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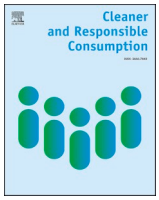

Using labels to support climate-friendly lunch purchases – An in-store study

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ABSTRACT

This study investigates how climate impact information influences consumers' in-store decision-making. To increase our understanding of consumer behaviour in relation to food choices and environmental impact, further research is needed to explore how consumers act in real-life settings rather than their intended behaviours. We conducted a real-life experiment in a food retail setting, where we studied the impact of carbon footprint labels on consumer choice. To do this, we used qualitative and quantitative methods, and applied the Capability, Opportunity, Motivation-Behaviour (COM-B) model to frame consumer behaviour. We found that the labels did provide consumers with increased capability and opportunity to make more climate-friendly food choices, but they failed to trigger consumer motivation to choose these options. To enhance motivation, there may be a need to implement other forms of interventions alongside labels. However, labels can continue to increase knowledge about the environmental impact of food products and pave the way for additional behavioural change initiatives. Our study also provides insights into how collaborating with private retailers on research projects can influence study design. These insights could be useful to those aiming to conduct similar studies.

1. Introduction

Food systems are responsible for approximately a third of global anthropogenic greenhouse gas (GHG) emissions (Crippa et al., 2021; Poore and Nemecek, 2018). The IPCC's Sixth Assessment Report highlights how socio-cultural interventions related to food, have the potential to significantly contribute to climate change mitigation (Dhakal et al., 2022). Such interventions include shifting diets, reducing food waste, and minimising overconsumption (Dhakal et al., 2022, Figure TS.21).

One way to shift towards more environmentally sustainable and healthy diets is by reducing the consumption of meat and dairy and increasing the intake of plant-based foods (Röös et al., 2015, 2024; Willett et al., 2019). These changes could have profound effects on meeting GHG emissions targets, especially in high-income countries (Hedenus et al., 2014; Poore and Nemecek, 2018; Springmann et al., 2018). In 2021, food represented approximately 29% of the annual average household consumption-based GHG emissions of a person living in Sweden (Naturvårdsverket, 2023). The average Swedish diet exceeds the EAT-Lancet Commission's boundaries for GHG emissions (Moberg et al., 2020). It has been estimated that the carbon footprint of an average meal in Sweden would need to be reduced by 1.3 kg CO_2 equivalents (kg CO_2-eq) to 0.5 kg CO_2-eq to reach sustainable levels (WWF Sweden, 2022).

To achieve a behavioural shift toward diets with lower GHG emissions, consumers need to have the capability, opportunity, and motivation to change their behaviours (Michie et al., 2011b). This change can be facilitated by people having sufficient information and knowledge as to why their behavioural change is needed (Lorenzoni et al., 2007; Michie et al., 2011b), and by people turning their knowledge into action (Hornik, 1989; Schruff-Lim et al., 2023). This study aims to increase the understanding of how environmental impact information

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influences people's food choices in an in-store context. To do this we tested how labels with climate impact information influence consumers' food choices in a real-life, retail setting. We frame our experimental design and the analysis of our findings in the Capability, Opportunity, Motivation-Behaviour (COM-B) behavioural change model (Michie et al., 2011b).

Our study is part of a larger project, CANDIES, led by researchers at the Stockholm Environment Institute (SEI, 2024). This project intended to deepen the understanding of consumer behaviour and decision-making for sustainable food consumption. In a previous study, Ran et al. (2022) identified several factors which influence the capabilities, opportunities, and motivations of consumers toward making more environmentally sustainable choices when shopping for food. The study found that consumers seek more trustworthy and accessible information to support their decision-making, preferably in-store. Climate impact labelling, for example front-of-package carbon footprint labels, is one intervention which has been used by physical retailers for many years to promote environmental-friendly food choices (Ytreberg et al., 2023). Carbon footprint labels have more so, been trialled as part of several studies (Majer et al., 2022; Potter et al., 2021).

The evidence on the effect of environmental impact labels or information on consumer behaviour remains inconclusive. Some studies suggest that these interventions can support decision-making (e.g. Brunner et al., 2018; Elofsson et al., 2016; Feucht and Zander, 2018; Potter et al., 2021), whereas other studies show that they have a limited effect on consumer behaviour (e.g. Bschaden et al., 2024; Slapø and Karevold, 2019). However, relatively few studies have examined the impact of labels on food consumption behaviour in real-life settings, particularly in retail contexts (Ran et al., 2024). Instead, labels have often been studied using surveys and choice experiments which assess consumers' stated intentions rather than their actual behaviours (Ran et al., 2024). Stated intentions have limited ability to predict consumer behaviour in real life, especially regarding food choices (Taufik et al., 2019).

To understand how behavioural-change interventions impact individuals' food choices, it is essential to test them in real-life settings (Potter et al., 2021; Ran et al., 2024). In this study, we therefore ask the following research question: *How do labels with information about carbon footprints influence consumers' in-store decision-making?*

To explore this question, we ran an in-store experiment at a Stockholm-based food retail company, Urban Deli. We tested the impact of carbon footprint labels on consumer choices of lunchbox meals and applied a quantitative and qualitative approach to our data collection and analysis.

2. Theory

2.1. Shifting food choice behaviour with information-based initiatives

There are a wide variety of interventions available to promote sustainable food choices among consumers. Several studies have explored information-based interventions, including labels, aimed at promoting environmentally sustainable food consumption (Betz et al., 2022; Camilleri et al., 2019; Emberger-Klein and Menrad, 2018; Potter et al., 2021; Thøgersen and Nielsen, 2016). In fact, a recent mapping identified that information-based interventions were the intervention type most commonly studied, and labels alone constituted 50% of the total number of interventions identified (Ran et al., 2024).

Most studies on labels assess their effects by examining stated or intended behaviours rather than actual behaviours (Ran et al., 2024). Studies based on stated intentions have limited ability to predict real-life consumer behaviour due to the intention-behaviour gap, which occurs between reflective thinking and in-the-moment decision-making (Barth et al., 2012; Gisslevik, 2018; Liobikienė et al., 2016; Sheeran and Webb, 2016). As a result, intentions can overestimate actual behavioural actions (Liobikienė et al., 2016; Sheeran and Webb, 2016). However, several studies which investigated the effects of carbon footprint labels on people's food choices in real-life settings, found that this type of intervention can have a positive, albeit modest, effect (Brunner et al., 2018; Bschaden et al., 2024; Elofsson et al., 2016; Lohmann et al., 2022). These real-life studies have primarily been conducted in restaurants or canteens (e.g. at universities), while studies in retail settings remain underrepresented (Ran et al., 2024).

