



**Article title:** Influences on single-use and reusable cup use: a multidisciplinary mixed-methods approach to designing interventions reducing plastic waste

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Professor Dan Osborn  
Editor-in-Chief UCL Open  
UCL Open: Environment

Dear Professor Osborn,

My co-authors and I would like to submit our Methodology paper entitled "*Influences on single-use and reusable cup use: a multidisciplinary mixed-methods approach to designing interventions reducing plastic waste*" for publication in the journal UCL Open: Environment. This manuscript corresponds to a Methodology paper as outlined in your list of accepted article types.

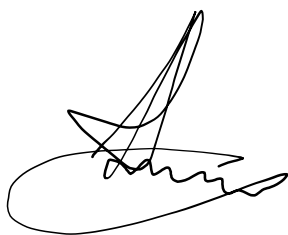
We are a multidisciplinary group of researchers including health psychologists, behavioural scientists and materials scientists from University College London. We are part of the UCL Centre for Behaviour Change (<https://www.ucl.ac.uk/behaviour-change/>) and UCL Plastic Waste Innovation Hub, whose aim is to develop new ways of designing-out waste from plastic packaging (<https://www.plasticwastehub.org.uk>).

This work investigates unsustainable patterns of plastic production and consumption therefore fitting the scope of the journal. This paper aims to examine behavioural influences on use of single-use and reusable coffee cups as a basis for promoting reusable cup use. This is important as cups intended for single-use pose a significant environmental threat. Many of these cups are lined with thin layer of plastic. Due the limited facilities capable of separating and sorting the materials for recycling, many end up littered, in landfill or incinerated. Efforts to reduce the number of single-use cups used are therefore key to pro-environmental consumption.

Due to COVID-19 related disruptions, this study has been temporarily postponed. However, we feel there is added value in sharing our research method with the wider scientific community. There are limited published examples of behaviour change frameworks applied within this context. In addition, the method outlined in this paper is applicable to understanding and changing an array of environmentally significant behaviours, offering an illustration and adaptable template for other researchers and practitioners.

Yours Sincerely,

Ayşe Lisa Allison  
PhD Student, UCL Plastic Waste Innovation Hub  
(On behalf of my co-authors)



# Influences on single-use and reusable cup use: a multidisciplinary mixed-methods approach to designing interventions reducing plastic waste

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**Keywords:** single-use, reusable, coffee cups, plastic waste, circular economy, intervention, behaviour change, influences, COM-B, Behaviour Change Wheel.

## **Abstract**

*Background:* An estimated 2.5-5 billion single-use coffee cups are disposed of annually in the UK, most of which consist of a plastic lining. Due to the difficulty of recycling poly-coated material, most of these cups end up as litter or in landfill. As hot beverage consumption is a consumer behaviour, behaviour change interventions are necessary to reduce the environmental impacts of single-use coffee cup waste. Basing the design of interventions on a theoretical understanding of behaviour increases transparency of the development process, the likelihood that the desired changes in behaviour will occur and the potential to synthesise findings across studies.

*Aim:* The present paper presents a methodology for identifying influences on using single-use use and reusable cups as a basis for designing intervention strategies.

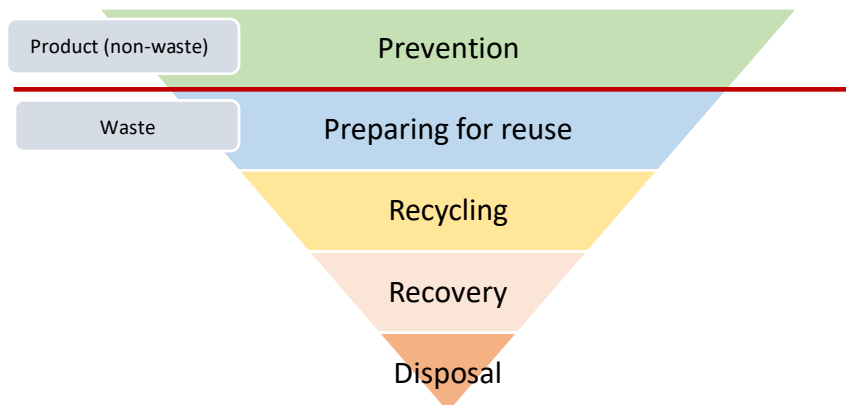
*Method and application:* An online survey and follow-up interviews were developed by a multidisciplinary group of practitioners, health psychologists, material scientists, behavioural scientists and catering staff. They used two behaviour change frameworks: The Theoretical Domains Framework and Capability-Opportunity-Motivation-Behaviour model of behaviour. Research findings can inform selection of intervention strategies using a third framework, the Behaviour Change Wheel. The application of the methodology is illustrated in relation the setting of a university campus.

