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Changing laundry habits in Norway

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Abstract

Maintenance is often the most energy-demanding stage during clothes' life cycle. Therefore, a shift towards more sustainable washing habits has great potential to reduce the consumption of energy, water and detergent. This paper discusses the change in laundering practices during the past 10 years in Norway and suggests strategies to help consumers change their laundry habits to more sustainable ones.

Quantitative information of consumers' experiences, habits and opinions concerning clothing maintenance was collected through three surveys in Norway in 2002, 2010 and 2011. The 2010 study was supplemented with qualitative in-depth interviews of a strategic sample of households.

The average washing temperature has decreased slightly during the studied time periods. Some products' washing frequencies remained the same, whereas other products such as jeans were used a few more days before washing. The cotton programme is the most used washing programme, but short programmes are gaining popularity. The laundry sorting processes vary greatly and are influenced by several factors such as washing temperature, colours, fibre type and use area. For some consumers, the use of several different sorting categories made it more difficult to collect a sufficient amount of clothing to fill the machine. They were also afraid that overfilling the machine would result in clothes that were not clean enough or had detergent residues. Detergent dosing practices are far from optimal. In 2010, although the majority of respondents only used eye measure and did not know the water hardness of their area, they still tried to vary detergent dosage based on the amount of laundry and the level of soiling. Different design for sustainable behaviour strategies could be used within detergent dosage systems, care labelling, machine programme selection (such as suggesting lower temperature and eco-programme), machine filling grade indicators, storage systems for slightly used clothing and textile material choice.

Introduction

The most energy-demanding time during the life cycle of clothing is often the use period (Madsen *et al*., 2007). Technological improvements in washing machines and detergents have reduced the total environmental impact per wash, but the total time that consumers spend on laundering has not been reduced (Klepp, 2003). Increased washing frequencies and the amount of clothing we own in Western societies potentially offsets the technological improvements.

Even though clothing maintenance has a substantial environmental impact, consumers connect environmental issues related to clothing mainly to the end of the use period when clothes are either given or thrown away (Laitala and Klepp, 2011). Less consideration is given to clothing maintenance and purchase stages. Research suggests several measures that consumers can take to decrease the environmental burden caused by textile maintenance (Uitdenbogerd, 2007; Bain *et al*., 2009; Laitala *et al*., 2011). They can lower washing temperatures, use eco-programmes, fill the machine to capacity, decrease washing frequency and assure correct detergent dosing. They can also avoid tumble-drying and ironing, and practice alternative freshening methods such as airing. How to best realize this desired behaviour is, however, not straightforward but may be informed by recent research into design for sustainable behaviour. Some design solutions may involve simply providing information or putting the user in control, while other design directions may focus on making undesirable behaviour impossible (Zachrisson and Boks, 2010). In-between solutions may persuade or seduce users towards sustainable behaviour, like the use of eco-buttons or detergent tablets that should secure optimal dosage in wash (Lilley *et al*., 2005). Lockton *et al*. (2010) collected a wide range of mechanisms that

can be used to realize design for sustainable behaviour, including choice editing, warnings, portion control, feedback, rewards, colour associations, positioning and even threatening. Pettersen and Boks (2008) discussed how to balance between the control applied in leading the users towards a more sustainable behaviour with the users' rights and free will. They suggested that designers should apply a reflective approach towards the ethical consequences.

Further information regarding consumer clothing maintenance habits and the reasons for their choices is required in order to study the possibilities for influencing consumer behaviour towards more sustainable practices. Laundering practices are constantly changing, influenced by social, cultural and moral norms (Shove, 2003). They must, therefore, be understood over time and across cultures. Before the industrial revolution, labour intensive practices such as washing textiles outside or boiling them on a stove were common. Such labour intensive practices are disappearing as a result of new technology such as the advent of the electric washing machine. Efficiency in spreading information from professionals has also been a factor; washing temperatures have dropped considerably since World War II, first from boiling down to 60°C in the 1980s (Klepp, 2003). At this stage, the change was increasingly led by new washing technologies; materials in garments that did not tolerate being washed at high temperatures; and the consumers themselves reducing the washing temperature to 40°C and lower, despite the experts' advice to continue washing at 60°C (Klepp, 2007). In recent years, experts' advice has varied depending on whether they have a hygienic or environmental argument as a basis. However, most experts agree that low washing temperatures can be used in home laundering, except in cases of epidemics or especially vulnerable user groups.

Throughout history, the level of washing and acceptance of body odours has varied greatly. Today, body odours are considered appalling, and daily washes and use of artificial perfumes is almost a norm (Ashenburg, 2007). These changes in social norms have led to increased washing frequency of our bodies and clothing (Shove, 2003).

