

Supplement

A. Online Survey Questions

Table A1: Personal and exclusion questions for the recruitment of trial participants for the study on dosing behavior. Red = Excluded, Red* = max. 15 % of trial participants. Translated from German.

ID	Personal questions	Answer options					
A1	Age	18-29	30-49		50-69		70+
A2	Which gender do you identify with?	male		female		divers	
A3	Household size	Free text					
A4	Which washing temperature do you use most often?	Cold	30 °C	40 °C	60 °C	95 °C	
A5	How many washes do you do per week?	Less than 1	1	2-3	4-5	6-7	More than seven
A6	How old is your washing machine?	Up to 1 year	Up to 5 years		Up to 10 years		More than 10 years

	Exclusion issues (highlighted red)	Answer options				
B1	Do you wash your laundry yourself using a washing machine?	Yes			No	
B2	How often do you use powder detergents compared to other types, e.g. liquid detergents, pods, tabs, capsules, ...?	Always	Pre-dominantly	Equally frequent with others	Rare	Never
B3	How often do you use a dosing aid to dose detergent?	Always	Pre-dominantly	Equally frequent with others	Rare	Never*

B. Laboratory Setup and Raw Data



Figure B1: Layout of washing machines in test room and positioning of the two dosing aids (smaller dosing aid [K], larger dosing aid [G]) on the washing machines with odd test or even person numbers.

Table B1: Overview of washing machines and maximum recommended load in kg for the cotton programme. Sequence according to Figure A1.

No.	Company	Type	Max. load in kg
1	Miele	Softtronic W1935 WPS WTL	7
2	Miele	Softtronic W1935 WPS WTL	7
3	AEG	Lavamat L89495FL	9
4	Miele	W754S	5
5	Bosch	WCM69 WAT28420	7
6	Miele	Softtronic W3245	5
7	Miele	Novotronic W963	5

Table B2: Dosage and load per participant number 1 - 50. Shown are the dosed detergent quantities in grams in washing machines number 1 - 7 (gray = smaller dosing aid, white = larger dosing aid), the loaded laundry in washing machines number 1 and 2 in kilograms and the detergent number according to Table A5.

