

Short communication

Influence of the container on the consumption of cosmetic products



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ABSTRACT

The container, also known as primary package or inner package, could be defined as the packaging designed to come into direct contact with the cosmetic product. To author's knowledge, no study was available regarding the effect of the primary package on the consumption of cosmetic products. The aim of the study was to assess the impact of the container on the consumption of three cosmetic products widely used, i.e. shampoo, shower gel and emollient cream. The three products were contained in a tube with a flip top cap and in a bottle with a pump. The study was conducted on 221 French adults: 108 women and 113 men. Results showed that the consumption of each cosmetic product was slightly higher when the product was packaged in tube with a flip top cap than in bottle with a pump. The difference of consumption could vary from 5 % to 23 % when calculated with mean values. This information could be interesting for safety evaluators, safety agencies and commercial services of cosmetic manufacturers.

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1. Introduction

Cosmetic products found on the European market have to be safe for consumer health when applied under normal or reasonably foreseeable conditions of use (EU, 2009). In order to perform a safety evaluation, consumption data are required to assess the exposure to the finished product and to his ingredients (EU, 2009). Consumption data are available in literature. These values were obtained in different population (European, American, French, Dutch ...) and for many types of cosmetic products such as shampoo, shower gel, toothpaste, deodorant, sunscreen cream, shaving gel or baby wipes products (Biesterbos et al., 2013; Ficheux et al., 2014, 2016; Garcia-Hidalgo et al., 2017; Gomez-Berrada et al., 2013, 2017a, 2017b and 2017c; Hall et al., 2007, 2011; Loretz et al., 2005, 2006, 2008; Manova et al., 2013; Wu et al., 2010).

Consumption values obtained in a same study could differ between cosmetic products of the same line. For example, the consumption of deodorant cream was 10 times higher than consumption of deodorant stick in Dutch adults (i.e. 1.0 g/use and 0.1 g/use, mean values) (Biesterbos et al., 2013). Among hair styling

products, the amount of foam used by French adult women was 10 times higher than the amount of wax used (i.e. 7.7 g/use and 0.7 g/use, mean values) (Ficheux et al., 2016). Similarly, a difference of consumption between body cream, body milk and body balm was shown on adult women (i.e. 6.6 g/use, 12.0 g/use and 12.7 g/use, mean values) (Gomez-Berrada et al., 2017a). These differences would be related to the different galenic form of the products. Furthermore, other parameters such as the type of container or the type of delivery orifice may have an effect on these differences of consumption. The container, also known as primary package or inner package, is the packaging designed to come into direct contact with the cosmetic product (Colipa, 2011). Many of these are available on the market. Cosmetic containers may be of different form (bottle, tube, jars ...), of different materials (plastic, glass, metal ...) and of different closure and distribution systems including pump, cap or sprayer.

To author's knowledge, no study was available regarding the effect of the container on the consumption of cosmetic products. This parameter should be assessed, as a difference of consumption could have an influence on exposure value and as a consequence on Margin of Safety calculation (MoS). The MoS represented the ratio between a No Observable Adverse Effect Level (NOAEL) and an exposure value (SCCS, 2016).

So, the aim of the study was to assess the effect of the container

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on the consumption of a shampoo, a shower gel and an emollient cream on adult men and women. Two containers were taken into account. Each product was packaged in a tube with a flip top cap and in a bottle with a pump.

2. Materials and methods

2.1. Tested products

Three highly consumed cosmetic products were studied: shampoo, shower gel and emollient cream. The shampoo and the shower gel were rinse-off products; the emollient cream was a leave-on product. The shampoo was applied on hair. The shower gel and the emollient cream were used on body. The three products were contained in a tube with a flip top cap and in a bottle with a pump. The packaging was similar for the three products in tube and for the three products in bottle. Each container had a capacity of 200 ml and a neutral appearance (Fig. 1). For each cosmetic product, the formulation was the same in the two containers.

2.2. Study design

This study was carried out in 2014 in the Northwest of France in the city of Rennes and surrounding area. Participants were healthy adult men and women who regularly used shampoo, shower gel and cream at home.

All volunteers signed a study information form and a volunteer consent form. Cosmetic products were provided to participants who were invited to use them at home in the closest possible way to their personal usage patterns.

The three products were split into two groups according to the packaging: tube with a flip top cap (group A) and bottle with a pump (group B). Each group of products was tested separately over a 2-week period. Half of the population used group A products over the first period and the group B products over the second period and inversely for the other half of the population.