These examples show that habits have changed relatively fast through different mechanisms and have been affected by new technologies, available information, as well as changes in society and its norms. Steering these processes of change will require a consideration of integrated socio-technical systems and will therefore be complicated. A number of studies have shown that changes in attitudes and values may have limited effect on everyday behaviour (Ajzen and Fishbein, 1980) and that there are several barriers for change (Throne-Holst *et al*., 2008). The importance of cleanliness in the Western cultures is an example of a cultural-normative barrier where individuals' fear of having a body odour that might be caused by unsatisfactory laundering may inhibit the change to lower washing temperatures. Other barriers may be individual-psychological and were based on earlier experiences or upbringing.

Understanding these and other barriers is essential for successfully choosing and applying design for sustainable behaviour strategies. Therefore, this paper aimed to provide quantitative data to illustrate changing laundering practices over time in Norway, allowing a more informed discussion on incentives and obstacles that may exist for consumers to change their laundry habits to more sustainable ones. Finally, we suggest possible strategies for overcoming these obstacles to steer behaviour in an environmentally friendly direction.

Methods

Quantitative information of consumers' experiences, habits and opinions concerning clothing maintenance was collected through three surveys in Norway. Special attention was given to washing frequency and temperature, programme selection, sorting process, and the detergents and other laundry aids used. In order to get more information on the reasons behind laundry practices, additional qualitative information was gathered through one set of in-depth interviews.

The first quantitative survey was conducted in 2002 by telephone, interviewing 1008 randomly selected Norwegian respondents[1] (Arild *et al*., 2003). The main topic was laundering habits and, therefore, the research questions were asked of the household member that was mainly in charge of the laundry. The gender distribution of respondents in this survey shows that main responsibility of doing laundry was primarily women's area (Table 1). These cases are not weighed to population.

The second survey was conducted in 2010 in order to collect quantitative information of consumers' experiences and opinions concerning clothing use, maintenance routines (washing, drying and ironing), disposal habits and environmental attitudes in Norway. Respondents were recruited through different channels. The majority of respondents were received through questionnaires sent by mail to 1200 randomly selected households. Due to low response rate, additional respondents were recruited through personal and work-related networks, and publicity in media[2]. A web questionnaire was available on the net from July 2009 to March 2011. A total of 546 answers were received (Table 1). A few of the questions were replaced during the survey period, so the total number of respondents varies some. The distribution of respondents is uneven with evident female domination (77%). The age group 25–39 is overrepresented in comparison to the average of the adult population, and the age groups below 24 years and above 60 are underrepresented. The received data are not representative for the whole population, which has been taken into account when conclusions are drawn. These cases are not weighed.

The third and most recent study is called SIFO survey, which is a country representative survey conducted yearly in Norway. This survey covers a variety of general consumption-related themes, where textiles and clothing constituted only a minor part. A total of 1124 people completed the web questionnaire in March 2011. These cases are weighed to present the Norwegian population. These respondents are selected from a pre-recruited, randomly selected sample of persons above 15 years of age, who are willing to participate in surveys.

The received data from all three surveys were analysed with the help of SPSS software (SPSS Inc., Chicago, IL, USA). The descriptive statistics from the different surveys are compared when the question setting has been similar enough to allow it. Even though

[1]The same study included three other European countries, but this paper concentrates on the Norwegian results.

[2]Web address to questionnaire was given in three magazine articles where SIFO researchers were interviewed about clothing consumption-related themes.

Table 1 Respondents divided by background variables and compared with Norwegian population (15 years and older) (Agerskov, 2010)

Background variables	Sample 2002	Sample 2010	Sample 2011	Norwegian population 2010
Number of respondents (*n*)	1008	546	1124	–
Gender				
Male	18%	23%	50%	50%
Female	82%	77%	50%	50%
Average age	47.7	39.2	45.2	45.9[d]
Age groups				
Below 24 years	5%[a]	9%[b]	10%[c]	16%[d]
25–39 years	30%	48%	29%	25%
40–59 years	42%	33%	38%	33%
60+ years	23%	9%	23%	26%

[a]All respondents were 14 or older.
[b]All respondents were 15 or older.
[c]All respondents were 18 or older.
[d]Figure applies for population above the age of 15.

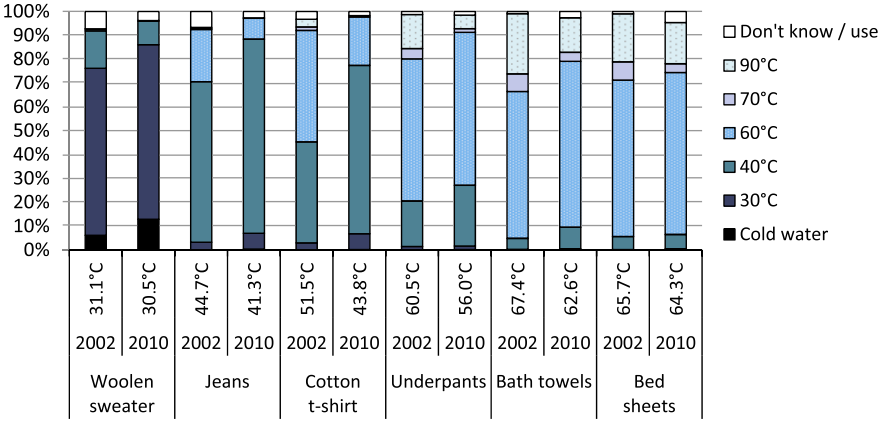

Figure 1 Distribution of washing temperatures for different textile products in 2002 and 2010. Average temperature given below the pillars (2002: $n = 1008$, 2010: $n = 546$).

