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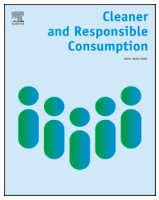

Applying behavioural science to reduce plastic waste from diapers: a mixed-methods study

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A B S T R A C T

Disposable absorbent hygiene products, particularly diapers, are a major contributor to global plastic waste. Focusing on high-priority strategies within the EU's waste hierarchy, waste prevention and reuse, we examine two behaviours that reduce reliance on single-use diapers: earlier toilet training and reusable diaper use. We identified behavioural patterning, influencing factors and support for interventions using a mixed-methods study of UK parents (surveys: n = 624; interviews: n = 35), underpinned by behavioural science frameworks (COM-B model, Behaviour Change Wheel). Reusable diapering remains a minority practice, with few users using them exclusively (10% of reusable users) and most combining with disposable diapers. Reusable diaper use was associated with earlier toilet training ($\chi^2(1, N = 322) = 4.05$, $p = .044$). While parents intend to begin toilet training by 30 months, our findings show that completion often occurs significantly later, highlighting a gap between intended and actual timelines ($\chi^2(18, N = 624) = 72.80$, $p < .001$). Barriers and enablers to both behaviours were identified across Capability (e.g., laundry demands, identifying readiness), Opportunity (e.g., product access, childcare support), and Motivation (e.g., environmental values, competing priorities). Recommended interventions include expert-led training, public awareness campaigns, reusable diaper provision and laundering schemes, and flexible work policies. Regulatory measures (e.g., diaper taxes, nursery admission policies) were less favoured. Creating supportive, resource-rich settings at key parenting stages, such as ante- and postnatal periods and early toddlerhood, can empower parents to adopt reusable diapers and earlier toilet training, aligning caregiving with broader sustainability goals of reducing plastic waste.

1. Introduction

Plastic waste from disposable diapers is a significant global sustainability challenge, with nearly 40 million tons of waste generated annually (Forum, 2023; Notten et al., 2021; Statista, 2024). Most of this waste ends up in landfills, incinerators, or the environment, contributing to pollution and greenhouse gas emissions. With globally rising birth rates and the increasing adoption of disposable diapers in many low- and middle-income regions (Statista, 2024), alongside trends toward later toilet training in higher-income regions (Blum et al., 2004; Choby and George, 2008; Kindred, 20242), the waste burden from disposable diaper use is set to intensify without targeted intervention. As most children globally use diapers, the waste problem is a near-universal sustainability issue.

Waste-reduction strategies such as reusable diaper adoption and earlier toilet training are promising: the use of reusable diaper alternatives directly reduces the volume of disposable diaper waste (Notten et al., 2021), while earlier toilet training gets children out of diapers sooner thereby shortening the overall duration of diaper use. Disposable diapers are designed for single use. Recycling and composting methods for disposable diapers exist, but their feasibility is constrained by cost, technological readiness, logistical scale (Płotka-Wasylka et al., 2022) and UK regulations (UK being the context of this study). In the absence of scalable recycling/composting solutions, reduction represents a key pathway for addressing this growing waste stream globally. Despite their high priority in the EU's Waste Hierarchy (Union, 2008) and potential for impact, these behavioural strategies to reduce disposable diaper use remain under-researched, highlighting a significant and urgent evidence gap.

The challenges of reusable diaper use and earlier toilet training are interconnected: delayed training extends diaper use, intensifying waste and environmental impact from disposables while highly absorbent disposable diapers can potentially contribute to delayed continence as toilet training urgency is hypothesised to be reduced, prolonging dependency (Li et al., 2020a; van Nunen et al., 2015).

Beyond increasing diaper waste, delayed toilet training also has important developmental implications. While no universal consensus exists on the optimal timing for toilet training (de Carvalho Mrad et al.,

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2021), research suggests that humans' biological readiness for toilet training remains stable, making external factors more likely influences on changing trends (Bakker and Wyndaele, 2000; Blum et al., 2003, 2004; Schum et al., 2001). Toilet training by 30 months, aligns with most children's developmental capacities and is associated with developmental benefits such as increased independence, self-regulation, and confidence when approached in a supportive, responsive framework (de Carvalho Mrad et al., 2021; ERIC, 2023). Previous generations in higher-income regions toilet trained earlier (Bakker and Wyndaele, 2000; Brazelton, 1962). In contemporary times, earlier toilet training remains common across lower- and middle-income regions (Albaramki et al., 2017; Blum et al., 2004; Choby and George, 2008; Duong et al., 2013b; Hooman et al., 2013; Tarhan et al., 2015), with some regions reporting children's continence as early as 9-12 months (Duong et al., 2013a). A recent study concluded earlier toilet training may protect bladder and bowel health, and that increased dysfunction was not observed compared to toilet training after 18 months (Hindmar sh et al., 2025). Toilet training delays are also associated with health risks such as urinary tract infections (Li et al., 2020a) and decreased quality of life in children (Kostekci et al., 2023), and strain on families and educators, with teachers reporting classroom disruptions due to incontinent children (Kindred, 20242).

In many communities, particularly in those where diaper use might be limited, some children begin toilet training from birth through an infant-assisted practice of 'elimination communication' (Thorpe, 2014). This involves caregivers closely observing their baby's cues and natural rhythms to help them go to the toilet outside of a diaper. By gently holding the baby in a secure, supported squatting position at appropriate times, caregivers can respond to and nurture the baby's emerging body awareness. This approach is associated with less frequent unexplained crying (Jordan et al., 2020) and strengthening the caregiver-child bond and the child's emotional development (Thorpe, 2014). Spending less time in diapers generally also helps lower the risk of diaper rash and related skin problems (Nield and Kamat, 2007). Collectively, this evidence demonstrates that early toilet training offers many developmental and environmental benefits without adverse health impacts for the child.

1.1. Theoretical framework

Since both reusable diaper use and timing of toilet training are behaviours likely influenced by a range of individual, social, and environmental factors, they can be studied through the lens of behavioural science. The Behaviour Change Wheel (BCW), is an integrative framework of 19 other behavioural and behaviour change frameworks and offers a structured method 'diagnosing' behaviours and designing behaviour change interventions (Michie et al., 2011). Detailed in Fig. 1, the COM-B model is an auxiliary framework to the BCW and is used to help identify influences (i.e., barriers and enablers) on behaviour in terms of Capability (e.g., psychological and physical factors such as physique, stamina, knowledge, intellectual capacity, memory, and decision-making processes), Opportunity (social and physical factors such as cultural norms and the physical environment) and Motivation (automatic or reflective processes involving intentions, desires, evaluations, habits, and instincts) to identify targets for interventions.

These COM-B categories can be further elaborated into the Theoretical Domains Framework (TDF) (Cane et al., 2012), shown in Table 1, which includes 14 domains representing individual, socio-cultural, and environmental factors influencing behaviour.

Fig. 2 shows the relationship between the COM-B categories and TDF domains.

COM-B and TDF are mapped against the BCW (Michie et al., 2014) to suggest which types of behaviour change interventions are more likely to be relevant and effective in addressing different influences on behaviours. This facilitates systematic progression from identifying what needs to change to informing selection and design of intervention strategies.

The BCW and associated COM-B/TDF have been extensively applied in diverse regional settings (e.g. higher-income regions (Allison et al., 2024b; Krusche et al., 2022) and lower- and middle-income regions (Murphy et al., 2023; Perros et al., 2023)) to facilitate behaviour change across various behavioural domains, including waste management (Allison et al., 2022a,b,c;Allison et al., 2021a; Gainforth et al., 2016; Zhang and Hale, 2022). Although most applications of the BCW and COM-B/TDF have historically been in health behaviour change, their use has broadened to environmental and waste-related behaviours, including the design of sustainability interventions, further supporting their relevance for the present study. It is also endorsed by national governments as an effective framework for guiding public health initiatives (England, 2020). Early toilet training and reusable diaper adoption are critical strategies for reducing disposable diaper waste. Since prior evidence on these behaviours has not been conceptualised through a circular economy lens nor consistently applied behaviour change theories, this research offers an opportunity to advance the circular plastics research and innovation agenda.

Applying these frameworks, this study aims to address the following

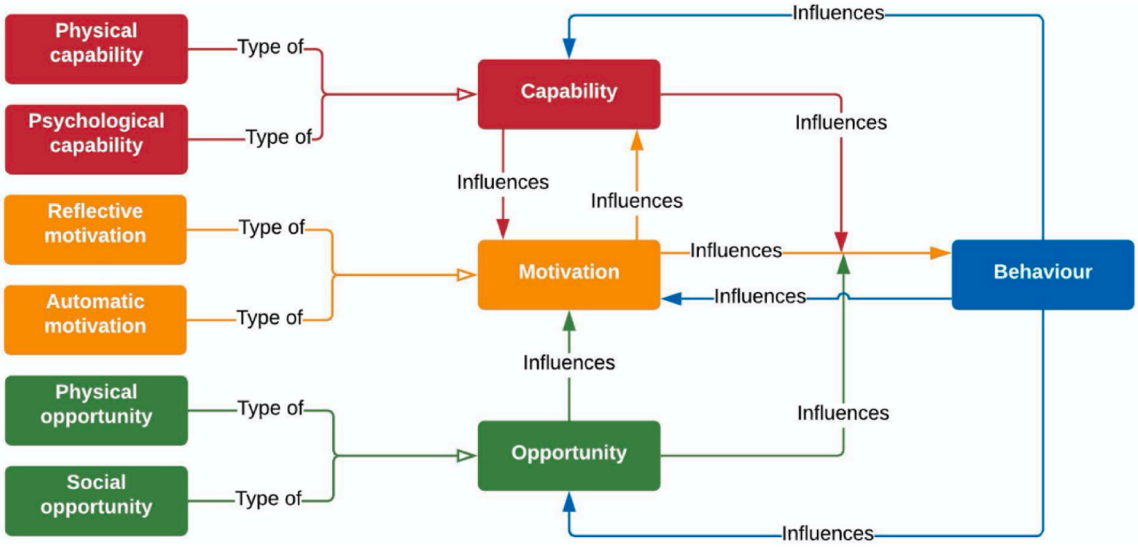

Fig. 1. The COM-B model. Image credit: https://www.besci.org/models/capability-oppportunity-motivation-behavior.

