

Smell and Sustainability: Can Odour Shorten the Life Span of Clothing?

Rachel McQueen, Jennifer Kowton and Lauren Degenstein

1. Introduction

Under Sustainable Development Goal 12, the UN Economic Programme noted a rapid increase in both worldwide material consumption and per capita material footprint, with the latter jumping from 7.3 tonnes per person in 1990 to 10.9 tonnes in 2015 (UN Secretary General 2019). Consequently, landfilled clothing and textile waste pose significant environmental problems, as textile waste has increased considerably over the last few decades due to the increased consumption of clothing (Morgan and Birtwistle 2009; Tokatli et al. 2008). Incineration and landfilling have accounted for about 84% of textile disposal in the US for more than a decade; both the volume of this waste and the cost to manage it on a per tonne basis are growing across the country (Johnson and Adler 2017). Clothing made from petroleum sources does not biodegrade, which adds to the growing problem of non-biodegradable waste (Geyer et al. 2017). Carbon dioxide is also produced during decomposition of organic materials, and methane, a potent greenhouse gas, is produced due to its incomplete biodegradation within landfills in the absence of oxygen (European Commission 2010). Despite methane capture technology and utilisation of landfill gas as a fuel source, it is still estimated that methane emissions from Canadian landfills make up 20% of the total national methane emissions (Government of Canada 2017). Incinerating textiles as an alternative to landfilling can also pose detrimental environmental and health impacts. If appropriate capture technology is not used, persistent organic pollutants such as dioxins can be released during incineration, and the ash from the incineration process still needs to be landfilled (Rabl et al. 2008; European Commission 2010).

In the USA, it is estimated that 21 billion pounds (9.5 million tonnes) of textile waste ends up in the landfill each year (Council for Textile Recycling 2017). In the UK, government initiatives aimed at improving the sustainability of the fashion and textiles industry, including focusing on consumer use, have resulted in reductions of 50,000 tonnes of textiles ending up in household waste since 2012 (WRAP 2017). While this is an encouraging start, 300,000 tonnes of clothing still enter household waste that is destined for landfilling or waste-to-energy initiatives (WRAP 2017). According to Value Village's State of Reuse Report (Value Village 2018), the average

North American consumer disposes of approximately 37 kg of used clothing each year. As such, textile waste accounts for 5%–10% of all materials in Canadian landfills annually (Weber 2015). Therefore, in order to keep clothing out of the waste stream, it is necessary to understand motivations for why consumers choose to throw clothing in the trash rather than use routes that may extend the life of clothing (Norum 2017).

Clothing disposal in the literature refers to the process of getting rid of an item of clothing that the consumer no longer wants to wear (Laitala 2014). Jacoby et al. (1977) describe three options available to consumers when they decide to dispose of a product: to keep the product, permanently dispose of it, or temporarily dispose of it. Repurposing the item may extend the life of the garment considerably. Through the process of upcycling, unwanted clothing can continue to be worn or reconstructed as something else. Alternatively, damaged or otherwise undesirable clothing could be used as rags (i.e., downcycled), both of which more closely align with the UNEP's Sustainable Development Goal 12.5 recommendation (UN Sustainable Development Goals n.d.). Most disposal methods involve permanent disposition, which may include selling it, giving it away, donating it, or throwing it in the trash (Laitala 2014). The choice of disposition option is influenced by many intrinsic (e.g., recycling behaviour, environmental awareness, fashion consciousness) and extrinsic factors (e.g., convenience of recycling/donating facilities, condition/quality of clothing) (Bianchi and Birtwistle 2010; Laitala and Boks 2012). Clothing disposal behaviours such as selling, giving away (usually to friends and family) or donating to charity are considered positive environmental behaviours as they keep unwanted clothing out of landfills (Bianchi and Birtwistle 2010). Furthermore, if the extension of the lifetime of an old garment leads to the displacement of the production, processing and disposal of another garment, then even further environmental savings are possible (WRAP 2017).

Discarding a garment directly in the trash is considered the least environmentally sustainable option that a consumer can make. Consumers may be more likely to throw away items that are damaged or deemed to be of “no use” to anyone else, perhaps due to poor quality materials or unfashionable items (Bianchi and Birtwistle 2010). When “laundering has not fulfilled its purpose” and odours are not effectively removed, Laitala et al. (2014, p. 142) state that consumers may use this as a reason to throw the garment away. Yet, the clothing disposal literature has rarely addressed the potential impact of odour and, if mentioned, it is often grouped with other changes that can occur to the garments during use (e.g., holes, fading) and prompt disposal (Laitala and Klepp 2011). This may be that persistent odour within clothing plays only a minor role in clothing disposition as a whole; however,

exploratory research has suggested that odour can lead to early disposal, even when the clothing is otherwise deemed functional or wearable (Ehnes et al. 2011) and, therefore, merits further investigation.

