Mind the (reporting) gap—a scoping study comparing measured laundry decisions with self-reported laundry behaviour

Citation for the original published paper (version of record):
Klint, E., Johansson, L., Peters, G. (2023). Mind the (reporting) gap—a scoping study comparing measured laundry decisions with
self-reported laundry behaviour. International Journal of Life Cycle Assessment, In Press.
http://dx.doi.org/10.1007/s11367-023-02189-3

The International Journal of Life Cycle Assessment
https://doi.org/10.1007/s11367-023-02189-3

UNCERTAINTIES IN LCA

Mind the (reporting) gap—a scoping study comparing measured laundry decisions with self-reported laundry behaviour

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Received: 9 January 2023 / Accepted: 1 June 2023

Abstract

Purpose Many environmental assessments of consumer products and household services rely on self-reported data. Life cycle assessments of domestic laundering are no exception. However, potential discrepancies between self-reported behaviour and actual everyday decisions are seldom investigated due to practical challenges in collecting relevant data. This means that environmental impacts relying on such self-reported data are much more uncertain than previously acknowledged.
Method Laundering data was collected at the Chalmers' HSB Living lab (CHSBLL), a combined multi-family house and research facility in Gothenburg. The collection was both done passively (through the washing machines) as well as actively (through surveys to the tenants). RFID-readers were also installed in the machines and a number of clothing items tagged, allowing for identification. The site-specific data was later supplemented with a large statistical representative study for domestic laundering of Swedish households. This unique data quality allowed the comparison of passively collected data with survey data from tenants in a real-life setup, while validating the results from a national perspective.
Result and conclusions The results suggest that consumers have trouble remembering personal choices regarding domestic laundering, meaning that self-reported data are more uncertain than previously thought. In general, the participants overestimated the amount of laundry they washed and underestimated their frequency of washing. Additionally, many participants showed an interest in changing to alternative wash programs although this change failed to materialize when they were presented with this option in real-life. The findings have potential consequences for environmental assessments and implicate those previous estimations underestimate emissions per kg laundry washed.

Keywords Household consumption · Laundry · Consumer behaviour · Living lab · Environmental assessments · RFID

1 Introduction

The environmental impacts of household consumption are receiving increasing attention in academic research (Ivanova et al. 2016). One such example is the act of cleaning our clothes.

Communicated by Adriana Del Borghi.

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Domestic laundering consumes a significant amount of energy, while also contributing to direct pollution from the use of cleaning chemicals (Bain et al. 2009). For example, Pakula and Stamminger (2010) found that domestic laundering represented on average 4–9% of all the energy used and 8–12% of all the potable water consumed in households in Europe. Since the amount of time and energy spent on cleaning our clothes has grown steadily since 1970s (Yates and Evans 2016), the absolute impacts can be expected to increase.

Unfortunately, few consumers express any willingness to change their washing and drying habits (Uitdenbogerd 2007; Klint et al. 2022; Godin et al. 2020), or believe that doing the laundry leads to any emissions that could affect the environment (Miilunpalo and Räisänen 2019, Arild 2003). However, contrary to this belief, consumer decisions are often one of the largest factors contributing the final environmental impact from laundry (Laitala et al. 2020a, 2011). In other words, to understand environmental impact

Published online: 26 June 2023

from laundering (and by extension domestic textile consumption in general) it is crucial to understand consumer behaviour. This means that having access to high-quality consumer data is central.

Data collection concerning laundering behaviour has traditionally been done through large surveys,[1] e.g. Arild (2003), Laitala et al. (2020a), Miilunpalo and Räisänen (2019), and Moon et al. (2020). Other methods include in-depth interviews, e.g. Hecht and Plata (2016) and Pink and Postill (2019), or having consumers record their behaviour in diaries, e.g. Conrady et al. (2013) and (Laitala et al. 2020b). However, many researchers and institutes fail to address some of the more common methodological challenges. For example, surveys allows for collection of large amount of data but are prone to a number of errors such as social desirability bias (Furnham 1986) and response bias (Podsakoff et al. 2003). Even more troublesome, survey data and in-depth interviews are based on self-reported information which only tells us how the participants *recall* their behaviour, not their actual behaviour in real-life (irrespectively of any possible biases). In this regard, diaries offer a more honest picture of behaviour (given that the participants are truthful). Unfortunately, diary logged data tells us nothing about whether the respondents would remember that same behaviour at a later time. This means that while all methods have their individual benefits and drawbacks, neither approach has yet been able to address the (possible) discrepancy between experienced/recalled behaviour and actual behaviour in real-life.

Traditionally, there have been practical issues collecting the needed type of data to test for possible discrepancies. However, a recent initiative in Sweden allows for a first smaller study. Opened in 2016, Chalmers' HSB Living lab (CHSBLL) is a combined multi-family house and research facility in Gothenburg. Here, tenants rent their living space (student dorms and smaller apartments), while at the same time agreeing to have live data collected throughout their stay[2] (e.g. daily energy usage and water consumption). Since the data collection is mostly done passively within the building, CHSBLL enables researchers to collect data that is less tainted with reporting biases and thus hopefully better reflects an honest view into everyday life. This data can then be combined with survey responses from the tenants, allowing for unique comparisons and analysis. Hopefully this approach will allow for initial insights into answering the research question: *How well can we recall previous decisions concerning washing our clothes?*

[1] For a more thorough review of laundering research, see Klint et al. (2022).

[2] For more information, visit www.hsb.se/hsblivinglab/

2 Material and methods

The main data used in this article was collected at the CHSBLL. Except for tenants in a few apartments that have their own washing machines, tenants at CHSBLL share a laundry space within the building (as common in many Swedish multi-family houses). The cost of using this facility is included in the rent. This shared laundry consists of three washing machines (Electrolux W575H, 8 kg), three tumble dryers (Electrolux T5190LE, 190 L), and one drying cabinet. In addition to the standard equipment, the machines were retrofitted with nine antennas (Kathrein MiRa ETSI) configured for radio frequency identification (RFID). This allowed for detection of passive RFID-tags placed in the machines (e.g. small custom made ID-tags attached to specific garments that could be read digitally).