Table 1
Theoretical Domains Framework (TDF). Table listing the 14 domains with their definitions.

TDF domain	Explanation
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
Optimism	The confidence that things will happen for the best or that desired goals will be attained
Beliefs about consequences	Acceptance of the truth, reality or validity about outcomes of a behaviour in a given situation
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

primary and secondary research questions:

1) What are the barriers and enablers to behaviour change concerning i) reusable diaper use and ii) earlier toilet training?
2) What behaviour change strategies can potentially overcome identified barriers and enablers and encourage behaviour change?

2. Method

2.1. Design

This study is approved under UCL ethical approval (CEP/2020/579) and reports the combined findings of an online survey and two sets of semi-structured qualitative interviews with UK-based primary caregivers. The research protocol for this study has been published elsewhere detailing the study rationale (including power analysis and discussion of how sample size was determined) and the theoretical behaviour change frameworks and data collection tools (survey and interview guides) used (Allison et al., 2024a). The interview and survey data used in this study is openly available via Open Science Framework (OSF): https://osf.io/fqgps/overview.

Participant quotes and references to the data collection instruments retain the terms 'nappy' and 'potty training' to refer to diapers and toilet training, respectively. This is because these terms were used to engage research participants, aligning with the commonly used terminology in the UK, the context of this research.

2.2. Online survey

2.2.1. Design

This was a cross-sectional, mixed-methods, online survey.

2.2.2. Participants and recruitment

A total of 624 participants took part in the survey, recruited via Prolific, a data collection platform (https://www.prolific.com). The inclusion criteria included being a parent or primary caregiver to a child currently in diapers or who has recently (i.e., in the last year) stopped using diapers due to toilet training. A pre-screener survey was conducted to identify potentially eligible participants from Prolific's pool. Those eligible were invited to complete the survey ensuring a balance between different diaper users (primarily disposable, hybrid or primarily reusable) and parental toilet training stages (soon to start, currently toilet training and recently completed toilet training). Participants were

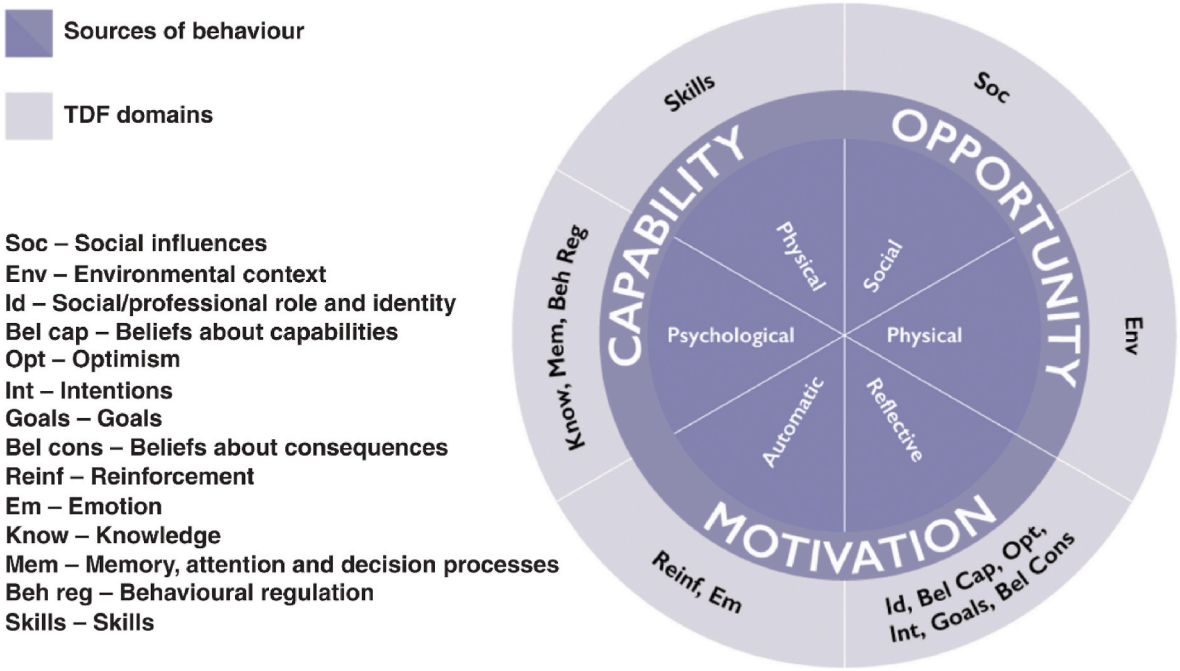

Fig. 2. Relationship between COM-B and TDF. Reproduced with permission from (Allison et al., 2021b).

reimbursed £9 per hour for their time completing the survey. Fig. 3 illustrates the distribution of survey responses across the UK, demonstrating a geographically distributed sample.

2.2.3. Materials

The survey captured quantitative and qualitative data across several domains:

- Diaper use: Types, frequency, and contexts/patterns of product use (disposable and reusable).
- Toilet training: Stages (e.g., not started, in progress, completed), child's age at each stage.
- Influences on behaviour: Assessed via Likert-scale items (5-point agreement scale) for both reusable diaper use and toilet training timing. They were structured around COM-B i.e. with at least one question per domain. Open-ended input was also invited.
- Intervention strategies: Participants rated their support for various potential strategies to promote reusable diaper use and earlier toilet training on a 5-point support scale (highly support to do not support at all); open-ended input was also invited.
- Demographics: Age, gender, number of children, employment, education, ethnicity, and pro-environmental identity.

Survey items were developed through literature review, COM-B and TDF mapping, and consultation within the research team and parents/primary caregivers experienced with toilet training or diaper use, then digitised in Qualtrics with iterative testing for content, accessibility, and usability.

2.2.4. Procedure

Informed consent was obtained before any data collection via the home screen of the survey. It was fully anonymous, and participants had the option to skip open-ended questions and those asking for demographic information. Participants could withdraw their data at any time during the survey and up until they received payment. If they do not complete the survey, their data was deleted and excluded from analysis.

2.2.5. Data analysis

We had initially planned to cluster survey items (independent variables) into COM-B constructs for the regression analyses; however, it was not theoretically justified when analysing the data. The internal consistency of the COM-B variables was assessed, but the results indicated low reliability, with no Cronbach's alphas above 0.69 and many falling below 0.50. Even after attempting to recode some variables into different COM-B domains, the reliability did not improve sufficiently to justify clustering the variables. As a result, we proceeded with the regression analysis using individual variables rather than grouping them into composite scales. The open-text survey responses were used to provide additional context to the quantitative analysis.

2.2.5.1. Current behaviour. Current behaviour concerning diaper use and toilet training were analysed descriptively using frequencies and percentages. We ran a Chi-squared test of independence to examine whether there was an association between diaper type (disposable vs reusable) between earlier and later toilet trainers (but only amongst current and completed toilet training to focus on actual or past behaviour rather than hypothesised intentions).

An additional analysis was conducted to assess whether a child's

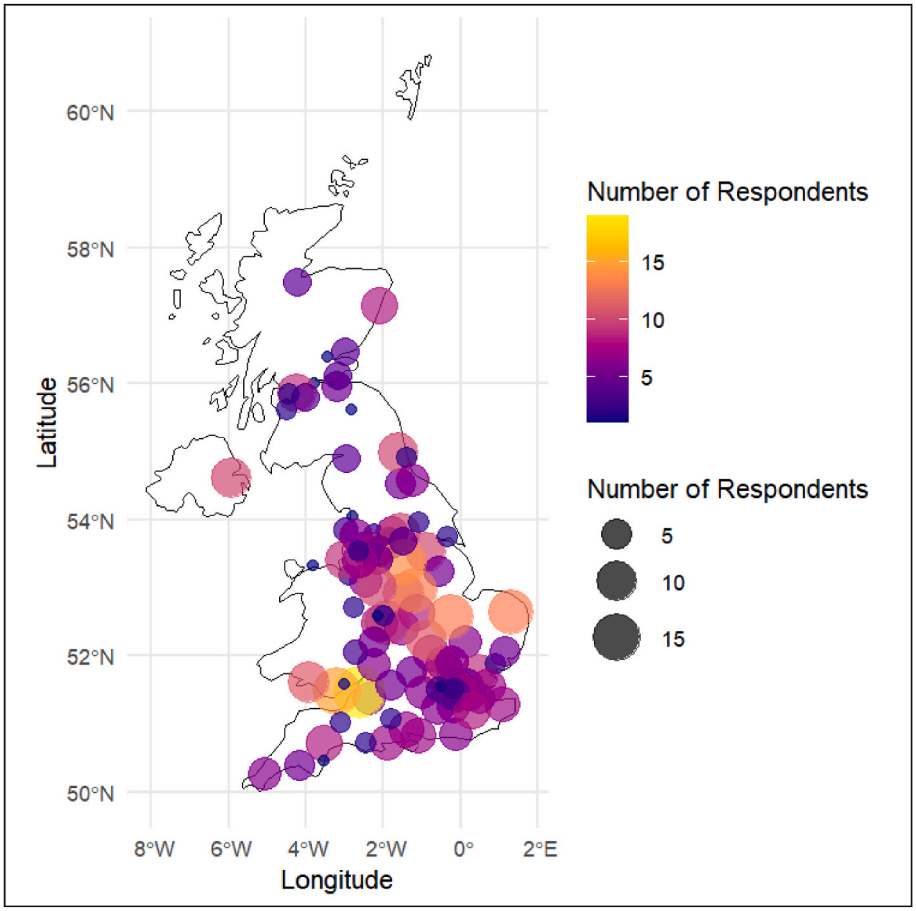

Fig. 3. Heatmap of survey participant distribution across the UK (n = 624).

toilet training progress deviated from planned. A Pearson's Chi-Squared test with Monte Carlo simulation[1] (based on 10,000 replicates) was conducted to test this.