Consumers make decisions everyday about the clothing they are going to wear and how that clothing item is going to meet their functional and/or aesthetic needs. Although consumers usually assess clothing on sensorial properties related to appearance (e.g., colour, design) and handle (e.g., softness, texture) or performance attributes (e.g., durability, resiliency), clothing fabrics can pick up odours during use or storage that may become perceptible to the wearer. This odour may then become another attribute impacting how a person assesses clothing. Clothing-related odours can come from a variety of sources, both internal and external to the human body (McQueen and Vaezafshar 2020). Odour perception is considered to be problematic because “olfaction intersects with social, cultural, and moral order” and, therefore, evokes judgments about the person, place or situation in which the perceiver finds themselves (Waskul and Vannini 2008, p. 53). North American consumers often develop cultural odour definitions formed through contextual relationships; therefore, the detection of odour, especially one that is seemingly out of context, can generate positive or negative assumptions about its source (Waskul and Vannini 2008). Clothing should not smell or, if it does, should smell of fresh scents associated with laundry detergent, indicative of cleanliness (Shove 2003). Yet, clothing that retains smells of sweat, becomes musty and stale, or picks up other environmental odours can generate a negative association and may impact the wearer’s satisfaction with the garment.

Cooper (2005) argues that extending the life of a product is essential in moving toward sustainable consumption, as products will less likely be disposed of due to quality issues. Drawing upon scholarship in product satisfaction and consumer-product attachment, Niinimäki (2017) argues that a positive or pleasurable use experience deepens attachment to clothing items, making it less likely that specific clothing items will be discarded. Schifferstein and Zwartkruis-Pelgrim (2008) describe the degree of consumer-product attachment as “the strength of the emotional bond a consumer experiences with a durable product” (p. 1). Due to the emotional bond with a product, the owner will experience a sense of loss if the object is lost and is unlikely to want to dispose of it (Schifferstein and Zwartkruis-Pelgrim 2008). Enjoyment related to using the product and memories formed with the product were both associated with strong levels of attachment, whereas life-vision, self-identity, market value, reliability and utility were not (Schifferstein and Zwartkruis-Pelgrim 2008). From a sustainability point of view, developing and maintaining product attachment is

important in order to avoid products being disposed of. Niinimäki (2017) positions her argument in sustainable clothing design toward extending the lifetime of clothing through the creation of positive or pleasurable use experiences with clothing, where enjoyment is experienced with wearing the clothing item. As described in an earlier article examining the emotional connection between a wearer and their clothing, Niinimäki and Armstrong (2013) demonstrate how experiential attachment could potentially prevent early disposal:

Clothing has a strong impact on our emotions, and it can elevate the wearer's mood. People feel attached to clothes because of their aesthetic beauty as well as through beauty experiences over time that develop in social situations and through positive multi-sensorial use experiences (p. 196).

In relation to our study, we are most interested in that "positive multi-sensorial" experience, as it provides justification for how odour perception applies to decreased use. Although Niinimäki and Armstrong (2013) discuss the importance of a pleasurable use experience in relation to continued ownership, it could also be concluded that a connection between odour detection and a particular item could facilitate a negative use experience that might initiate a premature disposal process.

In the present study, we explore Canadian consumers' experiences and perceptions of odour in clothing through focus group interviews and an online survey. We aimed to discover how prevalent the perception of odour in clothing was among textile consumers and how odour perception could influence their experience with clothing and impact their behaviours, particularly as it related to clothing disposal. We asked what types of odour consumers experience within their clothing and whether there were characteristics of clothing items they identified as being more susceptible to collecting and retaining odour. Through the perspective of odour as a negative use experience, we address the issues related to consumer dissatisfaction with odorous garments and the likelihood of premature clothing disposal.

2. Materials and Methods

A mixed-methods approach was taken, where qualitative and quantitative data were collected through focus group interviews and an online survey, respectively. This triangulation of data allowed for a more holistic examination of the research problem.

2.1. Focus Group Interviews

The topic of odour in clothing could be a potentially uncomfortable topic to discuss due to the personal and intimate nature of some odours. However, focus group

interviews were considered to be suitable as a means to collect data on a subject that have seldom been previously reported (Morgan 1997). Furthermore, the use of humour and laughter through conversations in focus groups has been recognized as an effective means to elicit information about intimate topics that may border on the “taboo” and how it may impact sustainable practices (Browne 2016).

Between 2014 and 2017, the research team conducted eight focus group interviews. Each focus group had both female and male participants and ranged from a minimum of six to a maximum of ten participants. A total of 58 participants (41 females, 17 males) were involved. The interviews ranged from 60 to 90 min in length. Each focus group was moderated by two researchers, with the primary moderator (JK) leading the discussion for all eight focus group interviews. At the beginning of the interviews, the participants completed a brief survey regarding general experience with odour in clothing. Guiding questions for the interviews began with participants being asked to recall and describe an item of clothing that they perceived to be odorous. Further questions related to discovering how odour in that clothing item made them feel; whether they had noticed if there were specific types of clothing that could become odorous; what they do with clothing if the odour persists; and what type of disposal methods are used when getting rid of odorous clothing.

Focus groups were audio-recorded with participant consent and transcribed verbatim. Two researchers analysed the transcripts and coded the data in order to identify common themes (Breen 2006).

2.2. Survey

We used quantitative survey data to assess whether consumers perceived odour in clothing and whether this led to premature disposal of clothing items. The survey also addressed the avenues of disposal for odorous versus non-odorous clothing items. The survey offset the qualitative focus group data as a larger group of Canadian consumers could be included in the study; however, the data elicited from the survey results were not as rich and detailed as the focus group interviews.

