Association of health benefits and harms of Christmas dessert ingredients in recipes from The Great British Bake Off: umbrella review of umbrella reviews of meta-analyses of observational studies

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ABSTRACT

OBJECTIVE

To determine the health benefits and harms of various ingredients in Christmas desserts from The Great British Bake Off.

DESIGN

Umbrella review of umbrella reviews of meta-analyses of observational studies.

DATA SOURCES

The Great British Bake Off website, Embase, Medline, and Scopus.

INCLUSION CRITERIA

Umbrella reviews of meta-analyses of observational studies evaluating the associations between Christmas dessert ingredients and the risk of death or disease.

MAIN OUTCOME MEASURES

Proportion of protective and harmful summary associations between ingredient groups from The Great British Bake Off Christmas dessert recipes and the risk of death or disease.

RESULTS

48 recipes for Christmas desserts (ie, cakes, biscuits, pastries, and puddings and desserts) were provided on The Great British Bake Off website with 178 unique ingredients that were collapsed into 17 overarching ingredient groups. A literature search identified 7008 titles and abstracts, of which 46 eligible umbrella reviews reported 363 unique summary associations between the ingredient groups and risk of death or disease. Of these summary associations, 149 (41%) were significant, including 110 (74%) that estimated that the ingredient groups reduced the risk of death or disease and 39 (26%) that increased the risk. The most common ingredient groups associated with a reduced risk of death or disease were fruit (44/110, 40%), coffee (17/110, 16%), and nuts (14/110, 13%), whereas alcohol (20/39, 51%) and sugar (5/39, 13%) were the most common ingredient groups associated with increased risk of death or disease.

CONCLUSIONS

Recipes for Christmas desserts from The Great British Bake Off often use ingredient groups that are associated with reductions, rather than increases, in the risk of death or disease. This Christmas, if concerns about the limitations of observational nutrition research are set aside, you can have your cake and eat it too.

WHAT IS ALREADY KNOWN ON THIS TOPIC

Desserts have been an essential part of Christmas celebrations for centuries

Early stew-like Christmas puddings were fairly healthy, with prunes, raisins, carrots, nuts, spices, grains, eggs, beef, and mutton; Christmas desserts have become more decadent

Questions have been raised about associated risk of death or disease from their consumption

WHAT THIS STUDY ADDS

Social media: "You should eat Christmas desserts from The Great British Bake Off if you want to be healthier and live longer!"

Newspaper: "Can you have your cake, and eat it too? Study finds most Christmas dessert recipes from The Great British Bake Off might reduce the risk of death or disease"

Real life journal club: This umbrella of umbrella reviews does not consider the complexities of nutritional epidemiology (eg, overall diet and lifestyle) and health, and therefore does not contribute meaningfully to the literature

Introduction

Desserts have been an important part of Christmas celebrations for centuries. In medieval England, the Roman Catholic Church decreed that a pudding should be made on the Sunday approximately four weeks before Christmas.[1] Although Christmas holidays are usually associated with unhealthy behaviours (eg, sitting around with excessive eating and drinking), these early stew-like Christmas puddings were actually pretty healthy, with fibre, protein, vitamin, and mineral rich ingredients like prunes, raisins, carrots, nuts, spices, grains, eggs, beef, and mutton.[2 3] However, our palates have evolved over time, and Christmas desserts have become more decadent, sweeter, and less meaty. According to Liam Charles, a runner-up on series eight of The Great British Bake Off television baking competition, Christmas "is the time to eat whatever you want."[4] However, many people may wonder if this inhibition is safe, especially when considering Christmas desserts. Concerns have consistently been raised that the ingredients used to make modern Christmas desserts (eg, butter and sugar) may not be good for our health. According to the Guardian, the most trusted newspaper outlet in the UK,[5] "sugar is bad; sugar is evil; sugar is the devil."[6]

How do we determine if modern Christmas desserts increase or decrease our risks of dying or developing disease? Social media (eg, Facebook) and newspaper headlines are likely the most accessible for dietary recommendations (eg, "six squares of dark chocolate a day 'may keep memory loss at bay'"[7]; "eating just one egg a day increases your risk of diabetes"[8]; "drink