To answer the research question in this article two studies were made. The first study focused on perception and behaviour for a specific garment (i.e. pants), while the second study allowed for a better focus on perception and behaviour concerning more general aspects of laundering.

To evaluate the validity of the data collected at CHSBLL, as well as to be able to estimate any implications of the results, the data from the studies were supplemented with a large survey concerning general laundering behaviours of Swedish households. This larger survey was collected during Nov 2022 in collaboration with NOVUS (a Swedish professional analysis and research company). Qualified respondents were selected on the basis of wash responsibility in their respective household (i.e. disqualified if they stated that had no responsibility of the laundering practices within the household). Quotas for household size, age groups, etc. were defined so that the final distribution of the respondents was representative of the Swedish population in general.

2.1 Study 1: RFID-tagged pants

For the first study, all tenants using the shared laundry at the CHSBLL were asked if they wanted to participate in a research project concerning pants. Signing up for the project meant that they would have all of their everyday pants tagged with RFID-tags, in addition to filling out a small survey throughout the year.

The tags made it possible to passively collect data regarding whether the pants were placed in any of the washing machines, tumble dyers, or in the drying cabinet in the laundry room. To ensure that the RFID-tags were fitted properly and could be read by the antenna installed in the machines, supervised sewing nights were arranged during September and December 2019.

Data was collected from September 2019 until the end of 2020 (i.e. for 16 months). During that same time period, the participants were asked to fill in an online survey about their washing habits regarding their pants (e.g. *How long time does it take before you wash your everyday pants?*), as well as ownership (e.g. *How many pairs of pants do you own?*). To capture any changes in perception and behaviour throughout the period, the survey was presented at three different occasions (during Dec-19, May-20, and Oct-20). The complete survey, including the participants' answers, can be found in the appended data file. An illustrated overview of the timeline and workflow for study 1 is shown in 6..

2.2 Study 2: intervention

The second data collection was performed using an online survey distributed to the tenants during April–May 2021 and once more during January–February 2022. The survey included questions regarding self-reported behaviours (e.g. *How many wash cycles do you run each month?*), as well as predictions of future behaviour. Additionally, the participants also had to grade how well they identified with the statement "I wash full machines" on a Likert-scale ranging from 1 (strongly disagree) to 5 (strongly agree). The complete survey, including the participants' answers on each occasion, can be found in the appended data file.

Just after the first survey was completed (i.e. on 31 May), the washing machines at the facility were altered. This meant that the tenants had the possibility to choose between three new wash programs, in addition to the standard choices they were used to. These three new programs were named + CLEAN, + FRESH, and + ECO all of which were limited to be run at 40 °C. At the same time, a small list of all available programs was mounted next to the digital display on each washing machine (see 6. for a complete graphical illustration of the used list). No additional information about the changes or available programs were presented, and no default program was pre-selected by the machines when operated.

Data were passively collected by the washing machines and tumble dryers until March 2022. The variables logged included the temporal aspects of machine usage, as well as the choice of wash program, laundry weight, energy usage, water usage, and detergent dose from the automatic dosing system. To capture any variance in the weight measurement system, a calibration curve for each machine was calculated and the final data adjusted accordingly (for more information see appended data file). An illustrated overview of the timeline and workflow for study 2 is shown in 6..

3 Results

On average, the respondents in the national representative study ($n = 1038$) stated that they ran 4.9 wash programs (std. dev. = 3.3) *per person* in their household each month. This relative frequency was lower for households with children (4.2 wash programs per person, compared to 5.3 wash programs per person), although the total amount of washes *per household* were substantially higher in absolute terms (15.1 wash programs per month, compared to 8.2 wash programs per month). For households without children there was no difference in stated wash frequency when controlling for the number of adults and age ($p = 0.457$). The average filling level for each wash was estimated to 83.0% (std. dev. = 15.4). The distribution of preferred wash temperatures of all participants is depicted in Fig. 1.

The stated relative wash frequency of the tenants at CHSBLL was 5.6 washes per person each month based on the survey in Apr/May 2021, and 5.2 based on the survey in Jan/Feb 2022. None of these values differ ($p > 0.1$) from the representative subgroup of the general population (i.e. respondents aged 18–29 years old, no children). Note that males are more prevalent amongst the tenants living at CHSBLL than in the general population (61–70% compared to 44.3%) (see Table 1).

3.1 Study 1: RFID-tagged pants

Seven volunteers living at the CHSBLL agreed to participate in the study. Five of the volunteers were between 20 and 25 years old, one was between 31 and 35 years old, and one was older than 50 years old. Four of the volunteers were male. All in all, 55 pants (mainly jeans) were tagged and registered.

The estimated and measured number of washes for the pants of each of the seven participants are depicted in Fig. 2. Note that two of the participants (F and G) moved out during 2020 (before the end of the data collection) and their data has been adjusted accordingly. Any variation in the participants own estimations of wash frequency in the surveys is depicted by error bars. Four of the participants underestimated their number of washes by approximately 50% (40–70%). The remaining three participants instead overestimated their number by 50% (140–160%). This meant that on average, the group washed their pants 11.1 times during the study while at the same time estimating a wash frequency of 7.1 times with a variability of the average estimation by +/- 1.3 washes (see Fig. 2).

3.2 Study 2: Intervention

When comparing the stated behaviour with the measured behaviour, the tenants underestimated how many times they washed while at the same time overestimated how much laundry (in kg) they washed per month (see Table 2). This held true for both the surveys, even after correcting for the response rate.