The effect of carbon footprint labels, however, depends on the level of environmental concern already held by the person making the selection (Grunert et al., 2014; Thøgersen and Nielsen, 2016). Consumers must also be aware of the label, understand what the label means, and be willing to take the information communicated into account in their decisions (Thøgersen and Nielsen, 2016). Real-life experiments have also emphasised the importance of label design (Brunner et al., 2018; Lohmann et al., 2022; Vanclay et al., 2011; Vlaeminck et al., 2014). It has been shown that in general, consumers prefer concise and simple labels (Feucht and Zander, 2018). Additionally, the effectiveness of carbon footprint labels can be improved by using relative scales to present the carbon footprint information, such as traffic-light colour schemes (Thøgersen and Nielsen, 2016).

Furthermore, for information interventions to be effective it is important that they are tailored to the consumer segments they intend to target (Funk et al., 2021; Klöckner and Ofstad, 2017). They should take into account different socio-economic attributes (Thøgersen, 2017) and prior beliefs of consumers (Abrahamse, 2020). Information should also be presented at suitable times to consumers, including before, during, and after they shop for food (Ran et al., 2022).

It has also been noted that consumers need an in depth understanding of environmental impacts for them to consider changing their behaviours (Vanhuyse et al., 2019). Research has found that consumer awareness of the food sector's impact on climate change is low (Bailey et al., 2014; de Boer et al., 2016; Stampa et al., 2020). Additionally, consumers have been found to have less knowledge about what makes food environmentally sustainable, in comparison to what makes food healthy (Hoek et al., 2021). Information-based interventions may therefore require complementary education efforts to enable consumers to make more environmental-friendly food choices (Gisslevik, 2018; Lindahl and Jonell, 2020; Willett et al., 2019).

2.2. Theoretical framework

In our study we have used the COM-B model (Michie et al., 2011b) to understand behaviour and to design our behavioural change intervention. By applying this theoretical model we can provide greater insight into the impact of our intervention (Hedin et al., 2019). Additionally, through reporting on its application we enhance the replicability of our work (Hoffmann et al., 2014). Despite the value of grounding behavioural change interventions in established behaviour theories, many real-life experimental studies fail to do so (Hedin et al., 2019).

The COM-B model describes how capability, opportunity, and motivation change behaviour (Michie et al., 2011b). According to the COM-B model, a behaviour occurs when a person has the capability and opportunity to engage in a behaviour and is motivated to perform it more than other behaviours (West and Michie, 2020). This model has been used extensively to develop interventions targeting health-related behaviours (Atkins and Michie, 2013; Howlett et al., 2021; Timlin et al., 2021). However, in recent years, it has gained popularity for understanding the determinants of environmentally sustainable behaviours and how to promote them (Arrazat et al., 2024; Hedin et al., 2019; Jürisoo et al., 2018; Lambe et al., 2020; Potter et al., 2021).

Capability is defined as an individual's physical and psychological capacity to engage in an activity, which requires having necessary skills and knowledge (Michie et al., 2011b). Opportunity is defined as the external factors beyond an individual's control which enable a behaviour (Michie et al., 2011b). This includes factors such as accessibility and the influence of social norms (Michie et al., 2011b). Motivation is

defined as the brain processes that energise and direct a behaviour (Michie et al., 2011b). This includes habitual processes, emotional responses, and analytical decision-making (Michie et al., 2011b).

In the COM-B model, capability and opportunity influence motivation (West and Michie, 2020), as well as behaviours, both directly and indirectly (Timlin et al., 2021). The COM-B components are interlinked and function in a feedback loop (Michie et al., 2011b). As noted by Michie et al. (2011b, p.4), "… *enacting a behaviour can alter capability, motivation, and opportunity* …", which can result in unintended outcomes when attempting to change behaviours.

Interventions which aim to change behaviours make use of 'behaviour change techniques' (Michie et al., 2011a). These are the components of an intervention which are designed to alter or redirect processes which regulate behaviour (Michie et al., 2011a). Such techniques, including feedback, self-monitoring, and reinforcement processes, are considered the "active ingredients" of an intervention (Michie et al., 2011a). Behaviour change techniques connect to 'mechanisms of action', which mediate the effect from interventions (Johnston et al., 2021). Carey et al. (2019) describe how mechanisms of action encompass a range of theoretical constructs such as 'knowledge', 'belief about consequences' and 'skills'. These constructs represent the processes through which a behavioural change technique affects behaviour (Carey et al., 2019). Mechanisms of action encompass both individual characteristics (e.g. intrapersonal psychological processes) and aspects of the social and physical environment (e.g. social support) (Carey et al., 2019).

In developing a behavioural change intervention, the first step is to establish the target behaviour that one wants to achieve (Atkins and Michie, 2013). Typically, one would have a theory about the mechanisms of action which would affect this behaviour (Johnston et al., 2021). Then one would seek to design interventions which incorporate behaviour change techniques that target the mechanisms of action (Johnston et al., 2021). In Fig. 1, we depict how the concepts of behaviour change techniques and mechanisms of action tie into the COM-B model, and how these concepts and model apply to our experiment.

In our experiment, the behaviour studied is the *choice of a ready-made lunchbox by a consumer in a retail store* (Fig. 1). Our target behaviour is that consumers choose a ready-made lunchbox with a lower carbon footprint. This behaviour can be mediated by mechanisms of action such as *knowledge, belief about consequences,* and *attitudes toward behaviours* (Johnston et al., 2021), which are a part of or influence the three COM-B components (Carey et al., 2019; Michie et al., 2011b). *Information about social and environmental consequences* is the behavioural change technique integrated in our intervention (Fig. 1), which targets the mechanisms of action (Johnston et al., 2021).

For our mechanisms of action, *knowledge* refers to the awareness about the existence of something (Carey et al., 2019). *Beliefs about consequences* relate to the perceptions of the outcomes of a behaviour, including what will be lost or gained from it (Carey et al., 2019). *Attitude toward a behaviour* refers to the evaluations of a behaviour on a scale ranging from negative to positive (Carey et al., 2019).

