**FULL/LONG TITLE OF THE STUDY**

Co-designing for healthy people and planet: food economic policy research

**SHORT STUDY TITLE / ACRONYM**

COPPER

**PROTOCOL VERSION NUMBER AND DATE**

Version 1.0. 30/03/2022

**RESEARCH REFERENCE NUMBERS**

**IRAS Number:** 313948

**FUNDERS Number:** NIHR133887

This protocol does not have regard to the HRA guidance and order of content

**SIGNATURE PAGE**

The undersigned confirm that the following protocol has been agreed and accepted and that the Chief Investigator agrees to conduct the study in compliance with the approved protocol and will adhere to the principles outlined in the Declaration of Helsinki, the Sponsor's SOPs, and other regulatory requirement.

I agree to ensure that the confidential information contained in this document will not be used for any other purpose other than the evaluation or conduct of the investigation without the prior written consent of the Sponsor

I also confirm that I will make the findings of the study publically available through publication or other dissemination tools without any unnecessary delay and that an honest accurate and transparent account of the study will be given; and that any discrepancies from the study as planned in this protocol will be explained.

**For and on behalf of the Study Sponsor:**

Signature: 

Date: 01/04/22.

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Name (please print): Heather House

Position: Director, Research Governance, Ethics & Assurance

**Chief Investigator:**

Signature: 

Date: .30./.03./.2022..

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Name: (please print): Peter Scarborough

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**STUDY SUMMARY**

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|---|---|
| Study Title | CO-designing for healthy People and Planet: food Economic policy Research |
| Internal ref. no. (or short title) | COPPER |
| Study Design | Mixed methods |
| Study Participants | Adults (aged 18 and over) resident in the UK drawn from the general population |
| Planned Size of Sample (if applicable) | **Survey & discrete choice experiment:** 1500 sampled from general population, plus 500 sampled from low income households.<br>**Deliberative forums & follow-up focus groups:** 45 |
| Follow up duration (if applicable) | N/A |
| Planned Study Period | 01/05/2022 – 30/04/2025 |

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| Research Question/Aim(s) | The primary research question for COPPER is: What impacts could food taxes and subsidies have on the incidence and prevalence of non-communicable diseases and health inequalities?<br><br>We will also study unintended impacts of food taxes and subsidies, including household-level economics, macroeconomics and planetary health.<br><br>The COPPER project has the following aims:<br><br>1. Co-design food tax and subsidy scenarios with the public and policymakers.<br><br>2. Develop an integrated data and model infrastructure.<br><br>3. Simulate the impact of scenarios on:<br><br>a. cost, nutritional quality and environmental impact of the diet, stratified by income and area-level deprivation<br><br>b. long-term impact on incidence and prevalence of diet-related diseases, NHS costs and health inequalities, stratified by area-level deprivation<br><br>c. jobs in the food industry, tax revenue and GDP and income inequalities<br><br>4. Feedback early results to policymakers and the public to identify potential barriers to implementation and to influence modelling strategy.<br><br>5. Produce final report combining results from scenario development and integrated modelling, and communicate findings with public and policymakers. |

**FUNDING AND SUPPORT IN KIND**

| **FUNDER(S)**<br><br>(Names and contact details of ALL organisations providing funding and/or support in kind for this study) | **FINANCIAL AND NON FINANCIAL SUPPORT GIVEN** |
|---|---|
| National Institute for Health Research | £1,411,734 |

**ROLE OF STUDY SPONSOR AND FUNDER**

The study sponsor (University of Oxford) and funder (NIHR) have no role in study design, conduct, data analysis and interpretation, and manuscript writing. The study sponsor has no role in dissemination of results. The study funder's policies and guidance with regard to dissemination of research outputs can be found here: https://www.nihr.ac.uk/documents/nihr-research-outputs-and-publications-guidance/12250

**ROLES AND RESPONSIBILITIES OF STUDY MANAGEMENT COMMITEES/GROUPS & INDIVIDUALS**

**Internal project governance:** The COPPER project has joint PIs (Scarborough and Smith). They will meet monthly to monitor progress on project goals. The research will be split between three work packages. Work package leads will set milestones and timetables and report on progress to the joint PIs at full project meetings which will be held quarterly. Regularity of work package meetings will be at the discretion of the work package leads.

We will recruit an advisory board that will meet on three occasions with the main aim of ensuring that the research outputs from the project are relevant to UK policymakers. The advisory board will consist of the PIs, work package leads, PPI lead, PPI representatives and policymaker representatives.

**Independent study oversight:** The funders of the COPPER project (NIHR) will recruit a Study Steering Committee (SSC) consisting of academics and members of the public. The SSC will meet annually and will be responsible for providing the PIs with challenging and robust scrutiny, and for reporting progress on project goals direct to NIHR.

**Patient & Public Involvement:** We have two PPI members on the COPPER project team, whose roles include: reviewing and revising the project application; contributing to the development of the research material for all studies that require public participants; contributing to the public communication strategy. The two PPI members will attend work package 1 meetings, full project meetings and advisory board meetings.

## PROTOCOL CONTRIBUTORS

The first version of this protocol was based on the Detailed Research Plan submitted to the NIHR in December 2021. All of the co-applicants (listed under 'key protocol contributors' above) contributed to the development of this plan. Subsequent versions of the protocol have been revised by the PIs (Scarborough and Smith) and Work Package leads (Kaur and Harrington).

PPI co-applicants (Ward and Taylor) have been involved with the COPPER project since the application stage, and have contributed to study design and research dissemination plans.


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| **KEY WORDS:** | Diet |
| | Nutrition |
| | Food systems |
| | Planetary health |
| | Health inequalities |
| | Tax and subsidies |