The recorded weight distribution of the amount of laundry washed at CHSBLL also shows an overrepresentation

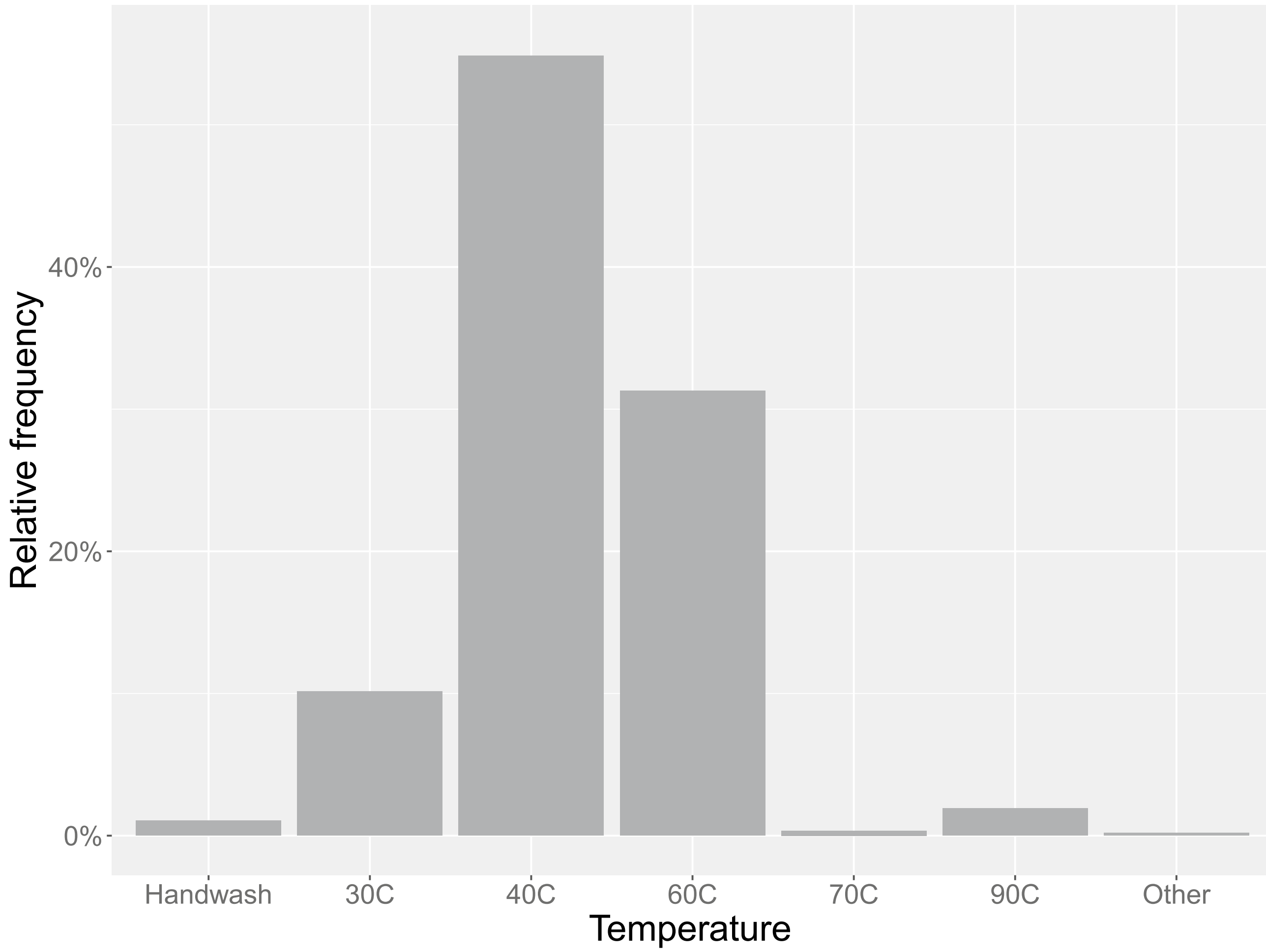

Fig. 1 Distribution of the stated preferred wash temperature in the national Swedish survey ($n = 1038$). Error bars show the standard error for each temperature

of smaller loads during each period. On average, 54% of the washes were below 2 kg and 82% were below 4 kg (i.e. below half of the machine capacity). However, when asked, most of the tenants (50% in June 2021 and 65% in March 2022) agreed or strongly agreed that they themselves washed full machines. A more detailed illustration of the weight distribution can be found in 6. and in the appended data file.

Table 1 Age and gender for the respondents each survey

Survey participants	*Apr/May 2021*	*Jan/Feb 2022*
Tenants using the laundry	21	25
Number of survey respondents	18	20
18–25 years old	16	15
25–35 years old	1	4
35–45 years old	1	1
Male	61%	70%
Female	39%	30%

For temperature, the collected data is quite consistent between experienced/recalled behaviour and actual behaviour, as well as between the two periods. The most popular wash temperature was 40 °C followed by 60 °C. Higher temperature washing programs were seldom used and the preferences did not seem to differ between the two time periods (see Fig. 3). Accounting for the variability in stated estimations, stated wash temperatures in each survey are consistent with the measured data.

As for the proposed new wash programs, most of the tenants at CHSBLL (64% in Apr/May 2021 and 76% in Jan/Feb 2022) stated that they were interested in changing their wash program from NORMAL 40 °C/60 °C to either + CLEAN 40, + ECO 40, or + FRESH 40. However, when presented with the choice (i.e. the intervention), few changed their actual behaviour. This discrepancy held true regardless of whether the possibility to change program was something new (pre-intervention) or if the tenants had had the choice before answering the survey (post-intervention) (see Fig. 4).

