



## Usability of administration devices for oral and respiratory medicines: Views from a UK primary school

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### ABSTRACT

The correct use of medicine administration devices is pivotal for optimal drug therapy in children. Little is known about end users' perspectives on administration device use. Thus, the aim of this study was to conduct a survey to gain information and opinions from caregivers and children regarding the usability of paediatric medicine administration devices.

A survey was conducted at a primary school in the United Kingdom in children aged 10–12 years and their caregivers. It focused on oral and respiratory devices and comprised two identical parts: 1) for the caregivers, 2) for the children with parental consent. Ethics approval (REC4612-016) was obtained.

A total of 57 caregiver-child pairs accessed the survey and it was completed by parents only (n = 4), children only (n = 31) or jointly (n = 22). Most participants (65 %) had taken liquid dosage forms (e.g., syrups/suspensions) compared to solid dosage forms (34 %). Oral devices most frequently used were oral syringes (42 %), measuring spoons (22 %), and household spoons (18 %), with parents most frequently demonstrating device use to their children.

Respiratory devices were used less frequently, and pressurised metered-dose inhalers with/without spacer (pMDIs) were the most commonly used devices (11/13). Instructions on use were provided by healthcare professionals to both caregivers and children.

Generally, oral and respiratory devices were considered easy to use and instructions were clear. However, for both oral and respiratory devices, some suggestions for device improvement were provided by participants.

Education/training by healthcare professionals and clear supplier instructions (e.g., pictograms) may be especially effective in ensuring that caregivers and children are able to use administration devices appropriately and receive sufficient information on their correct use.

### 1. Introduction

The correct and appropriate use of paediatric medicine administration devices is pivotal to ensure optimal treatment. Indeed, medication errors including those arising from the administration of an incorrect dose can lead to treatment failures and adverse events. Medication errors through erroneous device use is especially pertinent where the medicine is administered in a home setting by a parent or other caregiver, who may be less familiar with the device and dosing regimen compared to a trained healthcare professional [1,2].

An exploratory survey conducted in European healthcare professionals (HCPs) (doctors, nurses, and pharmacists) on their opinions of paediatric oral and respiratory administration devices, reported that

over 40 % of participants were aware that paediatric caregivers and patients have difficulty in using oral administration devices, especially oral dosing syringes, whilst over 70 % were aware of difficulties associated with correct use of respiratory devices [3]. Despite these perceived challenges, only approximately 30 % of participants indicated they always explain correct device use, with over 50 % believing adequate device instructions are either usually or always provided. The results of this survey provided some valuable insights into the experiences of HCPs regarding paediatric administration device use but highlighted the need to gain a better understanding of the views of children and their caregivers themselves.

A survey specifically designed for paediatric administration device children and caregiver users was therefore developed, to facilitate the

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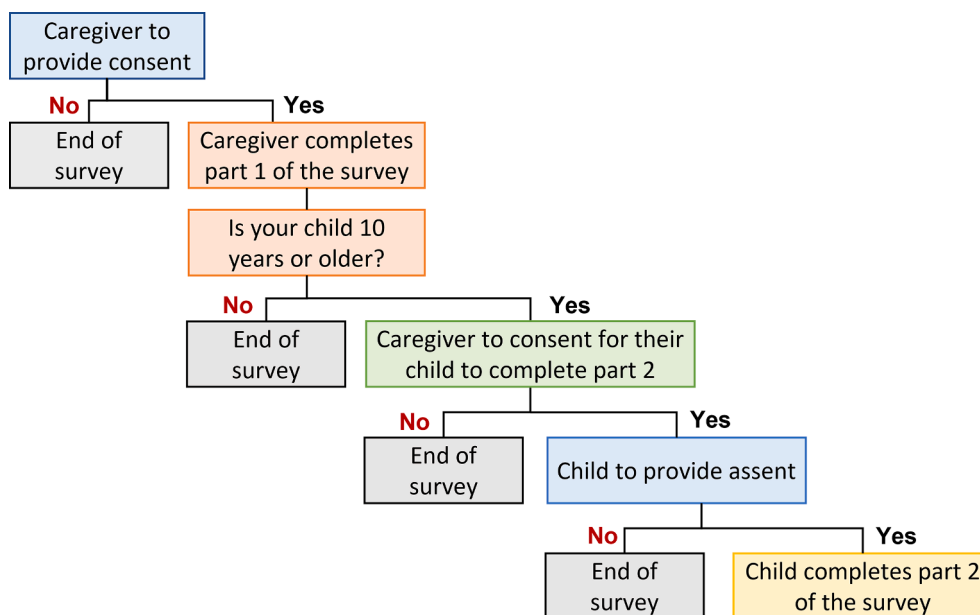


Fig. 1. Survey structure.

identification and extent of potential challenges associated with medicine device use. The acquisition of feedback from both children and their caregivers is important to identify differences in their experiences.

The ability of children to accurately respond to health questionnaires depends on their age and cognitive capacity, and self-reported outcomes are generally considered to be reliable in adolescents and children from approximately 9 years [4,5]. The survey was therefore designed to be completed by children and adolescents aged from 10 years, to promote the reliability of patient self-reported results, as well as adults caring for a paediatric patient aged from birth to less than 18 years.