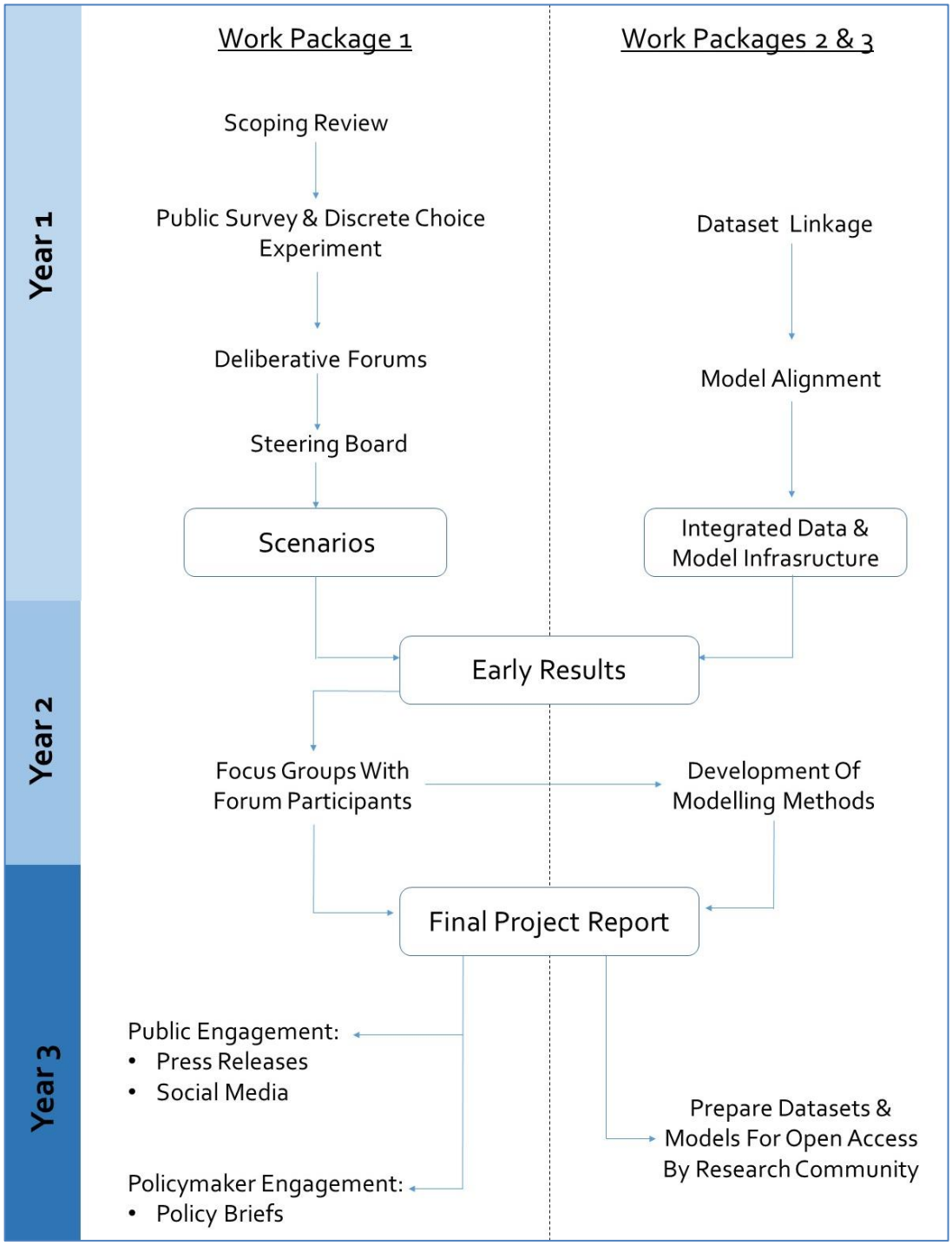

## STUDY FLOW CHART

The COPPER project consists of seven interlinked studies, the findings and results of which will feed into each other. Some of these projects will involve participants recruited from the general public, and some will involve evidence synthesis. The seven projects are:

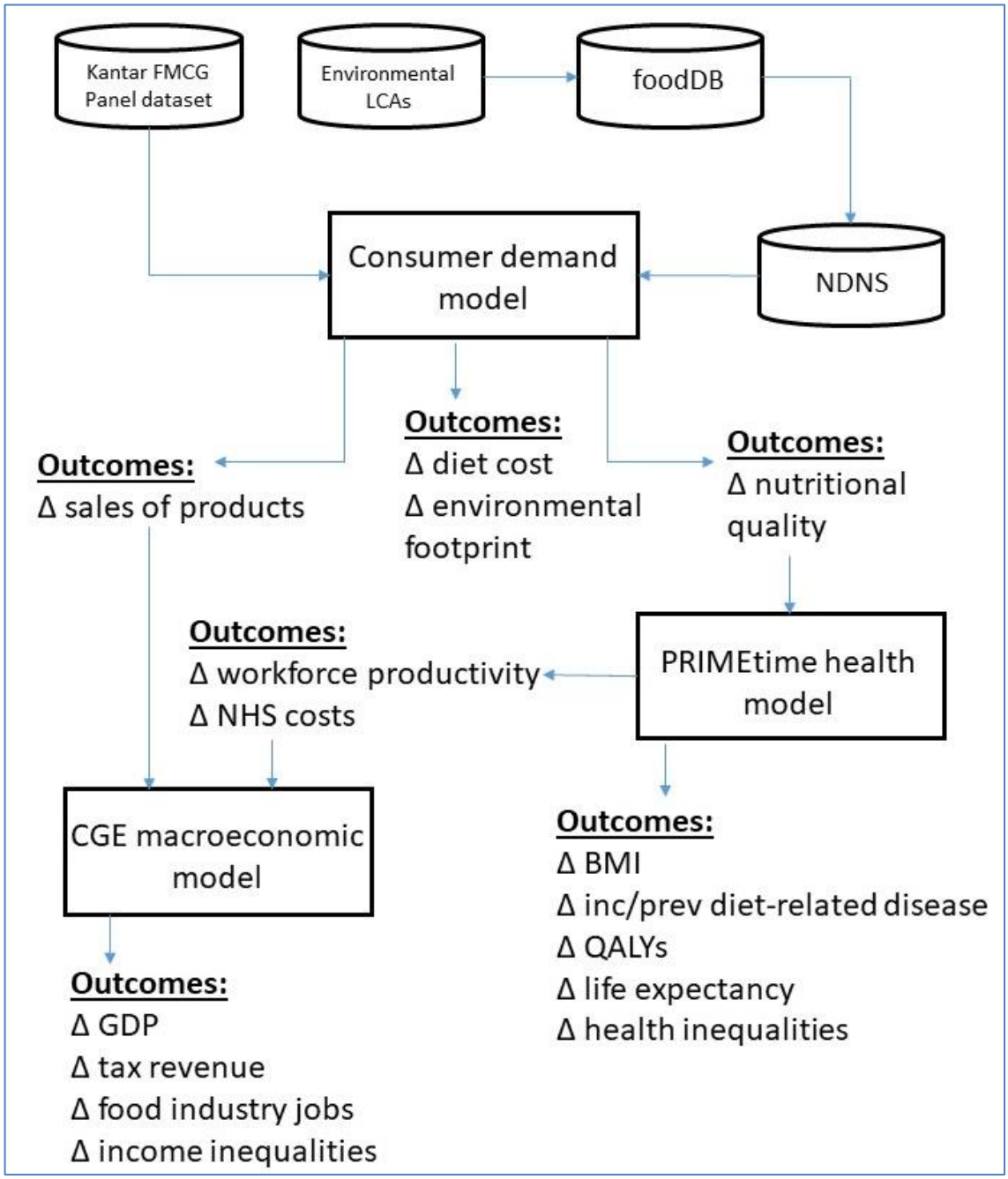
- **Scoping review** (evidence synthesis)
- **Public survey** (participants from general public)
- **Discrete choice experiment** (participants from general public)
- **Deliberative forums** (participants from general public)
- **Dataset and model infrastructure building** (evidence synthesis)
- **Scenario modelling** (evidence synthesis)
- **Focus groups** (participants from general public)

Two flow charts are provided below. The first demonstrates how each of these individual studies will provide results / outputs for use in other studies, and how they will contribute to the final project report. The second shows how the dataset and model infrastructure will be linked.

**Flow chart 1: Progression of studies throughout the COPPER project**



**Flow chart 2: Dataset and model infrastructure**



**STUDY PROTOCOL**

CO-designing for healthy People and Planet: food Economic policy Research (COPPER)

## 1 BACKGROUND

**The role of price in determining food choice:** Price is an important factor concerning food choices and may act as a barrier to a healthier diet. A meta-analysis of 27 studies found that healthier diets are more expensive then less healthy diets [1]. A systematic review of 136 studies concluded that poorer households, particularly those in low income countries, would be most negatively impacted by increases in food prices due to greater price sensitivities [2]. Another systematic review of price sensitivities found that demand for food away from home, soft drinks and juice were most responsive to price changes [8], although there is limited evidence on how these effects may differ by personal characteristics such as age, gender and/or body weight [3].

A systematic review by Cornelsen et al. [4] found that increasing the price of sweets/confectionery was associated with increased consumption of all other food groups except for fats and oils. This suggests that taxes on less healthy foods could yield dietary improvements through both reduction in the consumption of the targeted foods and increases of non-targeted, healthier foods. A systematic review of grocery store based interventions found that price interventions yielded a greater changes in purchases than other strategies such as labelling and in-store promotions [5]. A meta-analysis of interventional and prospective cohort studies found that price decreases had a larger impact on food purchases than price increases [6].