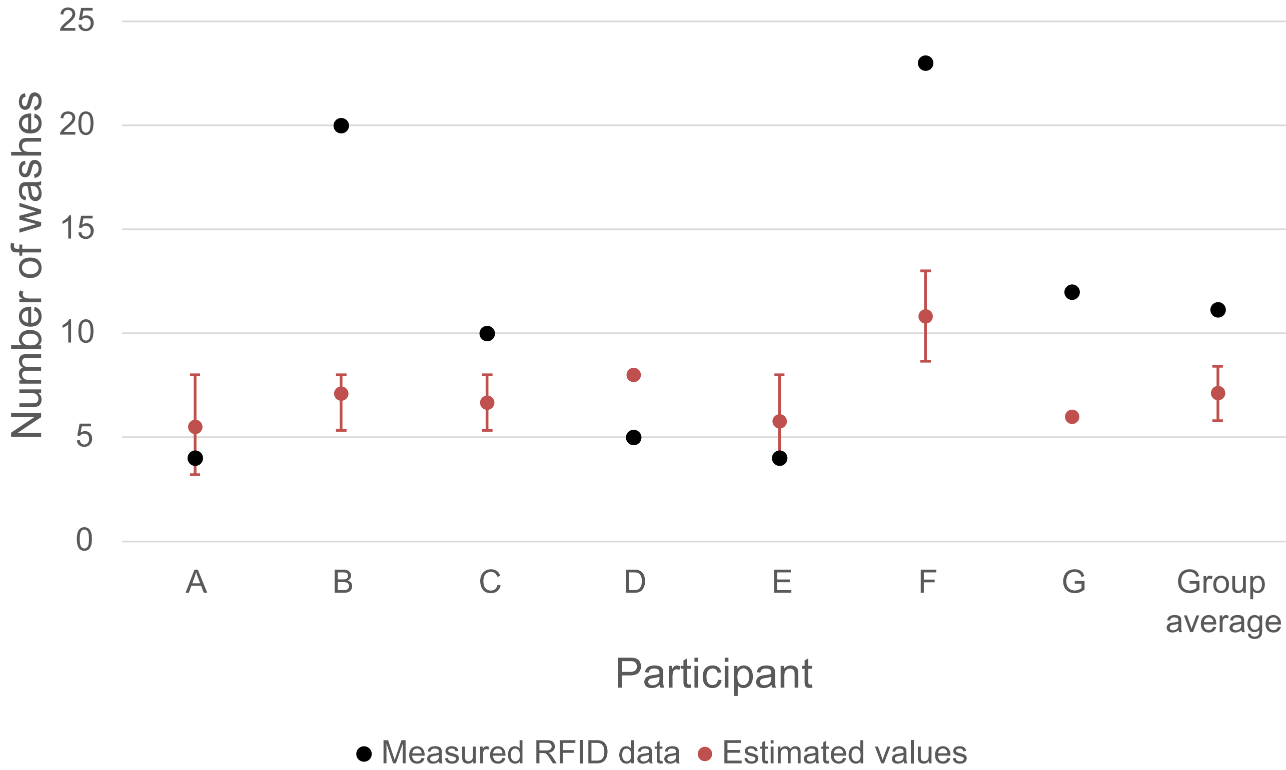

Fig. 2 Number of estimated and measured washes for participants (A-G). Variations in estimations depicted by error bars. Note that particpant D made the same estimation on each occasion (i.e. no error bars for the estimated number of washes)

In addition to this general data, 11 of the tenants at the CHSBLL were able to answer the survey both during Apr/May 2021 and Jan/Feb 2022. Looking at their responses, few (24%) stated that they were willing to change programs when asked in Apr/May 2021 (pre-intervention). However, after being exposed to the possibility in real-life, 42% changed their mind and stated that they were more inclined to change when asked in Jan/Feb 2022.

4 Discussion

Looking at the results, it is evident that remembering past laundering behaviour could be difficult for many consumers. While the participants in our study were able to recall their preferences for choosing a specific wash temperature, they failed to properly describe both the amount of laundry done and the number of wash cycles performed. In the case of loading rate, the tenants overestimated the amount of laundry they washed per month by approximately 100%. As for frequency, the tenants underestimated the number of wash programs by approximately 10–20%. The difficulty of estimating wash frequencies also became apparent when looking at the RFID-tagged pants. Here, half of the participants underestimated the wash frequency by 50%, while the other half overestimated the wash frequency by 50%.

Table 2 Comparison between estimated and measured washing behaviour as CHSBLL for Apr–Jun 2021 and Jan–Mar 2022

	No. of washes	Amount of laundry [kg]
Stated behaviour (2021)	101	501.6
Measured behaviour (2021)	133	291.1
Stated behaviour (2022)	104.2	594.24
Measured behaviour (2022)	165	369.7

Finally, looking at the stated preferences for alternative wash programs it does not seem to matter whether the tenants had previously been exposed to the new programs for their final behaviour. In both cases, tenants stated that they would choose the alternative program to a much larger extent than what happened when faced with the choice in real life. However, the tenants that were asked after the programs were introduced (i.e. post-intervention) were more positive to change, compared to the tenants that had not previously been exposed (i.e. pre-intervention). This suggest that the exposure only led to a change in attitude (i.e. the tenants were more positive to the new programs) but not to a change in behaviour.