*Conclusions:* We have developed a detailed method for identifying behavioural influences relevant to pro-environmental behaviours, together with practical guidance for each step and a worked example.

## INTRODUCTION

Tea and coffee consumption in the UK have become increasingly ‘on the go’ (1). This has led to a rise in the number of hot drinks sold in cups intended for single use — an estimated 2.5-5 billion single-use coffee cups are disposed of annually in the UK, most consisting of a paper body and plastic lining (2). Recycling these cups, although technically possible, is limited by a lack of facilities in the UK capable of separating the materials for recycling (2). Automatic sorting and collecting is also a challenge. Most cups end up as litter or in landfill contributing to environmental degradation (3). In addition, the carbon dioxide emissions generated by single-use coffee cups are approximately 1.5 times the weight of the cup (4). Efforts to reduce the number of single-use cups are key to consumption that supports sustaining the environment.

Product re-use has been identified as the optimal strategy to reduce waste once a product has entered circulation. This is in line with the “waste hierarchy” set out in Article 4 of the EU’s revised Waste Framework (Directive 2008/98/EC) (5), which ranks waste management options according to what is best for the environment (shown in Figure 1). This hierarchy recommends waste management strategies that prioritise reducing the amount of waste in circulation, rather than managing it once it is there. When waste is created, the Waste Hierarchy gives priority to preparing it for re-use, then recycling, then recovery, and last of all disposal (e.g., landfill, incineration). Life cycle assessments have shown reusable cups to be a more sustainable alternative to single-use cups, if used over 72 times (6).



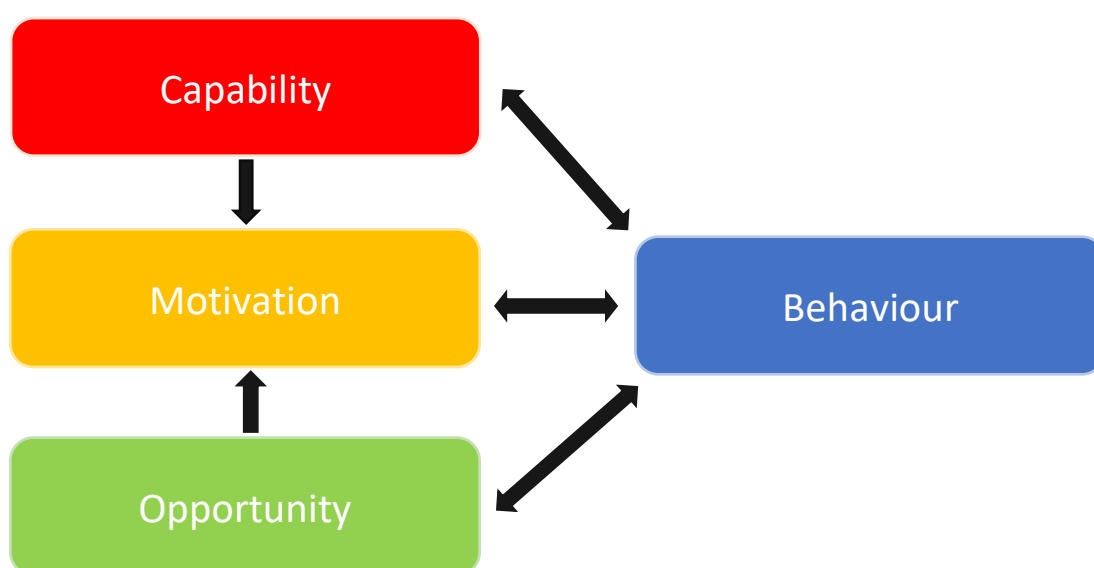
*Figure 1. The Waste Hierarchy as set out in article 4 of the revised Waste Framework (Directive 2008/98/EC)*

Efforts to increase reusable cup use have had varied success. An example comes from a UK University (University College London) which freely distributed reusable cups to students during their ‘fresher’s’ week with the aim of promoting their use across the campus catering outlets. This was followed by a ‘ditch the disposable’ campaign where a disposable coffee cup charge (‘latte levy’) was implemented across the campus (7). Although there was an initial increase in the number of hot drink sales made in reusable cups, this plateaued at an average 20%-25% across all campus catering outlets.