**Randomised studies of taxes and subsidies:** A systematic review of food taxes and subsidies found that experimental studies show that these interventions are effective at changing behaviour, but due to the highly localised nature of delivery of these interventions (e.g. in single grocery stores) results may not be scalable to populations [7]. Controlled experiments conducted in virtual supermarkets, rather than real-world settings, found that while a salt tax may lead to reductions in the total volume of salt purchased, there was also evidence that it led to substitution effects that could have potential adverse effects on overall nutritional intake [8]. Substitution effects were also identified in another review of controlled experiments, which concluded that while price changes can modify purchases favourably, effect on the overall nutritional quality of purchases is mixed [9].

**Natural experiments of taxes and subsidies:** A meta-analysis of natural experiments evaluating sugar drink taxes found that a 10% price increase was associated with a 10% reduction in purchases [10]. How the food industry responds to any tax scenarios will modify the effects that the tax has on consumer behaviour. The degree to which the tax is passed on to consumers (i.e. through a price increase), and whether they choose to reformulate products to avoid taxes are both important mechanisms. Evidence on the impact of taxes on reformulation is scarce, but it has been suggested that the impact is "…likely greater when they are mandatory, aligned with other regulations, and thoroughly monitored and evaluated" [11].

**Modelling studies of taxes and subsidies:** Evidence from modelling studies demonstrate that food price interventions, including taxes on sugar sweetened beverages (SSBs), saturated fats, sugar, salt and subsidies on fruit and vegetables, improve consumption and purchasing patterns that are associated with poor diet and non-communicable diseases (NCDs) [7,12]. While many studies model the impact of single dietary measures, fewer look at overall diet quality [13], and few studies include substitution effects (i.e. the impact of price changes on untargeted foods) [14]. Price interventions are likely to reduce health inequalities by preferentially improving health outcomes in lower income groups [15,16], but some studies show that low income populations only find small benefits [17].

**Brief description of project:** COPPER will be split into three work packages (WPs). In WP1, we will engage with the public and policymakers to co-design food tax and subsidy scenarios. We will collect evidence through reviews, surveys and experiments and present this evidence in public deliberative forums with participants from disadvantaged groups. At these forums the participants will select a

shortlist of six scenarios. Later in the project we will re-engage with the forum participants to guide our methods.

In WPs 2 & 3, we will build an integrated data and model infrastructure that models micro and macroeconomics (WP2), health and the environment (WP3) and focuses on inequalities throughout. Our models will encompass both demand- and supply-side reactions to scenarios; by consumers (e.g. changing food purchasing patterns) and the food industry (e.g. reducing portion sizes, improving nutritional quality of foods). We will estimate the impact of scenarios on cost, nutritional quality and environmental impact of the diet, then link those results with a model that estimates the effect on long-term health and NHS costs. Results from both models will be fed into a macroeconomic model to estimate the impact on Gross Domestic Product (GDP), tax revenue, income inequalities and employment in the food industry (see Flow Chart 2).

## 2 RATIONALE

The UK Government's fiscal policies only partially address the health and environmental impacts of the food system. At present, the Government implements the Soft Drink Industry Levy (SDIL), designed to reduce sugar consumption particularly in children and young adults, and has some subsidy programmes including free school meals and Healthy Start, which provides targeted subsidies for milk, fruit, vegetables and pulses for mothers in disadvantaged groups. Our VAT system exempts or includes foods on the basis of how and where they are sold or fairly arbitrary categorisations which have little to do with their nutritional quality. There are also subsidies for UK agricultural production which do not fully take account of the environmental impact of the food that is produced, and trade agreements that set tariffs on international imports that have been accused of being both bad for health [18] and the environment [19]. With this backdrop, it is unsurprising to see prominent calls from the National Food Strategy and the UK Health Alliance for Climate Change for more comprehensive fiscal policies that address both the health [20] and environmental consequences [21] of the UK food system. To support this joined-up evidence-based policymaking, we need to undertake a systems-wide assessment encompassing the health, environmental and economic impact of fiscal scenarios. To provide the political space needed for implementation of new tax and subsidy policy, we need to ensure that the views of the public – particularly disadvantaged groups – as well as policymakers are central to the design process.

The primary research question for the COPPER project is: What impacts could food taxes and subsidies have on the incidence and prevalence of non-communicable diseases and health inequalities? Our systems-wide modelling infrastructure will also allow us to answer questions about the unintended impact of food taxes and subsidies, including impact on household-level economics, macroeconomics and planetary health.

## 3 THEORETICAL FRAMEWORK

Within work package 1 we will use the following study designs:

- **Scoping review** of literature on food taxes and subsidies
- **Survey** of public attitudes towards food taxes and subsidies
- **Discrete choice experiment** exploring trade-offs between different policy options to achieve health and environmental goals, and eliciting preferences for policies
- **Deliberative forums** to allow members of the public from disadvantaged groups to consider the evidence, ethical issues, prioritise food tax and subsidy scenarios, and guide research methods for work packages 2 and 3.
- **Follow-up focus groups** to get feedback on methods, early results, and how to disseminate these results.

In work package 2 we will use the following methods:

- **Microeconomic modelling** of consumer demand related to changes in food prices
- **Macroeconomic modelling** of the impact of food tax and subsidy scenarios on the UK economy

In work package 3 we will use the following methods:

- **Data linkage** between datasets of food price and nutritional quality, environmental measures, and food consumption
- **Environmental modelling** of the impact of food tax and subsidy scenarios on GHG emissions, water use, land use and water pollution
- **Population health modelling** of the long-term impact of the scenarios on incidence and prevalence of non-communicable diseases, health inequalities, and NHS costs

Our evaluative framework is underpinned by systems theory [22,23]. For example, we will investigate both the intended and unintended consequences of fiscal policy, exploring how such policies impact on different sections of society and sectors of the economy, from farms to retail.

Throughout we will be guided by theories on co-design of research projects [24]. To ensure that the evidence generated by COPPER is appropriately communicated to policymakers operating in this field, we will follow a Knowledge Transfer Model [25] consisting of five steps from ‘knowledge awareness’ through to ‘knowledge application’ (e.g. through engagement with policymakers throughout and production of dedicated policy briefs).

## 4 RESEARCH QUESTION/AIM(S)

1. What food tax and subsidy scenarios do the public and policymakers prioritise?
2. What impacts could food taxes and subsidies have on:
    a. the incidence and prevalence of non-communicable diseases and health inequalities?
    b. household food budgets?
    c. tax revenue?
    d. GDP and jobs in the food industry?
    e. environmental impacts (greenhouse gas emissions, water use, land use and water pollution)?

### 4.1 Objectives

1. Co-design food tax and subsidy scenarios with the public and policymakers.
2. Develop an integrated data and model infrastructure.
3. Simulate the impact of scenarios on:

a. cost, nutritional quality and environmental impact of the diet, stratified by income and area-level deprivation
b. long-term impact on incidence and prevalence of diet-related diseases, NHS costs and health inequalities, stratified by area-level deprivation
c. jobs in the food industry, tax revenue and GDP and income inequalities

4. Feedback early results to policymakers and the public to identify potential barriers to implementation and to influence modelling strategy.
5. Produce final report combining results from scenario development and integrated modelling, and communicate findings with public and policymakers to ensure acceptability and feasibility of implementation.

### 4.2 Outcome

The outcomes for the individual studies conducted across the COPPER project are shown in the tables below. Throughout the project, we will stratify our results by socioeconomic status to explore impact on inequalities.