Quantitative data were collected using an online survey administered by Survey Monkey. A non-probability sample was selected using snowball sampling methods. People were asked whether they had ever disposed of clothing because it became too odorous to wear; people were then asked about what disposal methods they used for non-odorous clothing and then again for odorous clothing for six specific garment types (i.e., T-shirt, button-up shirt, sweater, jeans, athletic shirt, athletic pants). There were seven options for disposal methods: “keep the item but stop

wearing it"; "sell it"; "give it to a friend/family member"; "donate it to charity"; "repurpose it (make it into something new)"; "use it as a rag"; or "put it in the trash". The majority of responses were scored based on a 5-point Likert-type scale: 1 "never"; 2 "rarely"; 3 "sometimes"; 4 "often"; 5 "always or almost always".

Clothing disposal data were analysed by comparing the method of clothing disposal for each clothing item for (1) non-odorous clothing and (2) odorous clothing. Multiple paired t-tests were carried out to compare means within each disposal method group. Since there were multiple t-tests conducted, differences among disposal methods were deemed to be significant if $p < 0.001$.

3. Results

3.1. Focus Group Interviews

The survey completed by participants at the beginning of the focus group interviews indicated that the majority (i.e., 57 out of 58 (98%)) perceived odour within various clothing items they have owned. From the interviews it became apparent that (i) odour could come from different sources, but that body odour, particularly from the underarm region, was the most common; (ii) certain types of clothing can be more likely to pick up and retain odour; and (iii) persistently odorous clothing could lead to negative use experience and, consequently, premature disposal. These items were less likely to be disposed of in a way that would extend the life of the clothing item.

3.1.1. Sources of Clothing Odour

When discussing the different types of smell trapped in their clothing, participants in all eight focus groups agreed that body odour was of particular concern. This was not surprising given the close proximity of clothing to the body. All but one participant referenced body odour in their own clothing; however, perceptions of the frequency and/or intensity of the garment odour varied among participants. Frequent reference to the armpit region made it clear that underarm odour was the most common type of body odour and is considered unacceptable. Concerns with underarm odour were associated with work, formal and casual clothing as well as sportswear. Many participants also cited foot odour as being problematic, while a few also discussed genital odour. A number of other smells were presented as displeasing throughout the series of focus groups, these included food and spice smells; must from vintage clothing, cigarette or campfire smoke; odours present in specific workplaces (e.g., poultry farms, meat packing, oil rigs) and the odour of wet wool. Although participants in all focus groups declared these types

of odour, the experiences were noted only by specific individuals, not the group as a whole.

Despite it being evident that odour on clothing was usually perceived to be unpleasant and generated negative associations with odorous clothing, there were a few participants who referred to odours on specific clothing items as pleasant. Two participants in the same focus group described how they enjoyed the smell of their scarves during winter as the fabric retained the smell of their own fragrances. Furthermore, some inherently unpleasant smells were considered to be pleasant, or at least not completely offensive, due to positive memory associations. For example, one female participant described the “endearing” smell of her vintage clothing:

I have some vintage kind of grandma clothes that, yeah, the smell doesn't really come out and it's almost, like, endearing. It's not really a good smell but it's kind of like, like a car that my grandpa gave me when I was 18—his old car. It's like, that grandpa smell wasn't coming out. It's not necessarily a good smell, but it's kind of like an endearing smell. So, like, some of my grandma's pieces are like, you just accept that they have a, a vintage smell to them (FG2).

3.1.2. What Types of Clothing Smell?

Our study revealed a trend in the types of clothing most often associated with odour retention. In relation to underarm body odour, participants acknowledged persistent odour in tops constructed from synthetic fibres, heavier knitted fabrics, and clothing designed to hug the underarm area. Participants described their negative experiences with synthetics; for example, one female participant stated that “synthetic fabrics, fibres annoy me . . . they seem to absorb smells faster” (FG1). Whereas another described certain types of lightweight polyester shirts:

I also have experienced whenever I wear, you know those kind of sheer, polyester kind of chiffon shirts that are in fashion? Whenever I wear one of those, I can only wear that once before I have to wash it again because it definitely smells. And even if I take it off and I personally don't smell, it's like the fabric smells (FG4).

Her vivid description that the smell was a result of the interaction between her body and the sheer polyester fabric, and not her body alone, emphasised the role the synthetic fibre can play in intensifying odour. A third female participant claimed that she had learned from such experiences and is now

a little bit better in my choices, but I think I remember some shirts that contained polyester in my early twenties that I would, you know, feel embarrassed to be wearing after a few hours. I'm like, ugh, what's wrong with this? (FG1)

These sentiments were held by the majority of participants, and it became apparent that even without knowing why, participants understood synthetic fibres extenuated odour. Some other participants specifically mentioned cheap polyester, such as the free polyester tops that were provided for entering sporting events, as being particularly problematic. Whereas, some participants commented that clothing made from natural fibres in general, or more specifically those made from wool, were far less odorous and did not emit strong body odours during or after being worn.