The aim of this study was to conduct a pilot survey among children and their caregivers to gain an understanding of their views and experiences regarding oral and respiratory medicine administration devices, including the provision and clarity of instructions for use. In addition, feedback on the survey questions was used to inform the design and execution of wider surveys in other countries for example, across Europe, India and in Japan.

## 2. Methods

This study used a mixed-methods research design consisting of quantitative data collection from a survey and qualitative data gained from a workshop held at a school. The data were analysed to provide descriptive statistics from the survey responses as well as feedback from the school workshop. Prior to any research being undertaken, permission was acquired from school staff to conduct the workshop, and informed consent was gained from all pupils and caregivers involved in the project for the anonymous use of data.

The cross-sectional exploratory survey questionnaire was designed using a computerised software (Qualtrics XM) and focused on oral and respiratory devices (e.g., spoons and inhalers respectively), as these are commonly used for paediatric medicine administration.

The study was approved by University College London Research Ethics Committee (4612–016).

The survey was composed of 29 questions organized in two sections; the first part of the survey was aimed at parents/caregivers, whilst children aged 10 years and above were given the opportunity to answer questions themselves in the second part, if parental consent had been given. For children under 10 years, caregivers completed part one of the survey only, Fig. 1.

Both caregivers' and children's parts of the survey comprised three

sections. A broad selection of information was gathered in the first section, including general demographic information of the participant (including age, country and type of medicine used). Section two focused on oral (by mouth) administration devices (e.g., spoons, oral syringes) and section three focused on pulmonary (inhaled) devices (e.g., inhalers). The complete questionnaire is available as [supplementary data](#) (S1). Participants were only required to complete the section(s) that were relevant to them, depending on the medication they or their child was taking. A variety of question types were included, such as single select or multi select multiple questions as well as open questions to allow respondents to add their comments.

The questionnaire was pretested by the following Young Persons Advisory Groups: KIDS1 Barcelona, KIDS Bari and KIDS Albania. Feedback from the KIDS groups on the layout of the survey and the survey questions helped ensure it was understandable to its intended audience. The group highlighted the necessity of using simple terms for very young people and improving the readability of the survey.

Three primary schools and two secondary schools in the United Kingdom were approached via letter, e-mail, and in-person meetings, with a request to participate in the survey. Only one primary school in Kent agreed to take part in the study. All students were in Year 6, aged 10–12 years.

A workshop on 'make medicines for children' was organised as part of British Science Week in January 2020 (<https://www.ucl.ac.uk/pharmacy/news/2020/may/inspiring-young-learners-understand-medicines-children>). A hard copy of the survey questionnaire including the caregivers' consent form for their child to participate in the survey was sent home one week before the workshop. The parents were asked to complete the caregiver's section of the survey (part 1) and return it to school with completed consent forms to allow their child to complete the child's section (part 2) of the survey. During the workshop, interactive activities such as making liquid formulations, guessing flavours were conducted including the workshop on the administration devices. Students attended the workshop in groups of between 6 and 8. A short introduction on administration devices and their use was delivered before the students completed a hard copy of the devices survey, during which they were guided through each question.

### 2.1. Data analysis

Each question and section were analysed separately by calculating

the percentage of questions that were answered in accordance with instructions provided. Students or caregivers who had left any question blank were omitted from the analysis of that particular section.

A questionnaire was defined as partially complete if three or less entries were missing, whilst if more than three entries were missing, the questionnaire was classified as incomplete, and not complete if all entries were missing.

A thematic coding method was used to generate concepts and themes from open field answers for each general comment box. This analysis was not intended to be exhaustive, but to highlight themes beyond those considered when designing the survey.

### 3. Results

#### 3.1. Participants

Responses from the 57 hard copy questionnaires were transcribed into Qualtrics XM software by a researcher for data analysis.

Of the 57 returned questionnaires, 38/57 had been fully completed by children and 16/57 were completed by caregivers. In addition, 15/57 children and 10/57 caregivers partially completed the questionnaire. In general, the completion rate was greater among the children (67 %) compared to the caregivers (28 %), with over half of the caregivers (54 %) leaving the questionnaire incomplete or not complete at all, Table 1.

The majority of the caregivers completing the questionnaire were parents of the children (22/26). One questionnaire was completed by a grandparent and the caregiver was not specified on the remaining three. Caregivers were all older than 18 years except for one, who presumably was a sibling or other relative.

#### 3.2. Type of medicine used

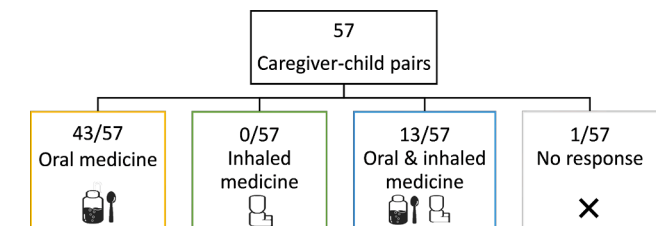
Participants were asked to select the type of medicine they/their child had already used and to complete only the section(s) of the questionnaire that was relevant to them, e.g., oral medicines only, inhaled medicine only, or both. The survey sections were organised as follows: 1) questions about dosage form use, 2) questions about device use, and 3) questions about device instructions.

