Portion size and energy content of lunches eaten outside the home

An explorative analysis of selected meals

Christina Holzapfel, Meike Wiechert, Magdalena Jocher, Stephanie Mittermaier, Hans Hauner

Abstract

In Germany, little is known about the portion sizes and energy content of lunches eaten outside the home. The present study aimed to investigate the portion sizes and the energy content of five popular lunches (pizza with salami, doner kebab, Currywurst with french fries, *Asianudeln* with chicken, and *Schweinebraten* with dumplings and coleslaw) from three different restaurants and on two different days. The energy content was measured by bomb calorimetry ($energy_{bomb}$) and using nutrition software ($energy_{software}$). The data were analyzed descriptively. Portion sizes varied between meals and restaurants. One portion of Currywurst with french fries weighed 318 g on average (min.: 272 g, max.: 372 g), followed by doner kebap, pizza with salami, *Asianudeln* with chicken, and *Schweinebraten* with sides (769 g on average; min.: 594 g, max.: 976 g). Overall, the investigated lunches had a mean $energy_b$ of 935 kcal and a mean $energy_s$ of 792 kcal. These findings show that these lunches are typically served with a large portion size and have a high energy content. Current recommendations state that lunch should make up no more than one third of daily energy intake, but these lunches exceed those values for most adults, even without considering energy-containing beverages and desserts. Given the high prevalence of obesity, it would be preferable to reduce energy intake from lunches eaten outside the home and introduce mandatory labeling.

Keywords: energy content, portion size, obesity, body weight, out-of-home consumption

Introduction

Overweight and obesity are among the greatest health challenges that Germany currently faces. According to the German Health Interview and Examination Survey for Adults (DEGS1), 67% of men and 53% of women in Germany have a Body Mass Index (BMI) ≥ 25 kg/m², and are therefore overweight. The prevalence of obesity (BMI ≥ 30 kg/m²) is 23% for men and 24% for women [1]. There are several reasons for this, but a high energy intake plays a major role.

Various trends in nutrition that have developed over the last few decades may be aggravating the problem of overweight and obesity. These trends include eating outside the home, excessively large portion sizes for meals eaten outside the home and the high energy density of these meals. In the USA, between 1977/78 and 2008, the proportion of daily energy intake consumed outside the home rose from 18% [2] to 35% [3] of total energy intake. A similar trend can be observed in Germany. Here, the number of people eating out at least once a day increased by more than 25% between 1991 and 2002 [4]. The 2011 Nestlé study on eating behavior in Germany also found a sustained trend towards more meals eaten outside the home [5]. Eating out is known to correlate with increased BMI [9] because it results in increased fat and energy intake [6–8].

Furthermore, portions are becoming larger over time, both at home and outside the home [10, 11]. Young and Nestle described an increase in portion sizes since the 1970s. The associated higher energy intake could also be associated with an increase in body weight [10]. Moreover, a recent study showed that the range of appetizers, side dishes and desserts offered at fast food chains in the USA increased by 226% between 1986 and 2016 [12].

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An US study also found that meals served in restaurants contain on average 66% of the recommended daily energy intake (1,327 kcal), which means that they contain too much energy [13].

With this in mind, it is needed to investigate the energy content of popular lunches in Germany. Therefore, the aim of this study was to analyze selected hot lunches served outside the home with regard to their portion sizes and energy content.

Methodology

In this study, a total of five hot lunches were analyzed with regard to their portion sizes and energy content. The meals selected were pizza with salami, doner kebab, Currywurst (sausage with a curry sauce) with french fries, *Asianudeln* (Asian-style noodles) with chicken and *Schweinebraten* (traditional roast pork) with dumplings and coleslaw. Each meal was purchased at three different restaurants or at three different food stalls (restaurants 1–15) in Freising (Bavaria) on two different days (day 1, day 2) in 2014. Each meal was purchased six times. The wet weight in grams of each meal was determined by weighing in the laboratory. To investigate the energy content, the energy value was determined using two methods.