2.3. Data collection

During the study, volunteers were asked to record in a diary the daily usage of each product over the two 2-week periods. At the end of each 2-week period, the participants returned the completed diaries and the tested products. The diaries were reviewed and checked to ensure they were correctly and completely filled out. All the cosmetic products were weighed with a precision balance with sensitivity equal to 10 mg at the beginning and at the end of the study to determine the individual total amount of product used.

2.4. Consumption data analysis

Amount per use: The amount of product per use was calculated by dividing the total amount of product consumed during the study by the corresponding number of use (g/use).

Amount per day: The amount of cosmetic product used per day was calculated by dividing the total amount of product used during the study by the corresponding number of days of the study (g/day).

Data were presented for adults regardless of sex, for adult men and for adult women.

2.5. Statistical analysis

Statistical analyses were performed on amount per use and on amount per day data. Only p-values less than 0.05 were considered to be significant.

Order of use: A Mann-Whitney test was performed on data obtained for men and for women to check that the same product packaged in tube with a flip top cap or in bottle with a pump was used in the same way over the first 2-week period and the second.

Gender: A Mann-Whitney test was conducted between women and men data.

Container: A Wilcoxon signed-rank test was performed on data obtained on products packaged in tube with a flip top cap and on products packaged in bottle with a pump.

3. Results

3.1. Demographics

Data were analysed for adults who correctly followed the protocol i.e. volunteers who used the different products and recorded it in a diary. 221 participants were included in the study: 108 women (49%) and 113 men (51%). Women were from 18 years to 69 years old, with mean and median values equal to 45 years. Men were from 22 years to 70 years old, with mean and median values equal to 42 years.

3.2. Consumption analysis

The consumption values per application (g/use) and per day (g/day) for the shampoo, the shower gel and the emollient cream (mean, standard deviation, median and 95th percentile) were presented according to the container in Tables 1–3.

3.2.1. Influence of order of use

No statistical difference was shown for men or for women



Fig. 1. Packaging of tested products.

The cosmetic products were packaged in a 200 ml tube with a flip top cap and in a 200 ml bottle with a pump.

A Shampoo.

B Shower gel.

C Cream.

Table 1
Consumption of shampoo depending on packaging: tube with a flip top cap and bottle with a pump.

Shampoo	Amount per use (g/use)		Amount per day (g/day)	
	Flip top cap	Pump	Flip top cap	Pump
Adults (men and women)				
Mean	9.6	8.1	6.1	5.1
SD	6.4	5.7	3.4	3.2
Median	7.8	6.3	5.3	4.4
P95	23.3	20.8	12.0	11.3
N	220	220	220	220
p value	***		***	
Adult men				
Mean	7.4	6.1	5.9	4.8
SD	4.3	3.9	3.6	3.4
Median	6.4	5.2	5.0	3.8
P95	15.6	12.0	12.1	11.2
N	113	113	113	113
p value	***		***	
Adult women				
Mean	11.9	10.3	6.3	5.4
SD	7.5	6.4	3.3	2.8
Median	9.9	8.3	5.6	4.8
P95	25.7	24.5	12.0	11.2
N	107	107	107	107
p value	***		***	

Data were expressed in amount per use (g/use) and in amount per day (g/day). For each product studied, mean, standard deviation (SD), median and P95 values were presented.

N: Number of data.

***: Significant difference at $p < 0.001$.

according to the order of use of cosmetic products with different packaging ($p > 0.05$, data not shown).

3.2.2. Influence of gender

A statistically significant difference depending on gender was shown for the shampoo for both packaging when data were expressed in amount per use ($p < 0.0001$ in the two cases); and for the shampoo packaged in bottle with a pump when data were expressed in amount per day ($p = 0.02$) (Table 4). For example with the shampoo packaged in tube with a flip top cap, women consumed on average 11.9 g of product per use with a P95 value equal to 25.7 g per use; men consumed on average 7.4 g of product per use with a P95 value equal to 15.6 g per use. For the shampoo packaged in bottle with a pump, women consumed on average 10.3 g of product per use with a P95 value equal to 24.5 g per use; men consumed on average 6.1 g of product per use with a P95 value equal to 12.0 g per use (Table 1). The distribution of shampoo consumption data depending on gender was presented in Fig. 2.

No statistically significant difference was shown concerning gender for shower gel and emollient cream. All p values are presented in Table 4.