From the pooled analysis of responses given by caregiver-child pairs (n = 57) it emerged that a large majority of the children, 43/57 (75 %), had previously used oral medicines only, whilst 13/56 (23 %) children

**Table 1**  
Questionnaire completion rate for children and caregivers.

	Fully completed <sup>a</sup> N (%)	Partially completed <sup>b</sup> N (%)	Incomplete / Not completed <sup>c</sup> N (%)
Children	38 (67 %)	15 (26 %)	4 (7 %)
Caregivers	16 (28 %)	10 (18 %)	31 (54 %)

<sup>a</sup> Fully completed: individuals who completed the questionnaire entirely.  
<sup>b</sup> Partially completed: individuals who started the survey but left 3 or less than 3 answers blank.  
<sup>c</sup> Incomplete / Not completed: individuals who started the survey but left more than three answers blank (incomplete) or did not complete the questionnaire (not complete).



**Fig. 2.** Number of caregiver-child pairs using oral medicines, inhaled medicines, or both of them.

had used a combination of both oral and inhaled medicines, and none had taken inhaled medicines alone. One pair left this question blank, Fig. 2.

An assessment of comparability of responses to this question was conducted for questionnaires that were completed by both caregivers and children (n = 22), from which it was found that overall, the responses were similar, with only 3/22 inconsistencies evident between the caregiver’s and child’s response. In two cases, the caregiver selected both oral and inhaled medicines while the child selected only one option. In the third case, it was the other way round.

#### 3.3. Oral medicines

For children who already used oral medicines, the pooled analysis of responses from children and caregivers showed that liquid dosage forms were the dosage form used most often, being used by 65 % of the children. Liquid dosage forms included: syrups (58 %), suspensions (4 %), or drops (3 %).

Solid dosage forms, such as tablets and capsules, were taken by 34 % of the children, and only one child (1 %) had taken granules. Table 2 reports for each caregiver-child pair the oral dosage form(s) selected. Most respondents indicated that more than one of the listed oral dosage forms had been taken.

Oral medicines were usually taken for short periods of time e.g., less than a week (61 %), and only a small percentage of study participants (13 %) took oral medicines chronically for one year or more. The frequency of medicine use varied among the participants; 34 % were taking the medicine once a day, 38 % twice a day, 25 % three times a day, and 3 % selected other, Table 3.

**Table 2**  
Type of oral dosage form used according to each ‘caregiver-child pair’. Cells in light blue (T) indicate tablets, cells in yellow (S) syrup, cells in green (SS) suspension, cells in red (C) capsules, cells in blue (D) drops, cells in grey (G) granules. Third column indicates who answered this question: a caregiver-child pair, a child only or a caregiver only. Last column indicates the number of caregiver-child pairs selecting a specific combination.

Caregivers	Children	Response given by	#		
T	-	Caregiver only	1		
T	T	Caregiver-child pair	5		
T	S	Caregiver-child pair	1		
T	S	C	Caregiver-child pair	1	
-	T	S	Child only	1	
-	T	S	C	Child only	1
-	T		Child only	7	
SS	T		Caregiver-child pair	1	
SS	-		Caregiver only	2	
SS	S	SS	Caregiver-child pair	2	
SS	S	S	Caregiver-child pair	2	
	S		Caregiver only	2	
	S	S	Caregiver-child pair	7	
-	S		Child only	21	
-	S	D	Child only	1	
-	T	S	D	Child only	1
-		C	Child only	1	
Total			57		

**Table 3**  
Duration and frequency of oral medicines used.

Duration	N (%)	Frequency	N (%)
Less than 1 week	33 (61 %)	Once a day	17 (30 %)
1–2 weeks	6 (11 %)	Twice a day	23 (40 %)
3–4 weeks	4 (7 %)	Three times a day	12 (21 %)
1–11 months	4 (7 %)	Four times a day	0 (0 %)
More than 1 year	7 (13 %)	Other	1 (2 %)
Unknown	3 (5 %)	Unknown	4 (7 %)
Total	57	Total	57

3.3.1. Oral devices used

From the pooled analysis of responses from children and caregivers, it emerged that the oral device most commonly used for the administration of liquid dosage forms was oral syringe (42 %, 32/77), followed by measuring spoon (22 %, 17/77), household spoon (18 %, 14/77), measuring cup (3 %, 2/77), and dropper (1 %, 1/77), Fig. 3. As with the selection of dosage form, participants could select more than one administration device.

Participants who selected a monolithic solid dosage form only, i.e., tablet or capsule, reported that they did not use any device to administer or take the medicine (14 %, 11/77).

A comparison of responses given to this question by each caregiver-child pair (n = 20), showed that there was consistency between the child and caregiver in 12/20 cases. However, in 6/20 cases the consistency was partial, meaning that there were some discrepancies between the devices selected, but with at least one device type selected by both the caregiver and the child. Inconsistency between the device selected by the caregiver and the child was found in two cases.