Bomb calorimetry

The physical energy value of the selected meals was determined by means of bomb calorimetry [14]. The meals were first coarsely chopped, frozen and freeze-dried. Afterwards, the dry weight in g was determined by weighing. After milling with a knife mill (GRINDOMIX Retsch GM200), pellets were created from a defined quantity of the powders obtained from milling. The pellets were formed using a tableting machine and burned in an isoperibol bomb calorimeter (Parr 6300 calorimeter). The complete combustion of the pellets into carbon dioxide (CO_2) and water (H_2O) releases heat, which the device records and converts into a gross energy value (kJ/g) [15]. To calculate the (net) energy values (= energy content [kJ]), the dry weight was multiplied by the respective gross energy value. The kilojoule values were multiplied by a factor of 0.239 to obtain the equivalent value in kilocalories (kcal). The physiological energy value is the energy content in meals that humans can use. This value is about 10% lower than the physical energy value because a portion of the energy is lost via feces, urine, gases or secretions [16]. The physical energy value determined by bomb calorimetry was therefore reduced by 10% so that it corresponds to the physiological energy value (= $\text{energy}_{\text{bomb}}$, energy_{b}).

Nutrition software

The physiological energy value of the selected meals was determined using a weighed food record and commercially available nutrition software (= $\text{energy}_{\text{software}}$, energy_{s}). After purchasing, the meals were seperated into their individual components as much as possible and then weighed. Food records were analyzed using the nutrition software OptiDiet 5.1 (*Gesellschaft für optimierte Ernährung* [GOE] mbH). The data of the software based on the German food composition database. The evaluation was done by entering the quantities for each of the individual components of the meals. The evaluation of the weighed food record data was done without knowledge of the results of the bomb calorimetry.

Statistics

The data were analyzed using Microsoft Excel 2010. Results are descriptively presented as mean values, minimums and maximums, and percentage differences between the methods, meals, restaurants and days.

Results

Portion sizes

The portion sizes of the different categories of lunches varied between categories, restaurants and days. One portion of Currywurst with french fries weighed 318 g on average (min.: 272 g, max.: 372 g), doner kebab 360 g (min.: 336 g, max.: 402 g), pizza with salami 424 g (min.: 386 g, max.: 454 g), *Asianudeln* with chicken 511 g (min.: 448 g, max.: 592 g), and *Schweinebraten* with sides 769 g (min.: 594 g, max.: 976 g). The following deviations in percent between the smallest and largest portion size were found within each of the categories: Currywurst with french fries: 37%, doner kebab: 20%, pizza with salami: 18%, *Asianudeln* with chicken: 32%, *Schweinebraten* with sides: 64%. The largest difference in portion sizes was in the *Schweinebraten* category (max. difference: 325 g). The smallest difference in portion sizes between restaurants was in the pizza category (max. difference: 38 g). When portion sizes were compared within the same restaurant on different days, there was a difference of 4 g (restaurant 6) and 6 g (restaurants 4 and 5) in the doner kebab category. In the *Schweinebraten* category, the portion size in restaurant 14 differed by 88 g when comparing different days.

Energy_{b}

Across selected meals, the average energy_{b} was 935 kcal (min.: 608 kcal, max.: 1,816 kcal). The *Schweinebraten* category had the highest average energy_{b} per portion with 1,235 kcal (min.: 819 kcal, max.: 1,816 kcal), and the doner kebab category had the lowest average energy content per portion with 664 kcal (min.: 608 kcal, max.: 730 kcal). The average energy_{b} for pizza was 1,121 kcal (min.: 1,035 kcal, max.: 1,258 kcal), for Currywurst 911 kcal (min.: 658 kcal, max.: 1159 kcal) and for *Asianudeln* 744 kcal (min.: 675 kcal, max.: 944 kcal). ◆ Figure 1 and ◆ Figure 2 show the differences and deviations in percent between the days for each category and restaurant. A comparison of measurements of different lunches served at the same restaurant on different days showed high differences in how much the energy$_b$ differed in each category between the two days (◆ Figure 1). The largest difference within a single restaurant was measured in the *Schweinebraten* category (max. difference: 437 kcal). When the energy$_b$ was compared between restaurants, the *Schweinebraten* category also showed the highest differences (max. difference: 997 kcal).

Energy$_s$

Within all analyzed meals, the average energy$_s$ was 792 kcal (min.: 475 kcal, max.: 1,557 kcal). The meal with the highest energy$_s$ was *Schweinebraten*, with an average of 1,192 kcal (min.: 900 kcal, max.: 1,557 kcal) per portion. The lunch with the lowest energy$_s$ was doner kebab with an average of 517 kcal (min.: 488 kcal, max.: 566 kcal) per portion. The energy$_s$ values for pizza with salami, Currywurst and *Asianudeln* were 1,002 kcal (min.: 912 kcal, max.: 1,072 kcal), 626 kcal (min.: 475 kcal, max.: 704 kcal) and 625 kcal (min.: 522 kcal, max.: 789 kcal), respectively.