3.2.3. Influence of packaging

A statistically significant difference depending on packaging was shown for men and or for women for the three cosmetic products tested (Tables 1–3). Generally, the amount of cosmetic product used per application and per day was slightly higher when the product was packaged in tube with a flip top cap.

In adult men, a statistically significant difference was shown when data were expressed in g/use and in g/day for the three cosmetic products. For example, adult men consumed 6.3 g and 10.9 g of shower gel per use when the product was packaged in bottle with a pump (mean and P95 values, respectively). Adult men

Table 2
Consumption of shower gel depending on packaging: tube with a flip top cap and bottle with a pump.

Shower gel	Amount per use (g/use)		Amount per day (g/day)	
	Flip top cap	Pump	Flip top cap	Pump
Adults (men and women)				
Mean	7.1	6.4	7.2	6.6
SD	3.5	3.3	3.3	3.4
Median	6.3	5.7	6.8	5.7
P95	13.0	10.9	12.4	11.9
N	221	221	221	221
p value	***		***	
Adult men				
Mean	7.1	6.3	7.3	6.5
SD	3.6	3.4	3.7	3.6
Median	6.1	5.4	6.3	5.5
P95	13.3	10.9	13.2	12.7
N	113	113	113	113
p value	***		***	
Adult women				
Mean	7.1	6.5	7.1	6.6
SD	3.4	3.2	2.8	3.2
Median	6.5	6.0	6.9	6.3
P95	11.9	10.8	12.2	11.1
N	108	108	108	108
p value	**		**	

Data were expressed in amount per use (g/use) and in amount per day (g/day).

For each product studied, mean, standard deviation (SD), median and P95 values were presented.

N: Number of data.

*, ***: Significant difference at $p < 0.01$ and $p < 0.001$ respectively.

used on average 7.1 g of shower gel per application with a P95 value equal to 13.3 g per application when the product was packaged in tube with a flip top cap ($p = 0.0003$) (Table 2). Similarly, adult men consumed 6.1 g of shampoo per use (mean value) and 12.0 g of

Table 3
Consumption of emollient cream depending on packaging: tube with a flip top cap and bottle with a pump.

Emollient cream	Amount per use (g/use)		Amount per day (g/day)	
	Flip top cap	Pump	Flip top cap	Pump
Adults (men and women)				
Mean	6.9	6.1	5.2	4.6
SD	4.2	3.6	3.2	2.9
Median	6.4	5.6	4.7	4.2
P95	13.5	12.4	10.4	9.9
N	209	209	209	209
p value	***		***	
Adult men				
Mean	7.3	6.0	5.2	4.4
SD	4.9	3.5	3.4	2.9
Median	6.4	5.6	4.7	4.0
P95	14.8	12.8	10.2	10.5
N	102	102	102	102
p value	***		***	
Adult women				
Mean	6.6	6.2	5.2	4.8
SD	3.4	3.6	3.0	2.9
Median	6.3	5.5	4.8	4.3
P95	11.8	12.2	10.6	9.7
N	107	107	107	107
p value	0.056		**	

Data were expressed in amount per use (g/use) and in amount per day (g/day).

For each product studied, mean, standard deviation (SD), median and P95 values were presented.

N: Number of data.

*, ***: Significant difference at $p < 0.01$ and $p < 0.001$ respectively.

Table 4

Consumption of shampoo, shower gel and emollient cream depending on gender. A Mann-Whitney test was performed on consumption data expressed in amount per use (g/use) and in amount per day (g/day) for the two containers: tube with a flip top cap and bottle with a pump.

Men vs Women	Shampoo		Shower gel		Cream	
	Amount per use (g/use)	Amount per day (g/day)	Amount per use (g/use)	Amount per day (g/day)	Amount per use (g/use)	Amount per day (g/day)
Tube with a flip top cap	<0.0001	0.236	0.682	0.870	0.547	0.722
Bottle with a pump	<0.0001	0.020	0.434	0.483	0.593	0.372

p values were presented in bold when a statistically significant difference was observed between gender.

Table 5

Comparison of consumption per use data (g/day and g/use) obtained on adults with literature data.