Other garment and fabric properties were also identified as significant in how much body odour may be picked up by the garment. An association between body odour and heavier, knitted fabrics was noted: "I perceive that the heavier the knit will absorb the smell . . . it just makes me uncomfortable and I feel unclean" (FG2), highlighting the negative feeling associated with odorous clothing. This sense of anxiety, felt when a person wears clothing that they perceive to smell, was also expressed by another participant in relation to clothing that fit close to the underarm:

I wear cardigans a lot to work and I find those are the worst. I don't know if it's 'cause they hug your armpits, you know, they're really close to your skin and that's when I'm always like, oh god, do I stink? Do other people smell me? (FG3).

The relationship between odour and tight-fitting clothing was expressed by others, for example: "I think it's especially when, like the t-shirt or whatever you're wearing is especially close to your armpit, that's what I've noticed, the tightness" (FG6). Identifying particular characteristics of their smelly clothing resulted in some participants seeking out certain types of garments, and avoiding other types, in future purchases: "I'm now buying looser because I find the more, like the closer they fit to your skin, I think that's when it starts smelling a lot more. So, the looser the top is, I'm finding that it's better" (FG2). Similarly, another participant stated, "I will buy natural fibres and I will avoid anything that is a, um, unnatural" (FG3).

Throughout the focus group interviews, a number of participants raised certain clothing stores or clothing brands, sometimes comparing them with another, with which they had experienced odour developing quickly and persisting within certain types of garments. Such bad experiences had the potential to influence their

future shopping purchases, exemplified in one participant's statement following a description about two cardigans she purchased from an online store: "I don't know what the specific fabric is or what it is, but I'm just not going to buy their cardigans anymore" (FG3).

Second-hand clothing was another category of clothing that a few participants mentioned throughout the focus group interviews. A specific musty smell associated with some types of vintage clothing was described, as well as the smell of a previous owner that may not come through until it was worn. Participants who mentioned such odours arising from second-hand clothing were not necessarily deterred from buying second-hand clothing, but it did alter their behaviour when it came to laundering, storing and even what occasions to wear the offending clothing item.

3.1.3. Options for Dealing with Persistently Odorous Clothing

The focus group interviews confirmed that many people have experienced odour building up within certain items of clothing to the point that the odour could not be removed and/or was perceived to return quickly when the freshly laundered item was worn again. Participants then dealt with persistently odorous clothing in a variety of ways. These decisions can be viewed as potential life-extending behaviours (e.g., keep, donate or give away the item) or life-shortening behaviours (e.g., make into rags, put into the trash).

When persistent odour was present, participants were generally not inclined to extend the life of odorous clothing. Giving away an odorous item of clothing to someone they knew was never an option, nor was reselling it. However, a few participants stated that they would include odorous clothing in clothing piles intended for donation along with other non-odorous clothing. As one female participant said, "I'm just lazy, I'll throw everything in one bag. And if it's stained too. I'll donate that too because I can't resale it" (FG2), indicating the role that convenience plays in this sorting decision. Others felt that it was up to the organization they donated their clothing to make the decision about whether it was acceptable for resale. As another female participant stated:

I probably would [donate it], 'cause when I donate it I would wash it and it would smell okay and if that person who purchased it or got it found out it did that, hopefully they would get rid of it (FG3).

Even though specific items of clothing may have been deemed annoyingly odorous to wear, some recognised that this odour might not be perceptible to others. As one individual explained, she had donated an odorous curling jacket "because I thought maybe it was just me that was, you know, holding onto a memory of a

scent or something like that, so I did donate that one" (FG5). Therefore, although an individual may have detected odour in their clothing, the smell could simply be considered in the mind of the wearer and unnoticeable to others.

Despite a few participants admitting they would donate clothing they perceived as odorous, a higher proportion indicated that donation was not an option as they would not donate clothes that they "can't handle the smell of" (FG1). Generally, this was because many felt if clothing was too smelly for them, then it would be too smelly for someone else. As one participant put it, "if I think it smells really bad, I don't think anyone else should have to deal with the smell" (FG1). However, that same participant explained that there could be some exceptions:

well, sometimes I'll ask if someone, like someone else if it stinks that bad and if they say no, then I'll consider donating it, 'cause I've seen, like I think I have a strong sense of smell (FG1).

Her reflection about determining where an odorous clothing item should go supports the earlier statement that some people may donate clothing they perceive as odorous because others will not detect it.

Some participants also explained that they would keep clothing they perceived to be odorous because they could not bring themselves to get rid of it. When this occurred, participants would keep the clothing item in their possession but not wear it, or delegate it to another purpose where persistent odour was less of a concern. Motivations for keeping these items included guilt about throwing them in the trash, because it was a waste of money to throw them out, or because the clothing item had sentimental value. Some participants would use an odorous clothing item for another specific purpose, in a sense, repurposing the garment. If the item was suitable, participants would use the garment to exercise in, do yard work, camp or wear for occupations which were by nature dirty and odorous (e.g., underneath coveralls in the oil rig). Despite the perception that odour development was a negative attribute, some participants described their attachment to specific clothing items that prevented them from getting rid of the garment. One participant described her attachment to a dress she had worn heavily for weeks while travelling:

I remember getting home with this dress and being like, I think we're done now. I don't think I can. I think it's absorbed so much odour at this point, that I, and, but that was four years ago and I still wear the dress sometimes (FG3).

