Are some diets "mass murder"?

Diets that are based on poor nutrition science are a type of global, uncontrolled experiment that may lead to bad outcomes, concludes **Richard Smith**

Jean Mayer, one of the "greats" of nutrition science, said in 1965, in the colourful language that has characterised arguments over diet, that prescribing a diet restricted in carbohydrates to the public was "the equivalent of mass murder."[1] Having ploughed my way through five books on diet and some of the key studies to write this article, I'm left with the impression that the same accusation of "mass murder" could be directed at many players in the great diet game. In short, bold policies have been based on fragile science, and the long term results may be terrible.[2-6]

Attributing disease or mortality to diet is scientifically difficult. Associations are first made through observational studies, but recording exactly what people eat is hard. We eat very varied diets, and maybe over time our diets change. Then converting our diet into components of fat, carbohydrate, protein, and the like is unreliable. So to make a link between diet recorded over a short period of time and diseases and deaths encountered perhaps decades later is inevitably difficult.

Then intervention trials are unreliable. Unlike with a drug trial, where there will be one variable (taking or not taking the drug), trials of diet include more than one variable: for example, a diet of less fat probably means more carbohydrate so as to supply enough energy. Adherence is an important problem in drug trials but a much bigger problem in trials of diets, as people may find it very difficult to follow an unfamiliar diet. Also, the trials are usually short term and rarely include hard outcomes such as cardiovascular events or deaths.

John Ioannidis, the scourge of poor biomedical science, has shown the great unreliability of most studies linking nutrition to disease and mortality,[7] and perhaps we fail to recognise the complexity of relations between diet and disease when we pick out single components, whether it's total fat, saturated fat, trans fats, sugar, or salt.

The big fat surprise

By far the best of the books I've read to write this article is Nina Teicholz's *The Big Fat Surprise*, whose subtitle is "Why butter, meat, and cheese belong in a healthy diet."[3] The title, the subtitle, and the cover of the book are all demeaning, but the forensic demolition of the hypothesis that saturated fat is the cause of cardiovascular disease is impressive. Indeed, the book is deeply disturbing in showing how overenthusiastic scientists, poor science, massive conflicts of interest, and politically driven policy makers can make deeply damaging mistakes. Over 40 years I've come to recognise what I might have known from the beginning—that science is a human activity with the error, self deception, grandiosity, bias, self interest, cruelty, fraud, and theft that is inherent in all human activities (together with some saintliness), but this book shook me.

I'm left with the impression that Jean Mayer's accusation of "mass murder" could be directed at many players in the great diet game

Teicholz begins her examination by pointing out that the Inuit, the Masai, and the Samburu people of Uganda all originally ate diets that were 60-80% fat and yet were not obese and did not have hypertension or heart disease.

The hypothesis that saturated fat is the main dietary cause of cardiovascular disease is strongly associated with one man, Ancel Benjamin Keys, a biologist at the University of Minnesota. He was clearly a remarkable man and a great salesman, described by his colleague Henry Blackburn (whom I've had the privilege to meet) as "possessing a very quick, bright intelligence" but also "direct to the point of bluntness, and critical to the point of skewering."[8]

Keys launched his "diet-heart hypothesis" at a meeting in New York in 1952, when the United States was at the peak of its epidemic of heart disease, with his study showing a close correlation between deaths from heart disease and proportion of fat in the diet in men in Japan, Italy, England, Wales, Australia, Canada, and the United States.[9] Keys studied few men and did not have a reliable way of measuring diets, and in the case of the Japanese and Italians he studied them soon after the second world war, when there were food shortages.

Keys could have gathered data from many more countries and people (women as well as men) and used more careful methods, but, suggests Teicholz, he found what he wanted to find. A subsequent study by other researchers of 22 countries found little correlation between death rates from heart disease and fat consumption, and these authors suggested that there could be other causes, including tobacco and sugar consumption.[10]

The Masai (left) originally ate diets that were 60-80% fat, but they were not obese and did not have hypertension or heart disease. Yet Ancel Keys (right) argued for a causative role for saturated fats in heart disease, which affected dietary policies for decades

ERIC LAFFORGUE/GAMMA-RAPHO/GETTY IMAGES

Fat versus sugar

At a World Health Organization meeting in 1955 Keys's hypothesis was met with great criticism, but in response he designed the highly influential Seven Countries Study, which was published in 1970 and showed