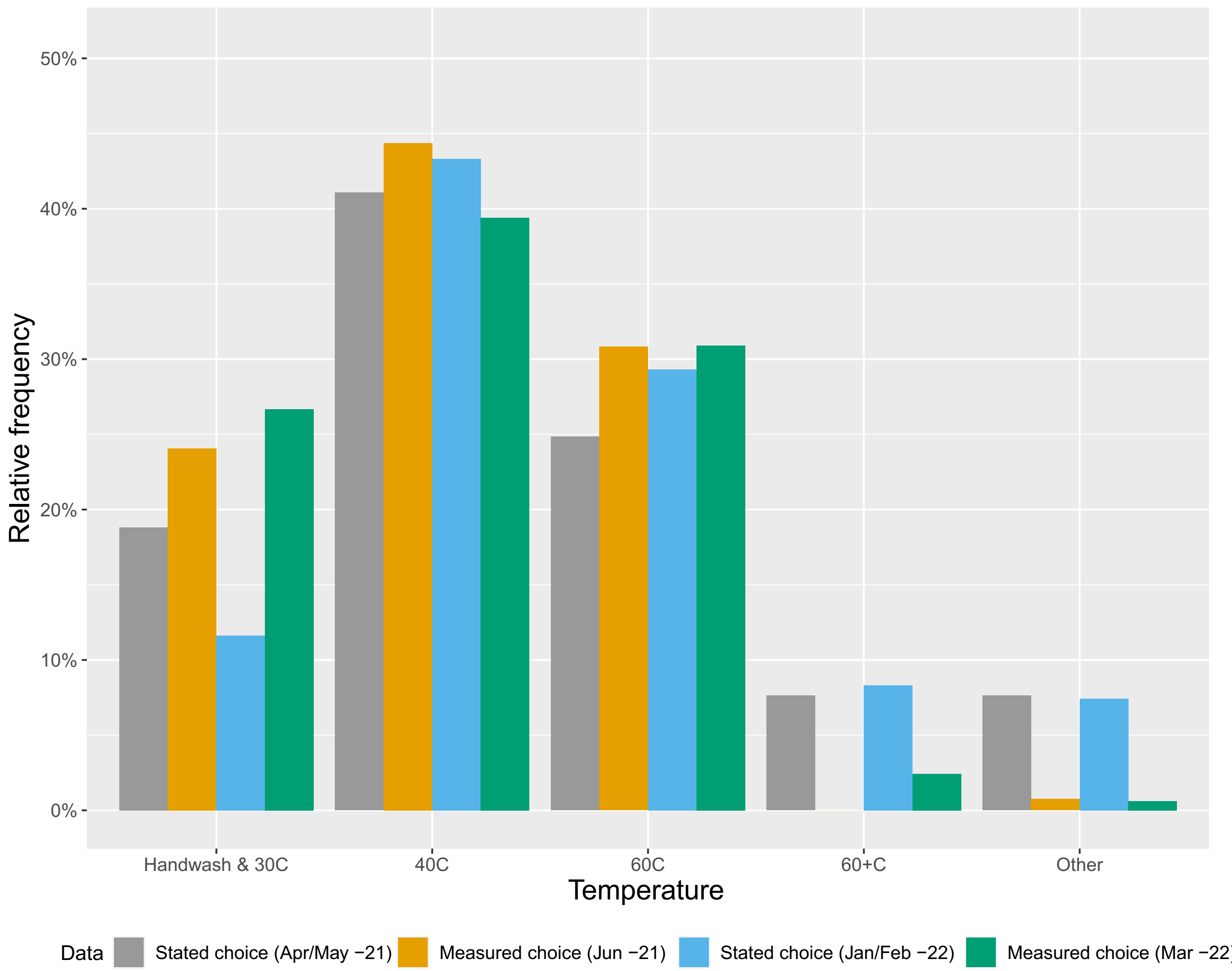

Fig. 3 Stated and measured wash temperatures at the CHSBLL during Apr–Jun 2021 and Jan–Mar 2022. "Other" includes any cleaning program that does not display a specific temperature, e.g. spin only, rinse, or machine cleaning. Error bars show the estimation variability weighted by each individual estimated wash frequency

4.1 Implications for environmental impact assessments

The tenants' stated wash frequency did not differ from the responses in the larger national survey when correcting for households with children. Additionally, the similar results at the two different periods (Jan–Mar 2021 and Apr–Jun 2022) suggest that the findings are robust over time, as well as amongst peers. This means that while this study is small, the findings might be indicative of tendencies in the larger population (at least for households without children). Should this be true, it raises some concerns for assessments of environmental impacts from domestic laundering.

For example, many assessments are based on, or derived from, the amount of textile being washed at each wash cycle. Common ways to take this into consideration are either as a variable that changes the demand of resources (e.g. more energy, water, and detergent is needed for larger laundry loads), or that the final impacts are normalized with the total weight to facilitate comparisons (e.g. greenhouse gas (GHG) emissions are expressed as CO_2-eq. per kg laundry washed). Additionally, if the result from such an assessment is incorporated into a larger assessment for a specific textile (e.g. an LCA of a shirt or a pair of pants), the final impacts from laundering are often allocated in accordance with the relative weight of the specific textile of interest.

However, all of these different calculations are dependent on data or estimations of how much laundry is being washed at each wash cycle. Unfortunately, very little reliable data on real-life consumer behaviour is available (Pakula and Stamminger 2010). That being said, there seems to be a consensus amongst practitioners that consumers use 65–75% of the nominal weight of a standard 5 kg washing machine when doing laundry. Some of the more frequently cited references for these numbers are shown in Table 3.