To assess the user-friendliness of the devices, respondents were asked to indicate their ease of use. The questionnaire allowed the selection 5 options: “very easy”, “easy”, “neither easy nor difficult”, “difficult”, “very difficult”. However, during the analysis, the response numbers from “very easy” and “easy” were combined together in a new category labelled “easy to use”, and similarly, this was performed for the “very difficult” and “difficult” responses, which were combined as “difficult to use”. In general, oral devices used by participants were considered easy to use, with few exceptions, Fig. 4. For oral syringes, measuring spoons,

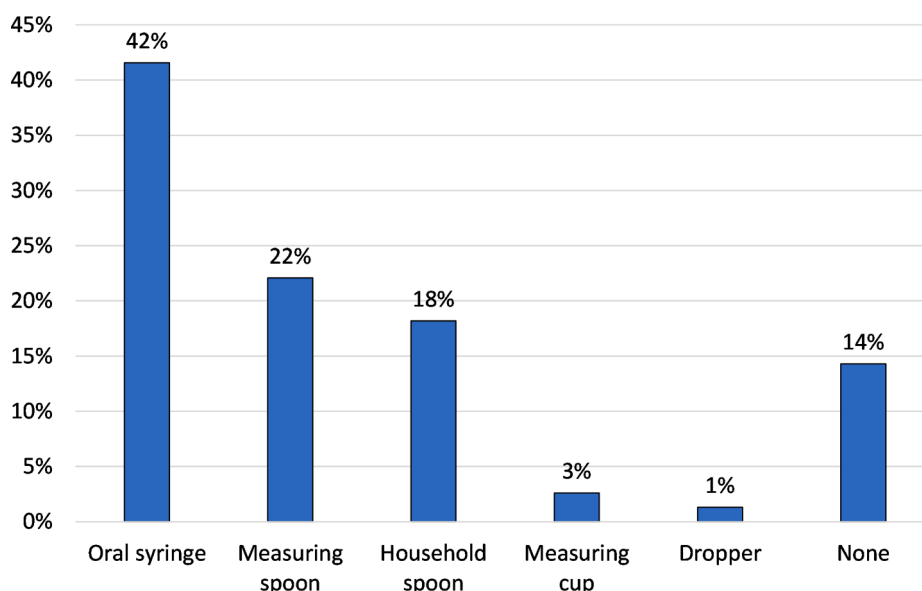


Fig. 3. Percentage of participants using each oral device for oral liquids.

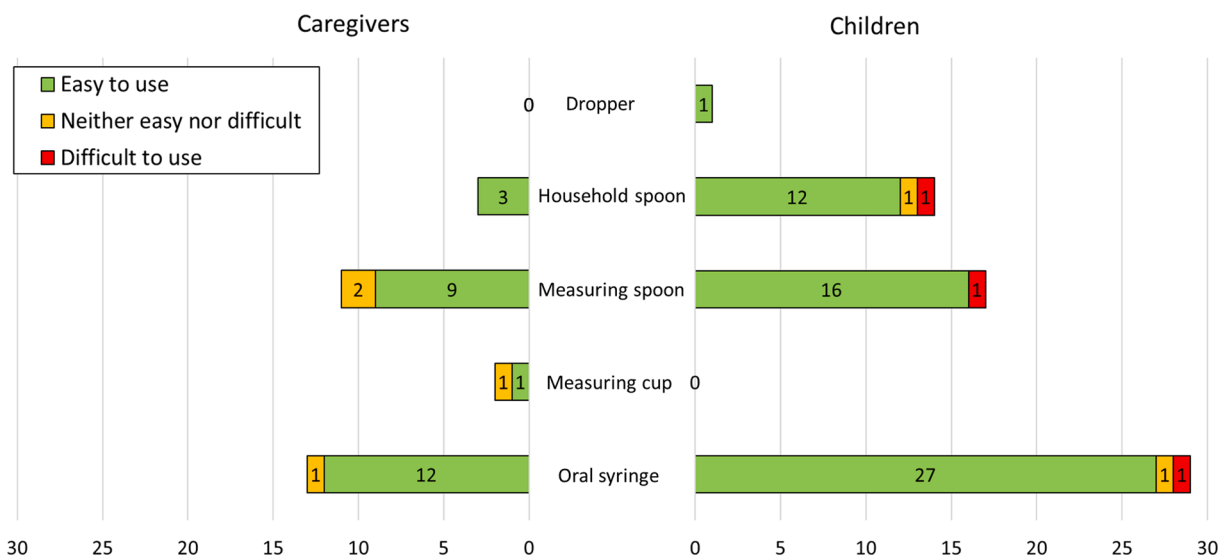


Fig. 4. Ease of use of oral liquid devices, ratings of caregivers (left) and children (right).

and household spoons, the numbers of “easy to use” largely exceeded the numbers of “neither easy nor difficult” and “difficult to use” (oral syringes: 12/13 caregivers and 27/29 children; measuring spoons: 9/11 caregivers and 16/17 children; household spoons: 3/3 caregivers and 12/14 children). Measuring cups, that were selected by two caregivers only, received an equal number of “easy to use” and “neither easy nor difficult to use” responses. None of the caregivers reported using a dropper in this study, one child only reported the use of this device which was considered “easy to use”.

### 3.3.2. Oral devices instructions

Participants were asked whether they had been shown how to use the device correctly and if so, who provided the instructions, Fig. 5. It was possible for the participants to select multiple answers to this question. A total of 51 answers from the children and 18 from the caregivers were received. Of the children, 30/51 (59 %) indicated “other”, specifying that their parents showed them how to use the oral device, whereas 10/51 (20 %) indicated a healthcare professional showed them how to use the device (8/10 doctors, 1/10 nurse, 1/10 pharmacist). The remaining 11/51 (22 %) stated that no one showed them how to correctly use the device. On the other hand, the majority of caregivers (12/18, 67 %) were not shown how to use the device correctly, with a healthcare professional providing a demonstration to only 5/18 (28 %) caregivers. Finally, 1/18 caregiver stated to have been shown how to use the device by another source, which was not specified.