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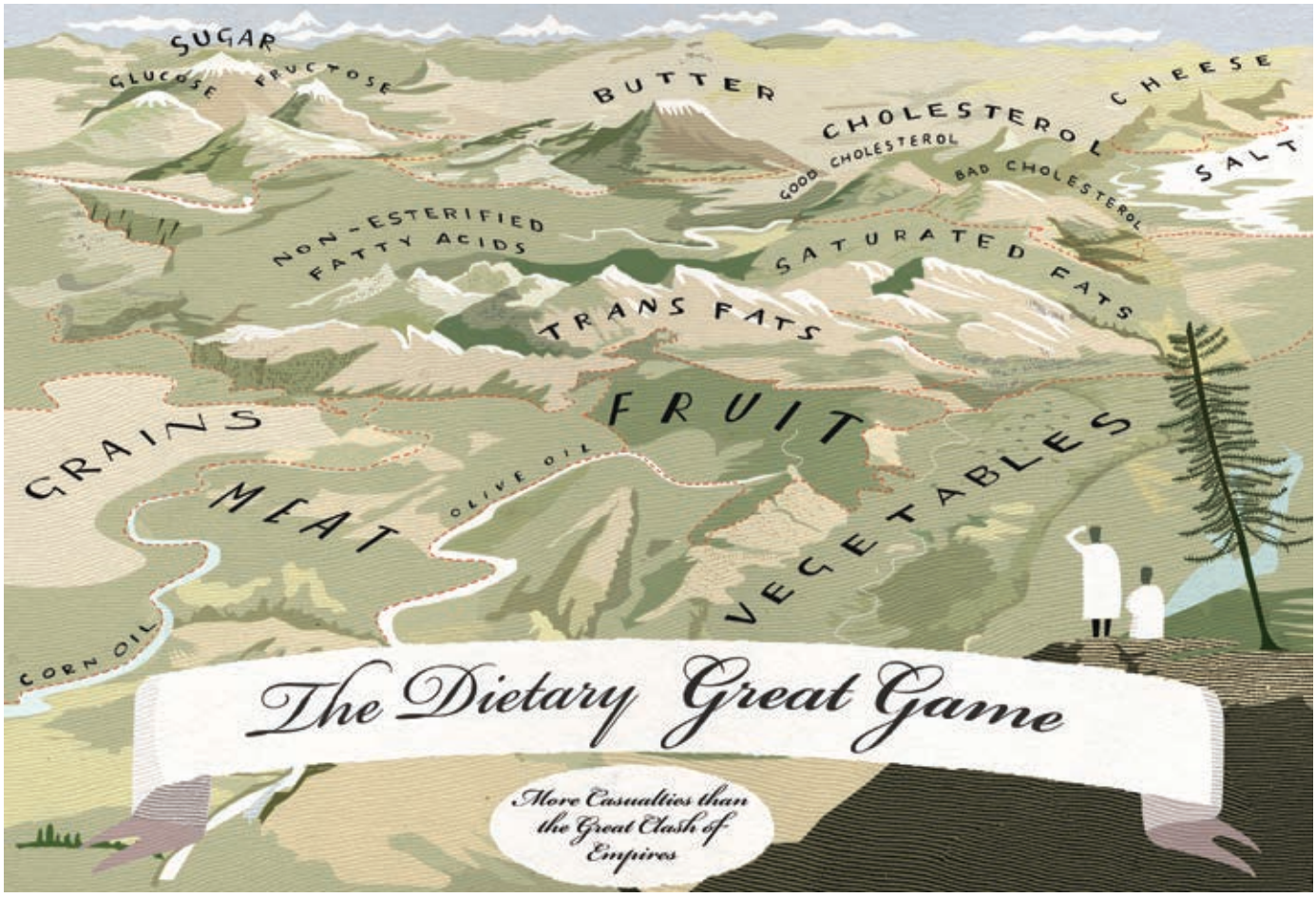

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a strong correlation between saturated fat (Keys had moved on from fat to saturated fat) and deaths from heart disease.[11] Keys did not select countries (such as France, Germany, or Switzerland) where the correlation did not seem so neat, and in Crete and Corfu he studied only nine men. Critics pointed out that although there was a correlation between countries, there was no correlation within countries and nor was there a correlation with total mortality. Furthermore, although the study had 12 770 participants, the food they ate was evaluated in only 3.9%, and some of the studies in Greece were during Lent, when the Greek Orthodox Church proscribes the eating of animal products. A follow-up study by Keys published in 1984 showed that variation in saturated fat consumption could not explain variation in heart disease mortality.[12]

