), $U$ = 14415.5, $P < 0.001$, $r$ = 0.38).

There were differences in the nutritional composition between "health-based" meals and others (not "health-based") — except for dietary fiber and total sugars. The largest effect sizes were observed for energy, where "health-based" meals had less energy content (Mdn = 2170.0 kJ) than others (Mdn = 2924.0 kJ), $U$ = 8800.5, $P < 0.001$, $r$ = 0.60; saturated fat: where "health-based" meals had less content (Mdn = 5.3 g) than other meals (Mdn = 11.6 g), $U$ = 13339.5, $P < .001$, $r$ = 0.47); fat, where "health-based" meals had lower content (Mdn = 15 g) than other meals (Mdn = 26 g), $U$ = 14096.5, $P < 0.001$, $r$ = 0.44; and for carbohydrate: where "health-based" meals had lower content (Mdn = 60.6 g) than other meals (Mdn = 77.2 g), $U$ = 15265.5, $P < 0.001$, $r$ = 0.41).

## *Nutritional profiles of meals*

Meals were profiled according to Front of Pack labeling criteria [19] and less than a tenth of meals ($n$ 48) were low in all nutrients examined (i.e., fat, saturated fat, total sugars, and salt); 14.1% ($n$ 70) were not high in any. Figure 2 presents the profiles for all meals, and across "health-based" classification. Most meals profiled high for salt (64.4%), fat (51.3%), or saturated fat (62.2%), and more than a third (37.0%, $n$ 184) of meals were high in all three. Most meals profiled low for total sugars (90.9%), reflecting their savory nature.

Of the 198 "health-based" meals, 38 were low in fat, saturated fat, total sugars, and salt; a quarter ($n$ 51 meals) were not high in any. Many "health-based" meals, however, profiled high for saturated fat (40.4%) and salt (46.5%). Other meals (i.e., not "health-based") profiled worse with higher proportions high for saturated