*Work Package 1*

| **Study** | **Outcome measures** |
|---|---|
| Scoping review | 1. Longlist of tax and subsidy scenarios<br>2. Identification of anticipated and unanticipated outcomes<br>3. Evidence of impact on health and health inequalities |
| Public survey | 1. Public attitudes towards food taxes and subsidies for health<br>2. Public attitudes towards food taxes and subsidies for the environment |
| Discrete choice experiment | 1. Preference for individual attributes of food / environmental policies<br>2. Preference for longlist of tax and subsidy scenarios<br>3. Preference variation by food / environmental attitudes |
| Deliberative forums | 1. Shortlist of tax and subsidy scenarios<br>2. Identification of anticipated and unanticipated outcomes |
| Focus groups | 1. Feedback on early results and methods<br>2. Feedback on public dissemination activities |

*Work Package 2*

| **Study** | **Outcome measures** |
|---|---|
| Econometric modelling | 1. Δ household-level diet cost, overall income and expenditure<br>2. Δ individual-level nutritional quality of diets<br>3. Δ sales of food and drink products |
| CGE macroeconomic modelling | 1. Δ Gross Domestic Product (overall and by sector)<br>2. Δ tax revenue<br>3. Δ employment by sector, including agriculture, food and drink processing and retail<br>4. Δ income inequalities |

*Work Package 3*

| Study | Outcome measures |
|---|---|
| Data linkage and analysis | 1. Linked dataset of food consumption, food price and environmental footprint of foods<br>2. Uncertainty ranges for food price and environmental footprints |
| Population health modelling | 1. Δ population BMI<br>2. Δ incidence and prevalence of diet-related disease<br>3. Δ Quality Adjusted Life Years<br>4. Δ life expectancy<br>5. Δ slope index of inequality |
| Environmental modelling | 1. Δ dietary greenhouse gas emissions<br>2. Δ dietary land use<br>3. Δ dietary water use<br>4. Δ dietary water pollution (eutrophication) |

## 5 STUDY DESIGN and METHODS of DATA COLLECTION AND DATA ANALYIS

**Work Package 1: Co-design of food tax and subsidy scenarios**

**Scoping review:** We will conduct a scoping review rather than a systematic review as the range of literature that we aim to cover is broad and our goal is to identify what others have investigated regardless of the methods that have been used for investigation [26]. The aim of this review will be to identify all food tax and subsidy scenarios that have been considered in the academic or policy literature which aim to promote health, reduce environmental burden or both. We will include tax scenarios where a tax is levied on food and drink as sold on the basis of food category, or on the properties of foods as sold such as nutritional content or environmental impact (GHG emissions, land use, water use and eutrophication). We will include subsidy scenarios where the subsidy is aimed at food and drink in similar ways, whether to the whole population (e.g. through negative VAT rates) or to population subgroups such as how the Healthy Start scheme currently works. We will not include tariffs on food commodities entering the UK, subsidies for UK agriculture or subsidies aimed at any food provided in a specific setting (e.g. free school meals). These will be excluded as our consumer demand model, which will drive the modelling work conducted in WPs 2&3, will be built on price responsiveness to specific food items as sold.

To identify papers for the scoping review we will use the reference list of the systematic reviews identified in the background section of the protocol. For each identified article we will conduct a forward citation search using Google Scholar to supplement our search. For the policy reports we will search the publications section of the following websites of policymakers and think tanks / advocacy groups who are active in this area:

- Office for Health Improvement and Disparities
- Public Health Scotland
- Public Health Wales
- Health and Social Care Public Health Agency Northern Ireland
- HM Treasury
- Department of Health and Social Care (DHSC)
- Department for Environment, Food and Rural Affairs (DEFRA)
- Houses of Parliament Health and Social Care Select Committee.
- Food Foundation
- Health Foundation
- Institute of Fiscal Studies
- Institute of Economic Affairs.

The scenarios that will be modelled in WPs 2&3 will emerge through the co-design process described here, which is designed to identify a shortlist of six scenarios representing the highest priorities for the public. This shortlist will be narrowed from a longlist of scenarios that emerges from the scoping review.

**Public survey and discrete choice experiment:** We will assess public attitudes towards the longlist through an online survey and a Discrete Choice Experiment (DCE) using participants drawn from the research agency Prolific with a sample boost for low income participants. The public survey will explore relationships between demographics, food preferences, health status, environmental concerns, and policy values and preferences, such as between tax and subsidy programs, and between taxes on products, such as sugary drinks, snacks or meat. The DCE will explore trade-offs between the scenarios, with attributes (and attribute levels) for each scenario informed by the scoping review. Participants will be given choices of policy options, which are described by their attributes, and invited to choose their preferred policy across different choice scenarios. A typical choice presented to the participants might be a small GHG tax that increases the point-of-purchase price of goods vs a large subsidy on fruit & vegetables that is paid for by increases in general taxation. As they choose, respondents are implicitly trading-off among the policy types (GHG tax versus fruit and vegetable subsidy) and their attributes (point-of-purchase tax versus additional taxes to fund a subsidy). Their choice responses are the data that we will use to estimate choice models. We will use advanced choice models that incorporate attitudes identified in the survey with the experimental choice data [27]. Depending on the scenarios identified in the longlist, the DCE may include a large number of attributes for participants to consider. If so, we will adapt our design so that subsets of respondents consider different attributes, with common attributes between the subsets. This will allow the choice data across subsets to be jointly modelled and relative preferences for all attributes estimated [28].

**Deliberative forums:** We will hold three deliberative forums with members of the public recruited from disadvantaged groups. Two forums will be held in-person and the third will be held online. For each forum we will recruit 12-15 people. The forums will take place over two days. On day 1, the participants will be given information about the COPPER project and the objectives of the forum, and then will be presented with evidence about food taxes and subsidies. This evidence will include: results from the public survey and DCE; the impact of the food system on health and the environment; the role of the food and drink sector in the UK economy; ethical and political considerations surrounding food taxation and subsidies. On day 2, we will conduct a Multi Criteria Decision Analysis (MCDA). This will involve asking participants to work together to evaluate the longlist of scenario options against various, often conflicting, decision criteria regarding impact of the scenario on health, health inequalities, the environment and the economy. The criteria used for this process will be presented to the participants at the start of day 2. The participants will have the opportunity to add to these criteria, if they feel that important aspects of the decision-making process have not been included. The participant evaluations will be aggregated to calculate an overall evaluation for each scenario [29]. They will also be asked to state whether or not they would choose to implement each of the scenarios. Alongside the longlist from the scoping review, we will include at least one ‘wild card scenario’ - a low-probability, high-impact scenario (e.g. raising food tax levels to a level commensurate with internalising healthcare costs associated with poor diet). The inclusion of wild card scenarios can help improve group decision processes by encouraging “…the reflection of implicit assumptions, a reduction of “blind spots” and thus helps to overcome established mindsets” [30]. This process will be recorded, and the session will be transcribed for thematic analysis after the forums. The thematic analysis will accompany the quantitative outcomes (ranking of the scenarios) to provide evidence of how decisions were made and what the participants felt were the most important aspects of the decision making process.

**Follow-up focus groups:** At the end of year 2 we will invite the participants of the deliberative forums to take part in a focus group to discuss the emerging results of the project. The aim of the focus group will be to present the early modelled outcomes for the scenarios and to ask the participants if they feel

these results change their opinion about how the scenarios should be prioritised. We will also ask them to consider other outcomes by which to measure the impact of the scenarios, and if there are particular population groups that will be disadvantaged by them. The group discussions will be recorded and transcribed for thematic analysis.