A total of 42 and 19 answers were collected from children and their caregivers respectively, in response to a question regarding the provision of instructions on device use. Overall, instructions were provided to the majority of children (69 %, 29/42) and approximately half of the

caregivers (47 %, 9/19). The remaining 47 % (9/19) of caregivers and 19 % (8/42) of children did not receive any instruction and a few participants did not know (children: 12 %, 5/42; caregivers: 5 %, 1/19).

Participants were then asked how clear they found the instructions provided, Fig. 6. For simplicity, response numbers for “very clear” and “clear” were combined together for analysis. Overall, instructions emerged to be clear for oral syringes and measuring spoons, with the number of “clear” answers largely exceeding all other responses. Only one child thought that instructions for oral syringes were not clear, whereas 2/7 caregivers and 3/20 children did not know. For measuring spoon, 1/5 adult found instructions “neither clear nor not clear”, and 3/11 children did not know. Both caregivers using a measuring cup thought instructions were clear. No answers were provided for droppers. Interestingly, 5 children indicated to have received clear instructions for household spoons and it is anticipated that these were most likely instructions provided by their caregivers.

Suggestions given by participants about what suppliers could do to make oral administration devices more user-friendly and/or fit-for-purpose can be classified into three main themes. The first theme refers to device instructions; despite most caregivers and children stating that instructions were clear, some respondents proposed the addition of pictures and the provision of online videos to improve the clarity of instructions. Other suggestions from children included making instructions “a bit bigger”, adding instructions directly to the device, and being instructed by a healthcare professional on how to use an oral device. The second theme concerned device appearance and design, with observations specific for oral syringes, for example to make them look “nicer” (as syringes are perceived to be “scary”) and to provide additional measures on the syringe. The last theme referred to

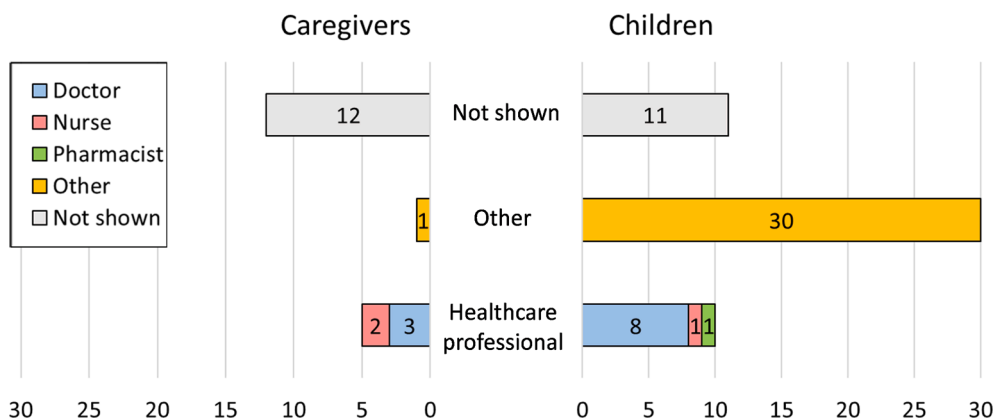


Fig. 5. Instruction providers, who showed how to use the oral liquid device correctly to caregivers (left) and to the children (right).

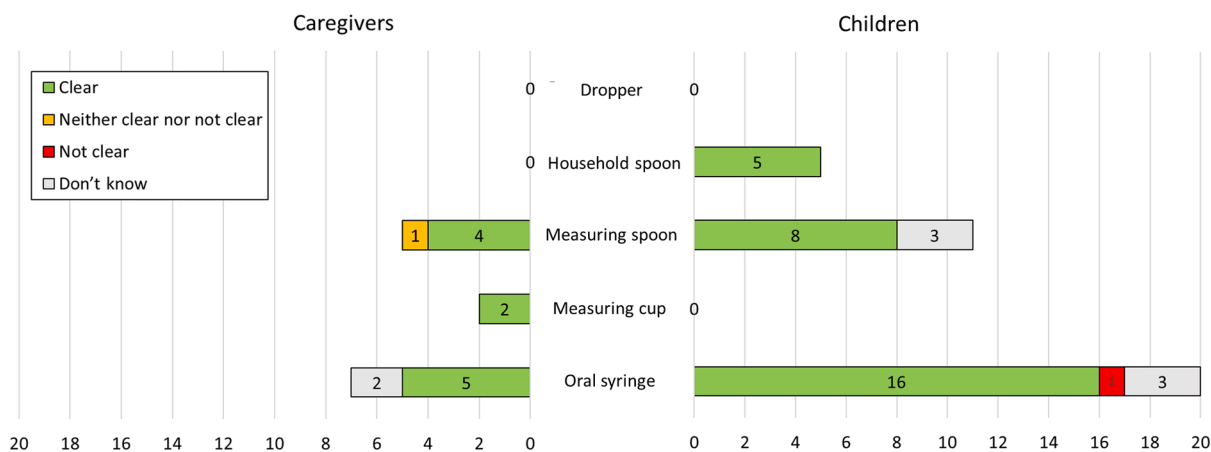


Fig. 6. Clarity of instructions for oral liquid devices, ratings of caregivers (left) and children (right).