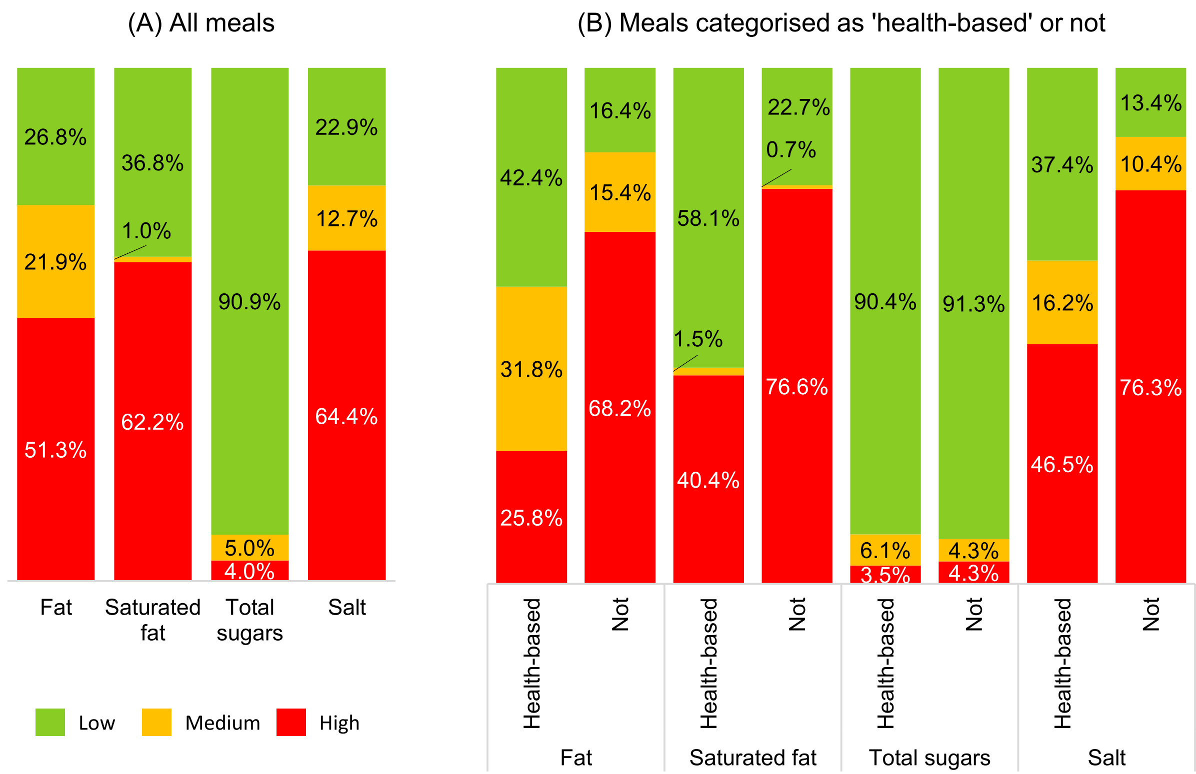


**Fig. 2.** MKDS meals profiled as low (green), medium (amber), and high (red) for levels of fat, saturated fat, total sugars, and salt (according to front-of-pack nutrition labeling) for all meals (A), and across "health-based" classification (B).

fat (76.6%) and salt (76.3%). "Health-based" meals had a better profile for saturated fat ($\chi^2$ (2, $n$ 497) = 66.3, $P < 0.001$, $\varphi_c = 0.37$), salt ($\chi^2$ (2, $n$ 497) = 49.5, $P < 0.001$, $\varphi_c = 0.32$), as well as total fat ($\chi^2$ (2, $n$ 497) = 86.7, $P < 0.001$, $\varphi_c = 0.42$). There was no association for sugar profile and "health-based"/not "health-based" meals ($\chi^2$ (2, $n$ 497) = 0.9, $P = 0.64$, $\varphi_c = 0.04$). Meals from one provider had a better profile for total fat, saturated fat, and salt, than the other provider, however, all effect sizes were small (0.18–0.24); there was no association between sugar profile and provider. Likewise, there was no association between meal type, vegetarian/non-vegetarian meals, and sugar profile, saturated fat, fat, or salt.

## Discussion

In this study, the nutritional composition of just under 500 meals from MKDS in the UK was analyzed. Meals were considered with respect to dietary recommendations and were profiled for fat, saturated fat, total sugars, and salt. Findings revealed a wide range of energy and nutrient content. Further, over half of meals profiled high for fat, saturated fat, and salt, with more than a third of meals high in all three. Recommendations for saturated fat (adjusted to one meal) were exceeded in just over half of meals in this study. Saturated fat content was not dissimilar (but with a smaller range) to previous research [14], conducted in Australia. Reductions in the levels of saturated fat are particularly relevant given that excessive saturated fat consumption is associated with increased risk of cardiovascular disease, type 2 diabetes, and certain cancers [25]. Almost two-thirds of meals profiled high for salt. This is particularly pertinent as the levels considered do not include salt added by the consumer (as directed in many recipes). High levels of salt have been reported in previous studies examining MKDS meals [14,15].

Almost three-quarters of meals fell short of dietary fiber recommendations and did not reach the equivalent of the dietary reference value adjusted to one meal. This low level is of particular note, given the acknowledged importance of dietary fiber and ongoing efforts to support diets rich in fiber, associated with lower risk of type 2 diabetes, cardiovascular diseases, colorectal cancer [26], and improved gut microbiome health [27]. The protein content of meals was high and more than double what would be expected for a lunch or evening meal. Almost a third of meals contained red or processed meat, and just under half of meals included cheese. Beans, nuts, or pulses were present in almost a third of meals, with fish or seafood in one in 10 meals. An interesting finding was the lack of oily fish in meals considered (i.e., the standard price meals). This is relevant with oily fish an important source of omega-3 fatty acids, and one weekly serving recommended [20]. Overall, meals fared well with respect to FV content, contributing two of the "5 A day" portions. This reflects previous research reporting adequate provision of vegetables in particular [15].

Two-fifths of meals were distinguished with "health-based" descriptors or tags. Although these meals had a better nutritional profile overall (than the other meals), less than half were low for fat and salt, and many did not meet dietary guidelines for saturated fat, carbohydrate, dietary fiber, and salt (adjusted to 30% for a meal).

The price of meals varied (£2.98–£6.25 per serving) according to the number of meals ordered per week. This was less than the average cost of a takeaway £9.75 per person [28] but more expensive than ready meals (reported median cost £2.20 [29]) and the average spend of eating at home (£1.26 per meal, estimated from weekly spend £28.83 per person [30]). The price of MKDS may be prohibitive for many, and may also limit their incorporation within interventions, as piloted with low-income US families [31,32] and

University students [33], and reported to be trialed with food bank users in London [34].