Progress in this area is likely to benefit from formative research to develop understanding of the factors influencing this behaviour. This seemingly simple behaviour of using a reusable cup is located within a complex system of several interacting groups of actors including: consumers, suppliers and caterers, operating at various organisational levels. Guidance for developing and evaluating the kinds of ‘complex’ interventions needed to tackle this type of system point to the importance of grounding interventions in both theory and evidence, local and more general (8, 9). To develop a plan for how to change behaviour (i.e., design an intervention) we first need to understand why behaviour is as it is and what it would take to bring about the desired change. Using suitable behaviour change frameworks can aid the process of identifying behavioural influences that need to be targeted for change to occur.

### **Behaviour change frameworks**

Shown in Figure 2, a framework that has been widely used for developing interventions is the Capability-Opportunity-Motivation-Behaviour model (COM-B) (10, 11). COM-B posits that for a behaviour to occur there must be the Capability, Opportunity and Motivation to perform the behaviour. Capability can be psychological (e.g., knowledge) or physical (e.g., skills); opportunity can be social (e.g., societal influences) or physical (e.g., environmental resources); motivation can be automatic (e.g., emotion) or reflective (e.g., beliefs, intentions).



*Figure 2. COM-B - a model for understanding behavioural influences (Michie et al., 2011; Michie et al., 2014)*

These COM-B components can be elaborated into the Theoretical Domains Framework (TDF) (12), shown in Table 1. It includes 14 Theoretical Domains, representing individual, socio-cultural and environmental factors influencing behaviour. These include people’s knowledge and skills, memory, attention and decision-making processes, beliefs about capabilities and consequences, goals and emotions as well as physical and social environmental factors.

<b>TDF domain</b>	<b>Explanation</b>
Knowledge	An awareness of the existence of something
Skills	An ability or proficiency acquired through practice
Social/Professional role and identity	A coherent set of behaviours and displayed personal qualities of an individual in a social or work setting
Beliefs about capabilities	Acceptance of the truth, reality or validity about an ability, talent or facility that a person can put to constructive use
Reinforcement	Increasing the probability of a response by arranging a dependent relationship, or contingency, between the response and a given stimulus
Intentions	A conscious decision to perform a behaviour or a resolve to act in a certain way
Goals	Mental representations of outcomes or end states that an individual wants to achieve
Memory, attention and decision processes	The ability to retain information, focus selectively on aspects of the environment and choose between two or more alternatives
Environmental context and resources	Any circumstance of a person's situation or environment that discourages or encourages the development of skills and abilities, independence, social competence and adaptive behaviour
Social influences	Those interpersonal processes that can cause individuals to change their thoughts, feelings, or behaviours
Emotion	A complex reaction pattern, involving experiential, behavioural, and physiological elements, by which the individual attempts to deal with a personally significant matter or event
Behavioural Regulation	Anything aimed at managing or changing objectively observed or measured actions

*Table 1. The Theoretical Domains Framework – 14 domains of individual, socio-cultural and environmental influences on a behaviour (Cane et al., 2012)*

The relationship between COM-B and TDF domains are shown in Figure 3. COM-B and TDF are part of the 'toolbox' of behavioural science frameworks that can be used to understand the influences on behaviour in its context (11, 13).