A dress that she wore when she was “so happy” could not be discarded and she would continue to wear it again when on holiday. Despite the smell she could justify why she could still wear it:

So that’s why I call it my camping dress so that it’s understood that it’s my dirty, comfy dress. Nobody can judge me because I’m making this conscious choice to wear this thing (FG3).

Another participant expressed her strong attachment to, and unwillingness to part with, an odorous shirt:

I like the look and the cut of it and that, like there’s so many things that I like about it, that I’m reluctant to give up on it yet it’s such a lovely shirt and it was a freakin’ lot of money so I’m, you know, I think it needs a little more time from the price tag to when I can actually throw it away (FG3).

The design and cut of the shirt, as well as the financial cost created a level of attachment influencing her decision to hold onto the shirt for longer, despite its persistent smell.

Repurposing odorous clothing into rags was an option explored by many of the participants.

If I find something has a persistent odour and I’m done with it, then I assume no one’s going to want it so I cut it up and use it for rags at work to wipe oil off things and stuff like that (FG2).

However, there was often a caveat that the fabric needed to be suitable as a rag. As one participant stated when explaining how she dealt with odorous clothing, “I’d probably turn it into a rag or throw it out if it wasn’t rag-able” (FG3). More specifically participants offered insight into what fabrics they deemed unacceptable as rags. For example, in relation to a cotton/polyester work uniform, one participant expressed “it’s also not made of really a nice fabric for using for rags because it’ll actually scratch up a lot of surfaces” (FG1). In another instance, a participant stated, “I found that with polyester shirts I don’t like to repurpose them as a cloth because they don’t really soak up water very well. So, I end up chucking them” (FG4). Towels, however, were deemed appropriate for such a purpose.

Throughout the focus group discussions, it became clear that if odour became persistent—to the point that the person no longer wanted to wear it—the most common disposal method was to throw them into the trash. As one participant explained: “Garbage, usually garbage because I don’t want to pass that on to someone

else, you know, if it's not in nice condition, I don't want to donate it even" (FG5). A few participants did acknowledge that the trash would be their choice of disposal 'in theory' but had never actually had to throw out odorous clothing as, for them, laundering was sufficient to remove odour.

3.2. Survey Results

A total of 240 usable responses were received for this survey after removal of responses from outside of Canada. Of this, 85% of the respondents were female and 15% male. Over half of the respondents were ranged between 18 and 35 years old (percent of age in years: 18–25 = 20.4%, 26–35 = 33.8%, 36–45 = 22.1%, 46–55 = 10.0%, 56–65 = 10.0%, 66+ = 3.8%). The majority of respondents (97.5%) indicated they had noticed odour in an article of clothing they owned after wear or use. Of the 234 respondents who detected odour in their clothing, approximately half (49.6%) reported that they had, at some time, gotten rid of an item of clothing because it became too odorous to wear. The most common type of odour was sweat-related body odour, followed by food odour (Table 1).

Table 1. Level of frequency at which different types of odours are perceived in clothing ($n = 234$).

Types of Odour	Mean ¹ (SE)
Body odour (sweat)	3.52 (0.23)
Food odour (cooking smells)	2.65 (0.17)
Musty odour (earthy/stale/damp)	2.28 (0.15)
Musky odour (pungent, sweet, heady, musk)	2.20 (0.14)
Body odour (e.g., unwashed hair, illness)	2.12 (0.14)

¹ Scale: 1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = always or almost always.

The greatest number of respondents disposed of athletic shirts ($n = 80$) at some time, as they became too odorous to wear. This number represented one-third of the total number of respondents. Slightly less than one-third of respondents noted having experienced T-shirts ($n = 72$) becoming too odorous to wear, followed by button-up shirts ($n = 44$) and sweaters ($n = 29$). Fewer respondents reported choosing to stop wearing athletic pants ($n = 19$) or jeans ($n = 11$) due to a persistent build-up of odour. The methods of disposal that respondents used on clothing without odour compared to odorous clothing are shown for the two clothing types that the highest proportion

of respondents indicated they have disposed of due to persistent odour. Figure 1 shows the results for T-shirts and Figure 2 shows the results for athletic shirts.

The most common method for disposing of non-odorous T-shirts and athletic shirts was donation. However, for athletic shirts, donating to charity did not differ significantly from being thrown in the trash ($t(158) = 1.63, NS$); whereas, donation and putting in the trash did differ for T-shirts ($t(142) = 6.74, p < 0.001$). The next most common method for disposing of a T-shirt was to downcycle the item into a rag. Selling or repurposing these items of clothing were the least common methods of disposal for the non-odorous clothing categories. When a T-shirt or athletic shirt had a persistent odour on it, the clothing was more likely to be thrown in the trash. This option differed significantly from the other methods of disposal.