The tested intervention is carbon footprint labels placed on the front of lunchboxes sold in a food retail store. We applied a classification system to our calculated carbon footprints which separated the footprints into 'low', 'medium', and 'high' groups relative to each other (see the Methods section for further information). These categories were displayed on the labels to communicate the relative carbon footprints in an accessible and simple way. This design decision was anchored in previous research which has shown that communicating relative impact on labels significantly increases their effectiveness (Emberger-Klein and Menrad, 2018; Feucht and Zander, 2018; Thøgersen and Nielsen, 2016).

To assess the impact of the labels, we analysed sales data of the lunchboxes using quantitative methods and consumer perspectives of the labels using qualitative methods. In defining our hypotheses about the impact of our intervention on lunchbox sales, we draw on real-life experimental studies involving carbon footprint labels on food products (Brunner et al., 2018; Bschaden et al., 2024; Lohmann et al., 2022; Slapø and Karevold, 2019; Vanclay et al., 2011). In these studies, carbon footprints have been communicated using relative scales.

In Vanclay et al.'s (2011) in-store study, no statistically significant shift in the overall purchasing behaviour was observed from their carbon footprint-label intervention. However, their descriptive data revealed a trend with an increase in sales of foods labelled with a low carbon footprint, and a decrease in sales of foods labelled with a high carbon footprint. Brunner et al. (2018) compared the outcomes for different meal groups, e.g. fish, meat, vegetarian. Their experiment showed that low-carbon footprint labels increased the sales of meat dishes, while high-carbon footprint labels decreased these sales. Additionally, Brunner et al. (2018) showed that a high-carbon footprint label did not necessarily have a greater effect than a low-carbon footprint label on food choice behaviours. This stands in contrast to findings from other studies which have compared positive versus negative environmental labelling (Thøgersen and Nielsen, 2016).

In Lohmann et al.'s (2022) study, the probability of selecting a meal labelled with a low carbon footprint remained unchanged, but the probability of selecting a meal with a high carbon footprint decreased. Instead, consumers chose meals with medium-carbon footprint labels when available. A similar trend was observed by Slapø and Karevold's (2019) for one of their two study intervention periods. However, Slapø & Karevold's (2019) noted that their medium carbon footprint meals were fish-based, whereas their low carbon footprint meals were purely

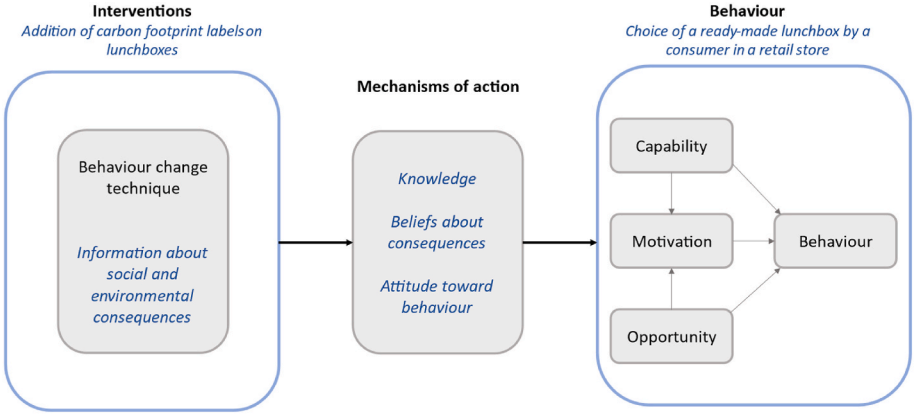

Fig. 1. Diagram connecting COM-B components (adapted from Michie et al., 2011b), interventions, behaviour change techniques, and mechanisms of action. The black text refers to the theoretical framework components, while the blue text refers to aspects specific to our study. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

vegetarian. This may have led customers to switch from the meat-based option to the fish-based option due to their similarity, when influenced by the label intervention (Slapø and Karevold, 2019).

Additionally, Brunner et al. (2018) found varying results from the introduction of a medium-carbon footprint label depending on the type of meal, e.g. fish, meat. Bschaden et al. (2024) implemented labels displaying the relative carbon footprint of meals in a company canteen, represented by cloud images (more clouds indicated a higher carbon footprint). Their results showed no difference in the percentage of employees who chose the medium carbon footprint meal between their intervention and control periods, even when a high carbon footprint option was available. In this experiment, the percentage of employees who chose high carbon footprint meals increased during the intervention period, while the percentage who chose low carbon footprint meals decreased.

In our study, we analysed the sales data for groups of lunchboxes categorised by their low, medium, and high-carbon footprint labels, as done by Lohmann et al. (2022), as well as the sales data for individual lunchboxes. We assume that the intervention increased consumer knowledge of the relative sustainability impacts of different lunchbox options by providing information about their carbon footprints. In addition, it likely influenced consumers' beliefs about the consequences of their choices.

Despite the mixed results from previous studies, we hypothesise:

1. The sales of boxes labelled '*high*' would be proportionally *smaller* during the experimental intervention than a control period without the label.
2. The sales of boxes labelled '*medium*', would be proportionally *the same* during the experimental intervention and a control period without the label.
3. The sales of boxes labelled '*low*', would be proportionally *larger* during the experimental intervention than a control period without the label.

3. Methods

We combined both quantitative and qualitative methods to understand the effect of the carbon footprint label. Short interviews with store customers were completed to gain a better understanding of the results from the quantitative analysis of sales data for lunchboxes. In gathering customer perspectives on their lunchbox selection, our focus was to understand how our intervention had shaped their capability, opportunity, and motivation toward choosing more climate-friendly options. By combining the qualitative and quantitative assessments we were also able to reduce potential biases, for example from interviewees trying to provide more socially acceptable answers to the interviewer (Graeff, 2005).

3.1. Experimental design and set-up

3.1.1. Overarching design and experimental setting

The carbon footprint label intervention was tested on takeaway lunchbox meals sold in-store by Urban Deli, a Swedish food retailer. The experiment was conducted in three of Urban Deli's store locations in central Stockholm. Urban Deli targets a consumer segment which primarily lives and works in the Stockholm region. Urban Deli employees were engaged throughout our study and took part in discussions related to the planning, scoping, and design of our experiment.