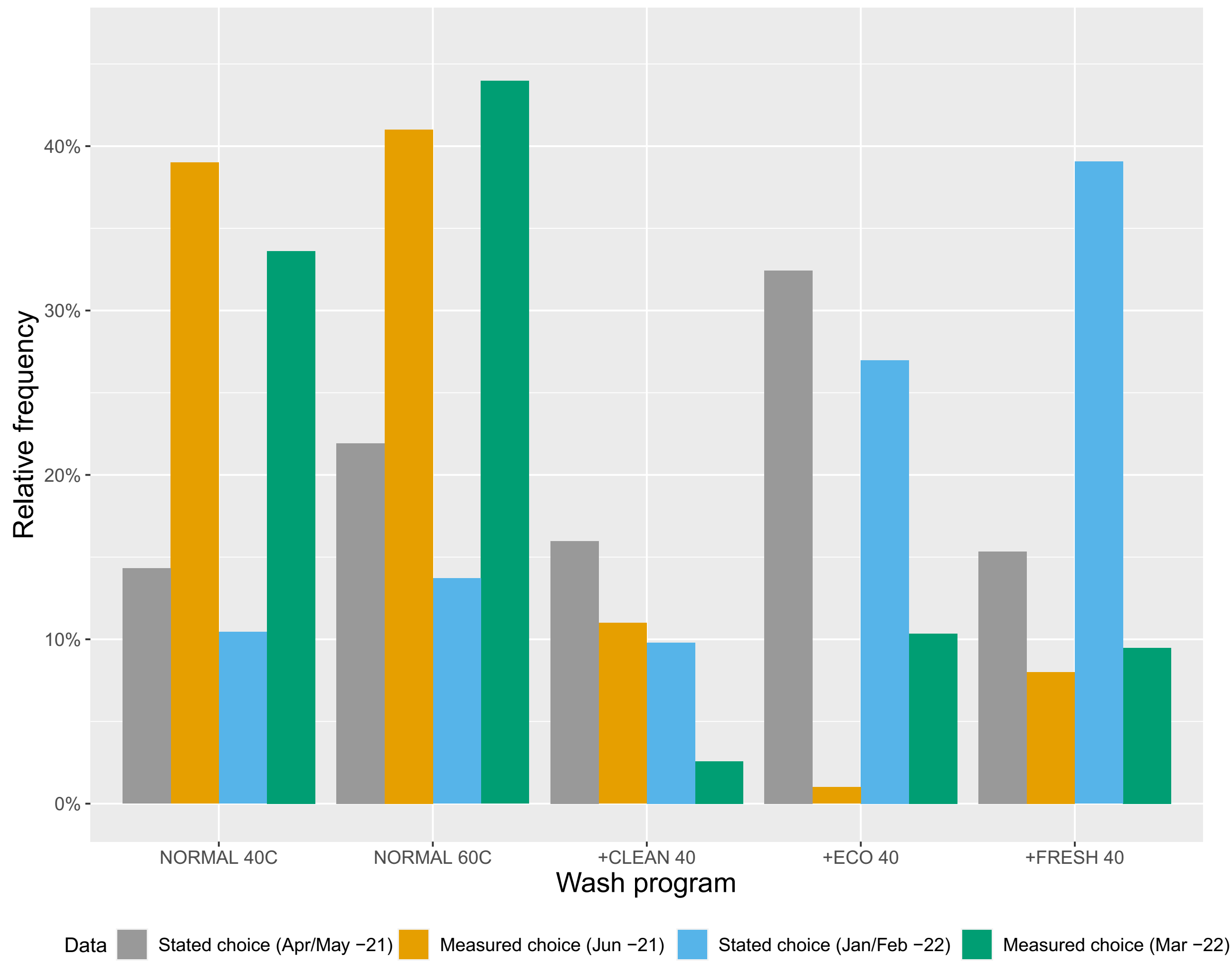

Fig. 4 Stated preference and measured behaviour for new wash programs during Apr–Jun 2021 (pre-intervention) and during Jan–Mar 2022 (post-intervention). Error bars show the estimation variability weighted by each individual estimated wash frequency

What is concerning is that 61–66% of European consumers at the same time state that they use the full capacity of the machine when washing, and that 7–12% state that they fill the machine to a point where it is almost overloaded (Presutto et al. 2007; Alborzi et al. 2017). These statements are thus the same as those expressed by the participants in

Table 3 Common sources for estimated laundry load

Source	Geographical area	Sample Size	Collection method	Laundry load [kg]
Berkholz et al. (2007)	Germany	100 households	Quantitative measures of electrical metering, Interviews	3.7
Presutto et al. (2007)	Europe	2500 respondents from 10 different countries	Online survey	3.2
Kruschwitz et al. (2014)	Germany	236 households	Interviews, survey, and consumer diaries	3.7
Pakula and Stamminger (2010)	Europe and North America	N.A	Calculations from consumer reports and national statistics, complemented by expert estimations	3–4
Pakula and Stamminger (2010)	China/Japan	N.A	Calculations from consumer reports and national statistics, complemented by expert estimations	1.3–3
Laitala et al. (2020b)	China, Germany, Japan, UK, and USA	144	Survey and consumer diaries	4.2–6

our study, who also expressed a high tendency to wash full machines. However, in contrast to the average laundry load depicted in Table 3, the majority of the measured laundry loads at CHSBLL were below 2 kg. Furthermore, the participants in this study overestimated the amount of laundry they washed by 100%, while at the same time underestimating how often they washed (see Table 2). This mistake could also be seen when looking at the estimations of how often the participants washed their own pants (see Fig. 2). Even if this is a result of having few participants or larger machines, the result indicates that remembering past actions concerning laundering is, with the exception of the choice of temperature, much harder than assumed. This would mean that the values expressed in Table 3, and by extension previous estimations of environmental impacts from laundering, are much more uncertain than previously thought.

One specific consequence of this to consider is that, as mentioned before, the weight of the laundry load is used to normalize the assessment of emissions. This means that the final impact (per kg laundry) is inversely proportional to total emissions calculated. In other words, product life cycle impacts increase nonlinearly as the amount of laundry being washed decreases (Koerner et al. 2010). For example, Klint and Peters (2021) estimated the environmental impact per kg laundry for a shared laundry room in a Swedish context. As a way to quantify the variability for the assessment, the relative change of GHG emissions was also calculated due to changes in temperature, amount of detergent, or choice of background system (i.e. building type or size of laundry room). However, as common for environmental assessments of laundry and/or textiles, all the calculations in the study were based on that a fixed amount of laundry was being washed by the machines (in that case 6 kg of laundry in the shared system). The measured data in this present study show instead that the amount of laundry being washed can vary greatly. Here, the data from the CHSBLL show a variation between 1 and 8 kg with an average value of 2.9 kg. Comparing it to the assumed average wash of 6 kg, the resulting environmental impact per kg laundry thus vary between + 500 and – 25%, with an average value of GHG-emissions that is approximately 100% higher than the estimations reported by Klint and Peters (2021). All in all, this means that the amount of laundry being washed is far more important for the resulting estimations compared with the other variables commonly investigated, which typically influence the GHG-emissions by + / – 10%. And while this example is based on a shared system with larger machines, the same dynamics can be expected for smaller machines as well (although with less dramatic results).