**Table 4**

Type of respiratory device used by the children as indicated by each caregiver-child pair. Last column indicates the number of caregiver-child pairs selecting a specific combination.

Caregivers	Children	Response given by	#
–	Manually-actuated pMDI	Child only	6
Manually-actuated pMDI	–	Caregiver only	1
Manually-actuated pMDI & spacer	–	Caregiver only	2
Manually-actuated pMDI & spacer	Manually-actuated pMDI	Caregiver-child pair	2
Manually-actuated pMDI & spacer	Breath-actuated pMDI	Caregiver-child pair	1
–	Dry powder inhalers	Child only	1

alternative devices, as some children suggested the use of a “straw” to take liquid medicines. However, many adults and children stated that the devices were already “easy to use” and there was no need for improvement.

**3.4. Inhaled medicines**

The number of responses collected for respiratory devices was lower than for oral devices as few children in this study had used an inhaled medicine before (13/52). In total, 6 caregivers and 10 children answered this part of the survey.

**3.4.1. Respiratory devices used**

The device most commonly used by the children was manually-actuated pressurised metered dose inhaler (pMDI) with or without spacer (11/13). Other devices selected were breath-actuated pMDI (1/13), and dry powder inhaler (1/13), as shown in Table 4. In some cases, either the caregiver or the child did not specify the type of inhaler used, and there was one case in which the device selected by the caregiver and the child differed. Interestingly, some caregivers indicated the use of a spacer with the pMDI, but this was never indicated by the children, presumably because children thought the spacer was a part of the device.

The inhaled medicine was taken by all children for a duration of 1 year or longer, with different frequencies, but often when needed.

As for oral devices, the question about ease of device use permitted the selection of 5 options: “very easy”, “easy”, “neither easy nor difficult”, “difficult”, “very difficult”. To facilitate the analysis, the response numbers from “very easy” and “easy” were combined together in a new category denominated “easy to use”, and similarly, this was performed for “very difficult” and “difficult”, that were reclassified as “difficult to use”. A total of 16 answers were received. The manually-actuated pMDI with/without spacer emerged to be “easy to use” according to most caregivers (4/6) and all the children (8/8), however, 2/6 caregivers thought the devices were “neither easy nor difficult to use”. The child using the breath-actuated pMDI believed it to be “easy to use”, whereas the child using the dry powder inhaler found it “neither easy nor difficult to use”, Fig. 7.

**3.4.2. Respiratory devices instructions**

Instructions on how to use a respiratory device were provided to all caregivers (6/6) and to the majority of children (7/10) by a healthcare professional (to caregivers: 4/6 doctors, 1/6 nurse, and 1/6 pharmacist; to children: 4/10 doctors, 2/10 nurses, 1/10 pharmacist), Fig. 8. The other 3/10 children were shown how to use a respiratory device by other sources, one of whom specified that their mother had shown them how to use the device.

Overall, instructions provided with the manually-actuated pMDI were considered to be “clear” by most of the participants (4/4 caregivers, and 5/7 children), and only 2/7 children using manually-actuated pMDI believed that the instructions given were “neither clear nor not clear”, Fig. 9. Finally, instructions provided for dry-powder inhaler and breath-actuated inhaler were indicated to be “clear”.

Suggestions provided about respiratory devices were divided in two themes. The first theme was about device instructions, with a few participants suggesting adding “a clear label on the box” of the medicine, and for an HCP to “show” the child how to use the device. The second theme was about device appearance and design, with the suggestion to add a dose counter directly on the device.

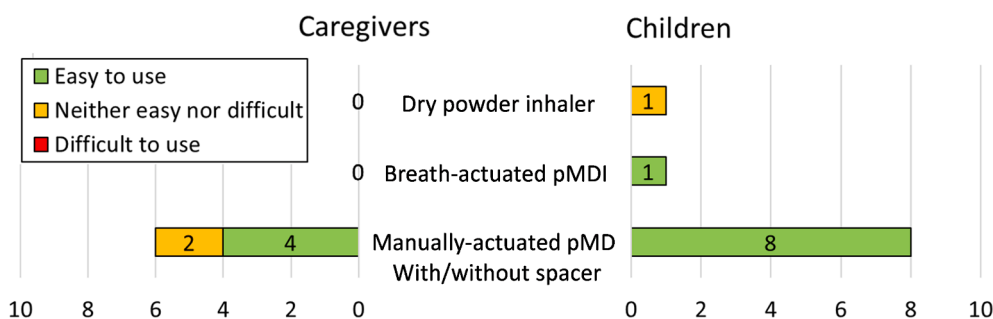


Fig. 7. Ease of use of respiratory devices, ratings of caregivers (left) and children (right).