the two first surveys are not country representative, they have several similarities such as the high percentage of female respondents. This enables the comparisons of washing habits over time.

The 2010 study included a strategic sample of 16 households selected for qualitative in-depth interviews in order to collect more detailed information on reasons behind households' clothing practices. People with different life situations and backgrounds from different areas in Norway were interviewed with a semi-structured interview guide. These results can be used in helping to interpret the quantitative data from the surveys. The interviews were recorded, transcribed, coded and analysed with ATLAS.ti software (ATLAS.ti GmbH, Berlin, Germany). Citations from these interviews are given with informant's age and a fictional name. To separate quantitative and qualitative results, survey participants are referred to as 'respondents', whereas interview participants are referred to as 'informants'.

As the laundry habits are varying between different cultures, these results are compared with similar studies from other countries in the Discussion section.

Results

Textile maintenance includes many different areas such washing, drying, ironing, storage and mending. In this paper, only the areas relating to washing are discussed.

Washing temperature and programme selection

We collected information of temperatures that are used for washing specific products from surveys conducted in 2002 and 2010. The percentage of washes in different temperatures as well as the average value are given in Fig. 1. The average washing temperature of woollen garments was significantly lower than for similar products in cotton in both surveys ($P < 0.01$). Most of woollen textiles are washed at 30°C. Products worn next to the skin are more often washed at higher temperatures than the outer garment layers (e.g. sweaters.)

A slight reduction can be seen in many products' average washing temperature[3]. For the six product groups given in Fig. 1, the average reduction is 3.7°C. The largest change can be seen in cotton t-shirts, which the majority of respondents today washed at 40°C instead of 60°C, causing the average temperature reduction to be 7.7°C. In Fig. 2 we have compared the results for different age groups of respondents, as the age distribution in these two surveys varied. It shows a reduction in average washing temperatures within each age group, and that younger respondents had lower average temperatures.

[3]For calculating the average washing temperature, unheated 'cold water' was calculated as 16°C.

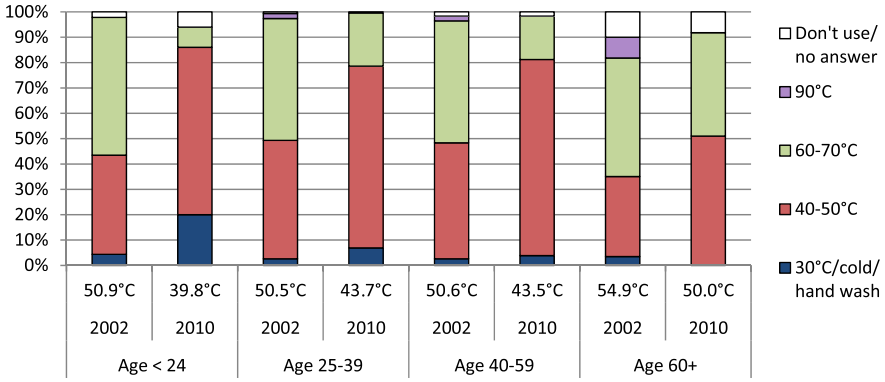

Figure 2 Comparison of t-shirt washing temperatures divided by age groups (2002: $n = 1008$, 2010: $n = 546$).

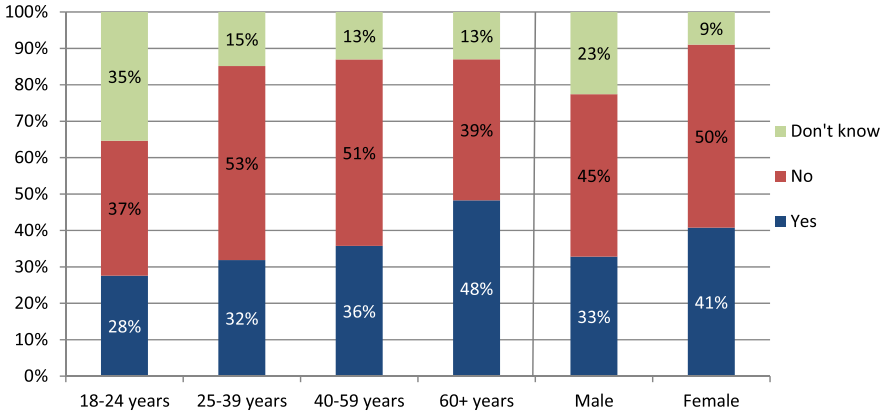

Figure 3 Reduction of washing temperature the past 5 years (2011: $n = 1122$).