Table 1 | The Great British Bake Off Christmas dessert recipes

Recipe	Ingredient groups
Andrew's boozy bauble cake	Alcohol; baking soda, powder, and other ingredients; butter; chocolate; eggs; food colourings, flavourings, and extracts fruit; nuts (general or tree; excluding peanuts); refined flour; salt; and sugar
Beca's gingerbread latte yule log	Baking soda, powder, and other ingredients; butter; chocolate; coffee; eggs; fruit; food colourings, flavourings, and extracts fruit; nuts (general or tree; excluding peanuts); refined flour; salt; spices; and sugar
Benjamina's winter wonderland cake	Alcohol; baking soda, powder, and other ingredients; butter; chocolate; coffee; eggs; food colourings, flavourings, and extracts; milk; refined flour; salt; and sugar
Briony's Santa's train station	Baking soda, powder, and other ingredients; butter; eggs; flood colouring, flavouring, and extracts; fruit; nuts (general or tree, excluding peanuts); refined flour; salt; spices; and sugar
Candice's two-tier stollen wreath	Alcohol; baking soda, powder, and other ingredients; butter; eggs; food colourings, flavourings, and extracts; fruit; milk; nuts (general or tree, excluding peanuts); refined flour; salt; spices; and sugar
Flo's spiced treacle and ginger biscuits	Baking soda, powder, and other ingredients; butter; eggs; food colourings, flavourings, and extracts; fruit; refined flour; salt; spices; and sugar
Helena's altar candle cake	Baking soda, powder, and other ingredients; butter; chocolate; coffee; eggs; food colourings, flavourings, and extracts; peanuts and peanut butter; refined flour; salt; sugar; and vegetable fat
Hermine's apricot custard crumble bunds	Alcohol; baking soda, powder, and other ingredients; butter; eggs; food colourings, flavourings, and extracts; fruit; milk; refined flour; salt; and sugar
Henry's three-tier raspberry, thyme and roasted rhubarb cake	Alcohol; baking soda, powder, and other ingredients; butter; eggs; floor colouring, flavourings, and extracts; fruit; refined flour; salt; spices; sugar; and vegetable fat
James's cola cake	Alcohol; baking soda, powder, and other ingredients; butter; chocolate; eggs; floor colouring, flavourings, and extracts; fruit; refined flour; salt; spices; and sugar
Jamie's chocolate mousse milkshake and churros	Alcohol; butter; chocolate; eggs; floor colouring, flavourings, and extracts; fruit; salt; refined flour; sugar; and vegetable fat
Jane's 12 days of decorating biscuits	Baking soda, powder, or other ingredients; butter; eggs; food colourings, flavourings, and extracts; nuts (general and tree, excluding peanuts); refined flour; spices; and sugar
Jon's pecan and maple buns with candied bacon	Baking soda, powder, and other ingredients; butter; eggs; food colourings, flavourings, and extracts; milk; nuts (general or tree, excluding peanuts); refined flour; salt; and sugar (bacon not considered)
Katie's 3D cake house	Baking soda, powder, and other ingredients; butter; eggs; food colouring, flavourings, and extracts; fruit; nuts (general or tree, excluding peanuts); refined flour; sugar
Kim-Joy's 'cosy by the fire' winter scene shadow box	Butter; food colouring, flavourings, and extracts; fruit; milk; nuts (general or tree, excluding peanuts); refined flour; spices; and sugar
Liam's 2 in 1: it's gotta be fun	Alcohol; baking soda, powder, or other ingredients; butter; chocolate; coffee; eggs; food colouring, flavourings, and extracts; fruit; milk; refined flour; salt; sugar; and vegetable fat
Mary Berry's rosace à l'orange	Alcohol; butter; eggs; food colouring, flavourings, and extracts; fruit; milk; refined flour; and sugar
Mary Berry's Christmas trifle	Alcohol; baking soda, powder, and other ingredients; butter; eggs; fruit; milk; nuts (general or tree; excluding peanuts); refined flour; and sugar
Mary Berry's Christmas pavlova	Alcohol; baking soda, powder, and other ingredients; butter; food colouring, flavourings, and extracts; fruit; and sugar
Mary Berry's gingerbread house	Baking soda, powder, and other ingredients; butter; chocolate; eggs; fruit; refined flour; spices; and sugar
Mary Berry's tunis cake	Butter; chocolate; eggs; food colouring, flavourings, and extracts; fruit; nuts (general or tree, excluding peanuts); refined flour; and sugar
Paul's Christmas entremet	Alcohol; butter; chocolate; eggs; food colouring, flavourings, or extracts; fruit; nuts (general or tree, excluding peanuts); refined flour; spices, and sugar
Paul Hollywood's black bun	Alcohol; baking soda, powder, and other ingredients; eggs; fruit; salt; spices; and sugar
Paul Hollywood's Chelsea bun Christmas tree	Alcohol; butter; eggs; fruit; milk; nuts (general or tree, excluding peanuts); spices; and sugar
Paul Hollywood's leaf bread	Baking soda, powder, and other ingredients; butter; milk; refined flour; salt; sugar; and vegetable fat
Paul Hollywood's Christmas kransekake	Baking soda, powder, and other ingredients; butter; eggs; nuts (general or tree, excluding peanuts); and sugar
Paul Hollywood's new year cake	Butter; cheese or yogurt; eggs; fruit; refined flour; spices; and sugar
Paul Hollywood's pandoro	Baking soda, powder, and other ingredients; butter; eggs; food colouring, flavourings, and extracts; fruit; milk; and refined flour
Paul Hollywood's stollen	Baking soda, powder, and other ingredients; butter, eggs; food colouring, flavourings, and extracts; fruit; milk; nuts (general or tree, excluding peanuts); refined flour; salt; spices; and sugar
Prue Leith's chocolate yule log	Alcohol; baking soda, powder, or other ingredients; butter; chocolate; eggs; refined flour; salt; and sugar
Prue Leith's last-minute Christmas pudding	Alcohol; baking soda, powder, and other ingredients; butter; eggs; fruit; milk; refined flour; spices; and sugar
Prue Leith's mince pies	Alcohol; butter; eggs; fruit; nuts (general or tree, excluding peanuts); spices; and sugar
Prue Leith's vegan baked Alaska	Alcohol; baking soda, powder, and other ingredients; chocolate; fruit; milk; nuts (general or tree, excluding peanuts); refined flour; salt; and sugar
Prue Leith's snow eggs	Baking soda, powder, and other ingredients; butter; eggs; food colouring, flavourings, and extracts; milk; salt; and sugar
Rahul's spiced apple and plum nut crumble with orange and ginger ice cream	Baking soda, powder, or other ingredients; eggs, food colourings, flavourings, and extracts; fruit; milk; nuts (general or tree, excluding peanuts); refined flour; spices; and sugar
Rav's 'Frozen' fantasy cake	Baking soda, powder, or other ingredients; butter; eggs; food colourings, flavourings, and extracts; fruit; nuts (general or tree, excluding peanuts); refined flour; and sugar
Rob's apple and cinnamon baked Alaska tarts	Baking soda, powder, and other ingredients; butter; eggs; food colouring, flavourings, and extracts; fruit; milk; refined flour; salt; spices; and sugar
Rosie's date, cranberry and mace panettones	Alcohol; baking soda, powder, and other ingredients; butter; eggs; food colouring, flavourings, and extracts; fruit; milk; refined flour; salt; spices; and sugar
Rowan's 'fried egg' breakfast buns	Baking soda, powder, and other ingredients; chocolate; eggs; food colouring, flavourings, and other extracts; fruit; nuts (general or tree, excluding peanuts); salt; spices; and sugar
Ruby's boozy chai, cherry and chocolate panettones	Alcohol; baking soda, powder, and other ingredients; butter; chocolate; eggs; food colouring, flavourings, and extracts; fruit; milk; nuts (general or tree, excluding peanuts); refined flour; salt; spices; and sugar
Sandy's after-dinner mint surprise Alaska tartlets	Alcohol; baking soda, powder, and other ingredients; butter; chocolate; eggs; food colouring, flavourings, and extracts; milk; refined flour; salt; and sugar
Selasi's bûche de Noël	Alcohol; baking soda, powder, and other ingredients; butter; cheese and yogurt; chocolate; eggs; food colouring, flavourings, and extracts; fruit; nuts (general or tree, excluding peanuts); refined flour; spices; and sugar

