Survey-based investigation into the current use of paediatric medicines and administration devices in China

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Abstract

The accurate, rapid and convenient administration of medicines to children is not possible without the use of appropriate administration devices. However, due to the unique nature of this patient population, inappropriate paediatric medication administration has been widely observed worldwide. According to previous surveys carried out in other countries including the UK and Japan, there has been a wide variation in the handling of paediatric devices among children. To date, little is known about the current situation in China where the variety of available paediatric administration devices is more limited than in Europe and the UK. The aim of this study was therefore to conduct a China-wide survey to gain a better understanding of the perspectives of children and their caregivers on paediatric medicines and devices. This study was conducted throughout China with 215 children as well as 749 caregivers of paediatric year groups from 1 to less than 18 years old. The majority of participants (83%) took oral dosage forms where granules, syrup and tablets were ranked as the Top 3 commonly used oral dosage forms. The most commonly used devices, i.e., measuring cups (47.3%) and household spoons (41.1%) were both well accepted by the vast majority of children. More instruction and demonstration by the healthcare professionals were provided to inhalation devices users with the nebuliser and facemask being the most commonly used. In particular, the role of pharmacists in China is expected to be better defined, which may in turn help with the education provided to paediatric users in operating medical devices. The data collected varied considerably with the age of children but not statistically significantly with the region in which the survey was conducted.

Keywords: Paediatric, Oral medicines, Inhalation, Devices, China, Survey

1. Introduction

Accurate, fast and convenient administration of medicines with the appropriate aid of various administration devices has become an essential part of paediatric therapy [1]. Whist more and more medicine administration devices have been developed for paediatric patients in recent years [2], their widespread use has brought unintended safety issues [2, 3]. Indeed, paediatric patients are diverse with significant differences in their needs compared to adults, with potentially poor patient compliance and lack of self-protection [4]. The medicine administration procedure is one of the most significant risk factors for all preventable adverse medicine events in children, which can also cause serious consequences, such as lack of efficacy, serious adverse reactions and even poisoning [5]. In addition to the most commonly used oral administration devices, respiratory administration device based therapy has been the primary treatment for children suffering from diseases such as asthma [6], where problems exist with the variety of inhalation preparations and the complexity of the devices, making the choice of an inhalation device and the accuracy of its application more difficult to ensure when used in paediatric population [7].

Dosing errors are observed around the world, and the reasons for inappropriate paediatric dosing are manifold [8]. Due to the uniqueness of paediatric patients, medication administration is mainly carried out by the parents who may not be able to select and use the administration device correctly [8, 9]. In addition, the identification of the required dose of medication may not be clear, or there may be instances where parents do not understand the dosing instructions correctly [10]. Although many studies have shown that oral syringes offer advantages in terms of accuracy, convenience and hygiene compared to other medical devices including dosing cups and spoons, most medicines are still not supplied with them [8, 11]. In terms of inhalation products, careful consideration is required regarding the choice of formulation and device, taking into account the age and abilities of the child. For example, children may have difficulty in correctly actuating a pressurized metered dose inhaler (pMDI) or may have insufficient inspiratory flow rate to achieve the required particle deposition in the lungs from dry powder inhalers (DPIs) [12]. Indeed, a lack of inhalation devices specifically developed for the paediatric population may contribute to the frequent occurrence of inappropriate paediatric

inhaled medicine use.

In response to these problems, the European Paediatric Formulation Initiative (EuPFI) has conducted several investigations in Europe into the use of medicine administration devices for children [4]. The findings show that devices for oral and respiratory administration are vital but often do not guarantee their suitability for use in children of all ages. Furthermore, there are significant differences in the availability of paediatric medical devices in different countries and regions of the world. Walsh, Math, Breitkreutz, Zerback and Wachtel [13] conducted a survey among healthcare professionals in six countries including France, Germany, Hungary, Italy, Spain and the UK, and found significant differences in the use of paediatric devices. Recent surveys carried out in the UK [14] and Japan [14, 15] also implied the large variation in paediatric equipment usage between the two countries.