Participant (No.)	Dosed detergent in machines number 1 - 7 in grams							Loaded laundry in machines number 1 and 2 in kilograms		Detergent	Participant (No.)	Dosed detergent in machines number 1 - 7 in grams							Loaded laundry in machines number 1 and 2 in kilograms		Detergent
	1	2	3	4	5	6	7	1	2			1	2	3	4	5	6	7	1	2	
1	35,31	42,40	36,16	33,83	41,70	41,76	37,17	2,34	2,73	11	26	56,60	38,09	53,64	55,52	38,14	31,38	40,36	4,3	4,36	1
2	97,11	87,93	112,50	123,60	90,22	81,39	74,56	2,64	2,62	8	27	84,16	101,01	70,41	76,75	87,60	86,63	83,63	4,45	5,09	1
3	75,20	80,54	76,04	67,95	86,54	79,20	78,14	4,33	3,68	3	28	41,21	23,83	42,59	41,60	16,84	22,61	19,49	3,74	3,65	3
4	47,75	35,50	42,58	43,39	33,87	33,47	32,62	2,53	2,32	1	29	36,90	41,32	27,50	28,91	47,12	42,15	44,36	1,82	2,69	1
5	64,11	68,68	60,40	60,30	65,30	65,44	69,61	3,08	3	12	30	66,41	64,88	64,43	58,72	55,32	73,55	52,94	3,32	3,80	5
6	69,39	76,92	78,97	93,17	84,83	71,83	74,18	3,13	3,12	7	31	77,12	86,78	83,62	80,67	81,88	75,47	73,91	3,45	3,12	1
7	39,80	52,38	37,48	38,95	64,39	67,0	57,54	3,57	2,77	1	32	77,10	75,14	81,90	79,86	70,77	58,92	71,28	3,32	3,11	1
8	59,32	70,47	68,82	50,25	58,32	57,37	53,67	2,90	3,33	8	33	24,86	24,16	24,14	27,20	35,81	33,71	31,12	1,38	1,58	10
9	96,62	83,81	83,79	86,58	79,88	85,25	83,01	3,72	4,07	1	34	57,50	59,99	59,46	65,06	54,31	56,21	57,34	3,29	3,36	3
10	45,63	50,31	58,89	48,52	37,07	36,79	37,59	1,98	2,75	12	35	60,52	96,43	70,41	63,39	74,16	91,48	78,21	3,59	4,40	3
11	46,07	57,68	43,42	41,22	50,94	55,62	46,18	3,21	3,13	10	36	30,82	39,46	42,62	51,06	37,37	36,03	34,72	3,16	3,32	3
12	85,07	42,56	88,13	91,08	90,07	83,52	75,91	4,41	3,48	5	37	87,0	110,21	71,86	73,55	97,02	84,75	82,25	3,73	3,22	1
13	54,75	64,06	53,31	58,25	67,31	70,95	69,71	3,65	3,83	7	38	63,43	47,07	64,06	55,69	54,94	50,08	47,8	4,06	3,54	8
14	91,85	81,28	87,41	85,8	84,26	76,23	69,59	3,09	3,67	1	39	69,79	65,50	63,02	63,47	67,49	64,08	67,97	5,76	4,36	8
15	43,13	44,36	41,47	40,08	49,20	52,87	51,20	2,82	3,07	1	40	102,57	87,42	130,15	129,62	102,53	84,20	75,57	2,74	2,55	4
16	88,45	54,43	73,24	70,51	50,34	47,52	46,56	2,23	2,64	4	41	53,94	59,01	76,56	53,78	74,30	47,81	57,71	4,21	3,82	7
17	61,02	60,83	62,62	58,15	65,50	62,86	71,86	3,78	3,44	3	42	189,59	160,86	179,88	182,83	160,91	156,42	158,87	2,80	2,84	2
18	20,94	21,76	24,10	23,03	19,76	12,32	14,97	1,30	1,92	7	43	134,79	133,29	145,29	75,45	141,64	113,35	78,01	4,52	5,02	1
19	35,73	43,70	58,81	35,67	51,30	44,55	43,04	2,63	2,77	10	44	84,80	91,35	79,22	76,55	93,62	82,9	84,46	2,63	2,54	12
20	139,67	140,66	136,23	139,57	132,49	92,76	74,63	3,62	3,40	12	45	36,99	31,8	20,78	21,96	41,62	28,44	46,87	2,85	2,80	4
21	26,18	33,19	26,6	21,22	34,05	33,2	25,6	2,95	4,26	7	46	34,53	33,18	34,70	31,08	28,60	27,94	28,17	3,77	3,53	3
22	67,47	64,32	68,86	71,41	69,07	71,86	65,12	2,65	3,51	3	47	38,51	52,1	36,76	37,74	46,23	49,22	50,86	5,55	4,98	7
23	40,82	32,19	25,59	19,66	30,49	29,67	29,47	3,73	3,58	4	48	41,29	31,07	43,37	42,75	27,30	31,35	34,47	4,26	4,17	3
24	70,30	82,09	56,69	62,95	67,87	70,01	76,24	2,40	2,50	7	49	36,46	31,64	22,16	22,46	26,97	26,26	20,75	4,21	3,84	7
25	77,09	84,89	76,08	74,89	79,82	77,13	79,68	3,15	3,25	1	50	35,13	32,55	40,11	44,82	27,80	32,68	23,55	2,08	2,34	7

Table B3: Dosage and load per participant number 51 - 97. Shown are the dosed detergent quantities in grams in washing machines number 1 - 7 (gray = smaller dosing aid, white = larger dosing aid), the loaded laundry in washing machines number 1 and 2 in kilograms and the detergent number according to Table A5.