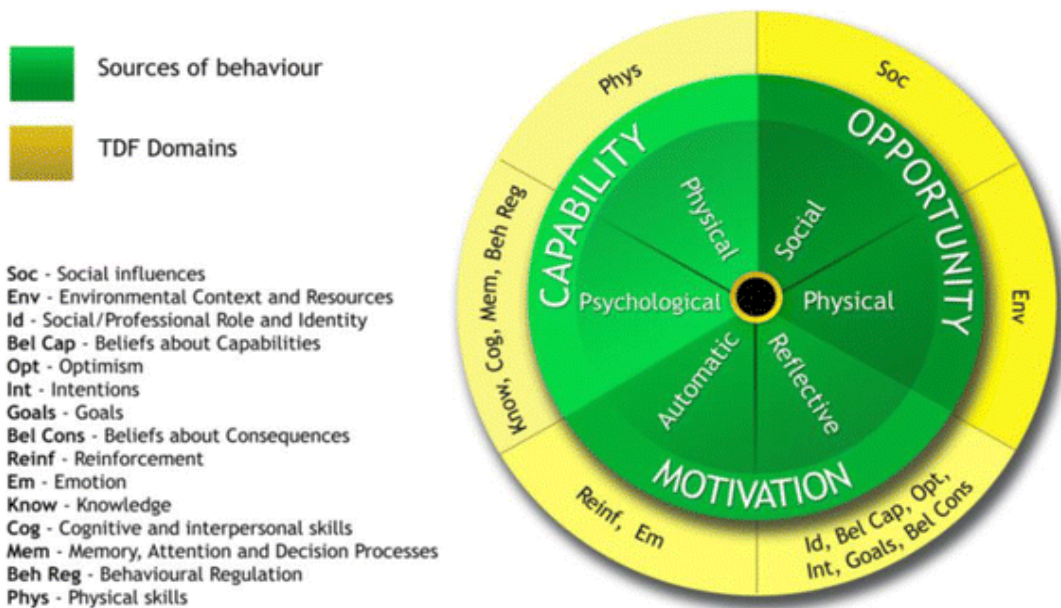


Figure 3. TDF domains linked to COM-B components

A third framework is helpful for using an understanding of behaviour and its influences to designing an intervention for individuals, organisations and populations: The Behaviour Change Wheel (BCW) (10, 11). Shown in Figure 4, the BCW is an integrated synthesis of 19 behavioural frameworks. It consists of three parts: 1) An inner hub, the COM-B model, 2) A middle layer of intervention types, and 3) an outer layer which are policy options for leveraging these types of intervention. Details about how to apply the Behaviour Change Wheel to intervention development can be found elsewhere (10, 11, 13-15).

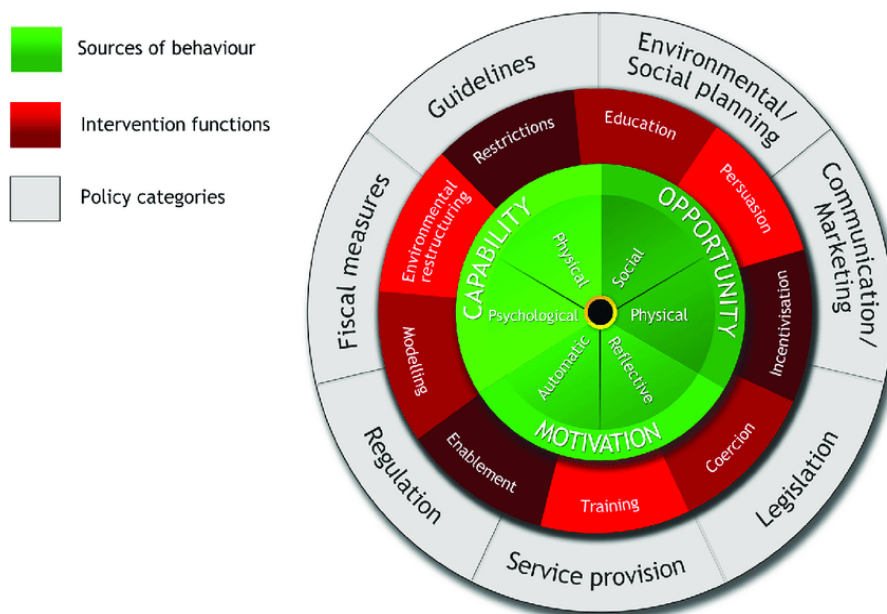


Figure 4. The Behaviour Change Wheel - a framework for intervention development, evaluation and evidence synthesis (Michie et al., 2011; Michie et al., 2014)

Data collection for this study began in March 2020. Due to the onset of the COVID-19 pandemic, data collection was first rescheduled to October 2020 then postponed until post-pandemic. There is added value in sharing the methodology developed with the wider scientific community. Although these frameworks have previously been applied to understanding behaviours relating to sustainability (16, 17), there are limited published examples of behaviour change frameworks applied within this context. Our paper provides an adaptable template that can be used by other intervention practitioners and researchers. Basing the design of interventions on a theoretical understanding of behaviour increases transparency of the development process, the likelihood that the desired changes in behaviour will occur and the potential to synthesise findings across studies.