Urban Deli sells various types of lunchboxes, including vegan, vegetarian, fish, shellfish, and meat-based options. This includes salads as well as meals that can be heated up. At the time of the experiment, the lunchboxes cost between 95 and 115 Swedish crowns (SEK) or 9 and 11 US dollars (USD). Furthermore, the lunchboxes are all sold under the same Urban Deli brand. This contributes to their comparability as branding can play into consumer choice (Boccia et al., 2023). Of the lunchboxes sold by Urban Deli, there are eight which are constant throughout a given quarter of a year. These eight lunchboxes were selected for our experiment to allow for a comparison in sales over time.

Urban Deli prepares and packages its lunchboxes at a central kitchen location, from which the lunchboxes are distributed to different stores. During the intervention period, the lunchboxes were also labelled with the carbon footprint labels as part of this preparation process. Due to the centralised preparation, we could not label only a portion of the lunchboxes while leaving another portion unlabelled for delivery to a specific Urban Deli store. Therefore, we were unable to designate one of the three store locations as a control store for selling unlabelled lunchboxes.

Although our experiment was grounded in prior research findings, it is important to note that working with a private retailer impacted its design. In our collaboration, we needed to consider the business priorities and operational schedule of Urban Deli. This influenced aspects such as the design of the carbon footprint labels and their placement on the lunchboxes. Additionally, we had to be mindful of the timing of our experiment and ensure it was organised in accordance with other in-store campaigns. This meant that our experiment could only run for three weeks, even though it could be useful to study the effect of information-based interventions over longer time periods (Bschaden et al., 2024). The influence of Urban Deli's input on the design of the labels is further described in the following section.

3.1.2. Carbon footprint labels

We calculated the carbon footprints of each lunchbox by including all ingredients that represented 1% or more of the total mass of a lunchbox recipe. We used average carbon footprint values from the Mistra Sustainable Consumption database (Kanyama et al., 2019) for the ingredients. If an ingredient was not available in this database, we used values from the Research Institutes of Sweden (RISE, 2024) database and the Swedish University of Agricultural Sciences (SLU)'s 'food-climate-list' (Röös, 2012). Additional details about the calculation methods can be found in the Supplementary Materials (SM), Appendix A.

The calculated carbon footprints were divided into the categories: 'low', 'medium', and 'high', which were relative to each other. Through consultation with Urban Deli, we created our own cut-off points for this categorisation. We decided that a carbon footprint higher than 2 kg CO2-eq/box would be categorised as 'high', while a carbon footprint under 1 kg CO2-eq/box was categorised as 'low'. A carbon footprint between 1 and 2 kg CO2-eq/box was categorised as 'medium'. The low, medium, and high categories were communicated on the labels. The purpose of this categorisation was to make the communication of the carbon footprints simple and accessible to consumers, while also facilitating the comparison of different carbon footprints. The carbon footprints and label information for each lunchbox are presented in Table 1.

Table 1
Lunchboxes, carbon footprint, and label information.

Lunchbox	Carbon footprint (kg CO_2-eq/box)	Label information (Carbon footprint categorisation)
Meatballs	6.0	High
Warm salmon	1.8	Medium
Shrimp salad	1.7	Medium
Salmon salad	1.0	Medium
Chicken salad	0.8	Low
Warm chicken	0.8	Low
Vegan curry	0.7	Low
Tempeh salad	0.3	Low

The labels were co-designed with Urban Deli and placed on the front of the lunchbox packaging. For Urban Deli it was important that the design aligned with their branding and that the labels were produced by their own designers (see label designs in Fig. 2). This influenced the size of the labels and meant that it was not possible to use traffic-light colours for the different label categories. Traffic-light colours have been shown to be useful in designing effective carbon footprint labels (Beyer et al., 2024; Thøgersen and Nielsen, 2016).

3.2. Data collection

3.2.1. Sales data

Sales data for the lunchboxes was provided by Urban Deli for the full duration of the experiment (November 9-26, 2021). This data was compared to sales data for a control period of the same length, which took place prior to the experimental period (October 22 – November 8, 2021). During this control period, the same or similar lunchboxes were sold. This method of comparing sales data from an experimental period with an earlier control period follows the approach used by Brunner et al. (2018) in their carbon footprint label experiment. In meetings with members of staff from Urban Deli, we were informed that no supply chain events or operational activities occurred that could have impacted the delivery of lunchboxes to meet consumer demand during the experimental and control periods. We were also informed that none of the eight lunchboxes studied sold out during these time periods.

3.2.2. Interviews

In their real-life experiments involving carbon footprint labels, both Lohmann et al. (2022) and Bschaden et al. (2024) analysed sales data of purchased meals and conducted consumer surveys. The surveys collected demographic data and perspectives on the labels, and were distributed via email, paper forms, or web-links and QR codes on leaflets (Bschaden et al., 2024; Lohmann et al., 2022). One limitation of distributing surveys via email is that it may capture responses predominantly from customers who are more inclined to take time to answer surveys (Andrade, 2020).

In our experiment we conducted short, semi-structured in-person interviews during the intervention period – allowing us to gather in-the-moment, in-store perspectives. We recruited consumers for the interviews at the three store locations and approached them directly after they had purchased their chosen lunchboxes. This ensured that the interviews did not influence their purchasing decisions. Prior to conducting the interviews, we obtained consent from the interviewees to be audio recorded and for their answers to be written down.

In total, 80 interviews were conducted between November 11-25, 2021 during common lunchbreak hours (11 a.m.–3 p.m.) by three different researchers. These were mostly held in Swedish, with a few exceptions in English. Most of the interviews lasted between 3 and 5 minutes, with a minority being shorter (around 1 minute) or longer (around 10 minutes). The demographics of the interviewee sample is presented in Table 2 below.

Table 2
Description of sample from in-store interviews.

Gender distribution	Female	49%
	Male	51%
	Other	0%
Age distribution	18–35	38%
	35–50	40%
	50–65	21%
	>65	1%
Food restriction	None	66%
	Gluten/lactose-free	13%
	Other allergy	3%
	Vegetarian	1%
	Vegan	6%
	Flexitarian	11%

The interviews included questions designed to capture aspects related to *capability*, *opportunity,* and *motivation* of the COM-B model. Specifically, we aimed to understand how the carbon footprint labels provided capability and opportunity for consumers to obtain knowledge about the climate impact of a lunchbox. Additionally, we explored the factors influencing consumer motivation when selecting a lunchbox.