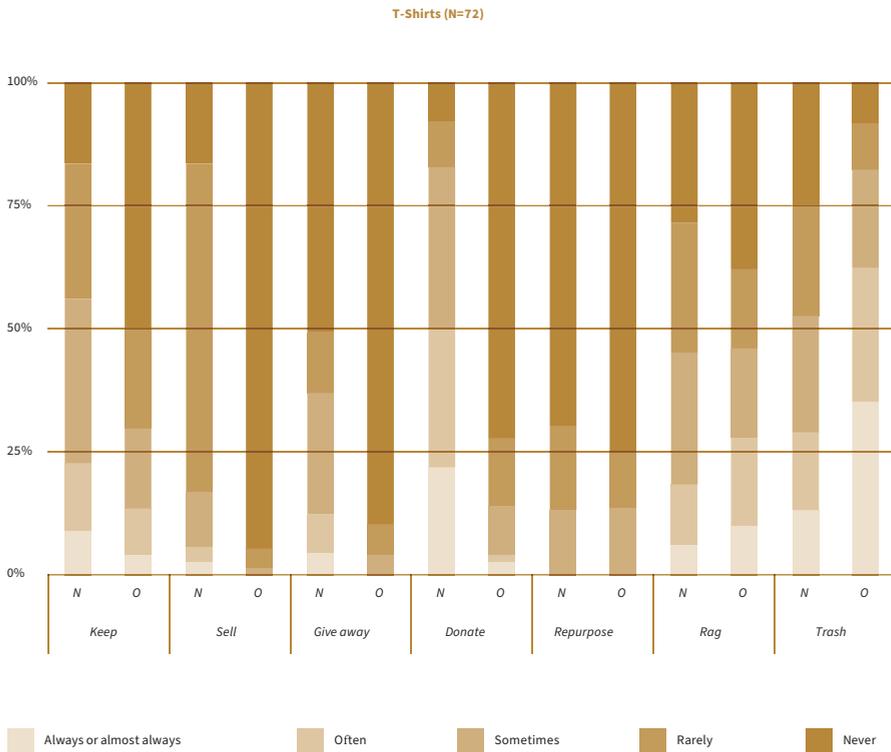


Figure 1. Frequency of disposal method for non-odorous (N) T-shirts and odorous (O) T-shirts. Source: Own illustration.

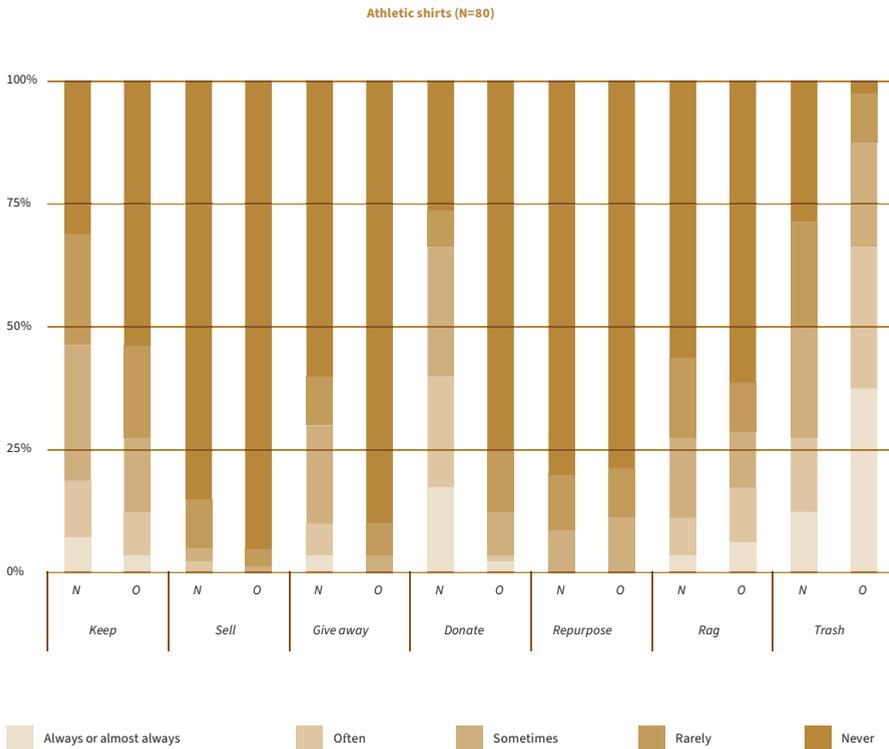


Figure 2. Frequency of disposal method for non-odorous (N) athletic shirts and odorous (O) athletic shirts. Source: Own illustration.

The method of disposal for non-odorous (N) clothing differed significantly from disposal methods for odorous (O) clothing for six of the seven disposal categories for T-shirts and five of the disposal categories for athletic shirts. Respondents were less likely to keep, sell, give away, donate or repurpose odorous T-shirts and were more likely to put odorous T-shirts directly in the trash. Respondents were just as likely to make an odorous clothing item into a rag as they were if it did not have any perceptible odour on it. Athletic shirts were unlikely to be repurposed even when odour was not present, which may explain why there was no change in this disposal method when odour was present.

Respondents also indicated that they were likely to have kept the item of clothing if it was still in good condition but had not become odorous (T-shirt: 4.28 ± 0.84 ; Athletic shirt: 4.24 ± 0.93), with the majority of respondents stating they would “often”

or “always or almost always” have kept their odorous clothing. All respondents were asked whether they had ever disposed of clothing. Of those who responded yes ($n = 220$), odour was one of the least common reasons for disposing of clothing, with clothing being worn out/having rips, never wearing it, no longer suiting their taste or no longer fitting being far more common methods for disposing of clothing (Table 2).