		Consumption (g/day); P95 values			Consumption (g/use); P95 values		
		Current study	Hall et al., 2007, 2011	Loretz et al., 2005, 2006	Current study	Loretz et al., 2005, 2006	Ficheux et al., 2016
			French	European	American	French	American
Adult population Shampoo	♂ and♀	11.3–12.0	12.2		20.8–23.3		
	♂	11.2–12.1			12.0–15.6		13.9
	♀	11.2–12.0		29.1	24.5–25.7	28	25.3
Shower gel	♂ and♀	11.9–12.4	22.8		10.9–13.0		
	♂	12.7–13.2			10.9–13.3		26.2
	♀	11.1–12.2		29.1	10.8–11.9	24.3	23.2
Cream	♂ and♀	9.9–10.4 ^a	9 ^b		12.4–13.5 ^a		
	♂	10.2–10.5 ^a			12.8–14.8 ^a		14.2 ^c
	♀	9.7–10.6 ^a		16.8 ^b	11.8–12.2 ^a	10.2 ^b	28.0 ^c

P95 values are used for comparison.

^a Emollient cream.

^b Body Lotion.

^c Moisturizing cream.

shampoo per use (P95 value) when the product was packaged in bottle with a pump. Adult men applied on average 7.4 g of shampoo per use with a P95 value equal to 15.6 g per use when the product was packaged in tube with a flip top cap ($p < 0.0001$) (Table 1).

In adult women, a statistically significant difference was shown for the three cosmetic products when data were expressed in g/day; and for shampoo and shower gel when data were expressed in g/use. For example, adult women consumed 10.3 g and 24.5 g of shampoo per use when the product was packaged in bottle with a pump and used on average 11.9 g and 25.7 g of shampoo per application when the product was packaged in tube with a flip top cap ($p < 0.0001$) (mean and P95 values, respectively). Adult women consumed 6.5 g and 10.8 g of shower gel per use when the product was packaged in bottle with a pump; and used on average 7.1 g and 11.9 g of product per application when it was packaged in tube with a flip top cap (mean and P95 values, respectively) ($p < 0.01$) (Table 1).

The distributions of consumption data obtained for shampoo and shower gel according to packaging were presented in Fig. 3.

It was interesting to note that the statistical differences were greater in men compared to women for shower gel and emollient cream.

4. Discussion

4.1. Strengths and weaknesses of the study

The present study provides current information on the impact of container on the consumption of three cosmetic products widely used in France and worldwide. To author's knowledge, no similar study was available in the literature.

The study was performed on adult men and women, with a number of subjects fairly high (113 men and 108 women). However, the sampling may not be representative of the French population. In fact, data collection was performed in

one city and some parameters such as the socio-professional category or the number of persons in the household were not taken into account. In the future, it could be interesting to perform a higher scale study in order to refine data obtained here. Furthermore, it would be important to collect data in children and in babies.

Cosmetic products were used at home without instructions for use. Participants were informed of the objective of the study and were made aware of the importance of consuming the products as usual. Although the products were not the personal ones, volunteers were regular users of the same types of products.

4.2. Data analysis

A difference of consumption depending on gender was shown for shampoo and could be related to length of hair. Conversely, no difference of consumption was shown concerning gender for shower gel and emollient cream. This similitude could be related to the body surface area which was not very different between men and women.

Results of the study showed that the amount of cosmetic product used per application and per day was slightly higher when the product was packaged in tube with a flip top cap than in bottle with a pump. The difference of consumption expressed in amount per use could vary from 5% (emollient cream in women) to 22% (emollient cream in men) when calculated with mean values. The difference of consumption expressed in amount per day could vary from 7% (shower gel in women) to 23% (shampoo in men) when calculated with mean values. This effect could be related to the gesture of the consumer that would allow a greater quantity of product in the hand when the cosmetic product was packaged in tube with a flip top cap. However, whatever the packaging, the quantity used by the consumer remained of the same order of magnitude.