The questions were both closed-ended and open-ended (see full interview guide in the SM, Appendix B). The close-ended questions regarded the lunchbox choice made by the consumer and whether they had seen the label. The open-ended questions addressed: (1) the consumer's in-store journey and potential habits they have in-store, (2) the reasons behind the consumer's final lunchbox choice, (3) the reasons why the label did or did not impact the consumer's lunchbox choice, (4) the consumer's thoughts about the label, and (5) the consumer's reflections about their choice after considering the label. The interviews also allowed respondents to share their opinions on the design of the intervention.

3.3. Data analysis

3.3.1. Statistical analysis of sales data

To determine whether our intervention had an impact on the sales patterns of the lunchboxes, we analysed the sales data using two-sample proportion Z-tests in RStudio Desktop version 2024.04.2 + 764 (RStudio, 2024). Brunner et al. (2018) used this statistical test to compare the proportions of different meals sold during the experimental and control periods in their study of carbon footprint labels in a university restaurant. In contrast to studies by Brunner et al. (2018) and Lohmann et al. (2022), we did not have access to individual level sales data or demographic data which could be linked to the sales data.

We conducted Z-tests for both the individual lunchboxes and groups of lunchboxes (categorised by the low, medium, and high-carbon footprint labels). The proportions were calculated by dividing the sales of the individual lunchboxes or groups of lunchboxes, with the total sales of all eight lunchboxes. One-sided tests, which assess whether a

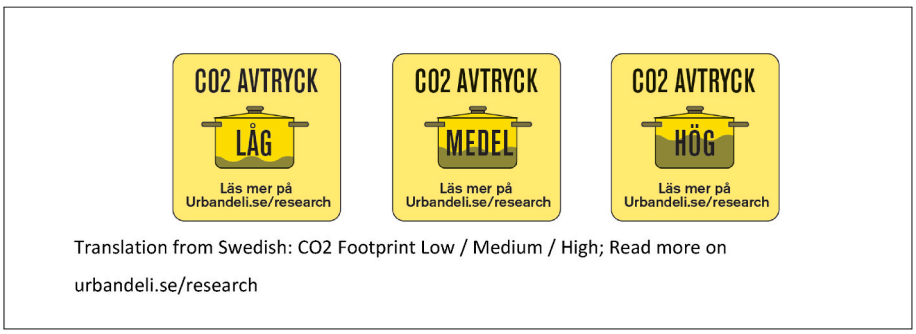

Fig. 2. Label designs for experiment.

proportion is greater or smaller than another proportion (UCLA: Statistical Methods and Data Analytics, 2024), were used for the 'high' and 'low' boxes. Two-sided tests, which assess if there is a difference between proportions (UCLA: Statistical Methods and Data Analytics, 2024), were used for the 'medium' boxes. In our experiment, we could not control for external factors that might have influenced lunchbox sales, such as weather, COVID-19 infection rates, and other in-store campaigns.

3.3.2. Interviews

The audio-recorded interviews were transcribed and the responses to the open-ended questions coded according to the components of the COM-B model (see Fig. 1). Three researchers independently coded the interview material and then discussed their codes to ensure a common understanding of the results. Simple descriptive statistics were produced for the close-ended questions. The descriptive analysis and coding of the interviews were performed using Microsoft Excel. The quotes presented in the Results section were translated from Swedish to English.

4. Results

4.1. Results from the sales data

The results from the two-sample proportion Z-tests for the grouped lunchboxes are presented in Table 3.

The results from the two-sample proportion Z-tests for the individual lunchboxes are presented in Table 4.

4.2. Results from the in-store interviews

For the lunchbox choices made by those interviewed, the sample was relatively representative of the division of sales among the eight lunchboxes during the experimental period (see Table 5).

4.2.1. Capability and opportunity

In our interviews, we found that 66% of interviewees did not have any food restrictions, while 16% had a non-chosen food restriction. For the 16%, this could restrict their lunchbox options and limit the opportunity of the label to influence their lunchbox choice. 76% of the interviewees reported seeing the label before buying the lunchbox.

We found that 76% of interviewees explicitly expressed positive sentiments toward the label or label information. These persons described the information as interesting and useful: *"It (the label) is clear and interesting. It's the first time I see this type of information and I think it is great."*, *"I saw some are high, some are low. I think it is interesting to know"*.

However, 92% of interviewees who had a positive attitude toward the label or label information, reported that it did not impact their lunchbox choice: *"The information is really good, yet if I had been as tempted by another box, I would maybe have taken that one"*, *"It (the label)'s good that it's there, but I don't think it would have changed any choice"*, *"For me it does not have an impact, but I think it could influence others"*.

It was also mentioned how the label confirmed pre-existing knowledge: *"I think I already knew this (the information) myself, but it impacts me absolutely"*.

In addition, there were questions raised about the carbon footprint calculations, the categorisation of 'low', 'medium', and 'high' information, and the colour of the labels: *"I suppose there is red and green too? I think a colour system would have worked on me"*, *"Low carbon footprint in comparison to what? This is not telling me that much information"*, *"I wonder if the packaging is included in this score?"*.

Furthermore, there was scepticism towards the labels and their legitimacy as they were Urban Deli–branded: *"I don't really believe that they just did that for good, I believe it's always for marketing reasons"*, *"On the one hand it feels good that it is low carbon footprint but at the same time it feels like clear marketing"*.

4.2.2. Motivation

Forty interviewees indicated how they were habitual consumers at Urban Deli and some quickly selected lunchboxes over their work lunch break. Their choices were often motivated by past experiences. They either chose their favourite box, rotated between boxes, or wanted to try one they had not tried before: *"I knew which one I (lunch box) wanted before I entered"*, *"I've tried this one (lunch box) and it tastes good"*, *"I thought: I haven't tried this one (lunch box) yet!"*.

The main recurring factors influencing lunchbox choices were habit, food preference, taste, convenience, and whether the meal was meant to be eaten warm or cold: *"I wanted something I did not need to heat up"*, *"I know I like this one (lunch box) and I wanted to grab something quickly"*," *I come very often so I know the ones I like"*. Health reasons were also given: *"I mostly think about carbohydrates"*, *"Chicken and salad felt good since I've been working out"*. 10% of the interviewees had a chosen food restriction, e.g. eating a vegetarian or vegan diet, which motivated their food choices. Additionally, comfort and convenience influenced the consumers, particularly when interviewees were pressed for time in selecting a lunchbox: *"I went straight to the one (lunchbox) I like"*, *"I just quickly grabbed one (lunchbox) I'm used to"*.