(*Continued*)

Table 1 | Continued

Recipe	Ingredient groups
Steven's telephone cake	Alcohol; baking soda, powder, and other ingredients; butter; chocolate; eggs; food colouring, flavourings, and extracts; salt; and sugar
Tamal's iced stollen wreath	Alcohol; baking soda, powder, and other ingredients; butter; eggs; food colouring, flavourings, and extracts; fruit; milk; nuts (general or tree, excluding peanuts); refined flour; salt; spices; and sugar
Terry penguin and snow cake pops	Alcohol; baking soda, powder, and other ingredients; butter; cheese and yogurt; eggs; food colouring, flavourings, and extracts; milk; refined flour; salt; spices; and sugar
Tom's Christmas tree biscuits	Baking soda, powder, and other ingredients; butter; eggs; food colouring, flavourings, and extracts; refined flour; spices; and sugar
Val's black forest yule log	Alcohol; baking soda, powder, and other ingredients; butter; chocolate; eggs; food colouring, flavourings, and extracts; fruit; refined flour; salt; and sugar
Yan's Christmas memories cake pops	Butter; chocolate; coffee; eggs; food colourings, flavourings, and extracts; refined flour; spices; and sugar

Full ingredients are available in supplementary table 1.

coffee to live longer!"[9]). Although that these posts and headlines often oversimplify and exaggerate the results, the challenge is that they are based on observational studies evaluating the associations between dietary exposures and the risks of dying or developing various diseases. Unfortunately, establishing causal relationships in observational studies is difficult. Some nutritional observational studies are well designed, but too many focus on individual ingredients, thereby not considering the effect of overall diet and lifestyle, and result in inherent limitations that are difficult or impossible to address.[10-12] For instance, confounding cannot be realistically resolved by simply adjusting analyses for a handful of commonly identified variables, especially given the fact that diet, environmental exposures, lifestyle, socioeconomic status, and education are highly correlated.[12 13] Furthermore, asking study participants to weigh, measure, and then self-report their own food consumption increases the likelihood of measurement error and recall bias.[10 11] When combined with selective reporting, individual nutritional observational studies are prone to generating spurious effects.

Once multiple observational studies evaluating the associations between specific ingredients and the risks of dying or developing various diseases have been published, redundant systematic reviews and meta-analyses using different approaches, which that are susceptible to their own weaknesses and biases, identify, synthesise, and evaluate the same retrospective evidence.[14] Once these systematic reviews and meta-analyses have been published, higher level reviews are often conducted to further summarise and simplify the findings. Umbrella reviews are studies that summarise the overarching evidence from other studies that have already summarised the evidence from individual studies evaluating the exposures and outcomes of interest.[15] But bah humbug, it is Christmas, and we are done being study design Scrooges. We have taken this opportunity to ignore the flaws of observational nutrition research and conduct a study that allows us to feel morally superior when we happen to enjoy eating the Christmas dessert ingredients in question (eg, chocolate).

We evaluated the potential health benefits and harms of the ingredients used in various Christmas desserts. Instead of randomly selecting Christmas

Table 2 | Overarching ingredient groups from the Great British Bake Offs Christmas desserts

Ingredient groups	No of recipes including ingredient	No of associations identified in umbrella reviews	No of significant associations (%)	Protective associations	Harmful associations	Protective significant associations, %
Butter (including cream or source cream)	22	14	2 (14)	1	1	50
Refined flour	22	6	0 (0)	NA	NA	NA
Sugar (sucrose, glucose, fructose)	22	12	7 (58)	2	5	29
Eggs	21	21	3 (14)	1	2	33
Baking soda, powder, and other ingredients	19	0 (none identified)	NA	NA	NA	NA
Salt	15	3	2 (67)	0	2	0
Food colourings, flavourings, and extracts	14	0 (none identified)	NA	NA	NA	NA
Fruit (apples and pears; berries; citrus fruit; fruit (general); or 100% fruit juice)	13	88	44 (50)	44	0	100
Alcohol (liqueur, spirits, or alcohol (general))	13	50	29 (58)	9	20	31
Milk (general or full fat)	12	32	12 (38)	8	4	67
Chocolate	10	10	7 (7)	7	0	100
Spices	10	0 (none identified)	NA	NA	NA	NA
Nuts (general or tree)	8	28	14 (50)	14	0	100
Coffee	4	60	21 (35)	17	4	81
Vegetable fat	3	2	1 (50)	1	0	100
Cheese and yogurt	2	32	6 (19)	5	1	83
Peanuts or peanut butter	1	5	1 (20)	1	0	100

NA=not applicable.