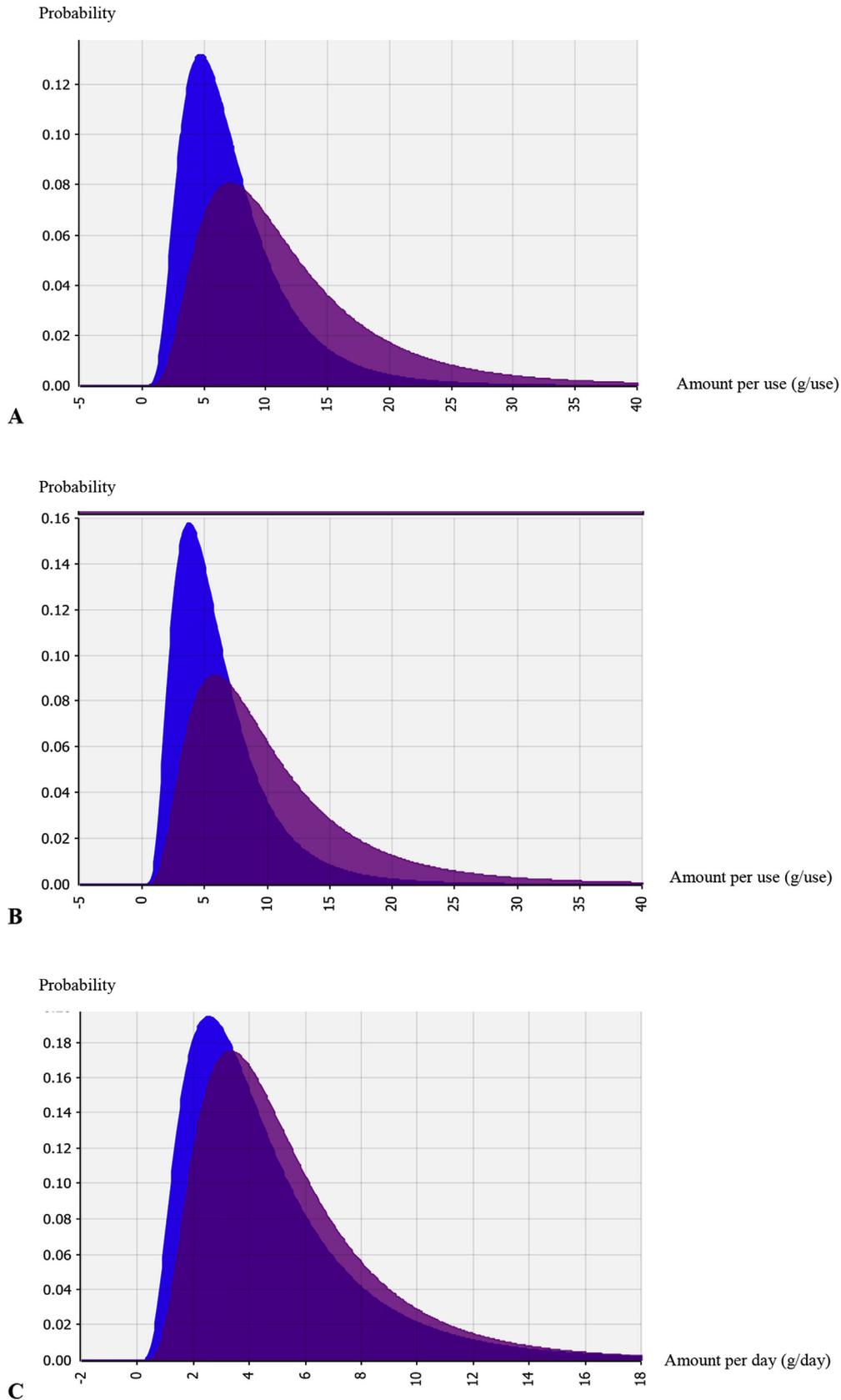


Fig. 2. Distribution of consumption of shampoo depending on gender.

Raw data were adjusted to lognormal distributions using @Risk software.

Blue distribution: adult men.

Purple distribution: adult women.

A Amount per use distribution obtained for tube with a flip top cap package.

B Amount per use distribution obtained for bottle with a pump package.

C Amount per day distribution obtained for bottle with a pump package. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

4.3. Comparison to the literature data (Table 5)

Consumption studies conducted in the Netherlands and in Switzerland were not included in this comparison because photographs were used to visualize the consumption per use (Biesterbos et al., 2013; Garcia-Hidalgo et al., 2017).

Shampoo data were in the same order of magnitude as those obtained on European adults and on French adults; and lower than those generated on American women (Ficheux et al., 2016; Hall et al., 2007; Loretz et al., 2006). This difference with American data could be explained by different consumer behaviour between countries. Shower gel values were lower than those available in the literature, and could be explained by a difference of viscosity or a difference of foaming power linked to the quantity of surfactant. Emollient cream data were similar to European data (Hall et al., 2007). Emollient cream data obtained on women were lower than those obtained on American women (amount per day) and on French women (amount per use). This difference could be related to the function of product which was different: emollient in this study versus moisturizing in Ficheux et al. (2016) study. A difference of viscosity could also explain the difference of consumption.