Comparison of energy values

◆ Figure 3 compares mean energy$_b$ values with mean energy$_s$ values. The smallest deviation between the energy values was found in the category *Schweinebraten* with 13%. The next largest deviation was in the category pizza with 20%, followed by *Asianudeln* with chicken (24%) and doner kebab (30%). The largest deviation between the two measured energy values was found in the category Currywurst, where the deviation was 38%.

D-A-CH reference values for nutrient intake

The mean energy$_b$ across the five categories was 935 kcal (min.: 608 kcal, max.: 1,816 kcal). Analysis of the lunches using the nutrition software found a mean energy$_s$ of 792 kcal (min.: 475 kcal, max.: 1,557 kcal) per portion. According to the D-A-CH reference values, the recommended energy intake for adults aged 19 to 25 years with a low physical activity level ([PAL] = 1.4) is 1,900 kcal/day for women and 2,400 kcal/day for men [17].

Assuming that energy intake is distributed across three main meals per day (with each meal provides 33% of the recommended energy intake), the energy content of the lunches investigated in this study exceeds the recommendations in most of the categories. ◆ Table 1 shows the energy content supplied by each meal in relation to the recommendations based on the D-A-CH reference values. If a woman eats a lunch providing either 792 kcal or 935 kcal on average, she will have already consumed either 42% or 49% of her recommended daily energy intake based on the reference values; a man will have consumed either 33% or 39% of his recommended daily energy intake.

According to the software-based calculations of energy content, only the doner kebab was below the recommended caloric intake per meal of 33% on average with regard to women's recommended energy

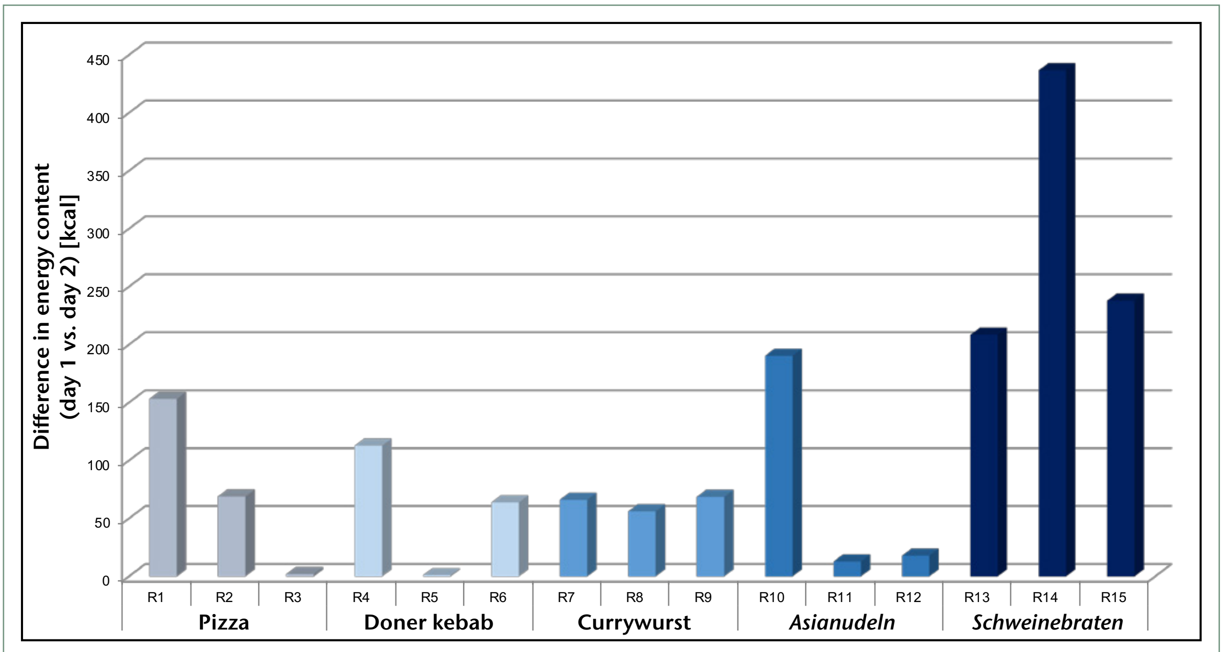

Fig. 1: **Difference in energy$_{bomb}$ (day 1 vs. day 2) at each restaurant in kilocalories [kcal]**
R = Restaurant