Box 1: Umbrella review evidence rating by strength of association

Convincing
- Highly significant associations ($P<10^{-6}$)
- Cases of n >1000
- I^2 <50%
- 95% prediction intervals excluding the null value
- Largest study nominally significant (P<0.05)
- No evidence of small study effects
- No evidence of excess significance bias

Highly suggestive
- Highly significant associations ($P<10^{-6}$)
- Cases n >1000
- Largest study reported a significant association (P<0.05)

Suggestive
- Cases n >1000
- Significant associations ($P<10^{-3}$)

Weak
- Significant associations (P<0.05)

Non-significant
- Not significant associations (P>0.05)

dessert recipes from cookbooks, we selected recipes from The Great British Bake Off, in our opinion, the greatest television baking competition of all time. Overall, we hoped to provide evidence that we need to have Christmas dessert and eat it too. Or at least, evidence that will inform our collective gluttony or guilt this Christmas holiday.

Methods

Christmas dessert recipes

To identify Christmas dessert recipes, we located all "Christmas" recipes listed on the official Great British Bake Off website (table 1; supplementary table 1).[16] We limited our sample to recipes for cakes, biscuits, pastries, and puddings and desserts. From each recipe, we then recorded the individual ingredients, excluding those that were primarily decorative and not food-based (eg, edible silver; supplementary table 2). For ingredients that were unlikely to be evaluated in observational studies, we recorded their key component ingredients (eg, Biscoff spread: sugar, butter, and refined flour; candied clementine: fruit and sugar). All ingredients were categorised into 17 overarching ingredient groups that were mostly likely to be evaluated in umbrella reviews: alcohol; baking soda, powder, and other ingredients; butter; chocolate; cheese and yogurt; coffee; eggs; food colouring, flavourings, and extracts; fruit; milk; nuts (general or tree, excluding peanuts); peanuts or peanut butter; refined flour; salt; spices; sugar; and vegetable fat (table 2; supplementary table 2). We did not consider bacon, which was included in one recipe, because it is not a proper dessert ingredient (and the first author is vegetarian).

Search strategy

We developed and performed a comprehensive search of Medline (Ovid), Embase, and Scopus to identify umbrella reviews of meta-analyses of studies evaluating the associations between dietary exposures and risks of diseases. We used a broad search string for the study design concept of umbrella review to ensure the largest number of potential records (supplementary text 1). Although an initial search was run from database inception until 25 December 2022, we updated our search on 29 August 2023.

Eligibility criteria

Two authors (JDW and AG) screened each record at the title and abstract level using Covidence (http://www.covidence.org). We included English language umbrella reviews of meta-analyses (or overviews of systematic reviews and meta-analyses) of observational studies evaluating associations between food or ingredient based exposures and risk of death or disease (ie, any mortality and disease outcomes, including those in children). We excluded umbrella reviews of meta-analyses of randomised controlled trials evaluating dietary interventions because these studies are rare and tend to report associations on the basis of comparisons between ingredients (eg, sugar *v* artificial sweeteners). Umbrella reviews were excluded at the full text level if they did not evaluate any of the ingredients identified in the eligible Christmas dessert recipes.

Data abstraction

For each umbrella review, we recorded the first author, year of publication, article title, and journal of publication. For each unique summary association between exposure and outcome, we recorded the summary effect estimate and corresponding 95% confidence interval, number of studies, number of cases, and total number of participants. For umbrella reviews that reported summary effect estimates for multiple exposure contrast levels, we prioritised those from dose-response analyses corresponding to the lowest level of consumption (eg, one egg per day, 25 g nuts per day), when available. However, for sugar, we recorded effect estimates from comparisons of the highest versus lowest levels of exposure. This was done to show the potential extreme effect of sugar consumption, even though Christmas desserts are more of an occasional exposure (we hope). For alcohol, although we attempted to identify evaluations focused on spirits or liqueurs, which are most likely to be used in baking, we also considered summary effect estimates for analyses based on general alcohol. When multiple umbrella reviews were identified evaluating the same ingredients and health outcomes, we prioritised the effect estimates from the most recent and largest meta-analysis.

Data analysis

Using descriptive statistics, we characterised the recipes and summary associations identified for each ingredient. We created forest plots using the summary effect estimates and 95% confidence intervals for each association for each recipe and ingredient group in R (forestplot package).