2.2.5.2. Influences on behaviour. Barriers and enablers to reusable diaper use and earlier toilet training were analysed using two separate hierarchical logistic regressions, with each survey item (COM-B variable) entered as an individual predictor. Separate control variable analyses identified relevant covariates for each regression, which were included in the models; full control variable analysis results can be found in Appendix A. R code for regressions are provided in Appendix B and data used as input provided via OSF: https://osf.io/fqgps/overview.

2.2.5.2.1. Hierarchical logistic regression analyses for diaper user type. A hierarchical logistic regression was conducted to predict the likelihood of using reusable diapers (0 = disposable, 1 = reusable) based on COM-B items (where 1 = strongly disagree and 5 = strongly agree), with gender and pro-environmental orientation included as control variables. People were grouped as reusable diaper users if they currently used reusable diapers (regardless of frequency) and disposable users if they only used disposables. The first step included gender and pro-environmental orientation, while the second step included 29 COM-B variables.

2.2.5.2.2. Hierarchical logistic regression analyses for toilet training timing. A hierarchical logistic regression was conducted to predict the likelihood of earlier toilet training timing (0 = earlier, 1 = later) based on COM-B factors (where 1 = strongly disagree and 5 = strongly agree), with gender, toilet training stage, and age included as control variables. People were grouped as earlier toilet trainers if they planned, were currently or recently completed toilet training before 30 months and later if after 30 months. The first step included gender, toilet training stage, and age, while the second step included 22 additional COM-B variables related to toilet training.

2.2.5.3. Support for interventions. Participants' support for the different types of intervention strategies for reusable diaper use and earlier toilet training were analysed descriptively using percentages and summarised as stacked bar charts.

2.3. Semi-structured interviews

2.3.1. Design

Cross-sectional semi-structured interviews.

2.3.2. Participants and recruitment

Eligible participants included parents or primary carers of a baby or young child who used diapers during the day, who were the main or joint decision maker regarding diaper choices, a current or past reusable diaper user, or someone aware of and having considered reusable diapers. Purposive maximum variation sampling (Rai and Thapa, 2015) was employed to obtain a mix between those not currently using reusable diapers but aware of them, those using a mix of reusables and disposables, and those exclusively using reusables for diaper use interviews.

For the toilet training interviews, participants were parents or primary caregivers of pre-school-aged children (1–5 years old) who were planning to toilet train, currently toilet training, or had completed toilet training within the last 12 months. Interviewees needed to be the main or joint toilet trainer in the household.

For the toilet training interviews, we sampled participants to obtain views from those who had not yet started toilet training, those who had started but not completed it, and those who had completed it within the last 12 months. Additionally, we aimed to canvas views from those with experiences of earlier toilet training (30 months or less) and later toilet trainers (after 30 months).

All interviewees were 18 or older, ordinarily resident in the UK, and had sufficient English to conduct the interview. Participants were recruited via social media posts in closed parenting groups and were reimbursed with a £20 voucher for their time.

2.3.3. Materials

Separate interview topic guides were developed for each behaviour. The interview guides had three sections: 1) current behaviour, 2) influences on behaviour, and 3) potential interventions to support behaviour change. Questions on influences on behaviour were structured around the domains and of the COM-B model and TDF, ensuring a range of potential influences on behaviour were explored. Interview questions were piloted with parents and primary care givers experienced in using diapers and toilet training and refined accordingly.

2.3.4. Procedure

Interviews were conducted online via MS Teams at a time convenient to the interviewee. Interviews lasted between 30 and 60 min minutes. The interviews were recorded, transcribed verbatim, and transcripts anonymised.

2.3.5. Analysis

Transcripts were analysed using a combined deductive framework and inductive thematic analyses approach (Atkins et al., 2017). One researcher (AA) led the analysis of the toilet training interviews, while another (ACO) led the analysis of the reusable diaper interviews with regular review from co-investigators (ALA, FL).

2.3.6. Influences on behaviour

First, 'utterances' from transcripts were organised according to domains from the TDF and a codebook was developed to maintain consistency. A second coder independently double-coded 10% of interview transcripts into TDF domains. The percentage of inter-rating coding agreement ranged between 76% and 86%, indicating good level of agreement (Graham et al., 2012; O'Connor and Joffe, 2020). Any discrepancies were discussed until an agreement was reached and TDF allocations revised accordingly.

Second, inductive thematic analyses in line with Braun and Clarke's approach (Braun and Clarke, 2006) were conducted within each TDF domain to generate content themes representing influences on behaviour. Similar reported influences were grouped and a label summarising the shared meaning the domain plays in influencing behaviour were created. Relationships between themes were also coded. To ensure the reliability and validity of coding, a subset of findings was continually reviewed by the lead author (ALA) during weekly meetings with input from another co-investigator (FL) when needed.

Following completion of the thematic analysis, a Behavioural Systems Map (BSM) was created in Kumu (https://kumu.io/), a visual mapping software used to build interactive systems maps and illustrate complex relationships, to visually present the findings. BSM is an adaptation of systems mapping methods, designed to identify and illustrate the factors influencing a behaviour and the relationships between them. Maps vary in complexity and scope but typically include elements representing actors, behaviours, influences and links illustrating how these elements interact within a wider system e.g., (Allison et al., 2024b; Davan Wetton et al., 2025; Hale et al., 2022). The map was directly informed by the coded themes and their relationships and was developed to synthesise and communicate results, rather than as a separate analytical approach.

2.3.7. Potential interventions

Ideas on potential influences to promote earlier toilet training and reusable diaper use were thematically coded and mapped onto BCW

[1] The Monte Carlo method was employed due to low expected frequencies in some cells, which could compromise the accuracy of the standard chi-squared approximation.

intervention types for categorisation.

3. Results

3.1. Study sample and behavioural trends

Table 2 summarises sample characteristics and patterns of current behaviour across the survey and interview datasets.

Reusable diaper users were less common (18% of total sample, despite targeted sampling via Prolific) with a minority of those reporting using them exclusively (10%); most users reporting a hybrid approach combining with disposable diapers.

A chi-square test of independence indicated a significant association between age range and toilet training stage, $\chi^2(18, N = 624) = 72.80$, $p < .001$. Standardized residuals (Table 3) revealed that more parents than expected were currently toilet training their children at 43–48 months (residual = 2.64) and 55–60 months (residual = 2.60), and fewer at 25–30 months (residual = −2.84). Among those who had completed, fewer completions occurred at 12–24 months (residuals = −2.26 and −3.52), with more at 31–42 months (residuals = 2.02 and 2.58). In contrast, parents who had not yet started were significantly more likely to plan to toilet train at 19–30 months (residuals = 3.94 and 3.16) and less likely at 37–54 months (residuals = −3.91 to −3.06). This suggests a delay between intended and actual toilet training timing.

There was a statistically significant association between diaper type and toilet training timing, $\chi^2(1, N = 322) = 4.05$, $p = .044$, with a higher proportion of reusable diaper users completing toilet training earlier.

3.2. Behavioural influences

To enable an integrated interpretation of behavioural influences, we present a narrative synthesis of qualitative interview findings alongside statistically significant survey results, organised by target behaviour and mapped onto the COM-B framework (overview in Table 4). While the TDF provided useful granularity for structuring data collection and coding, we found COM-B to be more parsimonious and accessible for organising and communicating findings, particularly to interdisciplinary audiences, given that TDF is itself an elaboration of COM-B.

Each section begins with the survey findings, followed by qualitative insights that contextualise and illustrate them. The full set of qualitative themes, descriptions, and illustrative quotes available in Appendix C (diaper use) and Appendix D (toilet training) which were used to create two behavioural systems maps to aid comprehension. Full regression results are also provided in Appendix E (diaper use) and Appendix F (toilet training).

Table 3
Standardised residuals for the association between age ranges and toilet training (TT) stages.

Age range	Planned TT	Current TT	Completed TT
Less than 12 months	−0.76	0.23	0.65
12-18 months	0.85	1.20	**−2.26***
19-24 months	**3.94***	−1.06	**−3.52***
25-30 months	**3.16***	**−2.84***	−0.71
31-36 months	−0.89	−0.94	**2.02***
37-42 months	**−3.91***	1.91	**2.58***
43-48 months	**−3.32***	**2.64***	1.12
49-54 months	**−3.06***	1.81	1.70
55-60 months	−1.81	**2.60***	−0.60
60+ months	0.43	−0.37	−0.12

Note: Positive Standardised Residuals (>1.96): The observed frequency is significantly higher than expected. Negative Standardised Residuals (<−1.96): The observed frequency is significantly lower than expected. Residuals near 0: The observed and expected frequencies are close, indicating no significant difference. * = significant at $p < .05$. Residuals are considered significant if they exceed ±1.96, based on the assumption that they follow an approximate normal distribution under the null hypothesis and a standardized Pearson residual that exceeds about 2 or 3 in absolute value indicates lack of fit of the null hypothesis in that cell (Agresti, 2002).

Table 2
Table summarising key sample characteristics across datasets.

Sample characteristic	Dataset		
	Interviews: Diaper use (D1)	Interviews: Toilet training (D2)	Online survey: Both behaviours (D3)
Sample size	N = 18	N = 17	N = 624
Gender	100%, Female	100%, Female	86%, Female; 14%, Male
Type of caregiver	100%, Parent	100%, Parent	99.68%, Parent; 0.32%, Other primary caregiver
Age	Mean = 35.39 years	Mean = 33.35 years	69%, 30-39 years
Total number of children	1.83	1.76	1.89
Pro-environmental identification	*Not collected*	*Not collected*	73%, 'definitely' or 'probably' pro-environmental
Ethnicity	83%, White	*Not collected*	82%, White
Education	94%, degree level qualifications	*Not collected*	65%, degree level qualifications
Household income (pre-tax, annual)	Not collected	82%, between £40,000 and £100,000	58%, between £40,000 and £100,000
Employment status	Not collected	Not collected	44%, full-time; 29%, part-time
Diaper types used (current behaviour)	39%, reusable; 28%, mixed; 33%, disposable	6%, reusable; 6%, mixed; 88%, disposable	4%, reusable; 14%, mixed; 82%, disposable
Frequency of reusable diaper use	*Not collected*	*Not collected*	Of those that use reusables, 10% used them exclusively; 82% used them up to half the time; 9% used them infrequently or rarely
Toilet training stage	*Not collected*	*Not collected*	48%, soon to start; 28%, currently toilet training; 24%, recently completed (in last 12 months)[a]
Toilet training timing	*Not collected*	71%, later planned, current or completed toilet training (>30 months); 47% earlier planned, current or completed toilet training (<30 months)[b]	A chi-square test of independence indicated a significant association between age range and toilet training stage, $\chi^2(18, N = 624) = 72.80$, $p < .001$. While many parents intend to begin TT earlier (19–30 months), they tend to initiate or complete training at older ages (31–48+ months), indicating a gap between intention and practice.