Only 7 of the 80 interviewees, explicitly mentioned the label as one of the main drivers of their lunchbox choices: *"I chose this one because it is good, and I saw that it had the label with low carbon footprint"*. Among these seven, two interviewees described pre-existing motivations to choose foods with lower environmental impacts. For most interviewees, environmental consideration was not a motivational factor, and the label information did not trigger sufficient motivating feelings to influence consumption behaviours: *"I think it (the label) is interesting, but it does not have any particular impact on my shopping behaviour"*, *"It (the*

Table 3
Two-sample proportion Z-tests of grouped lunchboxes (Carbon footprint label (CF) vs Control).

Group	Test	Sample size (n) and proportion (p)	Null and Alternative Hypotheses	Z-score	p-values	Result
Low	Carbon footprint (CF) 'low' label vs. Control	CF label: n1 = 5058 p1 = 0.4203 Control: n2 = 4348 p2 = 0.4147	H0: p1 < p2 **or** p1 = p2 H1: p1 > p2	Z = 0.5541	0.2897	H1 rejected
High	Carbon footprint (CF) 'high' label vs Control	CF label: n1 = 5058 p1 = 0.1690 Control: n2 = 4348 p2 = 0.1720	H0: p1 > p2 **or** p1 = p2 H1: p1 < p2	Z = −0.3848	0.3502	H1 rejected
Medium	Carbon footprint (CF) 'medium' label vs Control	CF label: n1 = 5058 p1 = 0.4106 Control: n2 = 4348 p2 = 0.4133	H0: p1 = p2 H1: p1 ≠ p2	Z = −0.2610	0.7941	H1 rejected

The use of * signifies a significance level of 0.1, ** signifies a significance level of 0.05, and *** signifies a significance level of 0.01.

Table 4
Two-sample proportion Z-test results for individual lunchboxes (Carbon footprint label (CF) vs Control).

Box	Test	Sample size (n) and proportion (p)	Null and Alternative Hypotheses	Z-score	p-values	Result
Warm salmon	Carbon footprint (CF) 'medium' label vs Control	CF label: n1 = 5058 p1 = 0.1273 Control: n2 = 4348 p2 = 0.1226	H0: p1 = p2 H1: p1 ≠ p2	Z = 0.6933	0.4881	H1 rejected
Chicken salad	Carbon footprint (CF) 'low' label vs. Control	CF label: n1 = 5058 p1 = 0.1485 Control: n2 = 4348 p2 = 0.1608	H0: p1 < p2 or p1 = p2 H1: p1 > p2	Z = −1.6414	0.9496	H1 rejected
Meatballs	Carbon footprint (CF) 'high' label vs Control	CF label: n1 = 5058 p1 = 0.1690 Control: n2 = 4348 p2 = 0.1720	H0: p1 > p2 or p1 = p2 H1: p1 < p2	Z = −0.3848	0.3502	H1 rejected
Shrimp salad	Carbon footprint (CF) 'medium' label vs Control	CF label: n1 = 5058 p1 = 0.1024 Control: n2 = 4348 p2 = 0.1178	H0: p1 = p2 H1: p1 ≠ p2	Z = −2.3656	0.0180	H1 accepted**
Salmon salad	Carbon footprint (CF) 'medium' label vs Control	CF label: n1 = 5058 p1 = 0.1809 Control: n2 = 4348 p2 = 0.1730	H0: p1 = p2 H1: p1 ≠ p2	Z = 1.0079	0.3135	H1 rejected
Warm chicken	Carbon footprint (CF) 'low' label vs. Control	CF label: n1 = 5058 p1 = 0.1052 Control: n2 = 4348 p2 = 0.0957	H0: p1 < p2 or p1 = p2 H1: p1 > p2	Z = 1.5315	p = 0.0628	H1 accepted*
Tempeh salad	Carbon footprint (CF) 'low' label vs. Control	CF label: n1 = 5058 p1 = 0.0963 Control: n2 = 4348 p2 = 0.0839	H0: p1 < p2 or p1 = p2 H1: p1 > p2	Z = 2.0886	p = 0.0184	H1 accepted**
Vegan curry	Carbon footprint (CF) 'low' label vs. Control	CF label: n1 = 5058 p1 = 0.0704 Control: n2 = 4348 p2 = 0.0743	H0: p1 < p2 or p1 = p2 H1: p1 > p2	Z = −0.7280	p = 0.7667	H1 rejected

The use of * signifies a significance level of 0.1, ** signifies a significance level of 0.05, and *** signifies a significance level of 0.01.

Table 5
Lunchbox choices of the interview sample compared to the division of sales during the experiment.

Lunchbox	Interview sample proportions (percentage of the total sample)	Sales data proportions (percentage of the total sales)
Meatballs	20%	17%
Warm chicken	25%	11%
Chicken salad	9%	15%
Tempeh salad	3%	10%
Salmon salad	10%	18%
Vegan curry	11%	7%
Shrimp salad	13%	10%
Warm salmon	10%	13%

The percentages were rounded off to the nearest whole number.

label) might impact others that care more about these issues".

Furthermore, two interviewees had considered choosing a box with a lower carbon footprint, but ultimately did not due to other factors: *"I saw the label and saw that it was average, and then you want to choose something with a low impact. But I really felt like having the shrimps, so I went with that."* In cases where the label did trigger motivating feelings, these were not always strong enough to override any initial choices*: "It (the label) gave me a slight feeling of climate anxiety, but not enough to change box"*.

When asked to reflect upon the label and their choice, there was a feeling of satisfaction among those who had made a low impact choice and feelings of anxiety among those who had made a high impact choice: *"I thought about it (the label) while I was paying and now I feel a little bad, I should have chosen something with low impact", "What a pity that it (the score) was average. But today I had a break and wanted salmon", "I would have liked to choose something better. But that didn't influence my choice"*.

One person mentioned needing more time to reflect on the label information for it to potentially have an impact: *"I think it could impact me, but I think I'm not fully done reflecting about this"*. Another person indicated how they would act upon the information in their next purchase.

4.3. Combined results – sales data and in-store interviews

The quantitative analysis of the sales data indicated that, overall, the labels did not significantly influence consumers' in-store decision-making. For the groups of high-carbon footprint boxes and low-carbon footprint boxes, the alternative hypotheses (H1) were rejected. For two of the individual low-carbon footprint lunchboxes, specifically the warm chicken and tempeh salad, the alternative hypotheses (H1) were accepted. This meant that the sales proportions of these lunchboxes were significantly greater during the experimental period than the control period. However, this was not the case for the other individual low-carbon footprint boxes. Additionally, the alternative hypothesis (H1) was accepted for the shrimp salad, whereby a significant difference was found in the sales proportions between the experimental and control periods. This was not observed for the two other medium-labelled boxes. The statistically significant difference in the sales proportions of the

shrimp salad might be attributed to other factors, such as seasonality.