**Work Packages 2 and 3: Economic modelling (WP2) and public and planetary health modelling (WP3)**

**Building the model infrastructure:** An overview of the datasets we will use in these two WPs, the three linked models, and the outputs that will be produced is shown in flow chart 2 (where Δ stands for 'change in'). The impact of food tax and subsidy scenarios on health, the environment and the economy will depend on their impact on consumption, and hence purchases, of food and drink, which in turn depend on the magnitude of price changes and the associated demand elasticities. These will be estimated using a consumer demand model that we will develop for the COPPER project, which will incorporate food items that are subject to the fiscal measure, other products which may be substitutes or complements to that food item and also the wider 'ripple-effects' on consumer income. We will link our datasets with environmental measures to estimate the impact on planetary health. Changes in nutritional quality of the diet will be fed into our health model to estimate long-term impact on diet-related disease and NHS costs. Results from both the health model and the consumer demand model will feed into our macroeconomic model to estimate impacts on GDP, tax revenue and employment.

In our scenario analyses we will model the impact of food tax and subsidy scenarios both cross-sectionally and prospectively. The consumer demand model will be cross-sectional and will estimate the impact of the scenarios on the economic cost, nutritional quality and environmental impact of household food purchases. The PRIMEtime health model and the computable general equilibrium (CGE) macroeconomic model will be prospective and will estimate impact on the long-term incidence and prevalence of diet-related diseases, NHS health care costs, and macroeconomic indicators including GDP, tax revenue and employment.

For the consumer demand model the comparator group (against which we measure the change in consumption due to tax and subsidy scenarios) will be current household food purchases. For the health and macroeconomic models, our comparator will be business as usual (BAU) projections of relevant health and economic trends. For example, the PRIMEtime model of long-term health impacts and NHS costs simulates future changes in prevalence of obesity and rates of disease, under a BAU scenario, by assuming a continuation of background trends in obesity prevalence and disease incidence and case fatality rates. These background trends are derived from past years of data and projected forward in time, and can be adjusted to reflect system shocks such as from the COVID-19 pandemic.

The models that we build and use in the COPPER project will simulate results for the entire of the UK. Wherever possible, they will be populated by data collected for the entire UK (e.g. the CGE macroeconomic model uses data on economic activity conducted throughout the UK). Where nationwide data are not available, we will use datasets that cover as much of the population as is available (e.g. age-sex specific trends in BMI for the PRIMEtime model will be estimated from the Health Survey for England series and the Kantar FMCG data covers Great Britain only). Our models will simulate the entire population of the UK, including both children and adults.

**Data linkage:** We will develop our consumer demand model through econometric analyses of Kantar Fast Moving Consumer Goods (FMCG) panel data – a representative panel of over 30,000 UK households with data on all food and drink purchases brought into the home and recorded through barcode scanners. We will use data from Kantar data from the calendar year 2022.

Whilst the consumer demand models will be fitted with Kantar data, we will run our scenarios by applying the demand models to a linked dataset based on consumption from the National Diet and

Nutrition Survey (NDNS). The Kantar dataset collects data at the household-level, whereas NDNS data are collected for individuals – this means that we will be able to run more granular scenarios through our health models, which can be stratified by age and sex. Also, some of the dietary risk factors that are used in the health model are based on food groups (e.g. processed meat) which are generated automatically from NDNS data and are not available in the Kantar data – therefore using NDNS data will assist model linkage.

We will link food consumption from NDNS with data on food prices, and the environmental impact of foods. The food price data will come from foodDB (our dataset of food and drinks available in eight online UK supermarkets) [31]. The environmental measures will be taken from the most comprehensive review of environmental life cycle assessments (LCAs) for foods that has been conducted [32]. These LCAs quantify GHG emissions, land use, water scarcity and eutrophication (water pollution) effects of food. Since the environmental impacts are quantified for primary food commodities (e.g. wheat, beef, potatoes), we will use the product ingredient information recorded in foodDB to estimate environmental impacts of processed food products from their constituent components. To do this, we will use an algorithm that has been demonstrated to be effective for a dataset of ~60,000 multi-ingredient food and drinks in foodDB [33 – under review].

We will then link the foodDB products with reported food consumption in the NDNS Years 9-11 (subsequent years will be added when made available). To do this, we will identify the five most commonly consumed food items for each of the 125 food categories in the NDNS. We will then develop string searches for each identified NDNS food item to find similar food items in foodDB. We will test the accuracy of these matches by comparing the nutrient composition data of NDNS food items to the nutrient composition data for the matched foodDB food items.

For each of the foods in NDNS, we will derive the distribution of price (due to wide product availability covering regular, premium and value brands) and of environmental impact (due to different on-farm production processes). These distributions will be used to generate uncertainty estimates in our modelled household price and environmental outcomes by using Monte Carlo methods.

**Consumer demand model**: We will build a UK-based micro-econometric model of food demand, based on the Almost Ideal Demand System [34]. We will take a 'food basket' approach. This will allow assessment of the impact of fiscal measures levied on specific nutrients (e.g. sugar, saturated fat) or a range of products (e.g. biscuits, bacon). It will also allow for assessment of the impact of multiple changes through the dynamic modelling of simultaneous changes in the price of many goods, which will impact own and cross-price elasticities.

Our consumer demand model will control for household demographics and will produce income, own and cross price elasticity estimates (that is, measures of how consumers change purchasing of a particular food based on changes in the overall food budget, changes in the price of the food, and changes in the price of other foods, respectively). We will stratify our consumer demand model by household income and area-level deprivation, which will allow us to consider differential price responsiveness for different population subgroups.

To estimate the impact of the food tax and subsidy scenarios on cost of diet, nutritional quality of the diet, and environmental footprint of the diet, we will apply our consumer demand model to our linked NDNS dataset. We will perform sensitivity analyses that approximate industry response to the scenarios (e.g. through tax / subsidy pass-on rates and reformulation responses to food taxes). We will use microsimulation on individual NDNS participant responses, which will allow us to incorporate income-specific price elasticities generated by the consumer demand model.

**Health model**: We will use the individual-level nutritional quality outcomes from the consumer demand model as an input to our PRIMEtime health model [35], which will aggregate health results for population subgroups. PRIMEtime uses proportional multistate life table models [36] to represent the UK population ageing through time. The PRIMEtime model estimates the impact of dietary risk factors (red and processed meat, fruit and vegetables, salt, saturated fat, fibre and energy density) on cardiovascular disease, cancer and dementia, mediated via body weight, blood pressure, serum

cholesterol levels and type 2 diabetes. Using closed-cohort simulations, we will simulate the current UK population (children and adults) over 100 years in both BAU and scenario analyses, which can be used to estimate the scenario impact on life expectancy, and the incidence of diet-related diseases over any specified time horizon. Using open-cohort simulations, we will simulate replacement of the current population using demographic projections of birth and migration. These open-cohort models can estimate the change in prevalence of obesity and diet-related diseases, up to 2050. Population health outputs will include changes in incidence and prevalence of diet-related non-communicable diseases and NHS costs. In addition to modelling health outcomes for the whole population, we will model scenario impacts on obesity, quality of life and life expectancy, by IMD quintile (for England only), from which we can determine whether the scenarios will widen or narrow health inequalities. For all results, we will estimate uncertainty intervals using Monte Carlo analyses where key model parameters are allowed to vary according to defined distributions.

**Macroeconomic model**: Our consumer demand model will provide estimates of change in demand for food and drink products, and our PRIMEtime model will provide estimates of workforce productivity due to ill-health and NHS costs. These will both feed into our computable general equilibrium (CGE) macroeconomic model, which will encompass the wider impacts of fiscal measures across food and non-food industries, households, and HM Treasury and will investigate how the impact is disseminated throughout the economy with multiple dynamic feedback effects. This modelling approach allows for analyses of fiscal policies across all sectors of the economy, together with health-related productivity impacts and health sector costs. It can be further customised using survey data to capture multiple household and labour types, and goods sectors can be aggregated or disaggregated to accommodate the focus of the analysis. We will build a CGE macroeconomic model framework that incorporates all major food and drink sectors. The CGE macroeconomic model will be powered by an estimated AIDS demand system which incorporates the demand system described earlier and further extends this to form a complete AIDS demand system covering both food and non-food commodities. We will estimate the impacts of the food price scenarios on total and sector-specific indicators including tax revenue, GDP (by sector), and distributional economic effects on population subgroups specified by quintile of area-level deprivation.