Finally, another interesting finding in this study is that the tenants laundering decisions were consistent regardless of any stated preferences or interventions. This is in line with previous studies of behaviour that showed that past frequencies of everyday activities are better at predicting future frequencies compared to any stated intentions (Gärling 1992). Given that this phenomenon is general, it is not surprising that many interventions targeting laundering behaviour have failed since they mainly focused on informing and educating consumers (Throne-Holst et al. 2008; Bartiaux 2008), rather than altering actual behaviour. Taking this into account, a more promising approach to policies or interventions could instead be to focus on the underlying causes of the behaviour (Klint et al. 2022), rather than consumer attitudes (e.g. challenging consumers to only use the eco-program for a month). This approach has been tried with positive results by Sahakian (2019) and Jack (2013), although the results from these studies are still based on self-reported behaviour with few participants.

4.2 Sources of error

While the findings in this study are interesting and could have larger consequences for environmental assessments of domestic laundering, there are some limitations and sources of error that needs to be addressed. First of all, while the rich instrumentation at CHSBLL offers a special opportunity, the tenants living at CHSBLL are aware that their housing situation is unique (i.e. living in a research facility). This might lead tenants to subconsciously alter their everyday behaviour, or that the tenants living in the facility are more inclined to be interested in research (i.e. not representative for domestic launderers in a more general sense). In addition to this, most of the tenants are young (18–25 years old), live in single households, and are native Swedish. The results might thus not be applicable in an international context.

Estimating wash frequency for specific items using a survey offers its own challenges. Disregarding the troubles of remembering past actions, the framing of the questions themselves will inevitably miss any variability in behaviour as well as nuances in the answer. Consider for example the simple question of "What is the usual period between washings of your everyday trousers (in months)?" Any answers to this question do not show whether or not the person washes *all* of their everyday trousers per month, or just a single pair. In addition, the answer does not entail the variability in wash frequency amongst different types of everyday trousers (e.g. leggings, jeans, and chinos) making any calculations even more uncertain. Fortunately, since the participants in this study were few, the potential problem could be alleviated by simply asking the participants for clarification after the study period was over (and adjusting the data accordingly).

Finally, the participants in this study use a shared laundering facility and not private washing machines. However, the number of available machines is large compared to the number of tenants having access to the facility (at least by Swedish standards). This could mean that using the laundry at CHSBLL is more similar to private ownership rather than a shared facility with limited availability. All this means that, while the measured data provide unique insights and is robust *per se*, we cannot claim to represent laundry behaviour in more general terms.

4.3 Further research

The results from this study strongly indicate that data on consumer behaviour regarding, and by extension environmental impacts from, domestic laundering are much more uncertain than previously thought. Because of this, further research needs to better establish the magnitude of this discovered variability. One way to do this could be to repeat the study in a larger setup that preferably include a more diverse group of tenants (e.g. recording survey and user data in one or several larger multi-family buildings located in different socioeconomical city areas). Unfortunately, such an endeavour might prove difficult since most washing machines are not equipped with a logging system keeping track of resource consumptions for specific programs, nor are they able to separate datapoints between unique operators. However, some of these challenges might disappear with the current growth of smart washing machines (Kim and Moon 2023), which allow for more detailed data collection by each user. While this possibility seems promising, the usage of these types of machines are currently not widespread. In the meantime, another possible route of exploration could be to collaborate with companies that provide pay-per-use services. Since these services ultimately bill consumers depending on resource consumption for running specific wash programs, it would be fairly easy to utilize this data in combination with costumer surveys (provided that the company, as well as the consumers, agree to participate). Such a set-up would also have the benefit of enabling individual matches between behaviour and survey responses, rather than on an aggregated level. It would also be interesting if a similar study could be repeated in a different country (i.e. outside the Nordic countries) to catch and record any potential cultural differences. However, it should be noted that a smaller study of such a set-up already has been published by Bocken et al. (2018). In it, the authors found that consumers tended to overestimate their washing temperature as well as underestimate their number of wash cycles each month (although the total amount of laundry in kg was not measured). Additionally, the authors nicely illustrated that economic feedback by the machines steered consumer behaviour; consumers that had to pay for doing the laundry washed less frequently and used colder temperatures.

Finally, with regards to the amount of laundry washed, there exist a possibility that consumers evaluate the fullness of washing machines visually (i.e. it looks full), rather than by the technical limitations of the machines (i.e. amount of laundry in kg). Understanding if such a tendency exists (and to what extent it influences laundering decisions) is crucial in understanding laundering behaviour in general.

5 Conclusion

By combining passively collected data with survey data, this research highlights that many consumers have trouble remembering personal choices with respect to domestic laundering. In general, the participants in this study overestimated the amount of laundry they washed, while at the same time underestimating the frequency of laundering. Similar tendencies could be observed for a specific item (in this case pants), and few of the participants were able to properly remember how often they washed their own pants. Finally, when asked, many of the participants showed an interest in changing to alternative wash programs. Unfortunately, this change failed to materialize when they were presented with this option in real-life, although many experienced a change in attitude towards the new programs after they were installed in the machines.

Estimating environmental impacts from laundry is almost always dependent on some sort of self-reported data. The findings presented in this study thus implicate that those previous estimations underestimate emissions per kg laundry. Unfortunately, this would have even larger consequences since estimations of environmental impacts from textiles in general tend to incorporate findings from laundry assessments into their own specific study.