Participant (No.)	Dosed detergent in machines number 1 - 7 in grams							Loaded laundry in machines number 1 and 2 in kilograms		Detergent	Participant (No.)	Dosed detergent in machines number 1 - 7 in grams							Loaded laundry in machines number 1 and 2 in kilograms		Detergent
	1	2	3	4	5	6	7	1	2			1	2	3	4	5	6	7	1	2	
51	36,33	33,93	34,24	30,36	40,41	37,56	30,7	3,27	2,42	4	76	113,36	96,61	101,24	117,54	84,2	84,78	89,63	2,92	3,26	1
52	71,25	37,15	90,53	51,54	34,91	34,15	34,01	3,68	2,15	8	77	41,33	50,02	65,72	40,79	44	40,7	41,25	3,6	3,99	1
53	39,11	37,39	40,27	35,19	42,99	61,15	47,06	2,78	2,58	4	78	104,34	81,10	95,03	99,91	49,15	45,23	57,01	2,89	3	1
54	76,54	84,29	90,95	78,96	81,89	75,36	78,89	4,04	3,7	2	79	45,47	48	50,39	36,76	59,2	54,41	51,91	3,77	3,55	1
55	71,22	60,83	56,71	54,97	91,48	74,36	73,9	4,92	4,96	4	80	44,28	40,17	36,93	30,34	32,62	25,59	33,94	2,61	3	4
56	55,41	40,08	42,68	38	40,2	42,38	40,51	3,21	2,95	15	81	58,55	61,82	57,6	57,62	64,45	55,58	56,6	4,97	4,93	7
57	67,95	64,27	64,78	67,63	69,18	58,64	63,19	4,49	4,82	3	82	45,33	39,21	42,78	38,3	36,3	33,22	35,12	2,44	2,17	9
58	69,86	63,49	62,44	55,7	66,65	58,55	68,18	4,53	4,38	7	83	34	47,09	32,59	30	56,16	42,62	46,26	3,61	4,06	1
59	54,63	52,52	49,54	47,79	55,17	52,32	43,49	4,35	4,59	2	84	40,45	25,28	33,59	36,06	26,63	25,05	30,69	3,47	3,63	14
60	52,39	22,43	38,64	20,33	20,46	21,1	21,45	2,74	2,38	1	85	15,53	16,83	11,43	11,95	18,13	27,97	17,58	2,32	1,9	13
61	46,24	46,31	46,63	47,52	46,08	51,02	47,9	3,63	3,45	7	86	36,85	24,92	33,27	32,77	26,37	21,32	19,86	3,43	3,8	3
62	70,62	56,01	61,03	63,27	50,11	45,31	56,07	3,45	2,98	3	87	50,51	59,51	42,93	42,16	55,86	51,24	58,01	2,15	2,02	1
63	41,17	59,49	43,12	37,01	59,03	58,53	58,45	3,39	2,99	1	88	23,45	20,48	22,79	27,92	34,84	29,01	23,18	3,05	2,75	10
64	36,06	34,28	36,79	36,42	25,39	24,89	23,68	2,61	2,31	1	89	36,92	34,84	36,37	34,01	37,84	33,92	32,15	3,25	3,1	1
65	83,02	77,86	58,91	51,59	53,45	36,6	49,15	5,24	5,35	3	90	55,33	47,77	53,59	54,29	52,35	51,16	52,65	5,23	5,95	3
66	73,19	72,3	63,07	66,63	67,27	66,76	59,04	2,66	3,49	1	91	63,51	68,87	61,43	70,42	78,11	63,59	74,97	2,85	2,91	3
67	80,36	70,61	67,07	83,36	77,71	65,16	73,58	3,01	2,65	1	92	56,72	62,49	50,69	55,49	57,93	59,74	57,56	3,52	2,52	3
68	96,42	88,62	91,75	100,43	89,6	83,24	86,16	2,97	2,92	7	93	44,02	53,5	42,76	46,35	56,94	51,72	53,9	4,75	4,75	1
69	26,52	30,06	24,76	23,81	39,11	32,17	31,76	3,28	3,47	5	94	78,74	87,87	87,7	76,95	73,42	69,67	73,5	4,18	3,74	4
70	61,19	65,22	59,91	68,01	61,8	55,93	60,36	3,06	2,4	5	95	36,52	39,41	36,25	37,84	64,84	58,5	42,25	3,35	2,98	15
71	73,29	50,77	69,89	66,51	90,98	86,39	77,15	4,38	4,34	7	96	86,97	44,97	98,98	93,03	48,22	44,02	47,37	4,56	4,4	1
72	50,05	43,45	51,43	64,27	39,56	39,08	39,19	2,52	3,07	1	97	29,24	31,34	25,45	20,19	23,97	26,22	27,69	2,69	2,77	3
73	34,73	33,03	30,57	30,21	25,55	34,21	27,39	4,73	4,7	8											
74	25	21,03	28,08	28,55	16,14	17,52	19,8	2,23	3,29	1											
75	72,83	73,96	66,9	60,8	72,59	53,16	55,73	2,22	2,05	1											