One of the questions of 2011 survey was whether the respondents washed clothes today at a lower temperature than five years ago (Fig. 3). The majority (47%) said they had not reduced the temperature, 37% said they had and 16% did not know. A comparison of age groups showed that the elder respondents were more likely to have reduced the temperature, although they would still wash at a higher average temperature than the younger respondents. In the interviews, Olivia (67) described reasons for her washing temperature reduction: '*I do not think I've used 95 for very long time. I did before on towels, but not anymore. [. . .] Detergents are more efficient, so 60 is actually enough. We do not have that dirty things. And I use a bit of stain remover if needed.*'

The respondents estimated the use frequency of different washing temperatures and programmes in 2010. The most commonly used washing programme was the cotton wash cycle at 40°C. This temperature was followed by 60, 30 and 90°C wash (Fig. 4). The average washing temperature was 48.4°C. The use of short programmes was second most popular and more common than eco-programmes. Wool programme use frequency may have been harder to estimate, as there is great variation between the seasons when it comes to use of wool. Survey respondents were not asked how many times they washed per week in total, but how often they washed at different temperatures or with different washing programmes. Based on these answers, an average number of washing cycles per week was calculated for different household sizes (Fig. 5)[4]. One has to take into consideration that this way of evaluation may not be that accurate as the average is based on several estimations of laundering frequencies instead of only one estimate, which may have been easier for the respondents to answer. This question was posed to the interviewed households, and these informants reported a lower number of washing cycles per week, on average, 1–3 cycles less for each household size.

Washing frequency, sorting process and filling grade

The number of days different textiles were used between the refurbishing cycles varied greatly (Fig. 6). Almost all would use underpants only 1 day, whereas woollen sweaters could easily be used over 10 days. In general, men and the older respondents were more likely to use the products a little longer between washes.

The results show that consumers use woollen products longer between washes than similar products in cotton. Barbara, 25 years old, described her washing habits of woollens compared with other textiles: '*I wash wool very seldom. Wool is almost self-cleaning. So wool is a bit . . . wool wash is even less frequent.*' The

[4]The results for households above six persons are uncertain due to low number of respondents.

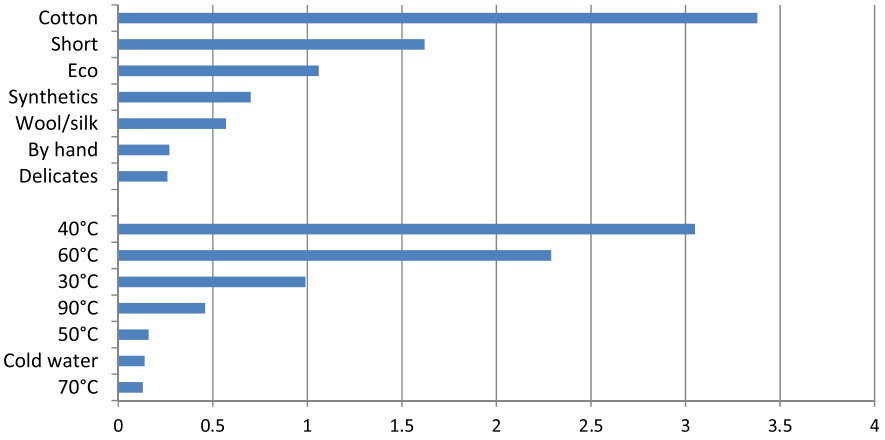

Figure 4 Number of washing cycles with different programmes and temperatures per week per household (average household size 3.1 persons) (2010: $n = 257$).

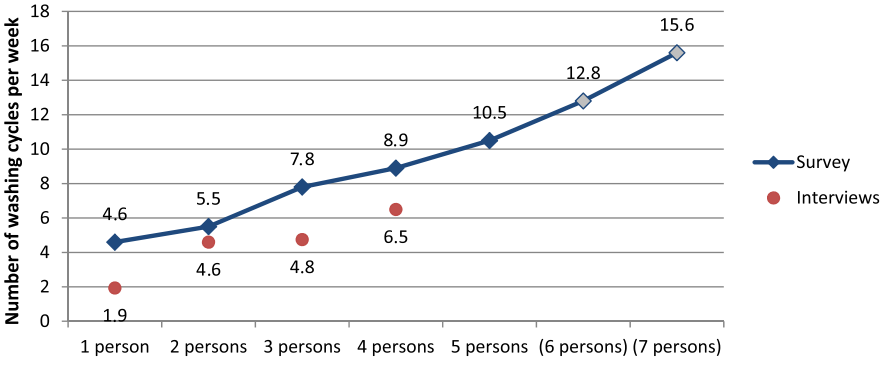

Figure 5 Average number of washing cycles per week for different household sizes (survey 2010: $n = 257$, interviews 2010 $n = 16$).