### **Aims**

This study aims to answer the following research questions:

1. What is current behaviour with respect to single-use and reusable cup?
2. What are the influences on single-use and reusable cup use?
3. What are the views on potential intervention strategies to promote reusable cup use?



## METHOD

This study has ethical approval from UCL (project ID: CEHP/2020/579, data protection: Z6364106/2020/02/86)

### **Study setting**

The study setting is the central campus of a large inner-London university whose sustainability strategy is to be single-use plastic free by 2024. Since previous efforts to eradicate single-use coffee cups across the campus had been of limited effectiveness, the university aims to develop of an intervention informed by behavioural science. The study is a collaboration between behavioural scientists at UCL's Centre for Behaviour Change (15), the multi-disciplinary team at the Plastic Waste Innovation Hub (18), UCL's Sustainability team (19) , representatives from UCL's catering team and Sheffield University's plastics research and innovation hub (20).

### **Design**

This will be a mixed-methods study including an online survey followed by semi-structured interviews conducted with a sample of survey respondents.

### **Phase 1: Online Survey**

#### **Participants**

Participants will include university students and staff. We aim to recruit 374 staff, 377 undergraduates and 379 postgraduates. This is based on a sample size calculation using the university's 2019 population statistics in a Raosoft sample size calculator (21) (at 95% confidence level and 5% margin of error) to calculate a minimum sample size for undergraduates, postgraduates and staff. We will invite approximately 623 staff, 628 undergraduates and 631 postgraduates to take part in the survey based on an anticipated 60% response rate for each group, in line with guidance for response rates and responsiveness for surveys (22). Exclusion criteria include being under 18 years of age, having completed the survey previously and not having sufficient English to complete the survey. Entering into a prize draw for gift vouchers will be used as an incentive for survey completion.

#### **Survey development**

We will administer an online survey to staff and students. The survey has been developed from three sources: a survey on attitudes towards reusable cups developed by our collaborators at Sheffield University, an evidence review of perceptions, behaviours and interventions related to reducing plastic waste (23) and discussions with UCL's Sustainability team to understand what information would be useful to them in planning the intervention.

A hardcopy of the survey has been piloted for comprehensibility and feasibility with a sample of UCL students and staff including members of the UCL Plastic Waste Innovation Hub and UCL Sustainability. A digital version, built on Qualtrics (24), has been piloted for usability with the

same sample of students and staff and a group of behaviour change experts. The final draft survey is openly available via Open Science Framework (OSF) at <https://osf.io/ujkwe/>.

The first section of the survey includes questions about demographic information and current behaviour relating to single-use reusable cups. Subsequent sections include: open-ended questions and, statements regarding behavioural influences and possible intervention strategies to promote reusable cup use, with agreement expressed on a 5-point Likert scale.

### **Procedure**

Participants will be recruited via social media and email. An advert containing a link to the survey will be posted in a select number of undergraduate and postgraduate Facebook groups. Invitation emails containing the survey link will be circulated to a select number of students and staff drawn from a select number of University mailing lists. Informed consent will be obtained from all participants prior to data collection. After completion, participants will be asked to leave their university email addresses if they were willing to be contacted about follow-up interviews and take part in the prize draw.

### **Analysis**

*RQ1: What is current behaviour with respect to single-use and reusable cups?*

Responses will be summarised using frequencies and percentages.

*RQ2: What are influences on single-use and reusable cup use?*

We will compute the mean scale scores for each COM-B domain and conduct exploratory factor analyses to assess the internal consistency of survey items. Responses across participant groups e.g., staff vs students will be compared. To identify domains associated with cup use, we will conduct a regression analysis. We will analyse responses to the open-ended questions via thematic analysis in line with Braun and Clarke's guidance (25). Any additional behavioural influences generated will be summarised as frequencies and mapped onto COM-B components of capability, opportunity and motivation.

*RQ3: What are the views on potential intervention strategies to promote reusable cup use? We will summarise the extent to which respondents support certain intervention strategies. Open-ended responses will be analysed by categorising participants' suggested intervention strategies according to Behaviour Change Wheel intervention types and component Behaviour Change Techniques from the Behaviour Change Techniques Taxonomy (26).*

## **Phase 2: Follow-up survey**

### **Participants**

From the survey respondents willing to be contacted for follow-up interviews, we will purposefully invite 15-20 participants to ensure an equal spread across staff, undergraduates and postgraduates.