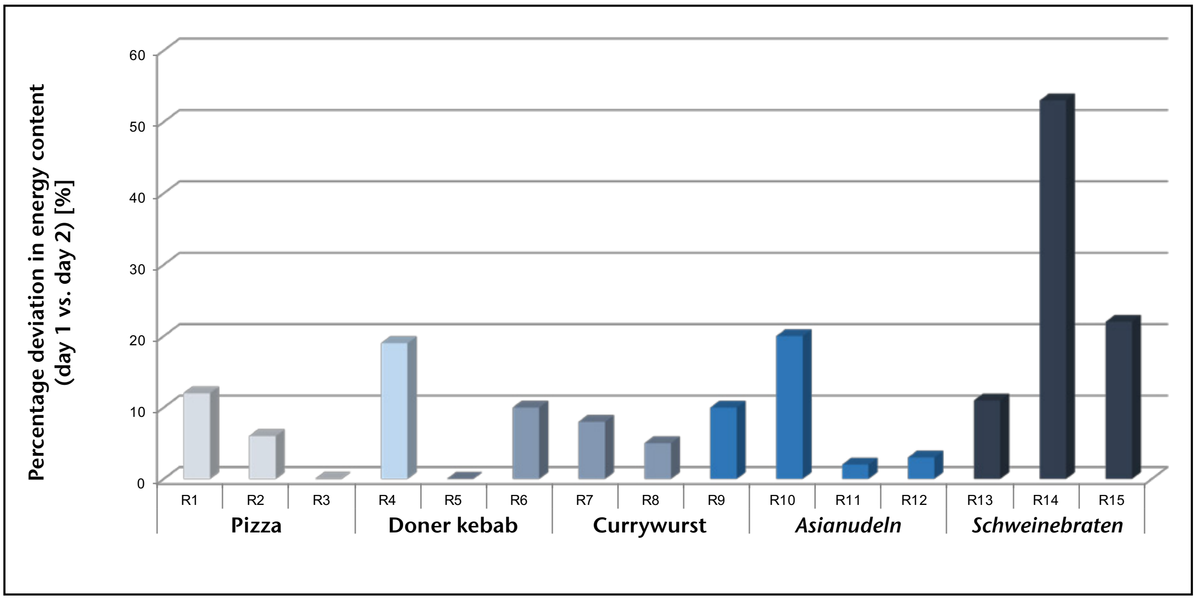

Fig. 2: **Percentage deviation in energy$_{bomb}$ (day 1 vs. day 2) at each restaurant in kilocalories [kcal]**
R = Restaurant