Meals included fresh vegetables, fresh meat, herbs, and spices—with recipe instructions. Previous work has reported how meal kits can promote basic cooking skills and familiarity with ingredients [14,16]. Whilst the benefits of home cooking have been reported [8,35], societal changes, working patterns, and affordable convenience food can hinder this [4]. The convenience of easy quick online ordering and home delivery of premeasured ingredients can facilitate home-cooked meals, with users highlighting the reduced time and mental load, and improved cooking skills [16].

It is interesting to note that the saturated fat and salt content of the MKDS meals in this study, compare favorably to luxury and standard (but not "healthy") ready meals from a previous study conducted in 2013 [29]. Further, when compared to the nutritional composition of takeaway meals in the UK [36], meals in the presented study fared well overall with lower energy, fat, and salt content. MKDS meals may be a beneficial replacement to takeaways and ready meals, and previous research found that families using MKDS reported relying less on takeaways and convenience foods, and perceived MKDS meals to be a healthier replacement [16].

### *Implications and recommendations*

Findings point to the need to revise MKDS recipes to reduce saturated fat and salt content. There may be opportunities to do this by adjusting the red and processed meat (featuring in almost a third of meals) and cheese content. Such changes are particularly relevant given the other aspects that MKDS offer, for example in influencing consumer diet, with improved cooking skills, vegetable consumption, and nutrient variety, (especially when considered as an alternative to convenience foods) [14,15]. Increases in dietary fiber content are also recommended, for example with a greater proportion of vegetables, beans, nuts, and pulses, and incorporating wholegrain rice or pasta. The lack of oily fish, within the standard price meals, is noteworthy and should be addressed to support dietary guidelines recommending one portion per week [37].

Many meal kits incorporated sachets of sauces and stocks; these may provide opportunities for reformulation to reduce salt content. Consideration should also be given to removing the instruction within recipes to add salt during cooking, particularly for meals with high salt content.

For consumer confidence and to support informed selection of meals, explicit criteria for the MKDS descriptors (e.g., "lean," "healthy choice") would be beneficial. Descriptors may be interpreted to confer nutritional benefit (e.g., healthy choice), potentially creating a halo effect [38], and this is important as a substantial proportion of "health-based" meals were high in salt, high in fat, and high in saturated fat.

The variation in energy and nutrient content highlights the importance of the selections made by consumers. This is pertinent given the strong link between excess energy consumption and obesity [39], and meals with similar energy content potentially having very different nutritional profiles [40]. Further work to ascertain how consumers select meals within the online food environment of MKDS is needed. This could inform strategies to support the selection of meals with better nutritional profiles and determine the relevance of supporting guidance. Likewise, the food choice architecture [41], how meals are framed to the consumer, and the subsequent influence on selection, are relevant and should be examined. Given the online nature of MKDS, there is the opportunity to provide real-time feedback to support consumers as they select meals. The provision of such actionable feedback has been highlighted as an underutilized strategy in behavior change [42].

### *Limitations*

The limitations of this study are acknowledged; notably, the data relate to all ingredients provided by MKDS but do not include store cupboard ingredients, salt added to taste, or any adaptations. FV content for some meals was estimated. The criteria for the assignment of descriptors by MKDS (which then formed the basis of the "health-based" classification) were not available and could not be checked. The dietary recommendations acting as the reference in this study were based on the convention that an evening or lunch meal would account for 30% of daily intake. Further, dietary recommendations relate to an overall diet rather than one meal. Other contributions (e.g., beverages and desserts) that may be associated with a meal were disregarded in this study.

## Conclusion

Over half of the meals from MKDS profiled high for salt, fat, and saturated fat, and contained low dietary fiber content. "Health-based" meals had significantly better profiles than other meals, notwithstanding many were high in salt, fat, and saturated fat. Reformulation to improve the nutritional profile of meals available from MKDS is needed.

The wide range of energy and nutrient content in meals highlights the relevance of the individual selections made by consumers. Further work is needed to understand how consumers select meals within the online food environment of MKDS, and the relevance of an environment supportive to consumers' selection of meals with better nutritional profiles.

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this article.

## CRediT authorship contribution statement

**Nicola Nixon:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis. **Hannah Ensaff:** Writing – review & editing, Methodology, Conceptualization.

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