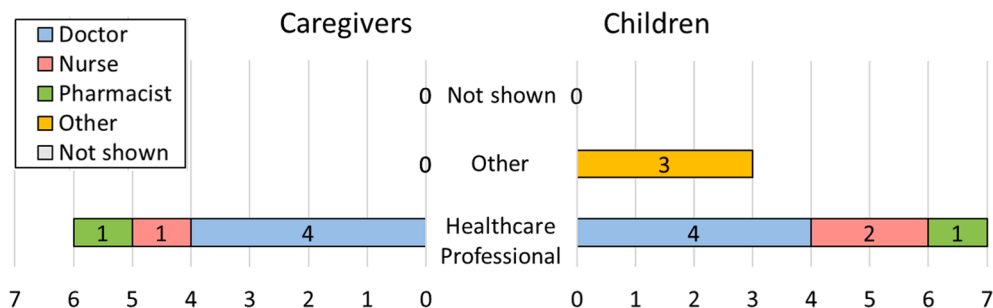


Fig. 8. Instruction providers, who showed how to use the respiratory device correctly to caregivers (left) and to the children (right).

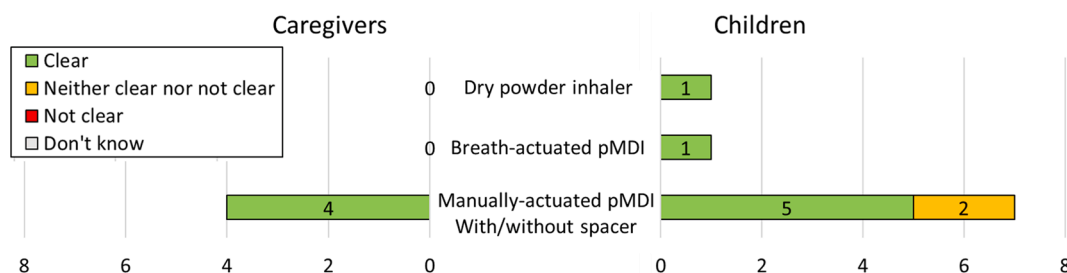


Fig. 9. Clarity of instructions for respiratory devices, ratings of caregivers (left) and children (right).

#### 4. Discussion

Results from this pilot survey have provided insights about children's and caregivers' views and experiences regarding oral and respiratory medicine administration devices. Oral and respiratory devices were selected for investigation as they are commonly used in community settings [3]. The oral route is the most frequently used for systemic products [6], and the respiratory route is considered the best route of drug administration for the treatment of acute and chronic airway diseases [3]. Moreover, results and feedback from this survey have been used to inform the design and execution of wider surveys distributed to many European and non-European countries [7–9].

The survey was addressed to each caregiver-child pair; however, the completion rate was greater among the children compared to the caregivers, with over half of caregivers leaving the questionnaire incomplete or not complete at all. This difference in completion rate was due to the children and adults completing the survey separately; children during the workshop where they were guided through each question by the researchers, whereas the caregivers completed it beforehand at home.

Despite the separate survey completion rates by children and their caregiver, there was good correlation of responses between questionnaires, indicating a good reliability of responses provided. Some discrepancies observed between the caregiver-child pair concerned the type of oral medicine used, and/or the type of device used, but most were regarding the frequency or duration of medicine use.

In this study, oral medicines were usually taken for short periods of time such as one week or less, most likely to treat minor illnesses. In contrast, respiratory medicines were used less frequently, and were usually taken for longer periods of time, such as one year or longer, suggesting treatment of chronic conditions of the airways.

All the children had already used an oral medicine, which was usually a liquid formulation such as a syrup, or suspension. Acceptance of solid oral dosage forms amongst children increases with age [10], and considering that children were all aged 10–12 years, a greater use of tablets or capsules was expected. Nonetheless, in Europe, the widespread use of liquid medicines also in older children has been reported previously [11]. Similarly, results from a study evaluating acceptability of oral dosage forms in India, showed that oral liquids were well accepted by children aged between 0 and 15 years [12]. Conversely, in Japan solid dosage forms, such as powders, are frequently prescribed to children of all ages, including very young children [9,13]. These variations in dosage forms use across countries are known to be related to market availability as well as different cultural preferences of healthcare professionals, caregivers, or end-users [11].

The apparent lack of administration device use for solid dosage forms was not unexpected since such devices are not generally required for tablets and capsules, although swallowing aids such as “pill swallowing cups” may be used [14].

The oral devices most commonly used to administer liquid formulations were oral syringes, followed by measuring spoons and household spoons. These findings are in line with a survey conducted in healthcare professionals (HCPs) in six European countries, where it emerged that oral syringes and measuring spoons were the most frequently supplied

oral administration devices [3]. The oral syringe is considered the measuring device providing the highest dosing accuracy and uniformity [15,16], and hence its widespread use. However, HCPs have been reported to consider oral syringes to be more appropriate for younger children compared to school-age children [3], whilst the results from this study showed that oral syringes were largely used in this school-age population compared to measuring spoons.

Despite being associated with increased risks of dosing inaccuracies [17], household spoons, appear to be largely used by caregivers to administer liquid medicines to their children, an observation that has also been noted in other countries such as Japan [9] and India [8]. In contrast, similarly to the results from the HCP survey, measuring cups and droppers were not frequently reported to be used in this study. Measuring cup was selected by only two caregivers, while their corresponding child did not report using this device, whereas dropper was selected by one child only. Measuring cups are considered appropriate for older children, from 6 years of age [3], and given the age range of the children in this study, it was interesting to note that only two participants had used them. Conversely, oral drops are a dosage form usually dispensed to infants, and this could partly explain why this device was not used in this population.