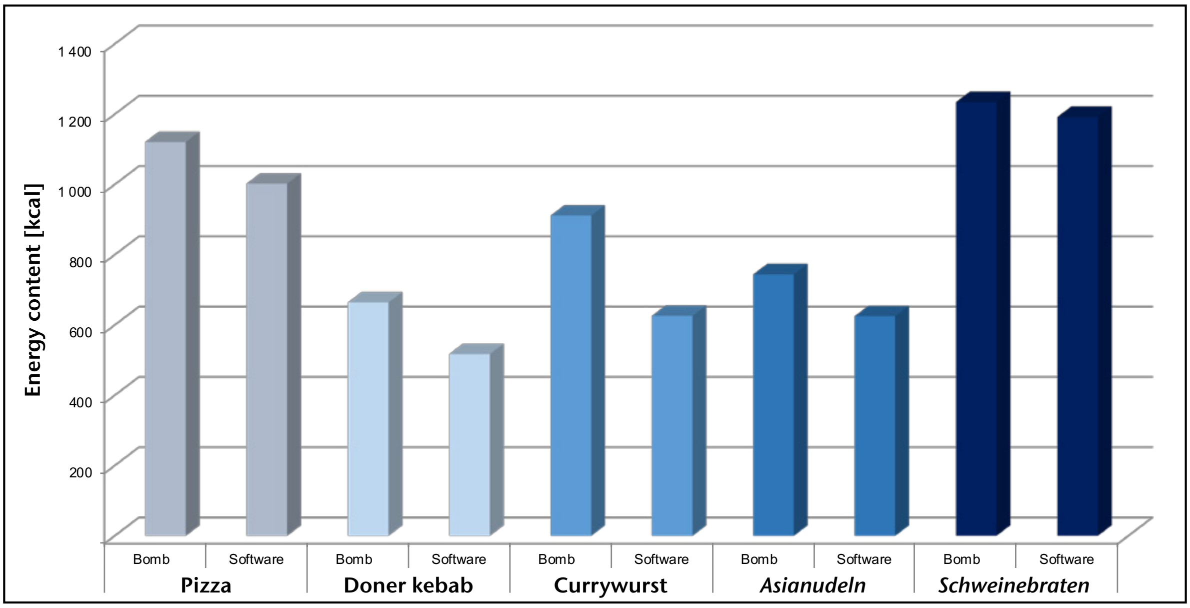

Fig. 3: **Comparison of average energy$_{bomb}$ with average energy$_{software}$ in kilocalories [kcal]**

intake. A portion of Currywurst or *Asianudeln* provided the recommendations of 33% of daily energy intake for women. None of the energy$_b$ values were within the recommended energy intake for a meal for women. For men, regardless of the calculation method, a portion of doner kebab or *Asianudeln* was below the 33% of the reference value for daily energy intake. Th energy$_s$ of the Currywurst was lower than the recommendations of 33% of daily energy intake for men (◆ Table 1).

Discussion

This study was able to demonstrate that the portion sizes and energy content of the lunches that were analyzed varied considerably, both between meals, restaurants and days. The main finding is that the Energy content of these lunches significantly exceeded the recommended energy intake per meal.

Meal	Energy$_b$ [kcal]	% of daily requirement		Energy$_s$ [kcal]	% of daily requirement	
		Women	Men		Women	Men
Pizza	1,121	59	47	1,002	53	42
Doner kebab	664	35	28	517	27	22
Currywurst	911	48	38	626	33	26
Asianudeln	744	39	31	625	33	26
Schweinebraten	1,235	65	52	1,192	63	50
Mean	**935**	**49**	**39**	**792**	**42**	**33**

Tab. 1: **Energy$_{b(omb)}$ and energy$_{s(oftware)}$ in relation to daily requirements** (recommended daily energy intake according to the D-A-CH reference values for nutrient intake [adults aged 19 to 25 years with a low physical activity level]: women: 1,900 kcal, men: 2,400 kcal)

Portion sizes

Large variations in the degree of standardization of portion sizes were measured. There were different degrees of variation in portion sizes both within and between restaurants, depending on the meal category. For example, in the category *Schweinebraten* with sides, the difference in one restaurant was nearly 500 kcal, i.e. the same dish contained 500 kcal more or 500 kcal less energy for the same price. This may be due to the characteristics of the individual components of the dish (e.g. the variable fat content of the meat) and due to variation in the quantities of these components (e.g. differences in the thickness and size of a slice of meat). The smallest differences in energy content were in the doner kebab category. This is probably because of the relatively uniform size of the flatbreads. Other studies have also found large differences in portion sizes within defined product categories [13, 18]. The study by Roberts et al. recorded the energy content of 223 dishes served in restaurants and fast food chains in five countries by means of bomb calorimetry. In some cases, a dish served in one restaurant had as much as double the energy content of the same dish served in another restaurant [19]. These data demonstrate that information about the energy content of dishes that is provided in nutrition tables or on restaurant menus can be very unreliable and misleading. For the majority of dishes, portion size and energy content appear to be excessive. This may contribute to excessively high energy intake, depending on the individual energy requirements and number of main meals eaten.

Energy content

The measured physiological energy content (= physical energy content minus 10%), which is the value most likely to correspond to the actual usable energy supplied by diet, was 935 kcal on average across the meals that were analyzed. Meals (including appetizers and side dishes) that were analyzed with bomb calorimetry in different cities in the USA, provided a mean energy content of 1,205 kcal (+/- 465 kcal). 92% of the meals contained more than 570 kcal per portion [20]. Although in both analyses the same analytical method was used to determine the energy content results from Germany and the USA can only be compared to a limited extent due to differences in eating habits and available food options between the two countries. Nevertheless, the conclusion drawn by both studies is that the energy supplied per portion is too high compared to actual energy requirements. In this study, the D-A-CH recommendations for energy intake for adults aged 19 to 25 years have been compared with the measured energy content values. Since the guiding values for energy intake decrease with age, older people will consume an even larger percentage of their recommended daily energy intake when eating the lunches that were analyzed. In addition, the reference values used in this study were the recommended energy intakes for adults with a normal body weight. Because the majority of adults are either overweight or obese, and because energy requirements increase with increasing body weight, the results cannot be transferred to higher BMI categories.