## **Interview development**

The interviews will explore in more depth the influences on single-use and reusable cup use. It will be developed based on COM-B components and TDF domains. It will include at least one open-ended question per domain, followed by a series of follow-up prompts. A draft topic guide is openly available via OSF at <https://osf.io/uikwe/>. Questions will be refined, depending on the results of the survey, in order to explore the most relevant barriers and enablers to single-use and reusable cup use. We will pilot the final version of the interview guide with three students and three staff members prior to data collection.

## **Procedure**

Participants will be invited for an interview and consent sought prior to the interview via email. We will conduct interviews over an online video-conferencing platform offering end-to-end encryption, lasting an estimated 20-45 minutes. They will be audiotaped and transcribed verbatim for analysis.

## **Analysis**

We will conduct an inductive thematic analysis in line with Braun and Clarke's approach (25) and map emergent themes onto COM-B categories. Additional guidance on conducting thematic analysis can be found elsewhere (27, 28). Below is a summary of the steps we will take:

- a) *Familiarisation with the data*. This involves breaking the transcript down into units of 'utterances', reading through all the utterances and noting down any recurring patterns;
- b) *Generation of initial codes to indicate themes*. As utterances are assigned codes, a coding framework detailing code labels and definitions can be developed and revised iteratively to help guide subsequent coding;
- c) *Searching for themes*. This involves organising codes into a tentative set of candidate themes;
- d) *Review of themes*. This involves a back-and-forth process of revisiting the raw interview data and coding framework in order to update the names, descriptions and definitions of candidate themes;
- e) *Mapping of emergent themes onto the COM-B categories of barriers and enablers*. In this step themes are mapped depending on whether they refer to capability, opportunity and motivation. They are barriers if they hinder the target behaviour and an enabler if they promote the target behaviour;
- f) *Assignment of names and definitions for themes*. This involves finalising the name, definition, description and example quotes for each theme;
- g) *Production of the report*. This involves writing up the analysis with feedback from co-investigators.

## DISCUSSION

This method outlines a clear sequence of activities for understanding single-use and reusable cup use as a basis for promoting reusable cup use. We have illustrated its applicability within in a large metropolitan University context. It can serve as a template for understanding a wide variety of environmentally significant behaviours and foundation for designing interventions that sustain environmental health. There is a wealth of literature using behaviour change frameworks to understand, change and synthesise evidence related to health-significant behaviours (29-34). The design of this method is novel in terms of its application within a sustainability context and development through multidisciplinary collaboration.

### Strengths and limitations

COVID-19 related disruptions, campus closure and bans on reusable cups for hygiene purposes (35) led to the decision to postpone data collection. If such restrictions persist or become mainstream, it may not be feasible to implement an intervention promoting reusable cup use. If/when restrictions ease, our systematic approach with step-by-step guidance offers a rubric for resuming the study at a later date. It also offers an adaptable template for other researchers and practitioners undertaking similar projects.

### Implications for future research and practice

The wider and long-term impacts of the COVID-19 pandemic on plastic use and waste by consumers is unknown. In addition to the bans on reusable cups across major cafe chains, the pandemic has led to increased demand for products in single-use packaging(36) and increased lobbying to lift bans on single-use plastic bags (37). These events may have created additional barriers to implementation: fear of reusable items and an association between single-use and hygiene entering public consciousness. There is already speculation that amongst the general public, single-use masks may be preferable to reusable masks due to perceptions of increased hygiene (38). Changing wasteful behaviour(s) must nonetheless remain a priority. To increase the likely effectiveness of such behaviour change, conducting targeted and up-to-date diagnoses of behaviour, as outlined in this paper, will be crucial.

### CONFLICTS OF INTEREST

There are no conflicts to declare.

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#### **AUTHOR CONTRIBUTIONS**

Conceptualisation, Ayşe Lisa Allison, Fabiana Lorencatto, Susan Michie and Mark Miodownik; Funding acquisition, Mark Miodownik; Methodology, Ayşe Lisa Allison, Fabiana Lorencatto and Susan Michie; Project administration, Ayşe Lisa Allison; Supervision, Fabiana Lorencatto, Susan Michie and Mark Miodownik; Validation, Fabiana Lorencatto, Susan Michie, Mark Miodownik; Writing – original draft, Ayşe Lisa Allison; Writing – review & editing, Ayşe Lisa Allison, Fabiana Lorencatto, Susan Michie and Mark Miodownik.

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