An analysis of the data from the Seven Countries Study in 1999 showed a higher correlation of deaths from heart disease with sugar products and pastries than with animal products.[13] John Yudkin from London had since the late 1950s proposed that sugar might be more important than fat in causing heart disease,[4] but Keys dismissed his hypothesis as a "mountain of nonsense" and a "discredited tune." Many scientists were sceptical about the saturated fat hypothesis, but as the conviction that the hypothesis was true gripped the leading scientific bodies, policy makers, and the media in the US these critics were steadily silenced, not least through difficulty getting funding to challenge the hypothesis and test other hypotheses.

Interventional studies were unconvincing

A series of interventional studies was carried out to test the fat hypothesis, but they were small, short term, and suffered from the problem of changing more than one variable at once. A *Lancet* editorial in 1974 said that little could be concluded from them.[14] Certainly they didn't show strong support for the saturated fat hypothesis.

A report from the American Heart Association in 1961 was the first to recommend substitution of polyunsaturated fats (corn or soybean oil) for saturated fat,[15] and a later report in 1970 recommended reduction in total fat. At that time E H Ahrens, a lipid researcher from New York who believed that carbohydrate was more important than fat in causing heart disease, worried that mass adoption of low fat diets might lead to increases in obesity and chronic disease.

Teicholz explains how through the political process the fat hypothesis led to a massive change in the US and subsequently international diet.[3] One congressional staffer, Nick Mottern, wrote a report recommending that fat be reduced from 40% to 30% of energy intake, saturated fat capped at 10%, and carbohydrate increased to 55-60%. These recommendations went through to *Dietary Guidelines for Americans*, which were published for the first time in 1980.[16] (Interestingly, a recommendation from Mottern that sugar be reduced disappeared along the way.)

Powerful lobby groups

It might be expected that the powerful US meat and dairy lobbies would oppose these guidelines, and they did, but they couldn't counter the big food manufacturers such as General Foods, Quaker Oats, Heinz, the National Biscuit Company, and the Corn Products Refining Corporation, which were both more powerful and more subtle. In 1941 they set up the Nutrition Foundation, which formed links with scientists and funded conferences and research before there was public funding for nutrition research.

Despite continuing doubts, it became, and still is, the global orthodoxy that saturated fat was an important cause of cardiovascular disease and that people should eat low fat diets. The biggest test of the saturated fat hypothesis came with the Women's Health Initiative, which enrolled 49 000 premenopausal women in a randomised trial of the low fat diet and cost $725m (£460m; €580m).[17] The women were followed for 10 years, and those in the low fat arm successfully reduced their total fat consumption from 37% to 29% of energy intake and their saturated fat from 12.4% to 9.5%. But there was no reduction in heart disease or stroke, and nor did the women lose more weight than the controls.

The successful attempt to reduce fat in the diet has been a global, uncontrolled experiment, which like all experiments may well have led to bad outcomes

A 2008 review by the Food and Agriculture Organization concluded that "there is no probable or convincing evidence" that a high level of fat in the diet causes heart disease.[18] A 2012 Cochrane review of 24 comparisons with 65 508 participants found no benefit from total fat reduction and no effect on cardiovascular or total mortality but a small reduction (relative risk 0.86 (95% confidence interval 0.77 to 0.96)) in cardiovascular events in men (not women).[19]

Recognising that the fat hypothesis was falling apart, some scientists, particularly Walter Willett, professor of epidemiology at Harvard (whom I've also met), began to promote the Mediterranean diet, which comes in many forms but is essentially lots of fruit, vegetables, bread and grains (including pasta and couscous), little meat and milk, and plenty of olive oil. Such a diet is much easier to eat than a low fat diet, and a combination of vested interests, including the International Olive Oil Council and a public relations company Oldways, which promoted the diet, has—together with the natural seductiveness of the Mediterranean region—made the diet popular. But the science behind it is weak, as a Cochrane review found,[20] and some of the evidence comes from R B Singh, whose research is suspect.[21]