Nutrition software

There were large differences between the energy$_b$ and energy$_s$ values. This was most likely due to the difficulty of entering the data into the nutrition software. For example, it was difficult to separate the purchased meals into their individual components with precision. The flatbread of the doner kebab meals was usually soaked with sauce, which made it impossible to differentiate between sauce (g) and bread (g). In addition, the nutrition software has a limited database, and it was therefore not possible to accurately reflect all of the meal components: alternative foods had to be selected where components were missing from the database. For example, the sauce in the doner kebab was recorded as "basic white sauce", the sauce in the *Schweinebraten* was recorded as "basic brown sauce" and the sauce in the Currywurst was recorded as "curry sauce". The exact sauce recipes that the restaurants used were not known, so they could only be reflected in the data entered into the nutrition software in a very imprecise manner. These difficulties may explain why the calculated energy$_s$ values were low, and thus explain the large deviations between the calculation methods. The weighed food record, which is considered the gold standard for dietary assessment, has similar issues: in everyday life, the only measurements that are usually available to input data into the nutrition software are gram measurements or other common household measurements, and the recipes people actually use often differ from the standard recipes in the database. This illustrates how difficult and imprecise the recording of nutrient intake is and how cautiously results obtained in this way should be interpreted.

Food labeling

In Germany, providing information about the energy content of dishes served in restaurants is neither common practice nor a legal requirement. A systematic review examined 28 studies with regard to changes in purchasing and consumption behavior in eating establishments as a result of nutritional labeling. The authors found that providing information about energy content on menus can lead to a reduction in the total energy content of food purchased in restaurants [21]. Providing information about the energy content of different meals can therefore help consumers to choose a less energy-dense meal. Offering different portion sizes during the ordering process can also lead to a decrease in the amount of energy consumed when eating outside the home [20]. Another interesting finding was that meals served in restaurants that voluntarily provided information about the energy content of their dishes contained less energy per product sold than meals in restaurants that did not provide this information [22].

Strengths and limitations

All bomb calorimetry measurements were performed by the same person using a standardized protocol. In addition, ten pellets from each meal were burned in the bomb calorimeter and their results were averaged. In studies conducted in the USA to validate the bomb calorimetry measurement method, defined meals were produced from various basic components whose energy content was calculated based on their macronutrient compositions. These meals were also burned in the bomb calorimeter. Bomb calorimetry was found to have high validity and measurement accuracy [13, 23]. In the software-based analysis, each single meal component was entered, which presumably increased the accuracy of the analysis.
In terms of limitations, it should be noted that only a limited selection of meals were included in this study, and this selection does not reflect the true range and variety of lunches. Only five lunches were selected as examples. In addition, the sample size for each meal was relatively small (N = 6). Since only five meals at three restaurants on two days were included, the selection of meals is not representative, especially because it refers to the regional offer. Additional items that consumers frequently order, such as ketchup, desserts or energy-containing drinks consumed alongside meals were not taken into account, so this could lead to an underestimation of actual energy intake at lunch.

Conclusions

This analysis of selected lunches shows that their portion sizes and energy content are high, and that consumption of these lunches entails the consumption of more than one third of daily energy requirements. Given the high prevalence of obesity, it would be preferable to improve the lunches on offer for consumption outside the home – for example by making portions smaller and adding more vegetables and salad, and by offering less energy-dense alternatives. Nutrition labelling should also be extended to meals eaten outside the home, as this would make it easier for consumers to choose demand-oriented meals. The current situation of out-of-home catering represents a high potential to make an effective contribution to healthy eating and the prevention of obesity.

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Conflict of Interest
Christina Holzapfel is a member of the Scientific Advisory Board of 4sigma GmbH, Oberhaching. Hans Hauner is the spokesperson of the *enable* Competence Cluster in Nutrition Research, which runs projects in cooperation with companies in the nutrition industry such as J. Rettenmaier & Söhne GmbH + Co KG and Dr. August Oetker Nahrungsmittel KG. Hans Hauner has received consulting fees from Nestlé Deutschland AG and DANONE GmbH. Hans Hauner is a member of the Scientific Advisory Board of Oviva AG.
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