[a] These figures are for the participants child(ren) currently in diapers or who recently stopped (in last year) due to toilet training.
[b] Some parents had multiple young children (under 5 years) and in some case had trained earlier with one but later with another so were reflecting on both experiences, hence why total percentage doesn't equal 100%.

Table 4
Summary of behavioural influences by COM-B and across regression and thematic analyses for each behaviour.

COM-B factor	Behaviour: reusable diaper use		Behaviour: toilet training <30m	
	Logistic regression	Thematic analysis	Logistic regression	Thematic analysis
Capability (physical and psychological)	Not knowing where to buy reusable diapers is linked to higher disposable diaper use.	Limited physical and mental energy post-birth, need for planning and mental effort, trial and error learning process, reliance on consistent routines, awareness of products and knowledge on proper use.	Being able to fit toilet training into household routine at 18-30m and believing one's child is physically and developmentally ready to potty train between 18 and 30m are linked to earlier toilet training.	Knowledge of strategies, resilient parenting skills, adaptive planning, recognizing child readiness, maintaining a consistent routine, prior toilet training experience, and managing cognitive overload.
Opportunity (physical and social)	Believing disposables are more expensive and worry about being judged are more linked to using reusable diapers, while not knowing many others who use reusables is linked to higher likelihood of using disposables.	Influence from other people's use of reusable diapers, advice and knowledge sharing, support from partners, family, friends, and childcare providers, availability and visibility of reusable diapers and access to cost savings and discounts.	Child showing interest and receptiveness at 18-30m associated with earlier toilet training. Needing to wait until after disruptive life events linked to later toilet training.	Access to resources, quality of public facilities, time, parental presence at home, and environmental factors like weather. Support from family, friends, and childcare providers; guidance from experts and peer groups; influence of others' toilet training behaviours; social norms and expectations; and child's engagement in the process
Motivation (automatic and reflective)	Feeling bad about using disposables, believing reusables are better for the environment, and habitual disposable use are linked to disposable diaper use, while future intention to use reusables and alignment with identity and values are linked to higher reusable diaper use.	Influence of perceived environmental impact, positive emotions from doing good, behavioural alignment with identity and values, motivation driven by perceived health benefits for the child, aesthetic appeal of reusable diapers, desire for convenience, concerns about reliability and fit of reusables, negative feelings about different diaper types, strong intention and determination to use reusables.	Believing that delaying toilet training past 30 months can impact mental and physical health negatively linked with earlier toilet training.	Setting clear plans and goals for success, optimism about completion, belief in others' (e.g., nursery) active role in toilet training, emotional nature of the process, parental confidence, and beliefs about the challenges and benefits of early or late training, all influenced by personal parenting style and values (e.g., child-led).

3.3. Reusable diaper use

3.3.1. Capability (physical and psychological)

Not knowing where to buy reusable diapers was significantly associated with a lower likelihood of using them ($B = -0.99$, $SE = 0.28$, $z = -3.48$, $p < .001$, 95% *CI* [–1.55, −0.43], D3). This aligned with interviews. One disposable user reported: "*I didn't really know they existed … I thought of them as something people did in the 1950s*", (P14, D1). A reusable user reflected on their initial confusion: "*Even when I was given a kit … I didn't have a clue*", (P9, D1). The learning curve for reusable diapers was described as steep by reusable diaper users, as parents used trial and error ('learning by doing') to navigate selection, find the right products and adjust as their child's needs changed: *"It's a continuous learning journey, because newborns are different to toddlers"*, (P3, D1).

Reusables also placed an additional mental load on parents, particularly in relation to laundry and routine management which became too much for some. A reusable user reflected: *"If you leave them, it becomes a bit intense"*, (P4, D1). Despite these challenges though, many reusable users found them manageable after overcoming the initial hurdles: *"Once you start … it's just that start bit of trial and error", P9; "It's just changing your routines"*, (P1, D1). However, others found this too significant a logistical challenge to overcome, e.g., a former reusable users reflected: *"I don't want another thing hanging over my head … if I was to use reusables, I don't think mentally I would be OK"*, (P12, D1).

3.3.2. Opportunity (physical and social)

Agreeing that disposable diapers are more expensive was associated with a higher likelihood of using reusable diapers ($B = 0.47$, $SE = 0.19$, $z = 2.49$, $p = .014$, 95% *CI* [0.09, 0.86], $OR = 1.60$, 95% *CI* [1.09, 2.36], D3). This is supported in the interviews where people who used reusable diapers also acknowledged the long-term cost savings; however, many highlighted upfront costs and the trial-and-error learning process as significant initial barriers. Some parents mitigated these costs through second-hand options or local discounts: *"Buying from Facebook Marketplace made it affordable to try"*, (P10, D1); *"My local borough gave me a voucher for £50, which helped me get started"*, (P9, D1).

Knowing few people who used reusables was associated with disposable diaper use ($B = -0.54$, $SE = 0.20$, $z = -2.75$, $p = .006$, 95% *CI* [–0.93, −0.16], $OR = 0.58$, 95% *CI* [0.39, 0.85], D3). Interviews echoed that visibility and social modelling in normalizing reusable diaper use: *"My sister and a couple of friends used cloth nappies … that's influenced me"*, (P6, D1) and a disposable user put it*: "I've not had a friend that I can say, can you just show me exactly what to do? Can I borrow a nappy? Can you put it on my child and show me how you do it? There's no one that I've been able to have that sort of conversation with",* (P14, D1).

Interviews highlighted a negative social context around reusable diapers from both users and non-users. One former reusable user who went back to disposables reflected*: "Everybody who I know is or was using disposables and they kind of labelled me the kind of the hippie mum. I don't know whether to that take as a compliment … Had I had more support, I suppose, not support just in terms of my husband, but more of a village and more of a break",* (P12, D1). Reusable users also reflected*: "My parents think it's weird and gross, and they hate it" … "I've worked in nurseries, and I know staff's attitudes can be less than helpful … Parents pick up on that being inconvenient for nurseries",* (P2, D1).

Paradoxically, stronger agreement with the statement "I'm worried about being judged negatively for using reusable nappies" was linked to a higher likelihood of using reusables ($B = 0.60$, $SE = 0.20$, $z = 3.04$, $p = .002$, 95% *CI* [0.21, 0.99], $OR = 1.82$, 95% *CI* [1.23, 2.69], D3). However, this may reflect that reusable users are more

aware of and directly experience social judgement in their daily lives, whereas for those using disposables this judgement is more abstract. Nonetheless, positive support from partners and peers, including advice and knowledge sharing, often helped normalize and enable the behaviour: *"My husband's been really surprised at how easy it is … he's helping do it",* (P1, D1).

Taken together, these findings suggest that while negative social attitudes towards reusables may exist, many reusable users continue despite them, drawing on support networks or strong motivation (explored further in the next section). This may help explain why concern about judgement is higher among reusable users, illustrating that negative social context is present but not necessarily prohibitive.

3.3.3. Motivation (automatic and reflective)

Survey results indicated that stronger feelings of guilt about disposable diaper use were associated with disposable users ($B = -0.44$, $SE = 0.20$, $z = -2.24$, $p = .025$, 95% *CI* [–0.84, −0.05], $OR = 0.64$, 95% *CI* [0.43, 0.95], D3). Similarly, stronger agreement that reusable diapers are better for the environment than disposable diapers was also associated with a higher likelihood of disposable diaper use ($B = -0.65$, $SE = 0.27$, $z = -2.40$, $p = .016$, 95% *CI* [–1.17, −0.12], $OR = 0.52$, 95% *CI* [0.31, 0.89], D3).

At first glance, these findings appear counterintuitive. However, they likely reflect an attitude–behaviour gap: parents who recognise that reusables are environmentally preferable may still rely on disposables, leading to heightened feelings of guilt. In contrast, parents who already use reusables may feel less guilt because they perceive themselves as taking environmentally responsible action and may also have less absolute beliefs about reusables being better for the environment, having a more nuanced view of their impacts (e.g. water and energy use) through firsthand experience.

Nonetheless, both groups described feelings of guilt about disposable use in the interviews, as illustrated by comments from disposable users: "*I have sort of nappy guilt about the waste*" (P14, D1); "*Yeah, I'm ashamed about that really … but that's the way life has been, especially with two kids around*" (P16, D1), and a reusable user: "*I felt really guilty actually for not doing it*" (P9, D1).

These findings suggest that while guilt and environmental concern are common, they are not sufficient on their own to prompt a switch to reusable diapers, and parents will often continue to use disposables despite feeling bad about it.

Survey findings show that disposable diaper use is strongly associated with habitual behaviour ($B = -0.65$, $SE = 0.21$, $z = -3.06$, $p = .002$, 95% *CI* [–1.07, −0.23], $OR = 0.52$, 95% *CI* [0.34, 0.79], D3). Interviews reinforced this, with disposables widely perceived as the default option, making their use easy to adopt and maintain as a habit. As a hybrid user explained: *"So yeah, it was just disposable. This is the way you go. This is nappies. This is it, it is what it is"* (P10, D1). A former reusable user similarly reflected: *"[Using disposable diapers], it's kind of a default decision"* (P12, D1).