The interviews revealed that the labels to some extent increased the capability and opportunity among consumers to choose more climate-friendly lunchboxes. The labels provided information about the lunchboxes that would otherwise be difficult for consumers to know. However, the labels did not sufficiently motivate consumers to select more climate-friendly options during rapid, in-store decision-making.

Even though a majority of interviewees felt positive toward the label and its information, it was not a primary factor in their lunchbox decisions. Instead, factors such as taste, health, and food preferences or restrictions, played a larger role. Additionally, many interviewees were habitual consumers influenced by their previous lunchbox choices. Therefore, it can be concluded that factors other than the carbon footprint labels likely had a greater effect on consumers' lunchbox choices.

5. Discussion

5.1. Reflections on findings

In this study, we combined quantitative and qualitative methods to investigate the effect of a front-of-package carbon footprint label on the selection of ready-made lunchboxes in a food retail setting. Our analysis of sales data revealed that the label did not have a statistically significant impact on consumer food choices. From interviews, we found that customers generally had a positive attitude toward the carbon footprint labels and found them helpful, which aligns with findings from previous studies (Bschaden et al., 2024; Lohmann et al., 2022). The labels provided consumers with the capability and opportunity to make more climate-friendly lunchbox choices by enhancing their knowledge of the relative carbon footprints of the different lunchbox options. Furthermore, the way the carbon footprint information was communicated through the label design increased the opportunity for consumers to engage with and act on this knowledge.

However, the labels did not trigger sufficient motivation among consumers to make more climate-friendly choices. Instead, other motivational factors, such as taste and health, were found to be the main drivers of consumers' lunchbox choices. Prior studies show that food attributes such as taste and convenience generally are more important to consumers than environmental sustainability (Hoek et al., 2021; Ran et al., 2022). In addition, many interviewees were habitual consumers at Urban Deli. People are unlikely to consider new information which could influence their choices when acting out of habit (Verplanken and Orbell, 2022).

Our results confirm previous findings of the relatively limited impact of environmental impact information on consumers' food choices (Abrahamse, 2020; de Boer et al., 2016; Grundy et al., 2022; Ran et al., 2022), and the limited ability of labels to influence food consumption (Grunert et al., 2014; Parker et al., 2021; Röös and Tjärnemo, 2011; Slapø and Karevold, 2019). When environmental impact was described by consumers as a factor in their lunchbox choices, it was sometimes based on pre-existing motivations. This further supports the argument that the effectiveness of environmental impact labels on food choices can depend on an individual's prior level of environmental concern (Grunert et al., 2014; Thøgersen and Nielsen, 2016).

However, our study's results differ from those of other real-life experiments involving carbon footprint labels. Similar studies have observed an increase in the sales or probability of selecting foods with low-carbon footprint labels (Brunner et al., 2018; Vanclay et al., 2011), and a decrease in the sales or probability of selecting foods with high-carbon footprint labels (Brunner et al., 2018; Lohmann et al., 2022; Vanclay et al., 2011). In contrast, our study found no statistically significant difference in the proportions of sales between the intervention and control periods for the lunchboxes grouped by their low, medium, and high carbon footprints.

The studies by Brunner et al. (2018), Vanclay et al. (2011), and Lohmann et al. (2022) used traffic-light colours in the design of carbon footprint labels, which has been shown to increase their effectiveness (Beyer et al., 2024; Thøgersen and Nielsen, 2016). However, we were unable to use this colour scheme in our experiment because the retailer preferred a different label design which aligned better with their branding. Additionally, Beyer et al. (2024) found that their colour-coded carbon footprint labels were most effective when their carbon footprints were translated into environmental monetary costs. Our study highlights the importance of label design in motivating consumers and creating opportunities for them to make more climate-friendly food choices.

Differences in results between experiments testing carbon footprint labels may also be attributed to varying study contexts and the demographic characteristics of the populations involved (Rondoni and Grasso, 2021). Characteristics such as gender, age, education, income, and region of residency can influence individuals' willingness to pay for carbon footprint-labelled items, their low-carbon purchasing behaviour, and their awareness of the carbon footprints of agrifood products (Rondoni and Grasso, 2021; Shuai et al., 2014). Indeed, the influence of carbon footprint labels could vary between countries, depending on the level of environmental concern held by the consumers in a country and their familiarity with similar labels (Thøgersen and Nielsen, 2016). Furthermore, Brunner et al. (2018) noted how their carbon footprint label intervention primarily targeted university students, who are generally younger, more educated, and potentially more concerned about environmental and societal issues than the average population. The Urban Deli consumer population may differ from that of other retail stores in Sweden, suggesting that our intervention might have different effects in other contexts.

However, the purpose of this study is to further the understanding of how a carbon footprint label may influence food choices, and to explore why this label may or may not be effective. This makes the results relevant beyond the context of our study. The identified factors influencing consumers' capability and opportunity (such as the provision of clear and accessible information), and motivation (such as taste, health, and convenience) are relevant to food consumption behaviours across consumer groups and segments, as previously shown by e.g. Ran et al. (2022). Additionally, our findings are valuable as there is a lack of studies testing environmental impact labels in real-life, in-store contexts (Ran et al., 2024).

During the interviews with consumers, we encountered scepticism about the carbon footprint calculation methods and concerns that the label information may be influenced by Urban Deli's branding. Consistent with previous research, we find that the credibility and trustworthiness of product information is pivotal for consumer acceptance (Cho and Taylor, 2020; Kumar and Utkarsh, 2023). Our findings emphasise the importance of providing consumers with verified and unambiguous information from trusted sources (Cho and Taylor, 2020; Parker et al., 2021; Ran et al., 2022; Röös and Tjärnemo, 2011). Leonidou and Skarmeas (2017) additionally found that scepticism toward sustainability claims of products can be reduced if a company has a history of environmentally and socially beneficial practices.