Table B4: Recommended dosage per detergent type for the powdered heavy-duty detergents provided by the laboratory with the recommended dosage for medium-hard water and normally soiled laundry, divided into load sizes half, normal and maxi. The detergent numbers are different from those in the main text.

Detergent No.	Recommended Dosage on detergent packaging			Conversion [ml, g]
	Half [ml]	Normal [ml]	maxi [ml]	
1	75	100	160	100 ml = 74,0 g
2	58	80	125	80 ml = 67,5 g
3	75	100	140	100 ml = 65 g
4	58	80	125	80 ml = 67,5 g
5	55	75	105	75 ml = 66 g
6	60	80	125	80 ml = 67,5 g
7	65	85	135	85 ml = 67,5 g
8	65	85	135	85 ml = 67,5 g
9	65	85	135	85 ml = 67,5 g
10	47	82	127	82 ml = 67,5 g
11	65	85	135	100 ml = 79 g
12	100	100	130	100 ml = 75 g
13	75	100	130	100 ml = 65 g
14	60	80	125	80 ml = 64 g
15	75	100	155	100 = 65 g

C. Post-Test Interview Questions

Table C1: Interview after the practical part of the study in the laboratory of the Niederrhein University of Applied Sciences. Check dosage table* = Dosage tables provided. Translated from German.

ID	Question	Answer option							
C10	Mark what you have taken into account in the dosage.	Check dosage table*							
C11	Have you followed the dosage recommendation on the washing powder packet?	Yes (1)		No (3)		Approximate/rough estimate (2)			
C12	What did you think when you changed the dosing aid?	Free text input field							
C13	How would you classify your water hardness at home according to the dosing table?	Soft		Medium		Hard		No Idea	
C14	How would you rate your detergent consumption at home compared to the recommendations?	Just right		Too high		Too low			
C15	What practical problems do you generally have when dosing detergents?	Free text input field							
C16	How easy is it to read the scales of the smaller dosing aid when full (1) and empty (2)?	Good		Bad		Sufficient			
C17	How easy is it to read the scales of the larger dosing aid when full (1) and empty (2)?	Good		Bad		Sufficient			
C18	How did you estimate the degree of soiling of the laundry provided?	Slight		Medium		Heavy		No idea	
C19	How would you classify the fill level of the washing machines you previously loaded yourself?	Half load	Loosly filled	Full	Too full		No idea		
C20	Which dosing aid do you use at home (a collection of various dosing aids is available)?	Enter the number as labeled on the dosing aid						[]	

C21	Have you noticed the different sizes of the washing machines? (3x5 kg, 3x7 kg, 1x9 kg)	Yes	No
C22	Have you used more detergent in the larger washing machines or less in the smaller ones at least once?	Yes	No

D. Supplementary Analyses and Reference Data

Dosage aids used by participants at home and in the laboratory

An analysis of usage of dosage aids used at home by age showed only minor group differences. The prevalence of the large scoop is the highest regardless of age group (33 to 39%). The main difference is that in the age group ≥ 50 years, the small scoop is less common (12%), but the larger cylinder (27%) and barrel (23%) are more common.