In contrast, high intention to use reusable diapers ($B = 0.48$, $SE = 0.23$, $z = 2.08$, $p = .038$, 95% *CI* [0.03, 0.92], $OR = 1.61$, 95% *CI* [1.03, 2.52], D3) and alignment of reusable use with personal values ($B = 1.01$, $SE = 0.29$, $z = 3.48$, $p < .001$, 95% *CI* [0.44, 1.58], $OR = 2.75$, 95% *CI* [1.55, 4.85], D3) were significantly associated with reusable diaper use. Interviews reflected this, with users describing a proactive, problem-solving mindset: *"I'm someone who really likes to do the research, figure everything out"* (P6, D1). For many, using reusables brought a sense of pride and emotional satisfaction, reinforcing their environmental or spiritual values*: "To be honest, I feel very proud of myself … I'm very, very proud of the fact that we can do it and that we have done it"* (P8, D1); *"My faith draws me into a place where I do want to conserve the environment and God's creation … that's very important to my values"* (P4, D1).

Diapering choices also carried identity signals: some parents saw reusable use as part of eco-parenting and value transmission to their children, while others perceived it as a lifestyle they did not identify with. Reusable users reflected: "*[Using disposables] doesn't follow my kind of ethos of treading lightly*" (P6, D1); "*I think there's an element as well of … when she when she looks back, she can know that we have those [reusable diapers]. I think it just reflects the values … and knowing that that's a positive thing.*", (P1, D1) whereas a disposable user reflected*: "I feel like there's a sort of … identity around that, and I think I'm not … I feel too disorganised to be that sort of person"* (P14, D1). The same disposable user reflected on social cues: *"I've been to a lot of breastfeeding groups … they've got trendy dungarees on, and I often think they're probably a reusable nappy mum"* (P14, D1). Taken together, these findings reinforce that diapering choices may be value-laden, influenced not only by environmental beliefs but also by identity, self-perception, and social signalling.

Fig. 4 presents an interactive systems map of interview findings and illustrates the factors influencing diaper use.

3.4. Toilet training

3.4.1. Capability (physical and psychological)

Agreeing that one's child is physically and developmentally ready to potty train between 18 and 30 months, was linked to a lower likelihood of delaying toilet training ($B = -0.48$, $SE = 0.14$, $z = -3.40$, $p < .001$, 95% *CI* [–0.76, −0.20], $OR = 0.62$, 95% *CI* [0.47, 0.82], D3). This aligns with interview findings, where recognizing signs of readiness was crucial for timely initiation: *"I wouldn't really say I knew what to look out for*", (P5, D2). However, many parents expressed uncertainty about how to approach toilet training with confidence, describing it as one of the most challenging aspects of parenting: *"I didn't really know what I was doing. It's the hardest aspect of having a child*", (P6, D2). More broadly, parents often reported limited knowledge about toilet training: *"I don't feel like I knew that much about [toilet training]"* (P2, D2). While this period was often associated with feelings of overwhelm, some parents also viewed it positively. As one early trainer reflected: *"I'd say it's brought a bit of bonding … we all try to figure out things. It becomes a moment of learning for everyone, so it's easier"* (P8, D2).

The capacity to integrate toilet training into established household routines between 18 and 30 months was also linked to earlier initiation (($B = -0.36$, $SE = 0.14$, $z = -2.49$, $p = .013$, 95% *CI* [–0.64, −0.08], $OR = 0.70$, 95% *CI* [0.53, 0.92], D3). Interviews highlighted factors concerning mental capacity and behavioural regulation, with themes reflecting parental experiences of tiredness, resilience, and the planning and maintenance required for a consistent toilet training routine, e.g., earlier trainers reflected: "*You'll have to make time for it. It won't just fit in, you will have to make time.*", (P3, D2) and *"I think having patience is definitely important … they can have really good days and then … go back to square one … you've got to be really patient … and quite strong-willed … to keep pushing through even on the hard days.*", (P16, D2) while later trainers reflected: "*… tiredness definitely affects just parenting in in general.*", (P10, D2); "*I remember with her there been a couple of times I was like, I'm just too tired to deal with this … I haven't got the energy. I had a newborn … it was just too much*", (P1, D2). The overwhelm can lead to parents reverted to diapers out of convenience: "*We would inevitably fall back on, 'we'll just pop a nappy on' … because we've got to do XYZ*", (P11, D2). Prioritizing toilet training and setting specific training goals were identified as critical, with one parent noting the challenge of maintaining commitment: "*The challenge is myself, holding myself back … feeling like it's not convenient … or making it a priority*", (P12, D2).

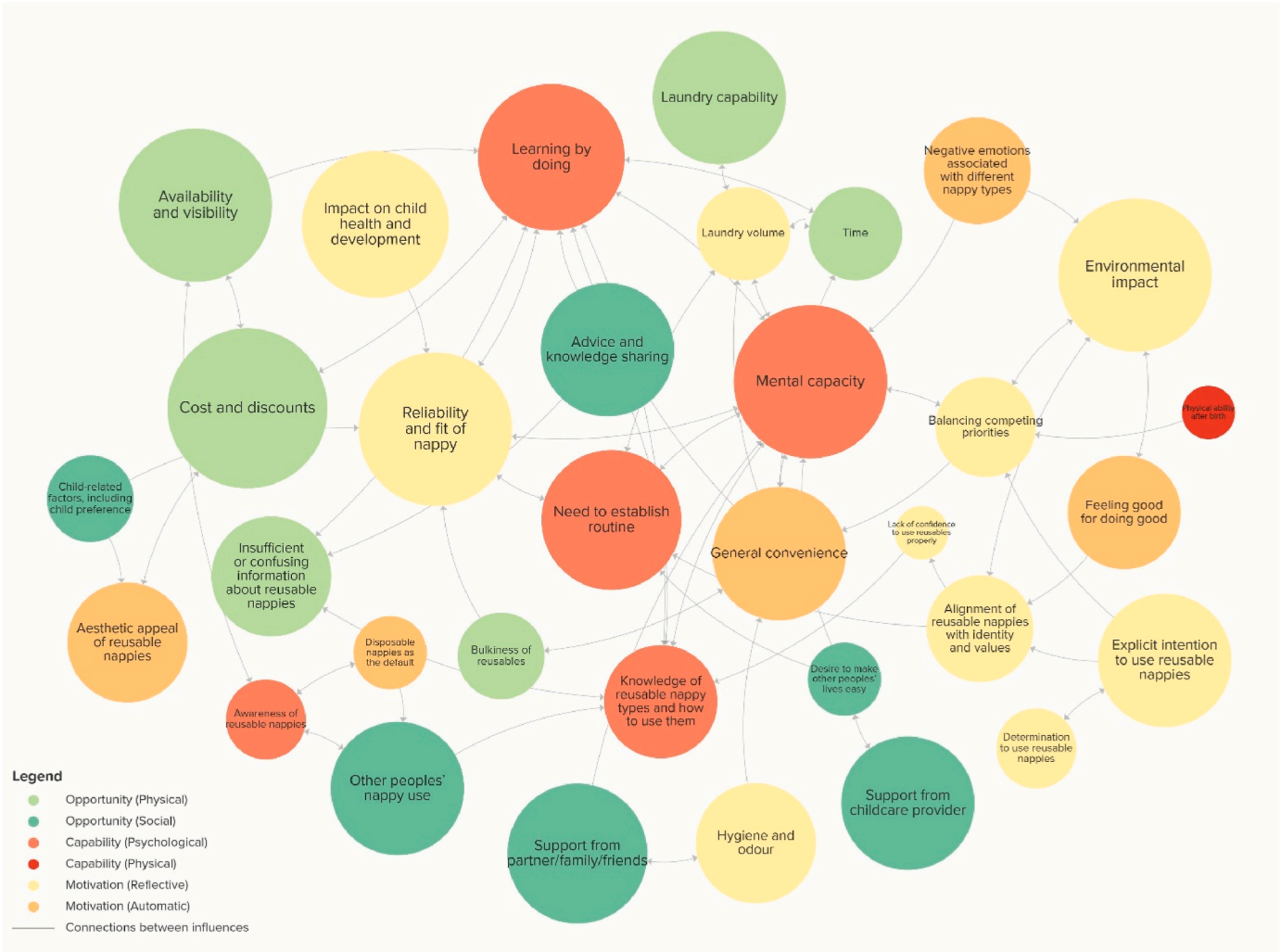

Fig. 4. Thematic findings for diaper interviews. The map can be filtered according to COM-B categories and barriers, enablers or mixed themes. Size of elements determined by the number of participants mentioning theme. Interactive map of themes, descriptions and connections can be found here: https://kumu.io/ALAllison/diapers.

3.4.2. *Opportunity (physical and social)*

Survey findings showed that experiencing major life disruptions (e.g. moving house or birth of siblings) increased likelihood of toilet training delays ($B = 0.22$, $SE = 0.09$, $z = 2.50$, $p = .012$, 95% *CI* [0.05, 0.39], $OR = 1.25$, 95% *CI* [1.05, 1.48], D3). Interviews echoed the importance of parents' consistent availability for training. However, in interviews a key external pressure on time was work but they weren't always prescriptive: while flexibility often made toilet training easier and high demands made it harder, parents' experiences varied, with some full-time workers training earlier and some with flexibility training later. Nonetheless lack of flexibility and work pressures consistently emerged as making the process more difficult while flexibility helped regardless of toilet training timing e.g. a later trainer reflected: "*I'm very lucky that I work for a company that's very flexible around childcare and I don't have to worry too much.*", (P15, D2) while another reflected "*I think our work life demands that's made it really hard … mainly work life demands.*", (P11, D2). It is possible that parents with higher capability (e.g., resilience, toilet training planning, and organisational skills) are better able to overcome limitations in physical opportunity to complete toilet training earlier.

Concerning social opportunity, support and guidance from child health experts, childcare providers, friends, family, and social networks were important actors, offering parents knowledge, confidence and practical strategies: "*They [childcare] gave me the confidence to just start … let's do it now*," (P12, D2); *"I knew from friends … they told me the signs,"* (P11, D2). However, interviews showed that early years or healthcare professional support was often lacking or inconstant. Later toilet trainers reflected*: "And just yeah, the lack of, you know, having a health visitor around or any other sort of support with our child.*" (P5, D2); "*Um. I spoke to the health visitor about, and she said just do it on your own time. There's no rush.*" (P2, D2); "*… there was quite a high staff turnover at one stage at the nursery … and I think that was leading to inconsistency in care … Good training for childcare providers so they can spot signs of readiness, support families, and be aware of different approaches … Having a supportive setting with well-trained, experienced staff will probably help."* (P4, D2); "*but I was kind of hoping [nursery] had a bit more of a steer of this really works or this, but they didn't seem to do that*" (P11, D2).