# 6 STUDY SETTING

**Public survey and discrete choice experiment:** These two studies will take place simultaneously using the same participants. The studies will be conducted online. We will use a research agency with a large participant database for recruitment. Eligibility screening will be conducted by the research agency. If invited participants provide informed consent (tracked through an online form) then they will be directed to a questionnaire to collect data.

**Deliberative forums:** We will hold three deliberative forums. Two will be held in person in two different geographic locations with heterogeneous populations (planned locations: Bridlington and Glasgow). The in-person forums will be held in a local community meeting space and recruitment will be restricted to the local area. The third forum will be held online using online meeting software (e.g. Microsoft Teams).

**Follow-up focus groups:** A year after the deliberative forums we will contact all of the participants and ask them to take place in focus groups so that we can feedback early results, receive their input on study design, and provide an opportunity for reprioritising the tax and subsidy scenarios that we are studying. These follow-up focus groups will take place online using online meeting software (e.g. Microsoft Teams).

# 7 SAMPLE AND RECRUITMENT

## 7.1 Eligibility Criteria

For all of the studies in the COPPER project that have human participants (public survey, discrete choice experiment, deliberative forums, and follow-up focus groups) we will apply the same eligibility criteria, which are defined below. We will recruit from the general adult population in the UK, with some additional criteria for specific studies as indicated below.

### 7.1.1 Inclusion criteria

- Aged 18 and over
- Resident in the UK
- Living within 10 miles of the location of the forum **(in-person deliberative forums only)**
- Household income less than £20k per annum **(low-income boost sample for public survey and discrete choice experiment only)**
- In employment, or due to start a new job in the next month, or unemployed (and job seeking) **(low-income boost sample for public survey and discrete choice experiment only)**

### 7.1.2 Exclusion criteria

- Resident in an institution

## 7.2 Sampling

**Public survey and discrete choice experiment:** We will collect data through an online questionnaire hosted by a research agency. We will recruit two samples – one that is nationally representative of the adult population in the UK, and a low-income boost sample.

**Deliberative forums:** For the deliberative forums, we are aiming to recruit a small number of participants from the local community, but we are not aiming for a representative sample. For our in-person deliberative forums our recruitment material will be tailored to the local community, and will be distributed through local voluntary action organisations (e.g. community pantries). We will also place recruitment material in discount supermarkets and GP practices. If necessary, we will supplement recruitment with face-to-face meetings at weight management groups. For our online forum, we will recruit by developing electronic recruitment material and distributing through engagement with food-based NGOs. We will engage with the following NGOs: the Food Foundation, Oxford food bank, Oxford Community Volunteer Action, Community Fridge Network, FareShare and Independent Food Aid Network. We will focus our recruitment for the deliberative forums at low income and single parent households. The forums will be open to all adults, but our recruitment strategy is designed to increase participation from hard-to-reach groups. We will provide participant incentives for these forums in accordance with rates suggested by NIHR. For the virtual forum we will provide data credits to support access.

**Follow-up focus groups:** The participants of the follow-up focus groups will be a subset of the participants for the deliberative forums who will be contacted by email a year after the forums have taken place.

### 7.2.1 Size of sample

**Public survey and discrete choice experiment:** These two studies will be conducted concurrently on the same sample of participants. We will recruit a sample of up to 1500 participants representative of the general population, and supplement this with a sample of 500 participants from low income households. Sample size calculations for the DCE will use the approach of de Bekker-Grob et al. [37]

to ensure our models have sufficient statistical power based on pilot work with a small sample drawn from the research agency. Using a significance level of 95% and power of 0.8, and assuming a multinomial logit model, we have conservatively assumed a sample size of 1500 for the general population sample.

**Deliberative forums:** We will recruit 12-15 people to attend each forum, which is the recommended size of deliberative forums such as this [38].

**Follow-up focus groups:** We will invite all participants from the year 1 deliberative forums, and expect to hold 1 or 2 focus groups with between 5 and 15 participants.

### 7.2.2 Sampling technique

**Public survey and discrete choice experiment:** We will recruit participants through a research agency to ensure a sample that is representative of the UK adult population for age, sex and ethnicity. Our preferred research agency uses 2011 census data to calculate the proportion of different sub groups in the UK population, cross-stratifying for age (five groups), ethnicity (five groups), and sex (two groups), resulting in 50 subgroups. An allocation algorithm is used to first allocate one participant space per sub-group (to ensure minimal representation). The remaining spaces are then allocated in proportion to the national population.

**Deliberative forums:** We will use convenience sampling, through methods described above. We are not aiming for a representative sample of the study population. Instead, we are aiming to recruit participants from the study population, with a particular focus on hard-to-reach groups.

**Follow-up focus groups:** All of the participants from the deliberative forums will be invited to take place in the focus groups.

## 7.3 Recruitment

The exact methods that will be used for recruitment of participants to studies involved in the COPPER project are currently under development subject to review by Information Governance and Ethics Committees in the Medical Science Division of the University of Oxford. Once these methods are finalised we will update the protocol and note the amendments in the appendix.

### 7.3.1 Sample identification

See 7.3 above.

### 7.3.2 Consent

See 7.3 above.

# 8 ETHICAL AND REGULATORY CONSIDERATIONS

The data that will be used in the COPPER project consist of the following categories: primary collection of research data through survey, discrete choice experiments, deliberative forums and follow-up focus groups; secondary analysis of data on food purchases and consumption; use of published data on population, disease rates, environmental outcomes and economic parameters in

models; primary collection of data on food from online supermarkets using automated data collection processes.

For the primary collection of research data, we will apply for ethics approval from the University of Oxford Medical Science Division Research Ethics Committee. We have received an 'in principle' ethics review of the project form this committee, which provides support for the commencement of the project. Applications for ethical approval for individual studies within COPPER will be submitted closer to their commencement date.

For secondary use of data on food purchases and consumption, and for the published data to be used in the models, we will follow the protocols provided by data providers. In all cases, we will only use anonymised datasets with no participant-identifiable variables.

For the primary collection of data on food from online supermarkets we will use the foodDB software platform. foodDB has collected data from online supermarkets in the UK since November 2017. Use of data collected in this way are an explicit exception to crown copyright law when used for non-commercial research [39] and we have previously published work using these data [e.g. 31,40].

### 8.1 Assessment and management of risk

The study of fiscal interventions in the food system is a fast moving field. There are now health-related food tax policies in more than 40 countries worldwide, the majority implemented in the last five years. In the UK, the policy environment has been altered recently by the publication of the National Food Strategy which contained recommendations for a tax on sugar and salt in foods [20] and a Public Health England commissioned project to explore health-related food taxation policies. Since our project was submitted for funding the food landscape has been hit by the cost-of-living crisis, which is likely to be exacerbated by the conflict in Ukraine. The main risk to the COPPER project is that we focus on scenarios that are unobtainable / non-implementable in the political space when we publish our results.

We have two strategies to mitigate this risk. First, we will maintain close communication with policymaking teams by inviting key representatives onto our advisory board – should short term political opportunities arise that require a rapid turnaround of scenario modelling we will be well placed to help out once our modelling infrastructure is developed. Second, our strong emphasis on co-design, and our plans to return to study participants and different stages of the COPPER project, will ensure that our plans remain adaptable and focussed on the needs of the public.

Within the COPPER project we will be conducting studies with the general public that are low risk. We will not be collecting any personal information from participants that is related to safeguarding issues. Therefore we do not anticipate that there will be any risk to participants for taking part in the study and we have not devised any specific plans for mitigation of harm.