Table 2. Level of frequency for reasons why respondents dispose of clothing ($n = 220$).

Reason for Disposal	Mean ¹ (SE)
Worn out (holes, rips, etc.)	3.76 (0.25)
Never wear	3.55 (0.24)
No longer suits my tastes	3.33 (0.22)
Doesn't fit	3.31 (0.22)
Found a better substitute	2.94 (0.20)
Need the storage space	2.60 (0.17)
Clothing is odorous	2.07 (0.14)
Negative memory associations	1.72 (0.12)

¹ Scale: 1 = never; 2 = rarely; 3 = sometimes; 4 = often; 5 = always or almost always.

4. Discussion

Odours can arise from a multitude of different sources. The most common source of clothing-related odour was body odour associated with sweat and, more specifically, odour arising from the underarm region. Not all odours may be considered unpleasant; nevertheless, there was a consensus that most odours picked up during wear were unacceptable and may even have become a source of embarrassment, particularly if the wearer thought others might also smell them. This embarrassment, or self-consciousness of wearing clothing that has become smelly, aligns with the findings of Waitt (2014) where “the aroma of sweat often prompted strong visceral reactions of embarrassment and discomfort” (p. 476). Wearing clothes that do not smell, or smell of “fresh” laundry scents indicating cleanliness, is an important societal norm where cleanliness is tied closely to good moral conduct and hygiene (Shove 2003; Waskul and Vannini 2008). Conversely, wearing clothes that smell stale and of sweat indicate a person not looking after oneself, poor moral conduct and invites judgement from others (Low 2005).

Another goal of our study was to understand whether there may be common types of clothing that are problematic when it came to retaining odours, particularly those emanating from the body. Fibre type was suspected to play a major role, given the scientific literature showing that polyester tends to be more odorous following use than natural fibres such as cotton and wool (Callewaert et al. 2014; Klepp et al. 2016; McQueen et al. 2014, 2007). Our study confirmed that many consumers have identified the odour-extenuating properties of synthetic fibres. For some, this translated into actively seeking out clothing made of natural fibres and avoidance of synthetics when making decisions about what to buy or wear from within their wardrobes. This supports Stanes and Gibson (2017) who also found that some participants in their study would avoid polyester, as its connection with “sweat, odour and plastic have made the very idea of wearing polyester taboo” (p. 33). Persistent odour could make the idea of donating or giving away an odorous garment inappropriate. Furthermore, polyester garments are not well-suited to be turned into rags due to the lack of absorbency, nor do these garments biodegrade in the landfill (Fedorak 2005; Li et al. 2010). Therefore, polyester poses a problem at the disposal stage, and this problem is compounded when odour makes a garment unsuitable for garment extension options.

Heavier knits and clothing that “hugged” the underarms were other garment characteristics identified as prone to picking up and retaining odours. Although these characteristics were usually raised independently, there is likely to be an interaction between the two. That is, if a heavier-weight knit fabric does not come into contact with an odoriferous part of the body, then it is less likely to smell. This assumption appears to be supported by the survey findings where far fewer respondents reported having ever disposed of a sweater because it had become too odorous to wear compared with a T-shirt. The survey results did not elicit further details about the fibre content or the garment design, but it is likely that the additional layer of fabric often between a sweater and underarm, and/or a naturally looser fit of many sweaters, may have contributed to sweaters being less prone to absorbing sweat and odours. However, as one participant put it, tight-fitting cardigans that may be worn “really close to your skin” also posed a problem, reinforcing the importance of garment fit.

Recognition of certain clothing brands, styles, fabrics and fibre types may compel some consumers to shop in different stores or avoid certain brands altogether. The connection between odour and second-hand clothing was identified by some participants as a potential concern, consequently altering their behaviour and satisfaction with such second-hand purchases. We did not delve deeply into the smell

of second-hand clothing from the perspective of consumers who wore these clothes, only touching upon it briefly with the few participants who chose to describe their own second-hand clothing odour experiences. The potential problem of past odours released from second-hand clothing may be a barrier for second-hand shopping (Laitala and Klepp 2018) and is worth pursuing in future investigations as it relates to other life-extension strategies. For example, the issue of odour may arise as a reason to deter consumers from participating in collaborative consumption practices such as clothing libraries or leasing. In a clothing library, individual clothing items would be worn by multiple users throughout their lifetime (Zamani et al. 2017), and depending on the clothing design, fabric and fibre type, perceptible odour could indeed become a barrier.

Persistent odour within clothing creates negative associations with such items, and, therefore, negative use experience, rather than the pleasurable use experience described by Niinimäki and Armstrong (2013), which generates satisfaction with the garment and has the potential to extend its life. Sometimes, strong attachment can still be experienced with odorous clothing, as in the example of the participant from the third focus group who described her “camping dress”. The negative attribute of odour on the dress did result in her wearing it less often, but the strong emotional attachment to the dress generated through memories of enjoyable times she had spent wearing it meant she could not part with it. Here, her pleasurable use experience could override the negative use experience of unpleasant odour, although she would wear it less and under very particular circumstances. Yet, instead of extending the life of clothes, persistent odour more often results in behaviours that shorten the life of the clothing. The dissatisfaction and frustration consumers can feel with persistently odorous clothing results in these items being directly discarded in the trash, rather than being given away or sold. Embarrassment related to personal body odour, or other sources of odour that could result in judgement from others (e.g., musty clothing), likely prevents people giving odorous clothing to others they know; the smell also devalues the clothing item, making it unacceptable for sale.