Related to this was working parents' reliance on multiple caregivers which often lead to inconsistency in toilet training routines: "*Not all staff were on board with our approach*", (P4, D2); "*You know, like Saturday, Sunday. He's with us. Monday goes to Nursery, Tuesdays with my parents, Wednesdays back to nursery again. So, it's harder to be consistent across all those different like areas.*" (P11, D2). Lack of workplace support was also reported: "*In our country we we've got it all*

muddled up with childcare and like I don't get me wrong, I'm not saying don't go to work. I love my job, but I don't think working parents are supported in this country at all" (P11, D2).

In addition to these environmental and social factors, children's own interest and receptiveness to toilet training between 18 and 30 months also shaped parents' opportunity to begin earlier, with higher receptiveness associated with an earlier training start ($B = -0.33$, $SE = 0.13$, $z = -2.49$, $p = .013$, 95% *CI* [–0.58, −0.07], $OR = 0.72$, 95% *CI* [0.56, 0.93], D3).

3.4.3. Motivation (automatic and reflective)

Survey findings showed that earlier toilet training was associated with believing delaying toilet training beyond 30 months could negatively impact their child's physical health ($B = -0.35$, $SE = 0.13$, $z = -2.71$, $p = .007$, 95% *CI* [–0.60, −0.09], $OR = 0.71$, 95% *CI* [0.55, 0.91], D3) and mental health and well-being (($B = -0.25$, $SE = 0.12$, $z = -2.05$, $p = .040$, 95% *CI* [–0.49, −0.01], $OR = 0.78$, 95% *CI* [0.61, 0.99], D3). In interviews, early trainers reflected: "*I just think the longer it goes on and on and on, everybody gets a bit stressed by it*", (P3, D2); "*[benefits include] their skin [from diaper rash] and them having that little bit of independence*", (P3, D2); "*… it's nice for them. It's so good and they feel so free when they don't, they're not tied down there like they're free with just their pants or undies.*", (P8, D2). Benefits for the parents were also reported: "*Really, it's … such a freedom … to just leave the house … without thinking about all the nappies*" (P3, D2); "*It is a bit costly for you to continue not potty training them*" (P8, D2). However, some parents expressed scepticism, viewing toilet training as a natural skill that children will acquire in their own time. As one late trainer reflected: "*At the end of the day … you don't see people at work in nappies. They're all gonna do it one day at their own pace*", (P5, D2). Some parents reported waiting for explicit cues from their children, often verbal signals, as an indication to begin training. For example, one later trainer reflected: *'Him being ready to potty train is being able to talk about it … when he can understand certain words'* (P7, D2). For some, this approach was connected to their parenting orientation but also worry about potentially harming their child if they start too early. Three later trainers explained: *'I think for us we are very, like, gentle parenting, but also kind of child-led'* (P1, D2); and *'We're very much baby-led. So we've done everything … everything baby leads, everything, I guess, has taken a bit longer'* (P15, D2)."; "*I think I was just so convinced that, like, I just didn't want it to damage my relationship with my child. I didn't want to put pressure on her.*" (P5, D2)

Fig. 5 presents an interactive systems map of interview findings and illustrates the factors influencing toilet training timing.

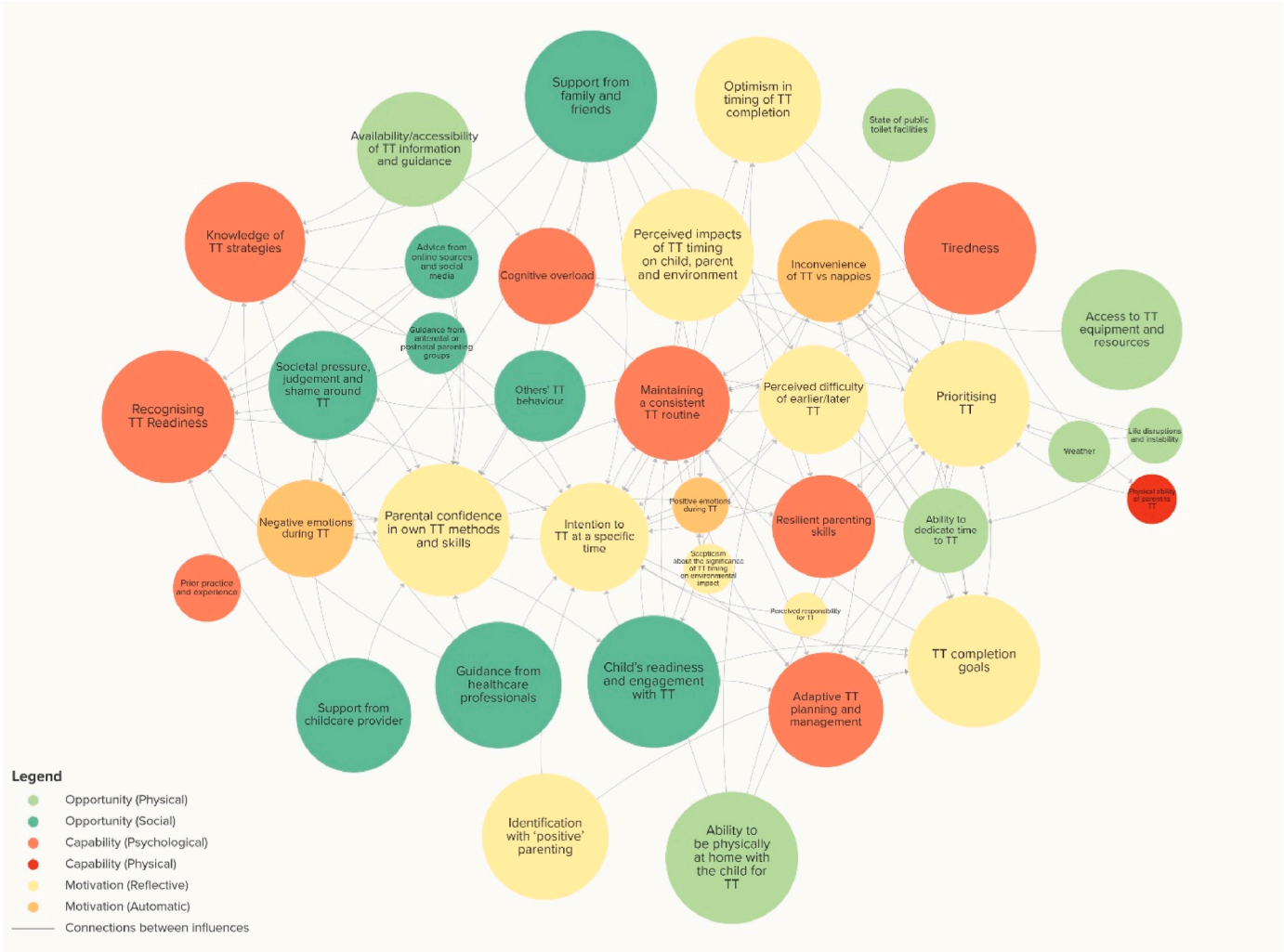

Fig. 5. Thematic findings for toilet training interviews. The map can be filtered according to COM-B categories and barriers, enablers or mixed themes. Size of elements determined by the number of participants mentioning theme. Interactive map of themes, descriptions and connections can be found here: https://kumu.io/ALAllison/diapers#toilet-training-influences.

3.4.4. Views on intervention strategies

Figs. 6 and 7 summarise support for different interventions enabling reusable diaper use and earlier toilet training respectively, from the surveys.

For diaper use, survey findings indicate that practical and material support interventions received the highest levels of public support. These included the provision of vouchers, starter kits, laundering services, and access to clear "how-to" information or training. While awareness campaigns were also supported, they were generally less favoured compared to more concrete forms of assistance. Support for behavioural 'nudge'-style interventions, such as setting reusables as the default in nursery/child-care settings or restricting disposable diaper advertising, was mixed. Punitive measures, such as financial penalties or taxation on disposable diaper use, received the lowest levels of support, highlighting a clear preference for enabling rather than penalising strategies.

For toilet training, parents most strongly endorsed enabling interventions that offer hands-on, professional support. These included training delivered by healthcare professionals, involvement from early years educators, and the introduction of paid parental leave to allow caregivers the time and flexibility to support toilet learning. Awareness campaigns, including public education and content delivered via social media, also received support but were generally rated lower than interventions offering direct guidance or structural support. Punitive or exclusionary approaches, such as restricting school entry for children not yet toilet trained or adding nursery fees for children still in diapers, were poorly received. Finally, financial disincentives, such as taxing disposable diapers to encourage earlier toilet training, were the least supported option, reinforcing a consistent preference for supportive, enabling strategies over coercive or penalising measures.

Table 5 summarises intervention strategies proposed by interviewees. The codebooks for these analyses are openly available via OSF: https://osf.io/fqgps/overview. In line with the survey findings on interventions with the highest support, parents most often suggested strategies focused on enablement, education, and environmental restructuring. Their suggestions pointed to early years educators and healthcare professionals as key actors for delivering support.

4. Discussion

Behaviour change is integral to enabling prevention and reuse, which is necessary to reduce disposable diaper waste. This study identified barriers and enablers to reusable diaper use and earlier toilet training, as well as parents' perceptions of interventions to support these behaviours.

The headline findings are that:

- *Reusable diapering is not common practice in the UK*, with disposables as the norm. Even reusable users often combine with disposables some of the time.
- *Toilet training tends to occur later than intended, and later than recommended by healthcare professionals (18*-30 months*)* revealing a gap between parental intentions before starting and actual behaviour.
- *Reusable diaper use is positively correlated with earlier toilet training,* suggesting that parents who adopt one behaviour may be more likely to adopt another.
- *The influences on both behaviours reflect a complex interplay of parental capability, opportunity, and motivation*, indicating that all three domains will need to be addressed to support meaningful behaviour change.
- *Parents prefer supportive and enabling approaches over directive or punitive ones, especially for toilet training.* To enable earlier toilet training, parents value support from key community figures who shape the caregiving environment such as employers, healthcare professionals, and early years staff. This includes having more time and flexibility for caregiving, guidance on identifying readiness, and practical, consistent advice, including hands-on help with toilet training. When it comes to reusable diapers, parents support interventions that: raise awareness and normalise their use; reduce costs (e.g. diaper 'libraries'); and provide logistical support, such as laundering services to sustain the behaviour. Interview findings also highlighted antenatal groups as key actors for early awareness-raising and training around reusable diapering.