Rise and fall of trans fats

Saturated fats such as lard, butter, and suet, which are solid at room temperature, had for centuries been used for making biscuits, pastries, and much else, but when saturated fat became unacceptable a substitute had to be found. The substitute was trans fats, and since the 1980s these fats, which are not found naturally except in some ruminants, have been widely used and are now found throughout our bodies. There were doubts about trans fats from the very beginning,[22] but Teicholz shows how the food companies were highly effective in countering any research that raised the risks of trans fats. It was Dutch research published in 1990 that signalled the beginning of the end for trans fats by showing that a diet high in trans fats led not only to raised LDL (low density lipoprotein) cholesterol but also lowered HDL cholesterol.[23] Willett of the Mediterranean diet did for trans fats in the US when he said, "We are really conducting a very large human-scale, uncontrolled, unmonitored national experiment."[24]

The Food and Drug Administration in 2003 called for trans fats to be included on food labels and in 2014 banned them. The requirement for labelling had already signalled the end, and when the FDA issued its ruling some 42 720 processed foods in the US contained trans fats. The impossibility of going back to saturated fat (because the idea that it is bad is so deep in our beliefs and continues to be supported by the American Heart Association) meant that food manufacturers have had to find a new substitute, interesterified fats, which may prove just as bad as trans fats. Again it's a mass uncontrolled experiment.

Another consequence of the fat hypothesis is that around the world diets have come to include much more carbohydrate, including sugar and high fructose corn syrup, which is cheap, extremely sweet, and "a calorie source but not a nutrient."[2 5 25] More and more scientists believe that it is the surfeit of refined carbohydrates that is driving the global pandemic of obesity, diabetes, and non-communicable diseases.[2 5 25-27] They dispute the idea that we get fat simply because energy in exceeds energy out, saying instead that the carbohydrates "trigger a hormonal response that drives the portioning of the fuel consumed as storage as fat."[26] This hypothesis would say that poor people are fat (which is true in many communities) not because they overeat or are particularly lazy but because they consume high levels of refined carbohydrates, the cheapest energy source, which causes them to become fat.[1]

Atkins and Ornish

Thinking along these lines led to the diet advocated by the US physician Robert Atkins that drastically restricted carbohydrates but allowed any amount of protein and fat. The diet was a rediscovery of the diet promoted by a London undertaker, William Banting, in 1864 in his best selling *Letter on Corpulence* and widely recommended by medical authorities until the 1950s.[1 28] The diet was tested in the A TO Z Weight Loss Study in 311 overweight or obese premenopausal women over a year against three other diets, including that advocated by Dean Ornish, another US physician, which requires that fewer than 10% of energy comes from saturated fat.[29 30] Women on the Atkins diet lost more weight and "experienced more favourable overall metabolic effects," including a fall in diastolic blood pressure of 4.4 mm Hg, against 2.1 mm Hg for those on the Ornish diet.[30]

Reading these books and consulting some of the original studies has been a sobering experience. The successful attempt to reduce fat in the diet of Americans and others around the world has been a global, uncontrolled experiment, which like all experiments may well have led to bad outcomes. What's more, it has initiated a further set of uncontrolled global experiments that are continuing. Teicholz has done a remarkable job in analysing how weak science, strong personalities, vested interests, and political expediency have initiated this series of experiments.[3] She quotes Nancy Harmon Jenkins, author of the *Mediterranean Diet Cookbook* and one of the founders of Oldways, as saying, "The food world is particularly prey to consumption, because so much money is made on food and so much depends on talk and especially the opinions of experts."[31] It's surely time for better science and for humility among experts.

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When somebody loses weight, where does the fat go?

Ruben Meerman and **Andrew Brown** explain why the answer might not be what you expect

Considering the soaring overweight and obesity rates and strong interest in this topic, there is surprising ignorance and confusion about the metabolic process of weight loss among the general public and health professionals alike. We encountered widespread misconceptions about how humans lose weight among general practitioners, dietitians, and personal trainers (fig 1). Most people believed that fat is converted to energy or heat, which violates the law of conservation of mass. We suspect this misconception is caused by the "energy in/energy out" mantra and the focus on energy production in university biochemistry courses. Other misconceptions were that the metabolites of fat are excreted in the faeces or converted to muscle. We present a novel calculation to show how we "lose weight."