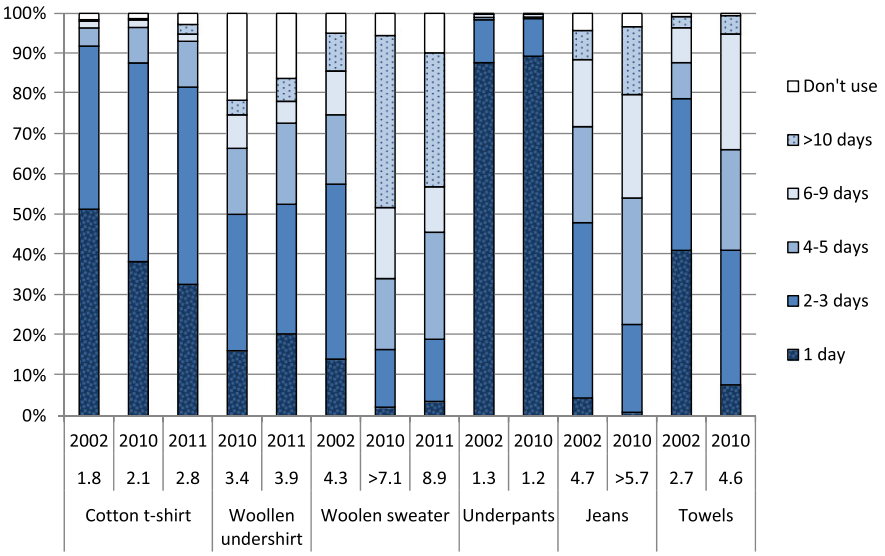

Figure 6 Number of days different textiles are used before wash (2002: $n = 1008$, 2010: $n = 546$, 2011: $n = 1094$).

2011 survey results showed that 72% of the respondents prefer to wash wool in the machine, as opposed to 17% that preferred washing it by hand.

The storage of clothes that were used, but not too dirty to be used again, was described by many informants as piles of clothing on a chair or bedside or even on the floor. Jenny, a 39-year-old mother of three small children, described the problems of having large amounts of clothing within this category: '*We've tried to make a system in the bathroom, where we hang up clothes that are used, so that we get to use them again . . . When they are not*

Figure 7 Used laundry sorting methods (multiple answers possible) (2010: $n = 545$).

spotty, you can use them the next day, especially the kids . . . Otherwise it becomes just a big chaotic pile, and eventually they end up in the laundry bin, right. So I try to think that they have to use the laundry until it's dirty at least. [. . .] But it is clear that there is a lot . . . when we clean up, then it's a lot that goes in the laundry bin.' She tried to ensure clothes were used longer between washes, but eventually they still got washed before they were too dirty to be used. Some other informants even washed without evaluation of soiling degree, habitually after 1 day of use.

The laundry sorting processes vary greatly, influenced by several factors such as washing temperature, colour, fibre type, use area and care labelling (Fig. 7). Only 3% of respondents wash everything together. Younger respondents are more likely to sort colours into only two categories (light and dark). Washing temperature as basis for sorting is more common among the female respondents, as well as the higher age groups. Woollen products are often washed separately from other fibre types, and 73% of survey respondents state that they do not wash wool together with other textile materials. For some consumers, the use of several different sorting categories made it more difficult to collect sufficient amount of clothing to fill the machine. One example of this is described by Camilla, 29: '*Wool wash . . . It's something I typically postpone a very long time, because I think it's a bit . . . I may have one woollen shirt for example, that I should wash, but I have no other wool clothes that I should wash with it, and so it will only wait very, very long time, until eventually I have to wash it.*'

The question of filling grade was not included in the surveys, but the interviews showed similar tendencies among many informants. They said they mainly washed 'full machines, but not too full'. They did not want to overfill the machine in fear of not getting a good cleaning result or having detergent residue on the garments.

Detergents, laundry aids and dosing

About one-half of the respondents in 2002 said that they used a measuring cup for detergent dosing, and one-third never used it. The use of measuring cup seems to have receded in recent years, as in 2010, the majority (58%) based their dosage only on eye measure. Only 12% accurately followed the instructions given on detergent packages and used a measuring cup. However, as the questions were stated differently, the results give an indication but cannot be compared directly.