The pattern between (mostly part-time) reusable diaper use and earlier toilet training observed in our study aligns with a systematic review suggesting a link between disposable diapers and later attainment of continence (Breinbjerg et al., 2021). Another study found that

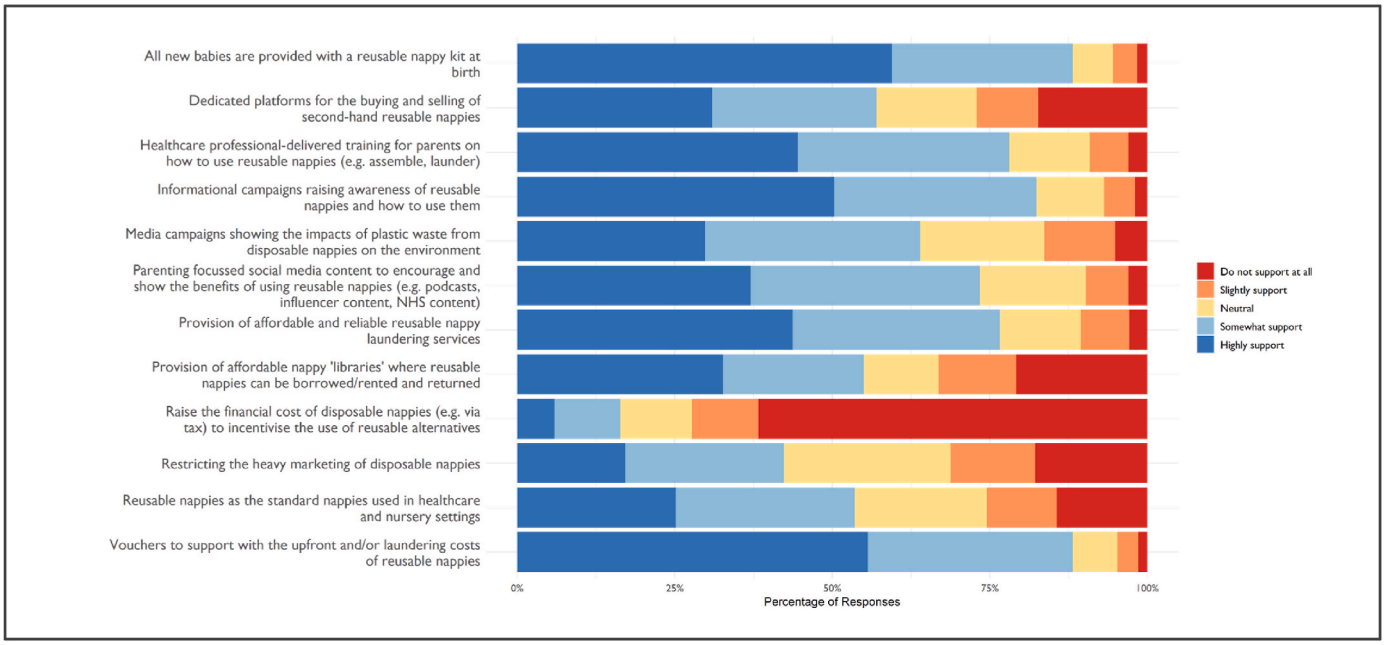

Fig. 6. Support for reusable diaper use interventions from the survey (n = 624).

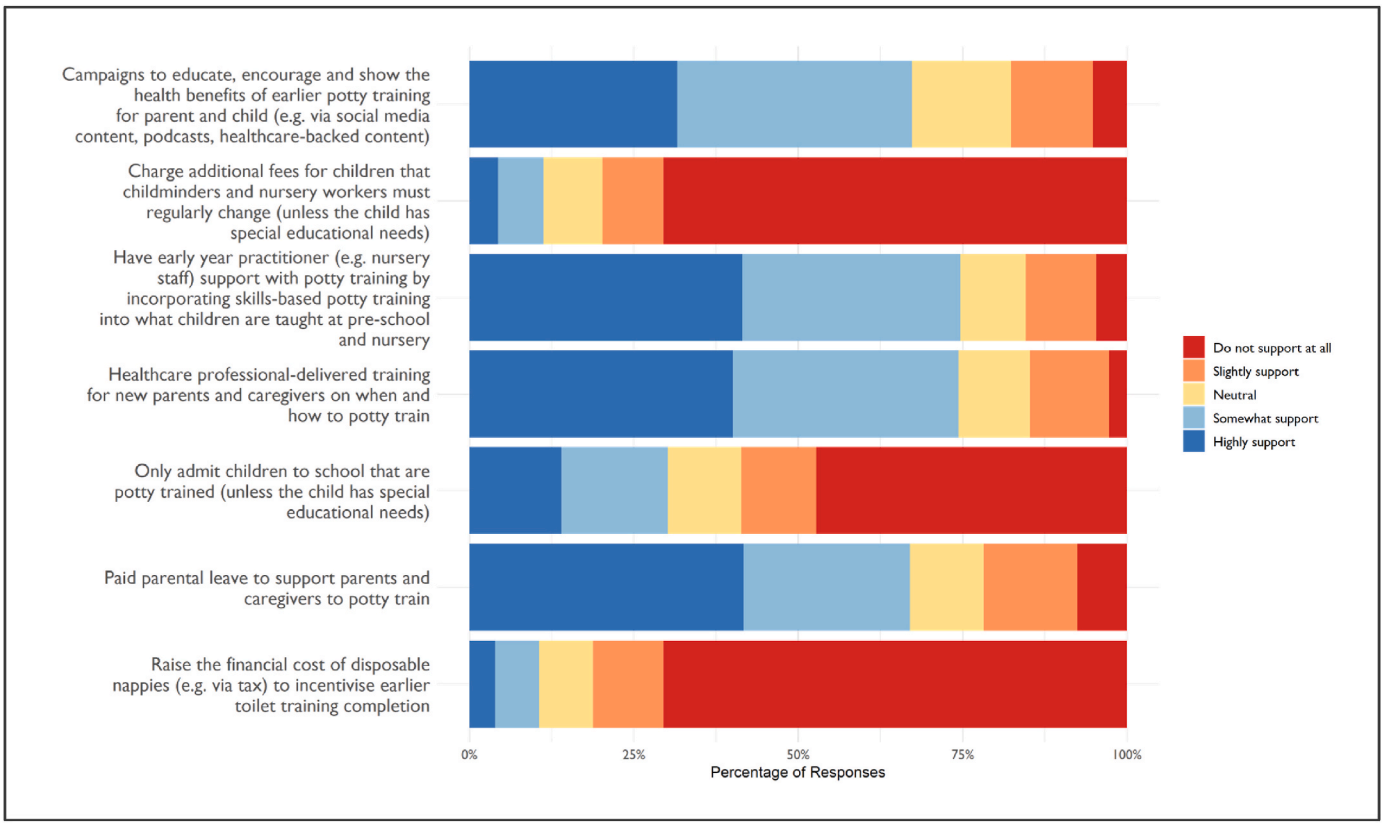

Fig. 7. Support for toilet training interventions from the survey (n = 624).

children who used cloth diapers, even part-time, tended to toilet train earlier than those using disposables (Geist and Bammer-Zimmer, 2023). The high absorbency of disposable diapers, thought to reduce children's awareness of wetness, has been hypothesised to explain this relationship (ERIC). However, our findings point to a more complex behavioural landscape, shaped by parental capability, opportunity, and motivation rather than diaper absorbency alone.

In the UK, reusable diapering and early toilet training represent departures from the prevailing norm of full-time disposable diaper use. Both likely require more time, planning, and motivation than default practices. The fact that these behaviours were associated among the same parents could reflects shared underlying drivers such as reflective motivation, stronger behavioural regulation, and caregiving flexibility. In this view, the link between reusable use and early toilet training may reflect broader, overlapping parenting orientations and capacities.

Toilet training was viewed as a significant milestone, often accompanied by pressures on parents' time and bandwidth (Jansson et al., 2008). In this context, it is plausible that parents who adopt reusable diapers also demonstrate greater resilience to these pressures. A US study found that patience was a key trait in successfully navigating reusable diapering (Siemensma and Hunter, 2007). Reusable diaper use emerged as a deliberate choice rather than a default, driven by environmental concern, emotional reward, and alignment with personal values. This commitment to a less conventional and comparatively more effortful practice may reflect a broader caregiving orientation that also influences approaches to toilet training. However, despite high motivation and behavioural regulation, full-time adoption remained rare. Practical barriers persisted, including inconsistent norms and support across childcare settings and social networks, as well as logistical challenges like laundry. These findings align with previous research on the difficulties of sustaining reusable diaper use (Colley et al., 2024; Pendry et al., 2012; Watson et al., 2023).

Practical and psycho-emotional barriers also intersected to affect toilet training. While most parents in our sample planned to toilet train between 18 and 30 months which is consistent with UK guidance (ERIC, 2023; Visiting, 2025), in practice, training and completion occurred later. Factors contributing to this intention–behaviour gap included uncertainty around readiness cues, varying parental confidence, feelings of overwhelm, inconsistent routines, particularly due to work and multiple caregivers, and the convenience of disposable diapers, which lowers urgency and facilitates delay (Jansson et al., 2008; van Nunen et al., 2015).

Our data also uncovered parental values and beliefs that impact toilet training motivations. First, some parents preferred to wait for explicit signs of readiness, particularly verbal cues, reflecting broader child-led and positive parenting philosophies which prioritise verbal communication as a means of respecting the child's agency (Seay et al., 2014). However, this may inadvertently delay toilet training, as physiological readiness signs are overlooked. Second, others believed toilet training would occur naturally without structured involvement, a view echoed in previous research (Jansson et al., 2008). However, despite common assumptions that continence issues resolve with age, studies show they often persist into later life, with consequences for social, emotional, and academic development (Heron et al., 2017; Whale et al., 2018).