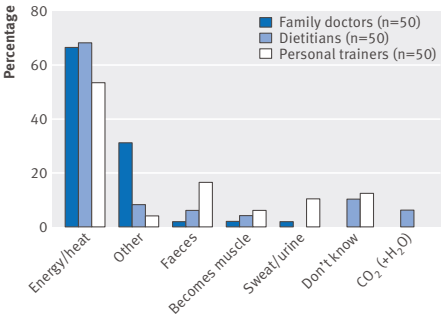

Fig 1 | Responses of a sample of doctors, dietitians, and personal trainers to the question "When somebody loses weight, where does it go?" (Correct answer CO_2)

Weight we want to "lose"

Excess carbohydrate or protein in the diet is converted to triglyceride and stored in the lipid droplets of adipocytes. Excess dietary fat needs no conversion other than lipolysis and re-esterification. People who wish to lose weight while maintaining their fat-free mass are, biochemically speaking, attempting to metabolise the triglycerides stored in their adipocytes.

The chemical formula for an average triglyceride molecule can be deduced from fatty acid composition studies. In 1960, Hirsch and colleagues published data that yield an "average fatty acid" with the formula $C_{17.4}H_{33.1}O_2$.[1] This 50 year old result is in remarkable agreement with more recent data.[2] Three "average fatty acids" esterified to the glycerol backbone (+3C, +6H) give an "average triglyceride" with the formula $C_{54.8}H_{104.4}O_6$. The three most common fatty acids stored in human adipose tissues are oleate ($C_{18}H_{34}O_2$), palmitate ($C_{16}H_{32}O_2$), and linoleate ($C_{18}H_{32}O_2$),[1 2] which all esterify to form $C_{55}H_{104}O_6$.

The complete oxidation of a single triglyceride molecule involves many enzymes and biochemical steps, but the entire process can be summarised as:

$C_{55}H_{104}O_6 + 78O_2 \rightarrow 55CO_2 + 52H_2O$ + energy

Stoichiometry shows that complete oxidation of 10 kg of human fat requires 29 kg of inhaled oxygen producing 28 kg of CO_2 and 11 kg of H_2O. This tells us the metabolic fate of fat but remains silent about the proportions of the mass stored in those 10 kg of fat that depart as carbon dioxide or water during weight loss.

To calculate these values, we traced every atom's pathway out of the body. The carbon and hydrogen atoms obviously depart as CO_2 and H_2O, respectively. The fate of a triglyceride molecule's six oxygen atoms is a conundrum solved in 1949 by Lifson and colleagues.[3] They used labelled heavy oxygen (O^{18}) to show that the oxygen atoms of body water and respiratory carbon dioxide are rapidly exchanged through the formation of carbonic acid (H_2CO_3). A triglyceride's six oxygen atoms will therefore be shared by CO_2 and H_2O in the same 2:1 ratio in which oxygen exists in each substance. In other words, four will be exhaled and two will form water.

Novel calculation

The proportion of a triglyceride molecule's mass exhaled in CO_2 is the proportion of its

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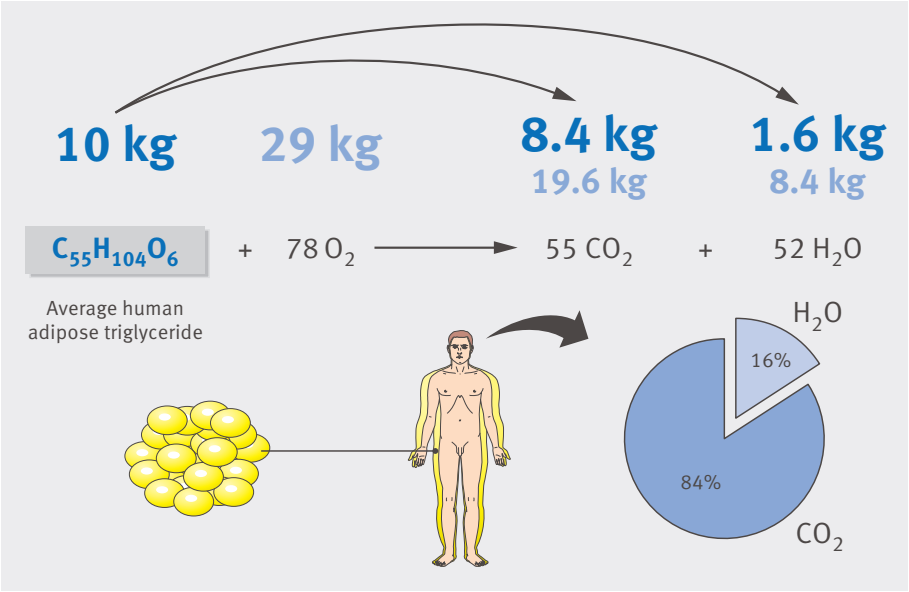