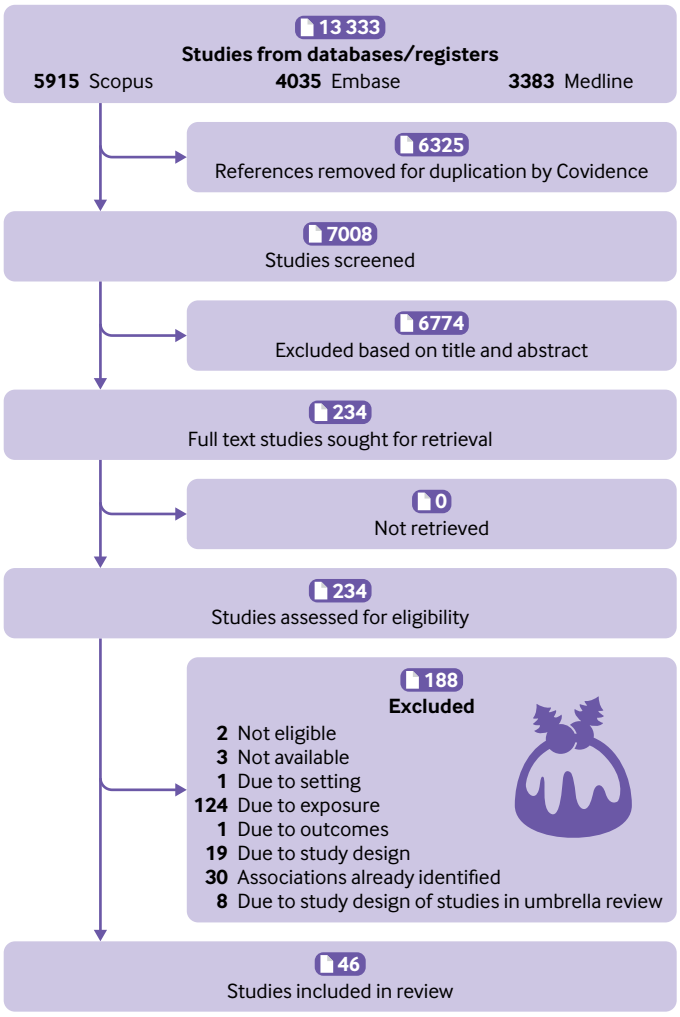

Fig 1 | Study flowchart

Sensitivity analyses and quality assessment

All summary associations were classified across five levels, using standard umbrella review methods in these categories: non-significant, weak, suggestive, highly suggestive, and convincing (box 1). For associations without this information reported in the umbrella reviews, we recorded the information necessary to make the appropriate calculations and classifications: total number of cases, largest study reporting a nominally significant result (P<0.05), 95% prediction intervals, I^2 value, Egger regression asymmetry test, and evidence of excess significance.

To further summarise the overall confidence in the results of the meta-analyses with significant summary associations, we identified AMSTAR (A MeaSurement Tool to Assess Systematic Reviews) classifications reported in the eligible umbrella reviews. AMSTAR 2 is the most recent version of the tool and is composed of 16 items with a suggested rating scheme of high, moderate, low, or critically low.[17] The older version of the tool is composed of 11 items, and the rating scheme is not always standardised across umbrella reviews (eg, high, medium, and low; high, medium, low, and very low).[18] Therefore, we condensed all low, very low, and critically low classifications from AMSTAR 1 and AMSTAR 2 into the one category of low. For any umbrella reviews that did not conduct their own AMSTAR evaluations, we conducted our own AMSTAR 2 evaluations.

Patient and public involvement

Patients and the public were not involved in the planning, design, and implementation of the study because this study used secondary data. No patients were asked to advise on interpretation or writing up of this article.

Results

Description of included recipes

We identified 48 recipes for Christmas cakes, biscuits, pastries, and puddings and desserts on the Great British Bake Off website (table 1, supplementary table 1, supplementary table 3), such as Val's Black Forest Yule Log (a favourite of chocolate fiend authors JDW and JSR) and Ruby's Boozy Chai, Cherry and Chocolate Panettones (an aspirational bake for RR). These 48 recipes included a total of 178 unique ingredients, which were condensed into 17 overarching ingredient groups (table 2).

Description of included studies

Our literature search for umbrella reviews identified 13 333 titles and abstracts (fig 1); 6325 were excluded as duplicates, leaving 7008 for initial screening. We excluded 6774 during the initial screening based on the title and abstract. Among the 234 full text studies assessed for eligibility, 188 were excluded, mostly because they did not evaluate any of the relevant ingredients. We were left with 46 unique umbrella reviews that met the inclusion criteria (supplementary table 4).

Box 2: Prue Leith's chocolate yule log

Prue Leith's chocolate yule log is described a Swiss roll "subtly laced with Irish cream liqueur to add to the festive spirit."[19] Among the 50 significant associations for this recipe, only 20 (40%) suggested that the ingredient groups decreased the risk of death or disease. Among the 30 harmful associations, most were for alcohol (n=20 (66%)) (supplementary figure 2). Therefore, we are not convinced that this dessert adds to the "festive spirit" because it would not be appropriate to "subtly lace" a dessert that you serve to your family and friends with alcohol that increases your risk of developing liver cancer (relative risk 1.04 (95% confidence interval 1.02 to 1.06), per 10 g per day), gastric cancer (1.42 (1.20 to 1.56), per ≥42 g per day), colon cancer (1.07 (1.05 to 1.09), per 10 g per day), upper aero-digestive tract cancer (1.18 (1.11 to 1.26), per 10 g per day), gout (odds ratio 2.02 (95% confidence interval 1.51 to 2.69), highest *v* lowest), and atrial fibrillation (odds ratio 1.35 (1.24 to 1.48), per one drink per day). It is also worth noting that the alcohol is included in the cream filling, and therefore will not be reduced due to any baking, consistent with Prue's preference for "boozy bakes."

Box 3: Rav's Frozen fantasy cake

Rav's Frozen fantasy cake is described as "a tall, three-layered sponge, sandwiched with passion-fruit buttercream and covered in blue-tinged vanilla buttercream."[20] Among the 70 significant associations for this recipe, 62 (89%) suggested that the ingredient groups decreased the risk of death or disease. The recipe contained several healthy ingredients, including almonds and passion fruit (ie, supplementary figure 3).

Christmas dessert ingredient groups and the risk of death or disease

The 46 umbrella reviews included 363 unique associations between ingredients included in the Christmas dessert recipes and risk of death or any disease (supplementary figure 1). No umbrella reviews were identified for food colourings, flavourings, and extracts; spices; and baking soda, powder, and other baking related ingredients (eg, yeast, gelatine powder, and corn flour; table 2), whereas the ingredient groups with the largest number of associations identified were fruit (n=88), coffee (n=60), and alcohol (n=50). The median number associations between ingredient groups and risk of death or disease was 17.5 (interquartile range 7-32). All 22 recipes included refined flour, butter, and sugar.