It is clear that the physiology of children has not changed since the time when most were toilet trained before 30 months, so the rise of toilet training age is due to other behavioural and cultural norms. Efforts by governments to reverse these and reduce the average age of toilet training in their populations requires a challenge to the prevailing beliefs of parents. Early toilet training is compatible with child-led approaches, but it involves recognizing and responding to less explicit readiness signals, which are physiological (e.g. being able to sit on a potty) and cognitive (e.g. understand the role of a potty). In addition to reducing waste, early toilet training (before 30 months) is also associated with a range of public child health and developmental benefits (de

Table 5
Ideas for potential interventions from interviews. N = number of participants to suggest the intervention.

BCW intervention type	Intervention idea
Reusable diaper interventions (total n=18)	
Education	• Clear information and instructions about types of reusable nappies and how they work (n = 7) • Information about reusable nappies from healthcare providers (e.g. hospitals, midwives, doctors, health visitors) (n = 5) • Information about environmental impacts of reusable vs disposable nappies (n = 2) • More information about existing incentive schemes (n = 1)
Training	• Information about reusable nappies/demonstration in antenatal classes (n = 8)
Enablement	• Diaper library (n = 8) • Community support groups (n = 2) • Promote reusable wipes as a gateway to reusable diapers (n = 2) • Better drying equipment (n = 1) • Quicker drying reusable diaper (n = 1) • Diaper consultants (n = 1) • Promote reusable period products as a gateway to reusable diapers (n = 1)
Modelling	• Increase visibility/marketing of reusable diapers (n = 6) • Promoting reusable diapers as attractive/desirable (n = 1)
Incentivisation	• More discount/incentive schemes for reusable diapers (n = 2)
Environmental Restructuring	• Diaper laundry services (n = 3) • Free reusable diapers provided to pregnant parents-to-be (n = 5) • Better fitting/more reliable reusable diapers (n = 1) • Simpler reusable diaper options (n = 1) • More industry ambition (n = 1)
Restriction	• Restriction of disposable diaper availability (n = 2)
Toilet training interventions (total n=17)	
Education	• Evidence-based information/advice from health visitors (n = 7) • Free access to central, non-judgemental, evidence-based advice and information, including guidelines for TT initiation/readiness (n = 5) • Clear stepwise instructions for TT (n = 1) • Information/advice from nursery (n = 1) • Campaign raising awareness for the benefits of early TT (led by healthcare professionals) (n = 2)
Enablement	• TT parenting classes or drop-in session (n = 3) • More frequent contact with health visitors (n = 2) • Personalised information for individual child (e.g. special needs) (n = 1) • Access to learning resources for the child (storybooks/videos) (n = 1) • Providing equipment for TT to parents from an early age (n = 1) • Non-judgmental support group for parents combined with advice from healthcare professionals (n = 1) • Dedicated person for TT at nursery (n = 1) • Training for childcare providers (n = 1) • Online forum for TT (n = 1) • TT phone helpline (n = 1) • Support sessions run by nursery (n = 1)
Modelling	• Normalising early TT (n = 1)
Incentivisation	• Funding/vouchers for TT equipment (n = 2)
Environmental restructuring	• Provide TT equipment kit with potty, pants and guidebook for those with lower income (n = 4)

Carvalho Mrad et al., 2021; Duong et al., 2013; Fereday et al., 2011; Hindmarsh et al., 2025; Kostekci et al., 2023; Li et al., 2020b; Thorpe, 2014).

Research shows that individuals often favour interventions targeting others' behaviour rather than their own, which may explain strong support for healthcare professional, nursery, and workplace involvement and highly unfavourable views for penalising parents with higher taxes and nursery admission policies (Diepeveen et al., 2013). Less intrusive interventions, such as information provision, are also generally more acceptable, though often less effective (Diepeveen et al., 2013). This presents a challenge: acceptability is important but insufficient for impact (Sekhon et al., 2017). While parents preferred supportive strategies, potentially more effective but neutral/mixed-reaction measures, such as default systems for reusables in nurseries, may require careful framing within trusted care settings for impact.

Taken together, our findings suggest that both targeted individual-level strategies and broader systemic changes are needed to build parental capability, opportunity, and motivation for lower-waste practices. These are as follows:

1. **Workplaces.** In our survey sample (who were all primary caregivers), over three-quarters were employed, with nearly half in full-time work. Toilet training friendly caregiving policies could alleviate some of the time and availability pressures on working parents, particularly in dual income households. Flexible parental leave models, such as those outlined under the Netherlands' Work and Care Act (Wazo), Chapter 6, which allows leave to be taken flexibly until a child's eighth birthday, is an example of how policies can extend support for caregiving beyond infancy (Netherlands, 2022).
2. **Healthcare professionals.** As trusted sources of guidance, they can advise, challenge misconceptions and champion reusable diapers and early toilet training during routine contact points and appropriate development stages, including antenatal and postnatal care. In many countries this happens through routine child health visits with community nurses or paediatricians; in the UK this role is typically filled by health visitors, a workforce that has seen major cuts in recent years (Anderson, 2025).
3. **Early-years settings.** Across OECD countries, rising workforce participation and growing enrolment in early childhood education reflect an increasing reliance on institutional childcare (OECD, 2021). As children spend more time in early-years settings such as nurseries, these environments offer key opportunities to champion reusable diapers and early toilet training.
4. **Businesses and service providers.** Particularly concerning reusable diapers, they can help address logistical barriers such as diaper laundering services that make reuse more attractive and feasible for time-constrained families. Services such as collection, laundering, and delivery could expand beyond households into nurseries, helping to normalise reuse and create ripple effects that drive broader cultural shifts.
5. **Public communication and social marketing actors.** Credible public actors, such as experts and public health agencies, can shape parental knowledge, beliefs and norms through targeted communication. By normalising and bringing greater visibility to reusable diapering, and addressing misconceptions about earlier toilet training, wider uptake can be supported. Aligning messages with positive parenting philosophies and providing practical, actionable support may be especially effective entry points in the UK. However, campaigns are likely to require tailoring to different demographics, with further research needed to identify which messages resonate with whom. A recent step in this direction is a national online toilet-training guide, endorsed by UK government departments, which aims to provide clearer and more consistent guidance for parents and childcare practitioners (Visiting, 2025).

A key strength of this study is its emphasis on prevention and reuse, which are central to the waste hierarchy but remain under-examined in research on diaper reduction solutions (Union, 2008). We integrate behavioural theory with mixed-methods data to generate novel insights into caregiver experiences and potential interventions in the UK context. While the survey used more guided questions about current behaviours, influences, and possible interventions, the interviews asked about interventions in a more open and unprompted way, providing complimentary perspectives. Findings may not be generalisable across settings, and the self-reported, cross-sectional nature of the data limits causal

inference. Future research should include longitudinal and cross-national studies to better understand toilet training trajectories and caregiver experiences and behaviours globally. There is also a need for economic modelling to quantify the costs and benefits of earlier toilet training, particularly in terms of health, environmental, and service impacts, to better understand the case for policy intervention. Further, integrative interdisciplinary intervention evaluation approaches would be valuable for policy and practice, by clarifying how behaviour change translates into material environmental and economic impacts.

5. Conclusion

Taken together, our study shows that reducing reliance on disposable diapers requires change at both individual and systemic levels. Parents need motivation, confidence, and persistence to adopt earlier toilet training and reusable diapering, yet these behaviours also demand more time and logistical effort than prevailing defaults. Creating supportive, resource-rich settings at key parenting stages, from ante- and postnatal care through early childhood, can reduce these barriers and empower families to sustain these practices. National and local authorities also have a central role in setting consistent guidance, embedding caregiver-supportive policies, funding supportive services, and shaping public norms, alongside workplaces, healthcare, childcare, businesses, and public communications/social marketing actors. Aligning efforts across these sectors is critical to easing individual burdens, enabling motivation to translate into action, and advancing sustainability goals by reducing diaper waste. Importantly, the evidence highlights co-benefits that extend beyond environmental sustainability, including improved child health, development, and wellbeing. In this context, behaviour change science clarifies the real-world capabilities, opportunities, and motivations that shape how parents manage diapering and toilet training (for example, what they can do, what gets in the way, and what matters to them). These behavioural conditions do not compete with innovation in products, services, or support systems; they show where new or improved options are genuinely needed and likely to work for families. In doing so, they help define the space in which effective solutions can emerge. Advancing circularity in care-product systems therefore requires bringing behavioural insight together with the thoughtful design of products, services, policies, and infrastructures that reflect lived needs of families navigating continence care while still enabling new possibilities for prevention and reuse.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process

During the preparation of this work, the authors used Microsoft Copilot to support generation of R scripts, and to enhance the clarity, grammar, accessibility, and coherence of the manuscript. To ensure validity and accuracy, all LLM-assisted code was executed in R by the authors. Faulty or incomplete code was corrected prior to use and interpreted independently by the authors. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the published article.

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CRediT authorship contribution statement

Ayşe Lisa Allison: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Abbie Curtis O'Reilly:** Data curation, Formal analysis, Methodology, Validation, Writing – review & editing. **Alicia Abicht:** Data curation, Formal analysis, Methodology, Validation, Writing – review & editing. **Danielle Purkiss:** Conceptualization, Funding acquisition, Methodology, Project administration, Writing – review & editing. **Susan Michie:** Conceptualization, Funding acquisition, Writing – review & editing. **Mark Miodownik:** Conceptualization, Funding acquisition, Investigation, Supervision, Validation, Writing – review & editing. **Fabiana Lorencatto:** Conceptualization, Funding acquisition, Methodology, Project administration, Supervision, Validation, Writing – review & editing.

Declaration of competing interest

The authors declare no conflicts of interest.

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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.2026.100400.

Data availability

All data and supplementary files associated with this study are publicly available through the Open Science Framework (OSF): https://osf.io/fqgps/overview.

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