As regards respiratory devices, the most commonly used in this study was the manually-actuated pMDI with or without spacer, which is in accordance with the HCP study that reported pMDIs to be the most frequently supplied respiratory devices as they are considered to be appropriate for the whole paediatric population [3]. Interestingly, none of the children who selected pMDI reported using a spacer with it, even when their caregiver did. Presumably, the children thought the spacer was part of the device itself. One child reported using a breath-actuated pMDI, although their caregiver selected a manually-actuated pMDI. Finally, it was interesting to note that only one child reported using a dry powder inhaler (DPI), despite this device being considered suitable for this age-group. DPIs may be dispensed to children aged 5 years and above, once they are able to generate sufficient flow to effectively use the device [18].

Surprisingly, very few difficulties in using both oral and respiratory devices emerged from this study. When asked about device ease of use, only three children found the oral device difficult to use, whereas none of the participants using a respiratory device selected “difficult” to use. This was quite unexpected in particular for respiratory devices, as they are known to be more complex to use compared to oral devices. Difficulty with coordination (inspiration with device actuation) is the most frequently cited issue with respiratory devices [3]. However, this was not reported in this study.

Both child and caregiver participants reported that respiratory device use had always been demonstrated to them, usually by a healthcare professional such as a doctor, nurse or less frequently a pharmacist. Conversely, demonstration of how to use an oral device was less common. Two thirds of caregivers and a quarter of children stated that no-one had shown them how to use the oral device, and where a child received help, it was usually from the caregiver. This difference may be because healthcare professionals might consider oral devices to be less complex and easier to use than respiratory devices, and hence the

provision of instructions is not required. In addition, it may be assumed that patients will refer to the Patient Information Leaflet (PIL) for further guidance if needed [3]. Interestingly, one child proposed that correct oral device use should be taught by a healthcare professional, which suggests that the ultimate end-users would benefit from and welcome training. This point was also raised in the HCP survey, where it was recommended that explanation of and training on correct device use should be an integral part of routine patient care and that clear roles and responsibilities for this should be defined within the healthcare team [3].

When provided, instructions for oral and respiratory device use were judged to be clear by most of the participants. Regarding oral devices, it emerged that for caregivers, instructions provided for measuring spoons were slightly clearer than those provided for oral syringes. However, children thought the opposite.

Since household spoons are not recommended for the measurement and administration of medicines [19], it is surprising that participants reported being instructed on their use. It is possible that participants were referring to a different oral measuring device when answering this question, although it is not possible to establish this from the results of the study.

Various suggestions on how to make administration devices more user-friendly and/or fit-for-purpose were provided by participants, in particular for oral devices. Respiratory devices were used less frequently, and thus fewer suggestions were given.

In general, common suggestions for both oral and respiratory devices included to add instructions directly on the box of the medicine or on the device; this could facilitate correct device use should the PIL be lost or misplaced. Moreover, several participants suggested that clear instructions in the form of pictograms or videos could facilitate the understanding of device instructions. The use of pictorial illustrations has been shown to improve caregivers' accuracy and adherence in administering liquid medicines as they reinforce and draw attention to written information and are helpful for patients with low literacy [20,21].

Another suggestion was to ask a healthcare professional to instruct and show the child how to use the oral device, instead of a caregiver having to do this. Some participants suggested improvements to the appearance/design of the device. For oral devices these suggestions focused on oral syringes, requesting to make them look "nicer" (as syringes are perceived to be "scary") and to provide additional graduation measures on the syringe. Difficulty in identifying the correct dose on oral syringes has been reported previously, and marking or colour-coding the required dose on the device have been proposed to reduce this issue [22]. For respiratory devices a suggestion was to add a dose counter directly on the device. The addition of dose counters to pMDIs would allow patients to know when their inhaler will be empty, and previous studies have reported the importance of incorporating dose counters to improve disease management and patient adherence [23,24]. The use of various novel electronic adherence monitoring devices in children to monitor actuation, inhalation and technique has also been investigated [25]. Finally, some children suggested the use of alternative devices, for example, a straw for taking liquid medicines.

The main limitations of this study were the small sample size of the population studied and the narrow age range of the children participating. This may have limited the generalisability of the results obtained. However, this was a pilot study to facilitate the planning and execution of a wider online study conducted across many European and non-European countries. Hence, a key purpose of this study was to evaluate the questionnaire regarding its clarity and ease of use.

Since the pilot survey used a paper-based questionnaire, on occasion participants ticked more than one response option, which made analysis of the results challenging. The primary learnings from the pilot survey that have been applied to the wider online questionnaire, include ensuring key questions, such as type of medicine or device use are mandatory, and allowing participants to only select a single option from the list of medicines and devices most recently used. This is to ensure it is

possible to identify the device that each respondent is referring to when answering the questions.

## 5. Conclusion

This pilot survey has provided some useful insights from a sample of British children and their caregivers about their views and experiences regarding oral and respiratory medicine administration devices. Although the oral and respiratory devices used were perceived by the majority of participants to be easy to use with clear instructions, consideration must be given to ensure that caregivers and children are able to use administration devices appropriately. Education and training by HCPs and clear supplier instructions in the form of pictograms in addition to text may be especially effective in facilitating the correct use of devices. Larger surveys are needed to complement and enlarge the findings from this study, and feedback from the pilot has helped inform the design and execution of a wider survey distributed to many European and non-European countries.

## Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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## Appendix A. Supplementary material

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ejpb.2022.08.006>.

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