Overall, 149 (41%) summary associations between ingredient groups and the risk of death or disease were statistically significant. Of these, 110 (74%) suggested that the ingredient groups reduced the risk of death or disease: 32 (29%) for cancer incidence or mortality, 20 (18%)) for neurological or brain disorders, 16 (15%) for cardiovascular disease incidence or mortality, 16 (15%) for other, 12 (11%) for metabolic disease, five (5%) for autoimmune disease, five (5%) for liver related diseases, and four (4%) for mortality). The most common ingredient groups associated with reduced risk of death or disease were fruit (44 (40%)), coffee (17 (16%)), and nuts (14 (13%); box 2, box 3, and box 4).

For ingredient groups, 39 (39/149, 26%) associations suggested a significant increase in the risk of death or disease: 22 (56%) for cancer incidence and/or mortality, five (13%) for autoimmune diseases, four (10%) for neurological/brain disorders, four (10%) for other, two for cardiovascular disease, and one each for metabolic and mortality). The most common ingredient groups associated with increased risk of death or disease were alcohol (n=20 (51%); box 2) and sugar (n=5 (13%); table 2).

Sensitivity analyses of quality

Among the 149 significant summary associations between ingredient groups and the risk of death or disease, 96 (64%) came from meta-analyses with overall confidence ratings of very low, critically low, or low; 20 (13%) of medium or moderate; and 33 (22%) of high according to the AMSTAR 1 or 2 tools.

Most of the significant associations (127/149, 85%) were classified as having weak evidence (P<0.05). Twelve (8%) associations were classified as having suggestive evidence (>1000 cases and P<0.001; table 3, fig 2), of which 8 (67%) suggested that the ingredient groups reduced the risk of death or disease (three of these came from meta-analyses classified as having an overall confidence rating of high). Nine (6%) associations were classified as having highly suggestive evidence (>1000 cases, $P<10^{-6}$, largest component study P<0.05), of which five (56%) suggested that the ingredient groups reduced the risk of death or disease. We classified one (1%) association that showed a harmful link between alcohol and atrial fibrillation as having convincing evidence.

Box 4: Paul Hollywood's Stollen

Paul Hollywood's (the silver fox judge on the Great British Bake Off) Stollen is described as a "delicious yeasted cake filled with dried fruit and a swirl of marzipan."[21] Among the 82 significant associations for this recipe, 70 (85%) suggested that the ingredient groups decreased the risk of death or disease. The recipe contained several healthy ingredients, including almonds, milk, and various dried fruits (ie, supplementary figure 4). Overall, without the eggs, butter, and sugar, this dessert is essentially a fruit salad with nuts. Yum!

Discussion

In this umbrella review of umbrella reviews, we identified 363 associations between ingredient groups used in recipes for Christmas desserts from The Great British Bake Off and risk of death or disease. Approximately 40% of all associations were significant, of which nearly 75% suggested that the ingredient group was associated with a reduction in an individual's risk of death or disease. While nuts, fruit, and coffee were the ingredient groups most likely to be associated with protective associations, alcohol was the main ingredient group associated with harm (if Prue Leith, The Great British Bake Off judge who enjoys a dash of alcohol in and with her bakes, is reading this, we are sorry!). We can conclude, so long as we put aside the limitations of the observational nutrition research studies that underlie the meta-analyses that underlie the umbrella reviews, that the health benefits of most ingredients in The Great British Bake Off Christmas desserts outweigh the harms. That said, all Christmas desserts could be made even healthier by replacing any alcohol with milk or coffee.

When we think about the harmful ingredients in Christmas desserts, the first things that likely come to mind are sugar and butter. While we identified 12 associations in umbrella reviews between sugar and the risk of death or disease and 14 between butter and the risk of death or disease, only two could be classified as having suggestive or highly suggestive evidence (sugar may increase the risks of hyperuricaemia and gout). In 2023, *The BMJ* published an umbrella review on dietary sugar consumption and health,[22] of which most of the dietary exposures evaluated were sugar sweetened beverages. The good news for those of us who like Christmas desserts: none of the recipes used sugar sweetened beverages as an ingredient, no doubt because they would have resulted in bakes with a soggy bottom. Overall, the authors of that umbrella review concluded that "reducing the consumption of free sugars or added sugar to below 25 g/day (approximately six teaspoons/day)" is recommended

Table 3 | Associations between ingredient groups and the risk of death or disease with suggestive, highly suggestive, or convincing evidence