The majority of respondents in 2010 varied their detergent dosage based on the amount of laundry and level of soiling. They were more likely to use less detergent if the laundry was not that dirty or there was not so much of it than to increase the amount in opposite cases. Very few took into account the water hardness, size of washing machine or the water level of the washing programme. Sixty-three percent of the respondents did not know or even try to guess the water hardness of their living area. These results indicate that detergent dosing is not optimal. However, only 4% always used the same amount, indicating that the consumers try to vary the dosage to fit the need. Some of the informants used the washing machine to get variation to achieve required cleaning level instead of varying detergent amount. Markus (42) explained: '*We have a quite new, modern washing machine. We can set it for dirty laundry, less dirty and . . . You can control the wash from two hours to one hour, four different lengths. So we use that quite a lot*'.

The majority of respondents in the 2002 and 2010 surveys used fabric softeners often (Fig. 8). The interviews revealed that they could be used for many different purposes: desired scent, softness, improved antistatic properties and easier ironing. The use was also related to tumble-drying. Many informants said that they needed it if they did not use a tumble dryer. The use of stain removers was a lot less common. The number of respondents that used softeners and stain removers seems to have increased during this period, but the slight difference in question setting does not allow certain interpretation. Today, the most common method for treating stains with stain remover seems to be to apply it directly to the stain as a pre-treatment to washing.

Cleaning effect and hygiene

We were also interested in respondents' opinions related to washing results, as these experiences have a potential to affect future washing behaviour. Most common problems associated with laundry that a majority of respondents had experienced were textiles loosing colour, not getting clean results and textiles loosing shape (Fig. 9). Eighty-five percent of respondents have seldom or never experienced the washing machine smelling bad. This is a problem connected to insufficient microbial reduction often associated with constant use of low washing temperatures (Amberg *et al*., 2009). Another way to notice this can be clothes receiving an unpleasant odour in the wash, but this was not common among the respondents either. As a minimum, one wash at 60°C once a month is recommended to avoid the problems connected to biofilm formation, as well as letting the machine dry with door open between the washes (Bain *et al*., 2009). During the 2002 survey, 9 out of 10 respondents agreed to statements that it is

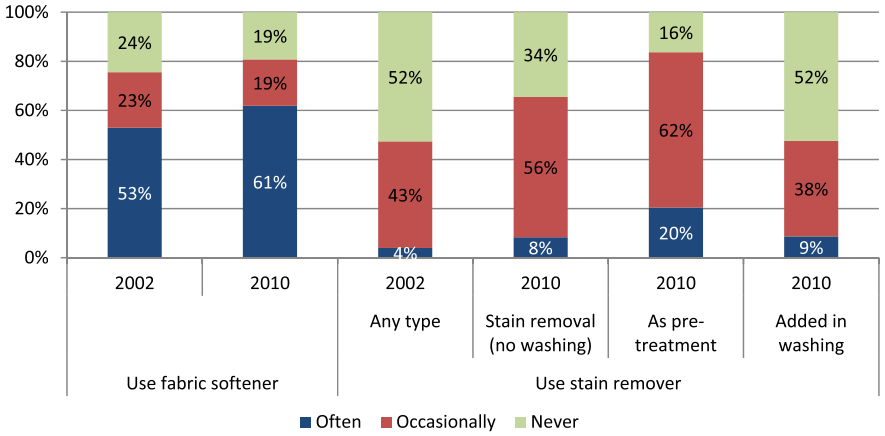

Figure 8 Use of fabric softeners and stain removers (2002: $n = 1008$, 2010: $n = 268$).

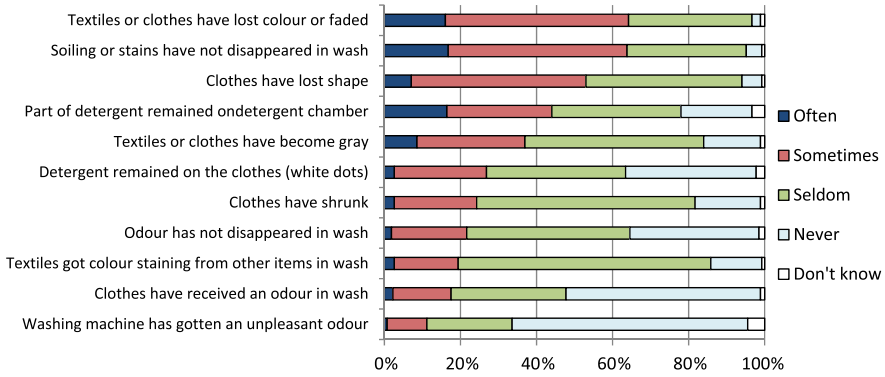

Figure 9 Experiences of problems related to clothes washing (2010: $n = 268$).