To date, little is known about the impact of administration modes on medicine efficacy and patient adherence in China where the variety of available paediatric administration devices is more limited than Europe and the UK. This study, therefore aimed to better understand the use of oral and inhaled medications and associated administration devices among children in China including the challenges encountered and provide advice on how to improve the current situation through conducting anonymous surveys. The specific questionnaire was adapted from the survey previously developed by EuPFI to collate basic information including age, region, type of medicines used and frequency of use. In addition, children's and/or caregivers' comments on the simplicity of the dosing device, the clarity of instructions as well as the demonstration provided by the healthcare professionals prior to the use of administration devices were investigated. A key aim was to analyse data collected among different age groups and various representative regions in China to facilitate the provision of guidance on the further improvement of paediatric medicine delivery devices both in China and worldwide.

2. Methods

2.1. Identification of population and sample

The subjects of this study were children and/or their caregivers (parents, grandparents, guardians or others) from different regions of China. Specifically, the southern region includes Anhui, Guangdong, Hunan, Jiangsu, Jiangxi, Shanghai, Sichuan, Zhejiang and Chongqing while the northern region includes Beijing, Hebei, Henan, Heilongjiang, Jilin, Liaoning, Inner Mongolia, Shandong, Shanxi, Tianjin and Xinjiang.

2.2. Questionnaire design

The questionnaire was modified and translated into Chinese from the original version provided by the EuPFI [14]. It was designed to gain a better understanding of the current use of oral and inhaled medicines as well as associated administration devices among children aged from 1 to less than 18 years old in China. The main participants in the questionnaire were the caregivers, but capable children could also complete the survey by themselves with the permission/confirmation of their caregivers. More specifically, it was focused on children's use of dosage forms, administration routes, frequency, administration devices used, opinion on ease of use and as well as their views on the provision and clarity of instructions for administration and potential challenges. The feedback and data collated among different age groups and different regions were investigated and compared.

2.3 Data collection

Questionnaire distribution and data collection were all carried out electronically across a large number of provinces in China from September to October 2022 to minimize the limitation in geographic coverage associated with hard copy in-person surveys. Specifically, the top two communication platforms in China, i.e., WeChat and QQ were selected for the dissemination of the study given the uniqueness of communication media used in China, where participants provided information via the link to the survey. This approach was employed to facilitate data

management and analysis. The survey response was closely monitored throughout the entire course of collection and in some regions, individual communication was carried out to increase the response rate in order to ensure the quantity of data for statistical analysis.

2.4. Data analysis

SPSS software package version 22 (IBM) and WPS software were used for statistical analysis on a range of variables, including the frequency of medicine administration, the type of device, the provision of and clarity of instructions on devices and their correlation with region and age. Data collated from different regions and age groups were analysed using variance test, and chi-square test as appropriate. A significant difference was accepted when $P < 0.05$.

3. Results

3.1. Participants

This questionnaire, which focused on the use of both oral and inhaled medicines in children in China, was carried out among two main groups of participants, i.e., caregivers of children of all ages and children aged between 1 to less than 18 years. A total of 964 completed questionnaires (caregiver survey and children survey) were returned from 20 provinces between North and South participating groups over approximately one-month investigation period. The number of caregiver-child pairs was 215. Among 749 caregivers, there were 536 parents (71.6%), 104 grandparents (13.9%), 66 other caregivers (8.8%) including siblings and other relatives, and 43 caregivers (5.7%) with no direct relations with the children. In terms of the age groups of children being surveyed, 15.4% (115/749) surveys were completed by caregivers for children aged from 1 to 4 years old, 35.4% (265/749) were for children aged between 5-9 years old, 49.3% (369/749) were for children aged between 10 to less than 18 years old. Fig. 1 describes the survey design and the number of questionnaires received in each part.