Our findings indicate the limited potential of labels alone in shifting consumer behaviour, suggesting that additional forms of interventions may be needed to achieve this goal. The effectiveness of climate-impact labels on food products can be enhanced, for example, by providing supplementary information about the labels or climate-friendly behaviours (Emberger-Klein and Menrad, 2018). Other types of *nudges,* i.e. interventions which can change people's behaviour without restricting their choices, which are not information-based, can also impact food consumption (Lohmann et al., 2022; Ytreberg et al., 2023). Lohmann et al. (2022) describe how interventions such as changing the menu order and highlighting vegetarian menu options have had a greater impact on shifting consumer behaviour in cafeteria settings than their study's carbon footprint labels. Additionally, placing environmental-friendly plant-based meat substitutes next to meat-based alternatives in physical retail settings, has been shown to increase sales

of the plant-based substitutes (Coucke et al., 2022).

However, relying on consumer decision-making to reduce environmental impacts may place a moral burden on individuals (Dubois et al., 2019; Röös et al., 2020; Voget-Kleschin, 2015; Willett et al., 2019). Therefore, government and policymakers have a role to play in promoting structural changes. This might include the implementation of taxes on foods with more negative climate impacts and the subsidisation of products with low climate impacts (Bouman and Steg, 2022; Feucht and Zander, 2018; Grubb et al., 2020; Lindahl and Jonell, 2020; Parekh and Svenfelt, 2022; Reisch et al., 2013). As Dubois et al. (2019, p. 144) put it, "*short term voluntary efforts will not be sufficient by themselves to reach the drastic reductions needed to achieve the 1.5 °C goal, instead, households need a regulatory framework* supporting *their behavioural changes*".

Additionally, retailers can play a key role by making environmental-friendly food choices more readily available (Grubb et al., 2020; Lindahl and Jonell, 2020). Retailers can be supported in such initiatives through the provision of clear and trustworthy guidelines of which products are environmentally friendly and which products should be excluded from their assortments based on these criteria (Lindahl and Jonell, 2020). Voluntary agreements between food retailers to phase out products which are not environmentally friendly could also be helpful (Lindahl and Jonell, 2020).

Labels can continue to raise awareness and shape long-term attitudes and societal norms alongside these other interventions (Lohmann et al., 2022; Taufique et al., 2022). This may, in turn, promote the adoption of other measures, such as policy and regulatory initiatives, which may have a more widespread impact on consumer behaviour (Taufique et al., 2022).

5.2. Reflections on real-life studies, limitations, and future research

Our experiment was co-designed together with Urban Deli, a private sector retailer, who had their own business priorities and goals beyond the scope of this study. Consequently, in developing the carbon footprint label intervention, we had to balance maintaining our research interests and integrity while also considering and respecting Urban Deli's business priorities. This balance of interests influenced the timeframe of our experiment, whether we could use one of the Urban Deli store locations as a control store, and the design and placement of the labels. Similar considerations have had to be made in other real-life experimental studies. Vanclay et al. (2011) had to align the timeframe of their experiment with the operational requirements of the food grocery store they collaborated with. Additionally, Brunner et al. (2018) consulted the restaurant managers involved in their study about the design of their carbon footprint labels.

It has been noted that label-based interventions need to be trialled in different real-life contexts (Brunner et al., 2018; Vlaeminck et al., 2014). However, few studies discuss how collaborative partners in other contexts might respond to and shape the design of their interventions. For example, partners could be concerned about the impact of a label intervention on their profitability, as consumers may avoid having to make decisions with moral implications (Brunner et al., 2018). Therefore, it could be valuable for more studies to share their experiences of collaborating with other actors when testing environmental impact labels targeted at food consumers. These learnings from different research groups could be synthesised, similar to the approach taken by Vogel et al. (2023) for real-life interventions in supermarkets to promote healthy diets.

Regarding limitations to our study, we acknowledge that the labels may have had a greater impact with a different label design, such as a traffic-light colour scheme (Thøgersen and Nielsen, 2016). There were also various uncontrollable factors during the experiment which could have influenced our results, including in-store campaigns, weather fluctuations, and Covid-19 infection rates. Furthermore, our results were influenced by the specific group of consumers who purchased lunchboxes during the experiment and control periods, and who took part in the interviews. It is therefore valuable to test labels on different consumer samples and populations (Bschaden et al., 2024; Lohmann et al., 2022; Vlaeminck et al., 2014).

6. Conclusion

In our study, we ran an in-store experiment at a food retailer, which tested how carbon footprint labels impacted consumer choices of lunchboxes. We found that the implementation of the labels did not lead to a significant increase in the selection of lunchboxes with a lower carbon footprint or a decrease in the selection of lunchboxes with a higher carbon footprint. While the labels provided consumers with the capability and opportunity to choose more climate-friendly lunchboxes, they did not sufficiently motivate consumers to select these options.

Even though our results showed that the label intervention did not have a statistically significant impact on the sales of the different lunchbox groups (categorised by low, medium, and high carbon footprint labels), other similar real-life experimental studies have reported different outcomes. Additionally, labels have a role to play in increasing knowledge about the environmental impacts of food products. However, to effectively shift consumer behaviour, there may be a need to implement other types of interventions alongside environmental impact labels. This could include measures which do not place further responsibility on consumer decision-making, such as enabling retailers to make environmental-friendly foods more readily available.

We also highlight key factors to consider when conducting research in collaboration with private sector actors. Our real-life experiment was co-designed with a retailer, which influenced the design and placement of the labels, the possibility of having a control store, and the timing of our experiment. However, to address the knowledge gap regarding how environmental impact labels influence consumers' actual food choices, particularly in retail settings, these types of real-life studies are essential. Insights from our collaborative experience could therefore be valuable to researchers planning similar in-store or other real-life experiments.

CRediT authorship contribution statement

Ebba Engström: Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis. **Astrid Nilsson Lewis:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Conceptualization. **Åsa Moberg:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis. **Fedra Vanhuyse:** Writing – review & editing, Project administration, Methodology, Funding acquisition, Formal analysis, Conceptualization. **Elena Dawkins:** Writing – review & editing, Project administration, Methodology, Funding acquisition, Conceptualization. **Fiona Lambe:** Writing – review & editing, Methodology, Conceptualization. **Tina Sendlhofer:** Writing – review & editing, Investigation, Formal analysis. **Ylva Ran:** Writing – review & editing, Methodology, Funding acquisition, Conceptualization, Project administration, Writing – original draft.

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Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clrc.2024.100239.

Data availability

The data that has been used is confidential.

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