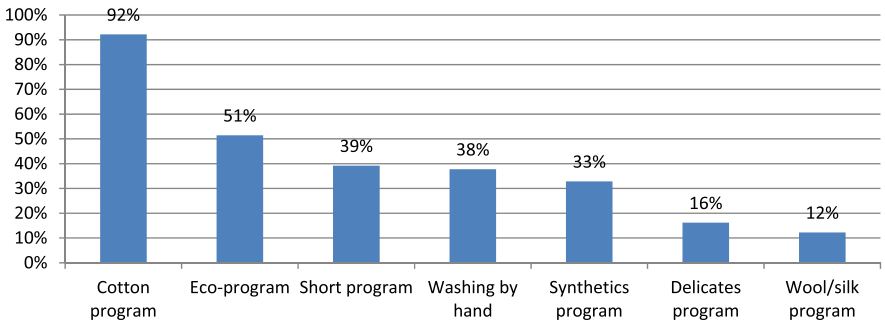

Figure 10 Percentage of respondents that trust a specified programme to clean a jam-stained shirt almost or completely clean (2010: $n = 204$).

embarrassing to wear clothes smelling of body odour, and that it is important that clothes are hygienically clean.

Respondents' opinions on the cleaning effect of different washing programmes are presented in Fig. 10. They were asked to estimate how well a specified washing programme would clean a jam-stained shirt. The cotton programme's cleaning effect was trusted the most. This was followed by the eco-programme, but at a much lower level. The wool and silk programme was considered to be the mildest with the lowest washing effect.

Discussion

When comparing these results to studies made in other countries, we can see clear cultural differences between Norway and other European countries. In 2002, laundry habits in Norway, Greece, Netherlands and Spain were compared (Arild *et al.*, 2003). The main differences found were washing temperatures and frequencies. For example, in Spain the majority of respondents washed cotton t-shirts in cold water, in Greece and Netherlands at 40°C and in Norway at 60°C. Our study from 2010 indicates that Norwegians are lowering the washing temperatures as well to 40°C, but are still not usually using 30°C or cold water for washing such products. This shows that the direction is good from the environmental perspective, but there is still potential for improvement in this area. Studies of average washing temperature in Europe have shown that it lies now usually between 40 and 55°C, depending on the region (A.I.S.E., 2009; IKW, 2009; Stamminger, 2009). The exception is Spain, where use of cold water for washing is more common.

Many washing machines have automatic temperature selections, or at least suggest a specified temperature for some programmes. This was frustrating for Barbara (25) '*Our new washing machine uses 40 as a default. But if I had chosen myself, I had probably chosen more often 30, because for me there is no difference between washing at 30 and 40*.' This is supported by a recent study on cleaning effects, which showed that the difference in cleaning performance between 30 and 40°C was not large, and that one can get a cleaner washing result at 30°C than at 40°C if a more efficient detergent is used (Laitala and Jensen, 2010).

The cotton programme dominated as the most used washing programme. It was followed by the short programmes, which were more common than the eco-programmes despite the fact that the trust in the eco-programmes' cleaning effect was higher than that of short programmes. This may be a reaction to the increased washing duration of the basic cotton program, which is a result of energy labelling requirements. According to Sinner's washing circle (Sinner, 1960), having the same washing performance with reduced water and energy consumption (and thereby reduced mechanical agitation) requires an increase in washing duration, unless more efficient detergents are used. The typical duration of a normal cotton programme in Norway is over 2 h. Eco-programmes are often even longer, on average, 26 min more and can last up to 4 h (Laitala and Vereide, 2010). Rapid programmes take usually 15–35 min but have reduced machine filling grade, something that consumers may be unaware of. One of the informants, Camilla (29), described that she felt that the normal cotton programme took a very long time: '*It may often be okay to just wash a little shorter. Because it's very seldom there are a lot of stains*'. She assumed that shorter washing time reduced the energy use and was sufficient for a laundry that was not very soiled. Another reason for the lower use rate of eco-programmes may be the lower trust in their cleaning effect compared with that of the cotton programme, despite the fact that high washing performance is required for energy labelling in the European Union (European Commission, 2010; EN 60456, 2011).

These results indicate that there is great potential in lowering the electricity consumption through design of washing machines. The customary suggested washing temperature could be lowered and the eco-programme could be a suggested programme that one could turn off if wished instead of having to actively select it. In addition, a machine filling grade indicator could guide the consumer to use the full capacity of the different washing programmes.

The calculated washing frequency for a family of four persons in the 2010 study was 6.5–8.9 washing cycles per week. This result is not far from a Norwegian study done in 2000, where households kept washing diaries. In this study, the average number of washes was 8 cycles per week for a household of that size. These same informants were interviewed before the diary-keeping, and all of them estimated their washing frequency to be lower than it was in reality (Klepp, 2003). Thus, studies based on washing narratives may give inaccurate estimations, and diary-keeping is a more appropriate method for getting a realistic picture. Several other studies have reported estimates for washing frequency. A worldwide comparison of laundry habits with varying sources estimated that the average number of washing cycles in West Europe was 3.2 per household. The estimates varied from 1.9 in China to 10.4 in Japan (Pakula and Stamminger, 2010). An internet survey in 10 European countries reported the average number of washing cycles per week per household to be 4.9 with variation from 4.1 to 6.0 between countries (Stamminger, 2009). Another internet survey of 23 European countries showed variations from 3.0 to 4.2 washing cycles/week, depending on the region (A.I.S.E., 2009). The household size affects the washing frequency. This was taken into account in a Finnish study, which estimated that single households washed 1.6 times a week, couples 3.3 and families with children 6.2 times a week (Aalto, 2003), which is slightly less than the results from our Norwegian survey from 2010.