Table D1: Relative frequency of use of the various dosing aids in households depending on the age group.

	Age Group		
	18-29	30-49	50+
Large scoop	33%	39%	38%
Small scoop	30%	32%	12%
Cylinder-shaped cup	21%	14%	27%
Barrel-shaped cup	12%	14%	23%
Cardboard scoop	3%	0%	0%

This showed that the types of measuring devices used in this study were also the most common types used at home. The large and small scoops account for 61% of the dosage aids mentioned. The readability of the markings on the dosing devices used in this study was rated as sufficient or good in 94% of the cases.

Dosing aids in two different sizes were placed alternately on each machine and the participants had to use the dosing aid on top for each machine. The smaller one has graduations up to 60 ml and a maximum capacity of 60 ml. The larger one has graduations up to 100 ml and a capacity of 140 ml.

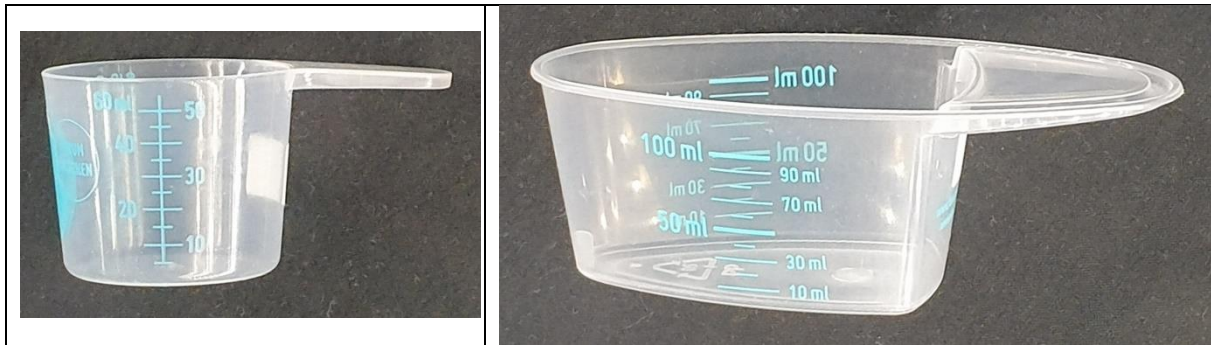


Figure D1: Dosing aids used in the experiments, the smaller dosing aid is labelled up to 60 ml, the larger one up to 100 ml.

The dimensions and configuration of the two dosing aids utilized in this study were devised by a working group of the 'Forum Waschen' (<https://forum-waschen.de/>) with the objective of providing consumers with suitable dosing aids. The group comprises experts from various sectors, including authorities, federal ministries, research institutions, a trade union, manufacturers of detergents and cleaning agents and household appliances, environmental organizations, universities, and consumer associations.

Detergent brand market shares and match with participant usage

The frequency of detergent brands used by the participants was compared with available market data on branded laundry detergents from Procter & Gamble (P&G) and Henkel, and also with the share of private label (Lebensmittel Zeitung, 2022; Kantar Media TGI, 2023). For the Kantar Media survey, the number of consumers surveyed was 10,089, this figure is missing for the *Lebensmittel Zeitung* survey.

Table D2: Comparison of detergents used by participants (n=97) with the available market data about branded detergent and private label market share.

	Participants	(Kantar Media TGI, 2023)	(Lebensmittel Zeitung, 2022)	Difference (percentage points)
Sum brands from Henkel	43.3%	37.0%	-	+6.3
Persil (Henkel)	30.9%	-	30.0%	+0.9
Sum brands from P&G	17.5%	14.0%	-	+3.5
Ariel (P&G)	17.5%	-	23.6%	-6.1
Private label	21.6%	19.0%	-	+2.6

The deviations in the categories compared here amount to a maximum of 6.3 percentage points, with an average absolute deviation of 3.9 percentage points.