### 8.2 Research Ethics Committee (REC) and other Regulatory review & reports

Before recruiting any participants and collecting any data, all of the studies in the COPPER project that involve human participants will be reviewed by the University of Oxford Medical Sciences Interdivisional Research Ethics Committee. This review will include the study protocol, informed consent forms and recruitment material. Where amendments to the ethical approval are necessary, we will halt the study and only proceed once we have received approval for the amendment.

### 8.3 Peer review

Plans for the COPPER project have been peer reviewed by:

- NIHR Research Design Service
- University of Oxford Research Services
- Four anonymous, independent, expert peer reviewers
- One anonymous, independent lay peer reviewer
- The NIHR Public Health Research fuinding panel.

### 8.4 Patient & Public Involvement

The COPPER project has two PPI co-applicants (Ward and Taylor) who have been involved in the project since the development of the stage 2 application. We also have a dedicated PPI Lead (co-applicant Sheehan) who is works on PPI across the NIHR Biomedical Research Centre at Oxford and has expertise in public health ethics, and the delivery of public deliberative forums.

The roles of the PPI co-applicants in the project include:

- reviewing and revising the project application
- attending full project meetings and work package 1 meetings;
- contributing to the development of the research material for all studies that require public participants;
- contributing to the public communication strategy.

We monitor the success of our PPI involvement by maintaining a PPI activity log in the form of a 'You said, we did' record. This activity log is updated by the work package 1 leads after each meeting and signed off by the PPI co-applicants.

We have access to a PPI panel for diet and obesity research that is maintained by researchers working on the NIHR Biomedical Research Centre in Oxford, which we will use when necessary for additional PPI input.

### 8.5 Protocol compliance

Adherence to the protocol will be monitored at full project meetings (which occur every three months), where it is a standing item on the agenda. Work package leads will report back on progress and will update the study PIs on any deviations from the published protocol. Once the proposed deviations have been confirmed (and any necessary amendments to the ethical reviews have been completed) the protocol will be amended and a new version will be published. New versions of the protocol will be tracked by date and version number on the front page and in the page footers. The appendix of the protocol will note what the amendments were and provide a short summary.

### 8.6 Data protection and patient confidentiality

The exact methods that will be used to ensure data protection and participant confidentiality are currently under development subject to review by Information Governance at the University of Oxford. Once these methods are finalised we will update the protocol and note the amendments in the appendix. Our plans will comply with the Data Protection Act 1998 and will ensure all data that are collected are securely managed and maintained, and only stored for as long as is needed for the purpose of the COPPER project.

### 8.7 Indemnity

The University of Oxford has a specialist insurance policy in place which would operate in the event of any participant suffering harm as a result of their involvement in the research (Newline Underwriting Management Ltd, at Lloyd's of London).

### 8.8 Access to the final study dataset

Plans for accessing study datasets are detailed in the COPPER project Data Access and Management Plan, which will be published in May 2022.A link to this plan will be added to the protocol once it is published.

## 9 DISSEMINIATION POLICY

### 9.1 Dissemination policy

We will produce a final report that summarises all of the work in the COPPER project and will be published towards the end of year 3. This final report will provide the basis for our communications strategy, which will translate the findings for the public and policymakers. We also anticipate that the project will produce around twelve academic papers. From work package 1, we will publish papers on the public survey, discrete choice experiment, deliberative forums, and follow-up focus group. For the modelling work packages we will publish papers on change in household spend, macroeconomics, health and the environment, both for the total population and focussing on inequalities. As part of the methods development for this project we will develop a linked dataset of food consumption, price and environmental outcomes which we will make available for use by the academic community, and our integrated modelling infrastructure will be suitable for further food system policy research.

We will work closely with our research partners the Food Foundation to use existing expertise and networks for public engagement. Our engagement activities will include dedicated communications support for all published papers to ensure maximum reach through social media and mainstream media, including through translation of research findings into infographics. To enhance the accessibility of our findings, we will work with a graphical illustrator and our PPI co-applicants to produce an engaging two-page overview of study results aimed at the general public, which we will translate into Polish, Welsh, Urdu and Punjabi (the non-English languages with largest number of speakers in the UK). For engagement with policymakers we will develop policy briefs based on our final report which we will host on our website and circulate around a contact list of relevant people working in Office for Health Improvement and Disparities, Department of Health and Social Care, Department of the Environment, Food and Rural Affairs, and HM Treasury.

### 9.2 Authorship eligibility guidelines and any intended use of professional writers

For all COPPER project academic outputs, including the final study report, authorship will be determined on the basis of the International Committee of Medical Journal Editors criteria for authorship.

## 10 REFERENCES

[1] Rao M, Afshin A, Singh G, Mozaffarian D. Do healthier foods and diet patterns cost more than less healthy options? A systematic review and meta-analysis. BMJ Open. 2013;5;3(12):e004277. DOI:10.1136/bmjopen-2013-004277.

[2] Green R, Cornelsen L, Dangour AD, Turner R, Shankar B, Mazzocchi M, et al. The effect of rising food prices on food consumption: systematic review with meta-regression. BMJ. 2013;346:f3703. DOI:10.1136/bmj.f3703.

[3] Mizdrak A, Scarborough P, Waterlander W, Rayner M. Differential responses to food price changes by personal characteristic: a systematic review of experimental studies. PLoS One. 2015;10(7):e0130320. DOI:10.1371/journal.pone.0130320.

[4] Cornelsen L, Green R, Turner R, Dangour AD, Shankar B, Mazzocchi M, et al. What happens to patterns of food consumption when food prices change? Evidence from a systematic review and meta-analysis of food price elasticities globally. Health Econ. 2015;24(12):1548-59. DOI:10.1002/hec.3107.

[5] Slapø H, Schjøll A, Strømgren B, Sandaker I, Lekhal S. Efficiency of In-Store Interventions to Impact Customers to Purchase Healthier Food and Beverage Products in Real-Life Grocery Stores: A Systematic Review and Meta-Analysis. Foods. 2021;10(5):922. DOI:10.3390/foods10050922.

[6] Afshin A, Peñalvo JL, Del Gobbo L, Silva J, Michaelson M, O'Flaherty M, et al. The prospective impact of food pricing on improving dietary consumption: A systematic review and meta-analysis. PLoS One. 2017;1;12(3):e0172277. DOI:10.1371/journal.pone.0172277.

[7] Niebylski ML, Redburn KA, Duhaney T, Campbell NR. Healthy food subsidies and unhealthy food taxation: A systematic review of the evidence. Nutrition. 2015;31(6):787-95. DOI:10.1016/j.nut.2014.12.010.

[8] Dodd R, Santos JA, Tan M, Campbell NRC, Ni Mhurchu C, Cobb L, et al. Effectiveness and Feasibility of Taxing Salt and Foods High in Sodium: A Systematic Review of the Evidence. Adv Nutr. 2020;16;11(6):1616-1630. DOI:10.1093/advances/nmaa067.

[9] Epstein LH, Jankowiak N, Nederkoorn C, Raynor HA, French SA, Finkelstein E. Experimental research on the relation between food price changes and food-purchasing patterns: a targeted review. Am J Clin Nutr. 2012;95(4):789-809. DOI:10.3945/ajcn.111.024380.

[10] Teng AM, Jones AC, Mizdrak A, Signal L, Genç M, Wilson N. Impact of sugar-sweetened beverage taxes on purchases and dietary intake: Systematic review and meta-analysis. Obes Rev.2019;20(9):1187-1204. DOI:10.1111/obr.12868.