Methodically, we see a challenge in getting correct data on washing behaviour through interviews and surveys. To obtain correct statistical information of everyday practices, one may have to follow the informants more closely. For example, it is difficult to estimate whether one is washing a full machine load, if one has never weighed the laundry. This has been taken in account in a recent German study, where informants were given scales for measuring the amount of detergent as well as laundry (Kruschwitz and Stamminger, 2011).

The changes in washing frequency over time between different clothing items varied. Some items, such as underpants, are mainly washed after one day's use. This was also valid for four European countries included in the 2002 study (Arild *et al*., 2003). In Norway, some products were reported to be used longer between washes now than before, such as towels and jeans. In jeans, we have seen a new trend to wash them more seldom, especially dark 'raw' denim materials, in order to keep the fit and colours unchanged (Tan, 2010; Hicks, 2011). Evaluation techniques of soiling or freshness of clothing varied. In a British study, it was documented how different senses, such as smell, touch and vision, can be used to evaluate the laundry experiences (Pink, 2005). Some of the washing could potentially be replaced by other cleaning methods such as stain removal, airing, using steam or brushing.

In addition to washing machine development, design of sustainable behaviour strategies can be used also in clothes design. One designer currently working with this theme is Emma Dulcie Rigby (Hanlon, 2010; Rigby, 2011). She has designed a clothing line based on interviews on which types of clothing items are seldom washed. Different themes in clothing were identified to affect the washing behaviour, such as material choice (wool), use area (home wear) and fit (loose).

Our results revealed that detergent dosing behaviour was far from optimal. This result is similar to a German study, which showed that consumers often gave no regard to soil level, detergent type, water hardness or machine capacity (Kruschwitz and Stamminger, 2011). To overcome this problem, washing machine producers have developed automatic detergent dosage systems (Sanner, 2011; Witte, 2011). However, these machines require that the user sets the correct information on the machine about water quality, soil level, etc. Even though most consumers do not know the water hardness level of their living area, this system may make them attentive to it as they will have to select a setting. This system does not address the problem of unnecessary and frequent washing of some items. In these cases, a better system for intermediate storage could be helpful.

The use of fabric softeners seems to be increasing in Norway. A comparison with Germany shows that they are used more often in

Norway than in Germany, where 35% never used them (Braun and Stamminger, 2011). Most of the informants were not that reflected over the use of fabric softeners and their potentially harmful chemical content. Steinemann (2009) revealed that many fragranced laundry products had volatile organic compounds that were not listed on product label, but were regulated as toxic or hazardous.

No major cleaning result problems were registered, although over every third had sometimes experienced detergent remaining in the washing chamber. Problems related to clothes getting ruined in the wash were mainly caused by mistakes in the sorting process, such as washing wool with the normal programme or washing a coloured item with whites. Smaller changes in textiles were common, such as dye fading and changes in shape. These problems are related to clothing quality in addition to the washing method.

Conclusions

We have witnessed a reduction in the average washing temperature to below 50°C in Europe. From an environmental perspective, a continuation of this tendency is desirable provided that the increase in washing frequency is discontinued or even reversed. Even though perceptions of cleanliness are not always directly connected to the level of soiling on textiles, cleanliness is considered important. It may be one of the barriers for more sustainable behaviour, such as further lowering the washing temperature. As the washing habits change and vary between the different cultures, the solutions should be adjusted to the local conditions. Using such insights, appropriate design for sustainable behaviour strategies can be determined depending on goal and context. Many relatively obvious strategies are based on information provision, feedback and enabling users to do the right thing. These include:

- improved detergent dosage systems in detergent packages and washing machines;
- textile care labelling that encourages low temperature washing at lower frequency (but does not prohibit efficient washing when it is needed);
- machine programme selection (such as suggesting lower temperature and eco-programme);
- machine filling grade indicator;
- improved storage systems for used clothing that does not yet need to be washed;
- using materials that can be washed more seldom and at lower temperature, such as wool.

The data from this study may also inform design strategies that are less based on pure information provision or feedback. Instead, they tap into ways to persuade or even steer users into sustainable laundering practices. Future research by the authors will address the generation and evaluation of the full spectrum of design strategies related to clothing, equipment and system design.

Even though the results apply for Norway only, we can see some potential for transferring the knowledge to additional geographic and cultural contexts. Emerging economies such as China, India and Brazil have increasing populations and a growing middle class. Will they follow our trends with frequent washing? This will have great consequences for the water and energy use in these countries.

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