Exposure and outcome	Effect estimate (95% CI)	Evidence grading	Protective or harmful
Fruit			
Higher *v* lower:			
Pharyngeal cancer	RR 0.60 (0.52 to 0.70)	Highly suggestive	Protective
Cholangiocarcinoma	RR 0.47 (0.32 to 0.61)	Suggestive	Protective
Nasopharyngeal cancer	RR 0.63 (0.56 to 0.70)	Suggestive	Protective
COPD	RR 0.72 (0.66 to 0.79)	Highly suggestive	Protective
Gallstone disease	RR 0.88 (0.84 to 0.93)	Suggestive	Protective
One additional serving per day:			
Ischaemic stroke	RR 0.88 (0.84 to 0.93)	Suggestive	Protective
Sugar			
Highest *v* lowest (fructose):			
Hyperuricemia	OR 1.85 (1.66 to 2.07)	Suggestive	Harmful
Gout	RR 1.62 (1.28 to 2.03)	Suggestive	Harmful
Milk			
200 g per day:			
Colon cancer	RR 0.94 (0.91 to 0.96)	Suggestive	Protective
Rectal cancer	RR 0.94 (0.90 to 0.97)	Suggestive	Protective
Coffee			
One additional cup per day:			
Chronic liver disease	RR 0.74 (0.65 to 0.83)	Suggestive	Protective
Liver cancer	RR 0.85 (0.81 to 0.90)	Highly suggestive	Protective
Skin basal cell carcinoma	RR 0.95 (0.94 to 0.97)	Highly suggestive	Protective
Highest *v* lowest:			
Ischaemic stroke	RR 0.80 (0.71 to 0.90)	Highly suggestive	Protective
Vegetable oil			
Highest *v* lowest:			
Type 2 diabetes	RR 0.76 (0.68 to 0.85)	Suggestive	Protective
Alcohol			
10 additional grams per day:			
Liver cancer	RR 1.04 (1.02 to 1.06)	Suggestive	Harmful
Rectal cancer	RR 1.08 (1.07 to 1.10)	Highly suggestive	Harmful
Colon cancer	RR 1.07 (1.05 to 1.09)	Highly suggestive	Harmful
Upper aero-digestive tract cancer	RR 1.18 (1.11 to 1.26)	Highly suggestive	Harmful
One additional drink per day:			
Atrial fibrillation	RR 1.35 (1.24 to 1.48)	Convincing	Harmful
≥42 additional grams of alcohol per day:			
Gastric cancer	RR 1.42 (1.20 to 1.67)	Suggestive	Harmful
Highest *v* lowest:			
Gout	OR 2.02 (1.51 to 2.69)	Suggestive	Harmful

CI=confidence interval; COPD=chronic obstructive pulmonary disease; OR=odds ratio; RR=risk ratio.

to reduce the adverse effect of sugars on health. We cannot make the same recommendation after our evaluation because we did not account for the amount of sugar in each recipe.

We found that most ingredient groups in Christmas desserts do not increase the risk of death or disease. However, across nearly 50 associations between alcohol consumption and the risk of death or disease, of which 60% were significant, we observed increased risks of developing colon cancer, gastric cancer, rectal cancer, gout, and atrial fibrillation. Yet, a large amount of alcohol is cooked off during the baking of these desserts (tip: if you ignore the recipe instructions and cook all bakes for over three hours, all the alcohol should evapourate![23]). Also, the media has repeatedly informed the public that people who consume low levels of alcohol are likely to have more beneficial health outcomes than people who consume no alcohol.[24-26] Furthermore, if the health risks of alcohol in your desserts are still of a concern,[27] just replace it with another healthy ingredient, like coffee.[28]

Real implications

Studies of diet in relation to disease are challenging to conduct.[10 12 29] In particular, individual dietary factors are often intercorrelated and difficult to disentangle from other time-varying behaviours that could impact the risks of various diseases.[10 12] Therefore, overall diet and patterns of food intake is better to assess rather than associations between single ingredients and death or disease risk. Accurate assessment of dietary patterns and histories of study participants is also a challenge. Concerns have been raised about the costs, burden on and self-reporting by participants, measurement error, and role of portion size in methods of food intake investigation, including 24 h dietary recall, food frequency questionnaires, food records, and dietary history.[29] Even if validated, these methods cannot eliminate the potential role of recall bias (ie, are we really going to accurately report how much Christmas desserts we frantically ate in the middle of night, after everyone else went to bed?). Additionally, observational studies need to have large sample sizes (thousands or tens of thousands) and long follow-up durations (decades) to ensure that outcomes accrue and are captured.[11] Although meta-analyses and umbrella reviews can provide an overview of all the evidence available across studies, these studies do not solve the issues faced by individual observational studies (eg, confounding, measurement error, and recall bias). Randomised trials and Mendelian randomisation designs are the most likely study designs to clarify uncertainties regarding associations between dietary factors and human health.[30 31] Given these challenges, it is important to not over-interpret the results from studies evaluating individual ingredients and health outcomes. It is Christmas, so just enjoy your desserts in moderation!

Limitations

This study has several limitations. As mentioned previously, limitations regarding observational studies of nutritional exposures exist. Umbrella reviews have not been conducted for all exposure-outcome relations, and our approach might not have captured all meta-analyses for the ingredients in these Christmas desserts (we see you, food colouring!). However, too many meta-analyses have been published to make searching for these associations realistic (and we already identified more than 300 associations).[14] We focused on identifying associations between specific ingredient groups used in the recipes (eg, milk or full fat milk) and not broader dietary exposures (eg, high fat dairy or animal fat). Our analyses did not account for the relative amounts of each ingredient group used in each recipe. This means that any recipe with fruit, even if it was only one berry, was weighted equally in terms of its protective effect in relation to the harmful effect of butter, even if it was four sticks! We acknowledge that a weighted analysis would have