5. Conclusion

It would be interesting to extend this study to other types of cosmetic products marketed in different packaging such as hair conditioner, micellar water, cleansing milk ... to assess a potential difference of consumption. Indeed, a difference of consumption influences the exposure and as a consequence the systemic exposure dosage (SED). For example, if a MoS calculation was slightly higher than 100 (the minimal threshold required by the SCCS to conclude that there is no risk for human health) for a substance incorporated in a cosmetic product packaged in a bottle with a pump, this ingredient may be “declared as safe” for the consumer and in accordance with the cosmetic Regulation (SCCS, 2016). Now, if this same substance incorporated in the same cosmetic product was packaged in a tube with a flip to cap, the MoS could be lower than 100 due to the increasing of the exposure. Packaging is then a parameter to be taken into account by the manufacturer because it could have real impact on the safety assessment. This original work could be interesting for safety evaluators, safety agencies and commercial services of cosmetics manufacturers.

Transparency document

Transparency document related to this article can be found online at <https://doi.org/10.1016/j.fct.2017.09.005>.

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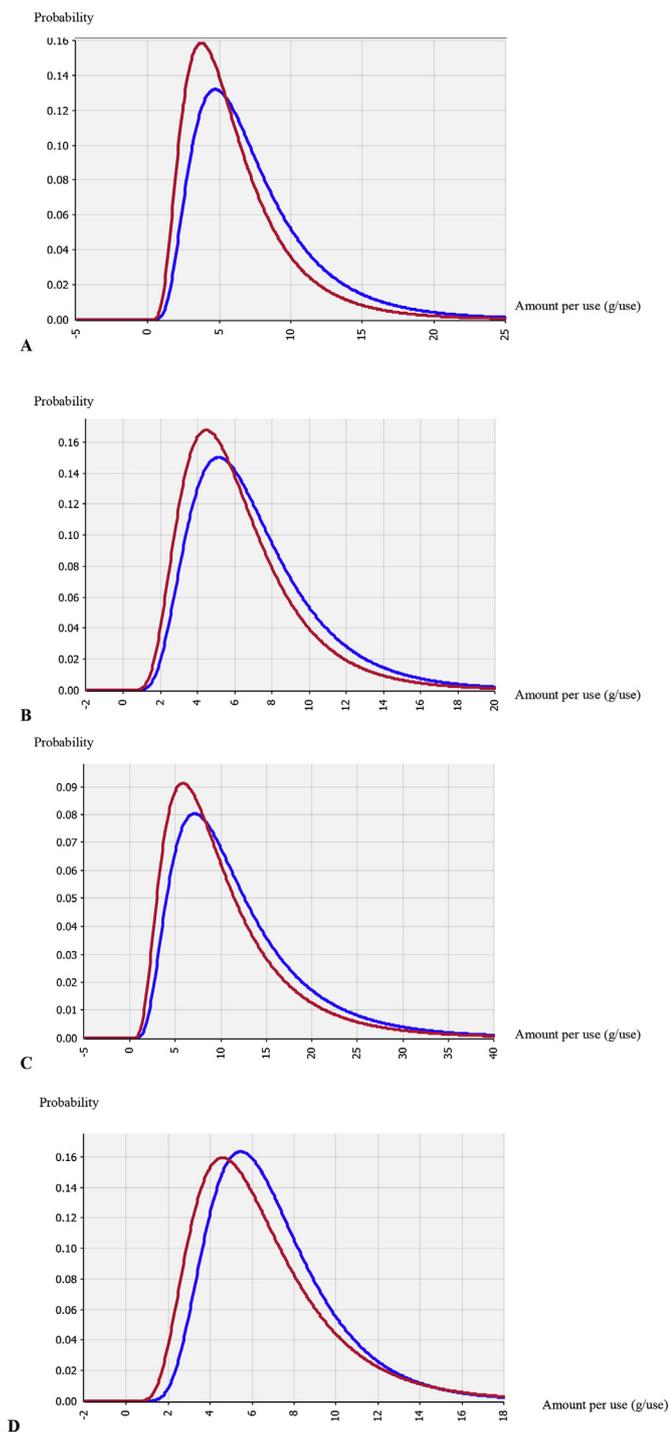


Fig. 3. Distribution of consumption per use of shampoo and shower gel depending on packaging.

Lognormal distributions were obtained using @Risk software.

Red distribution: bottle with a pump.

Blue distribution: tube with a flip top cap.

A Amount per use distribution for shampoo in men.

B Amount per use distribution for shower gel in men.

C Amount per use distribution for shampoo in women.

D Amount per use distribution for shower gel in women. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

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