[11] Vandevijvere, S., Vanderlee, L. Effect of Formulation, Labelling, and Taxation Policies on the Nutritional Quality of the Food Supply. Curr Nutr Rep. 2019;8:240–249. DOI:10.1007/s13668-019-00289-x.

[12] Eyles H, Ni Mhurchu C, Nghiem N, Blakely T. Food Pricing Strategies, Population Diets, and Non-Communicable Disease: A Systematic Review of Simulation Studies. PLoS Med. 2012; 9(12):e1001353. DOI:10.1371/journal.pmed.1001353.

[13] Emmert-Fees KMF, Karl FM, von Philipsborn P, Rehfuess EA, Laxy M. Simulation Modeling for the Economic Evaluation of Population-Based Dietary Policies: A Systematic Scoping Review. Adv Nutr. 2021;19. DOI:10.1093/advances/nmab028.

[14] Thow AM, Downs S, Jan S. A systematic review of the effectiveness of food taxes and subsidies to improve diets: understanding the recent evidence. Nutr Rev. 2014;72(9):551-65. DOI:10.1111/nure.12123.

[15] McGill R, Anwar E, Orton L, Bromley H, Lloyd-Williams F, O'Flaherty M, et al. Are interventions to promote healthy eating equally effective for all? Systematic review of socioeconomic inequalities in impact. BMC Public Health. 2015;15(1):457.DOI:10.1186/s12889-015-1781-7.

[16] Backholer K, Sarink D, Beauchamp A, Keating C, Loh V, Ball K, et al. The impact of a tax on sugar-sweetened beverages according to socio-economic position: a systematic review of the evidence. Public Health Nutr. 2016;19(17):3070-84. DOI:10.1017/s136898001600104x.

[17] Jain V, Crosby L, Baker P, Chalkidou K. Distributional equity as a consideration in economic and modelling evaluations of health taxes: A systematic review. Health Policy. 2020; 24(9):919-31. DOI:10.1016/j.healthpol.2020.05.022.

[18] Freund F, Springmann M. Policy analysis indicates health-sensitive trade and subsidy reforms are needed in the UK to avoid adverse dietary health impacts post-Brexit. Nat Food. 2021;2:502–508. DOI:10.1038/s43016-021-00306-9.

[19] WWF [Internet]. What we want from the UK-Australia trade deal. Available from: https://www.wwf.org.uk/updates/uk-australia-trade-deal [Accessed July 2021].

[20] National Food Strategy Team [Internet]. National Food Strategy: The plan. Available from: https://www.nationalfoodstrategy.org/ wp-content/uploads/2021/07/1669_NFS_The_Plan_July21_S11.pdf [Accessed July 2021].

[21] UK Health Alliance on Climate Change. All consuming: building a healthier food system for people and planet. London: UKHACC; 2020. Available from: http://www.ukhealthalliance.org/wp-content/uploads/2020/11/UKHACC-ALL-Consuming-Building-a-Healthier-Food-System-for-People-Planet.pdf [Accessed June 2021].

[22] Rutter H, Savona N, Glonti K, Bibby J, Cummins S, Finegood DT, et al. The need for a complex systems model of evidence for public health. Lancet. 2017;390(10112):2602-4. DOI:10.1016/S0140-6736(17)31267-9.

[23] McGill E, Er V, Penney T, Egan M, White M, Meier P, et al. Evaluation of public health interventions from a complex systems perspective: A research methods review. Soc Sci Med. 2021;272:113697. DOI:10.1016/j.socscimed.2021.113697.

[24] National Institute for Health Research (NIHR).Guidance on co-producing a research project. London: NIHR; 2021. Available from https://www.learningforinvolvement.org.uk/wp-content/uploads/2021/04/NIHR-Guidance-on-co-producing-a-research-project-April-2021.pdf [Accessed June 2021].

[25] Liyanage C, Elhag T, Ballal T, Li Q. Knowledge communication and translation – a knowledge transfer model. J. Knowl. Manag. 2009;13(3):118-131. DOI:10.1108/13673270910962914.

[26] Munn Z, Peters MDJ, Stern C, Tufanaru C, McArthur A, Aromataris E. Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. BMC Med Res Methodol. 2018;18:143. DOI:10.1186/s12874-018-0611-x.

[27] Buckell J, Hensher DA, Hess S. Kicking the habit is hard: A hybrid choice model investigation into the role of addiction in smoking behavior. Health Econ. 2021;30(1):3-19. DOI:10.1002/hec.4173.

[28] Hess S, Daly A, Dekker T, Cabral MO, Batley R. A framework for capturing heterogeneity, heteroskedasticity, non-linearity, reference dependence and design artefacts in value of time research. TRANSPORT RES B-METH. 2017;96:126-49. DOI:10.1016/j.trb.2016.11.002.

[29] Frazão TDC, Camilo DGG, Cabral ELS, Souza RP. Multicriteria decision analysis (MCDA) in health care: a systematic review of the main characteristics and methodological steps. BMC Med Inform Decis Mak. 2018;18(1):90. DOI:10.1186/s12911-018-0663-1.

[30] Mendonça S, Pina e Cunha M, Kaivo-oja J, Ruff F. Wild cards, weak signals and organisational improvisation. Futures. 2004;36(2):201-218. DOI:10.1016/S0016-3287(03)00148-4.

[31] Harrington RA, Adhikari V, Rayner M, et al. Nutrient composition databases in the age of big data: foodDB, a comprehensive, real-time database infrastructure. BMJ Open. 2019;9(6):e026652. DOI:10.1136/bmjopen-2018-026652.

[32] Poore J, Nemecek T. Reducing food's environmental impacts through producers and consumers. Science. 2018;360(6392):987-92. DOI:10.1126/science.aaq0216.

[33] Clark MA, Springmann M, Rayner M, Scarborough P, Hill JD, Tilman D, et al. The environmental impacts of food products available at food retail stores. Under review.

[34] Deaton A, Muellbauer J. An almost ideal demand system. American Economic Review. 1980,1;70(3):312-26.

[35] Briggs ADM, Cobiac LJ, Wolstenholme J, et al. PRIMEtime CE: a multistate life table model for estimating the cost-effectiveness of interventions affecting diet and physical activity. BMC Health Serv Res. 2019;19,485. DOI:10.1186/s12913-019-4237-4.

[36] Barendregt JJ, Van Oortmarssen GJ, Van Hout BA, Van Den Bosch JM, Bonneux L. Coping with multiple morbidity in a life table. Math Popul Stud. 1998;7(1):29-49,109. DOI:10.1080/08898489809525445.

[37] de Bekker-Grob EW, Donkers B, Jonker MF, et al. Sample Size Requirements for Discrete-Choice Experiments in Healthcare: a Practical Guide. Patient. 2015;8:373–84. DOI:10.1007/s40271-015-0118-z.

[38] Street J, Duszynski K, Krawczyk S, Braunack-Mayer A. The use of citizens' juries in health policy decision-making: a systematic review. Soc Sci Med. 2014;109:1-9. DOI:10.1016/j.socscimed.2014.03.005.

[39] Intellectual Property Office [Internet]. Exceptions to copyright – research. Published June 2014. Available from: https://www.gov.uk/ guidance/exceptions-to-copyright [Accessed July 2021].

[40] Scarborough P, Adhikari V, Harrington RA, Elhussein A, Briggs A, Rayner M, et al. Impact of the announcement and implementation of the UK Soft Drinks Industry Levy on sugar content, price, product size and number of available soft drinks in the UK, 2015-19: A controlled interrupted time series analysis. PLoS Med. 2020;11;17(2):e1003025. DOI:10.1371/journal.pmed.1003025.

## 11. APPENDIX: AMENDMENT HISTORY

| Amendment No. | Protocol version no. | Date issued | Author(s) of changes | Details of changes made |
|---|---|---|---|---|
| | | | | |