Although not as common as trash disposal, donation was one potential life-extension strategy that some participants would still use, despite persistent odour. The anonymity of placing odorous items amongst other unwanted clothing pieces and dropping them off at a charity store, recycling bins or for doorstep collection makes donating odorous clothing an easy option. As well, donating reduced the guilt some people felt when disposing of odorous clothing that was otherwise in good condition. Participants believed it could be possible that someone else could want the item if the smell was only detectable by them, or, at least, they had passed on the

decision to another about whether to throw out the garment or potentially extend its life.

Despite donation still being a viable method of disposal of odorous clothing for some focus group participants, the survey data indicated a considerable shift from donation of T-shirts and athletic shirts compared with their non-odorous counterparts. Subsequently, throwing odorous shirts into the trash was far more likely to occur than for non-odorous clothing items. Poor physical condition or stains are common reasons for discarding clothing into the trash (Birtwistle and Moore 2007; Degenstein et al. 2020; Norum 2017). Intimate clothing items, such as underwear, or other types that may be considered 'dirty' were also more likely to be thrown into the trash (Birtwistle and Moore 2007; Norum 2017). The survey results indicated that non-odorous athletic shirts were less likely to be donated and more likely to be put in the trash than non-odorous T-shirts (that were more likely donated and less likely trashed). Many respondents may feel that even just the process of having sweated in the clothing made the clothing unacceptable to pass onto others. If the disgust and shame people have with respect to their own sweat (Waitt 2014) extends to the clothing that was worn during exercise, then even when there is no detectable odour people may still believe nobody else would want their old exercise clothing. Another reason that the trash could be a common destination for athletic clothing is that it may be so heavily used that it gets worn out and, therefore, relegated to the trash can. As previously mentioned, worn out or poor-quality clothing can cause consumers to opt for trash disposal, rather than donation (Bianchi and Birtwistle 2010; Fisher et al. 2008).

Some participants extended the life of their odorous garments using them for another purpose where odour may be less of a concern. Although at some point the clothing item may end up in the trash following its use in this other life, it may by this time have become so dirty, stained and/or worn out that it was not prematurely disposed of. Its use for another purpose where the activity itself could result in further odour developing and adhering to the garment may prevent another garment from becoming extensively odorous. However, this option can only work for clothing items that still fulfil a necessary purpose. For instance, a dress shirt would not be worn underneath coveralls worn on an oil-rig; a chiffon blouse would not be appropriate for yard work. Likewise, a second life for clothing, as cleaning cloths or rags, was an option for some participants only when the fabric type was suitable. Such downcycling of odorous clothing for rags may only briefly extend the life of clothing and, therefore, is more likely classified as a life-shortening option

(McNeill et al. 2020). Converting odorous clothing to rags suggests that premature disposal is occurring, particularly if the clothing is in otherwise good condition.

It is necessary to note that, in spite of the finding that odour can lead to premature disposal as well as potentially less sustainable methods for clothing disposition, persistent odour is not a major determining factor leading to clothing disposal. In fact, odour was one of the least common reasons cited for disposing of clothing. Hence, persistent odour within clothing does not have a major impact on consumers' overall sustainable behaviour when it comes to clothing disposition. Instead, reasons such as being "worn out", "no longer suits my tastes", or "doesn't fit" are far more common reasons for disposition. These latter reasons are consistent with those identified in other studies (Laitala 2014). Nonetheless, working on solutions toward odour control within clothing may benefit some consumers who find persistent odour does develop in garments. Life cycle assessments of the environmental benefit of odour-control technologies have been conducted based on the assumption that laundering will be reduced (Walser et al. 2011). Reduced laundering has the potential to also extend the useful life of clothing (McQueen et al. 2017). However, there is no evidence that consumers change their laundering habits due to the presence of odour-controlling agents (Hicks et al. 2015), or that these technologies effectively control odour compared with fabrics composed of natural fibres (Klepp et al. 2016). A better understanding of the inherent fibre, fabric and garment characteristics that enhance, or reduce, odour build-up within clothing will help inform consumers about clothing purchase decisions they may be able to make to reduce the likelihood of clothing-related odour.

5. Conclusions

This study explores the perspectives and behaviours of consumers in relation to their experiences with odour in clothing. We found that perceptible odour within clothing is commonly experienced by people during wear. Persistent odour, where the odour can no longer be washed out or returns rapidly during wear, is less common, but it is an unpleasant experience when it does occur. Although odour can arise from many different sources and be noticeable in different types of clothing, we found there were some common types reported. Odour development within clothing during wear, in particular persistent odour, created a negative association with the odorous clothing items. This negative use experience typically resulted in wearers wanting to dispose of the clothing item before they may have otherwise done so (premature disposal). Additionally, although there were varying methods chosen for disposal, designating the odorous clothing item to the trash was common;

thus impeding sustainability efforts. Although odour is not a common motivator for disposal, it can lead to dissatisfaction with a garment when detected, leading to less environmentally sustainable disposal practices and also premature disposal.

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