Fig 2 | When somebody loses 10 kg of fat (triglyceride), 8.4 kg is exhaled as CO_2. The remainder of the 28 kg total of CO_2 produced is contributed by inhaled oxygen. Lungs are therefore the primary excretory organ for weight loss. (This calculation ignores fat that may be excreted as ketone bodies under particular (patho)physiological conditions or minor amounts of lean body mass, the nitrogen in which may be excreted as urea)

molecular weight (daltons) contributed by its 55 carbon atoms plus four of its oxygen atoms:

(661 Da (C_{55})+64 Da (O_4))/(861 Da ($C_{55}H_{104}O_6$))×100=84%

The proportion of mass that becomes water is:

(105 Da (H_{104})+32 Da (O_2))/(861 Da ($C_{55}H_{104}O_6$))×100=16%

These results show that the lungs are the primary excretory organ for weight loss (fig 2). The water formed may be excreted in the urine, faeces, sweat, breath, tears, or other bodily fluids.

Lifting the veil on weight loss

At rest, an average 70 kg person consuming a mixed diet (respiratory quotient 0.8) exhales about 200 ml of CO_2 in 12 breaths per minute.[4] Each of those breaths therefore excretes 33 mg of CO_2, of which 8.9 mg is carbon. In a day spent asleep, at rest, and performing light activities that double the resting metabolic rate, each for 8 hours, this person exhales 0.74 kg of CO_2 so that 203 g of carbon are lost from the body. For comparison, 500 g of sucrose ($C_{12}H_{22}O_{11}$) provides 8400 kJ (2000 kcal) and contains 210 g of carbon. Replacing one hour of rest with exercise that raises the metabolic rate to seven times that of resting by, for example, jogging, removes an additional 39 g of carbon from the body, raising the total by about 20% to 240 g. For comparison, a single 100 g muffin represents about 20% of an average person's total daily energy requirement. Physical activity as a weight loss strategy is, therefore, easily foiled by relatively small quantities of excess food.

Our calculations show that the lungs are the primary excretory organ for fat. Losing weight requires unlocking the carbon stored in fat cells, thus reinforcing that often heard refrain of "eat less, move more." We recommend these concepts be included in secondary school science curriculums and university biochemistry courses to correct widespread misconceptions about weight loss.

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Christmas dinner for doctors on duty: it's grimmer up north

For the first time in four years of working in the NHS, I won't be on duty on Christmas Day. It got me thinking—what am I most looking forward to? After considering a range of alcoholic drinks and a day without a bleep, I settled on Christmas dinner. For me it's the central event of the day, so why have I been starved of this luxury when I have previously worked on Christmas Day?

I decided to do a quick and dirty survey of acute hospitals across England to see what they offered.

Of the 160 acute trusts identified on the NHS Choices website, I managed to speak to representatives from the canteens in 60 hospitals on 8-12 September. The two who couldn't tell me their plans were excluded from further analysis. Of the remaining 58, only 37 were serving Christmas dinner, most during very restricted hours.

Delving deeper into these responses, I classed 23 hospitals to be in "the North" and 35 in "the South"—assuming an imaginary line crossing west to east at Birmingham. Of these, 28 (80%) in the South had an accessible Christmas dinner for staff, compared with only nine (39%) in the North.

Some hospitals in the South—including Frimley Park, Cheltenham General, and Gloucester Royal Hospitals—were very pleased to tell me that they offered Christmas dinner to all staff for free. Doctors working in the Royal Sussex County Hospital on Christmas Day can even pick up a free breakfast and dinner from the kitchen to eat whenever they can take a break.

So I ask, if some hospitals can provide this service, why can't they all? Is this another version of the postcode lottery? All this junior doctor wants for Christmas is Brussels sprouts for all!

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DID YOUR HOSPITAL PROVIDE LUNCH OR DINNER FOR ON-CALL MEDICAL STAFF THIS YEAR?

If your hospital doesn't appear on Emma's list (see thebmj.com), send us a rapid response to tell us what it provided

Avoid the Brussels lottery