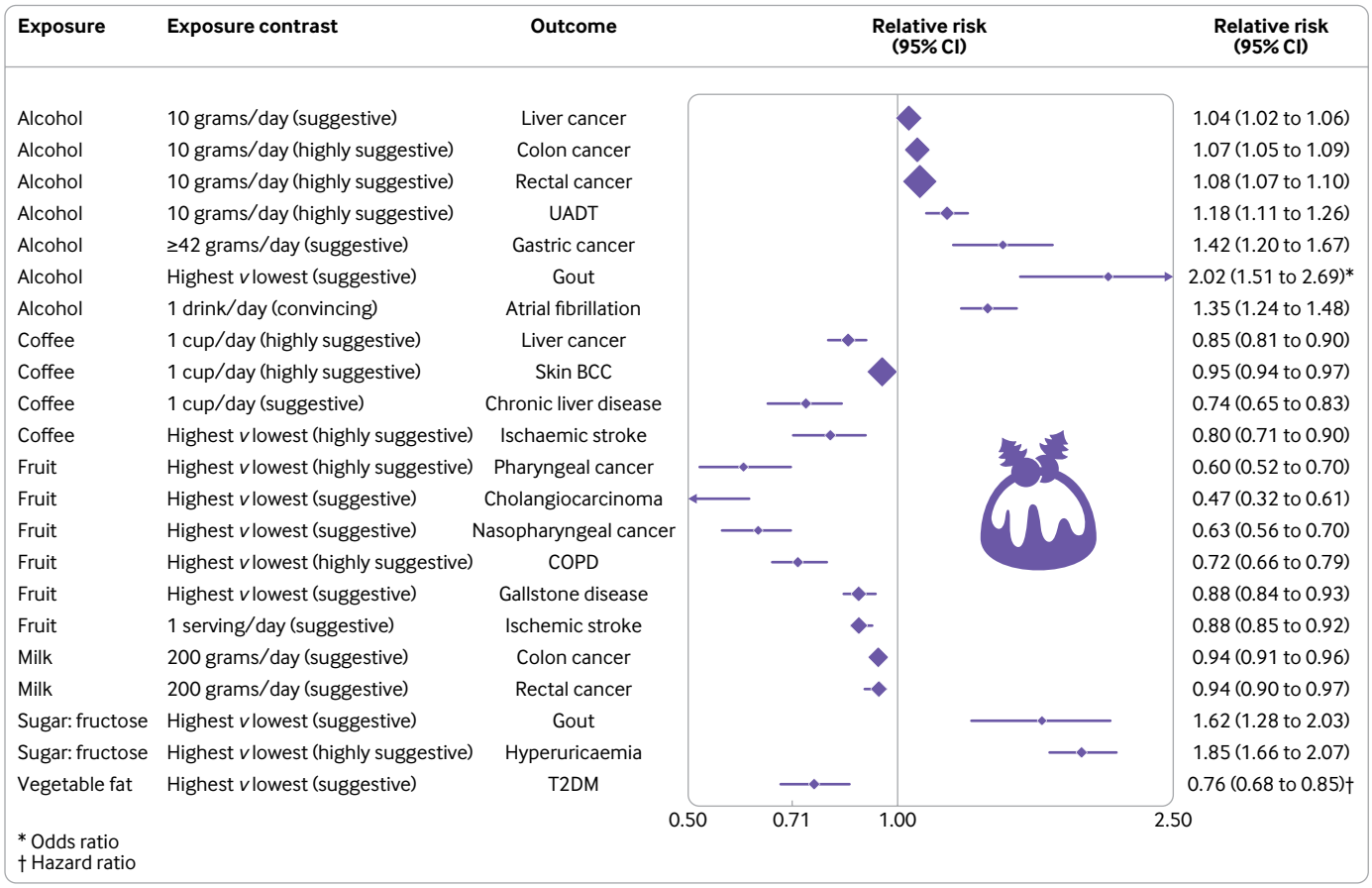

Fig 2 | Ingredient groups and the risk of death or disease with suggestive, highly suggestive, or convincing evidence. Log-scaled x axis. BCC=basal cell carcinoma; COPD=Chronic obstructive pulmonary disease; T2DM=type 2 diabetes mellitus; UADT=upper aerodigestive tract cancer. Levels of evidence are included parentheses (box 1).*Odds ratio, not relative risk. †Hazard ratio, not relative risk

been informative, but less fun. We did not preregister our review on PROSPERO. We promise that we did not switch our outcomes or search results (the risk of getting scooped was far too important to preregister). Additionally, we relied on the information reported in already published umbrella reviews, which relied on information reported in already published meta-analyses, which relied on the information reported in already published observational studies. Therefore, we cannot be held accountable for any dietary decisions made based on the findings of our study.

Conclusions

Our umbrella review suggests that recipes for Christmas desserts from The Great British Bake Off are more likely to use ingredient groups that are associated with reductions, rather than increases, in the risk of death or disease. This Christmas, if concerns about the limitations of observational nutrition research can be set aside, we are pleased to report that everyone can have their cake and eat it too.

Contributors: JDW design the study. JDW and AG collected the data. JDW conducted the analyses and wrote the manuscript. All authors participated in the interpretation of the data and critically revised the manuscript for important intellectual content. JSR complained about the amount of time that JDW talked about the study. JDW had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. JDW is the guarantor. JDW has no affiliation with The Great British Bake Off, even though Giuseppe Dell'Anno, winner of the 12th series, once responded to one of his tweets. JDW and RR almost kicked JSR off the paper (and all future collaborations) when they found out that he had never seen an episode of The Great British Bake Off. We would like to apologise to Prue Leith, Paul Hollywood, the contestants, and the crew of The Great British Bake Off, Love Productions, BBC One and Two, Channel 4, and all the UK on his behalf. However, as a dessert aficionado, JSR was still able to fulfil his co-authorship duties. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

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Arnold Ventures outside the submitted work. JSR also is an expert witness at the request of relator attorneys, the Greene Law Firm, in a qui tam suit alleging violations of the False Claims Act and Anti-Kickback Statute against Biogen Inc that was settled in September 2022. The authors declare no other relationships or activities that could appear to have influenced the submitted work.

Ethical approval: Not required.

Data sharing: The dataset will be made available via a publicly accessible repository on publication.

The lead author (JDW) affirms that the manuscript is an honest, accurate, and transparent account of the study being reported; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned (and, if relevant registered) have been explained.

Dissemination to participants and related patient and public communities: Not applicable.

Provenance and peer review: not commissioned; externally peer reviewed.

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Web appendix: Additional tables and details of database searches
Web appendix: Supplemental figure 1