Appendix

Figure 5 show a graphical illustration of the timelines for study 1 and study 2. In turn, Fig. 6 illustrates the complete list of information that was mounted next to the digital display on each washing machine during study 2.

A more detailed table of the recorded weight distribution of the amount of laundry washed at CHSBLL during study 2 is shown in Table 4.

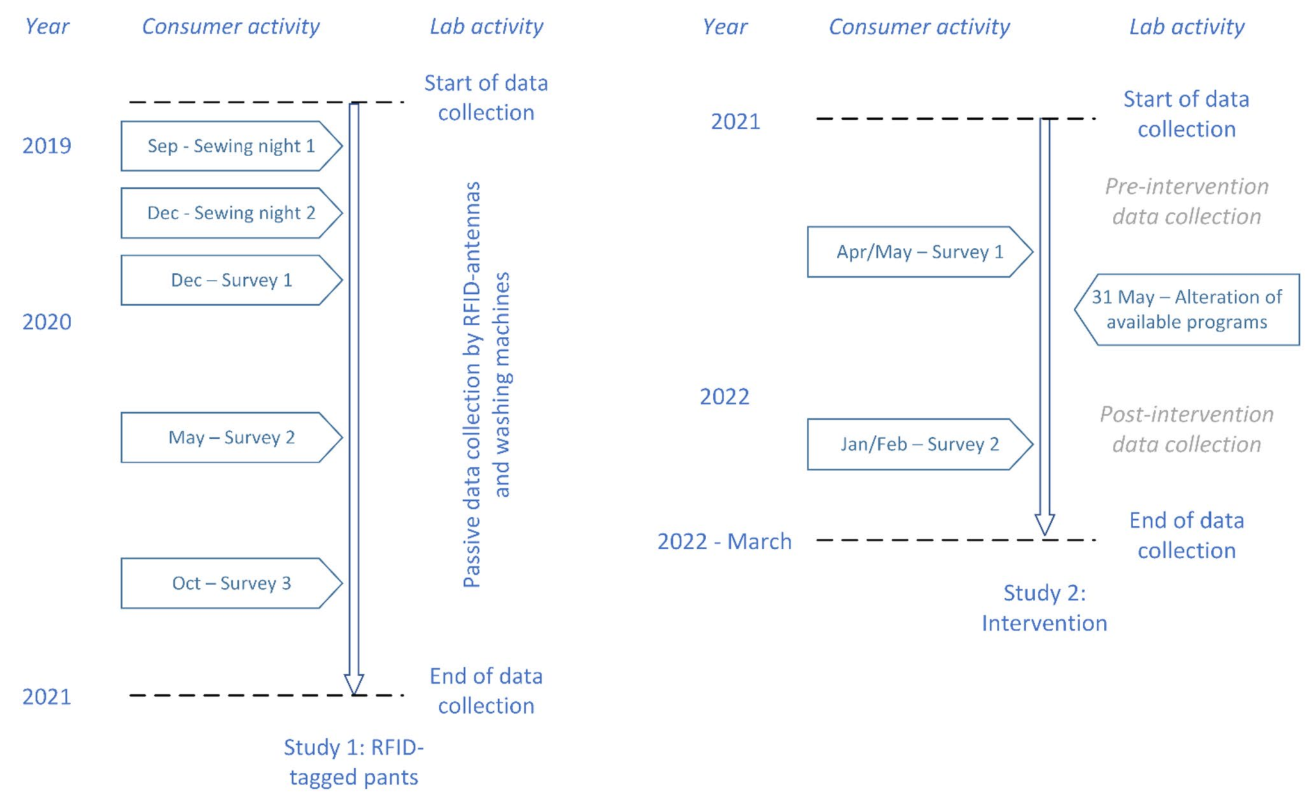

Fig. 5 Timeline for study 1 and study 2

Fig. 6 The list mounted next to each washing machine display. In addition to the names of the program, the display also shows the available temperature to choose from. Note that some programs can only be run with a fixed temperature

Menu option	***Description***
VÄLJ SPRÅK	Change language
NORMAL	Normal cycle / long spin (shorter drying time)
+CLEAN	Better against stains
+FRESH	Better against odour
+ECO	Reduced emissions
MILD	Mild, delicates cycle / short spin
HANDTVÄTT	Hand wash, delicates cycle / short spin
YLLE	Wool, delicates cycle / short spin
SKÖLJNING	One rinse / Short spin
ALLERGI	Allergy program
SKÖLJ TRUMMA	Rinse drum, flush detergent compartment
RENGÖR TRUMMA	Machine cleaning program
Subcategory	
VITTVÄTT	Whites
KULÖR	Coloureds

The number in each menu option indicate temperature in Celsius. Depending on the program, the following wash temperatures are available: 30°C, 40°C, 60°C, or 95°C. More instructions can be found on the left side of this machine.

Table 4 Recorded and calibrated weight distribution at CHSBLL, June 2021 and March 2022

Recorded weight	Relative number of washes at CHSBLL	
	June 2021	March 2022
0–0.99 kg	26%	25%
1–1.99 kg	28%	29%
2–2.99 kg	15%	15%
3–3.99 kg	13%	15%
4–4.99 kg	10%	4%
5–5.99 kg	0%	2%
6–6.99 kg	2%	7%
7–8 kg	5%	3%
Below 50% of machine capacity (< 4 kg)	82%	84%

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11367-023-02189-3.

Funding Open access funding provided by Chalmers University of Technology. Base funding for this work has been provided by the Formas grant 2016-01089 with additional support from Electrolux Professional and HSB Levande Lab Utveckling HB. Open access funding will be provided by Chalmers University of Technology.

Declarations

Conflict of interest The authors declare no competing interests.

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