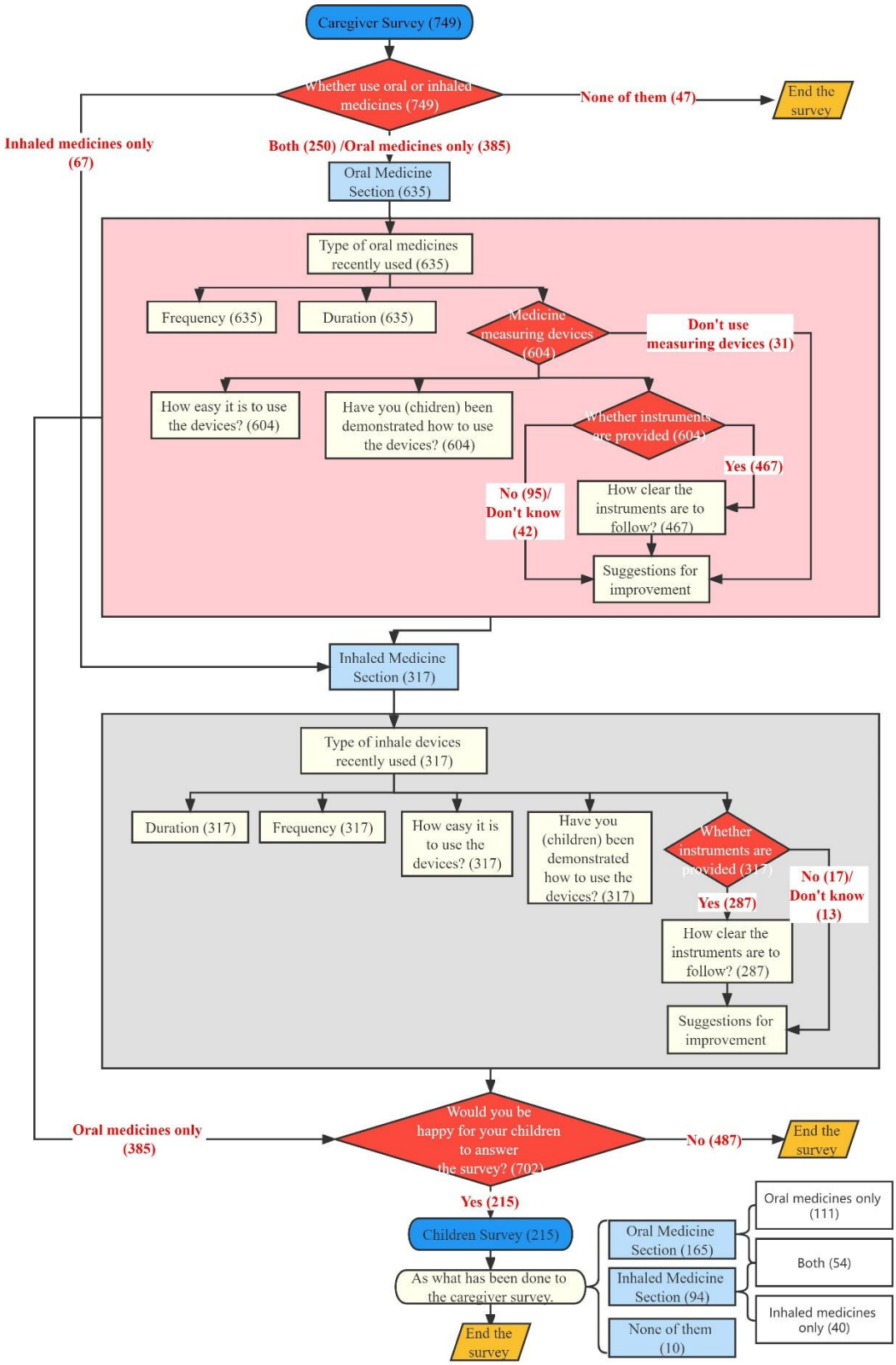

Fig 1. The flow chart of survey design and implementation.

Geographically, a total of 964 questionnaires were collected across 20 provinces in China, including Anhui, Liaoning, Beijing, Hebei, Jilin, etc. As shown in Fig. 2, Liaoning, Anhui and Shanxi were the Top 3 provinces which provided the most significant numbers of responses, accounting for 23.3% (225/964), 9.1% (88/964) and 8.2% (79/964), respectively. While all other provinces provided similar numbers, accounting for circa 5% or less.

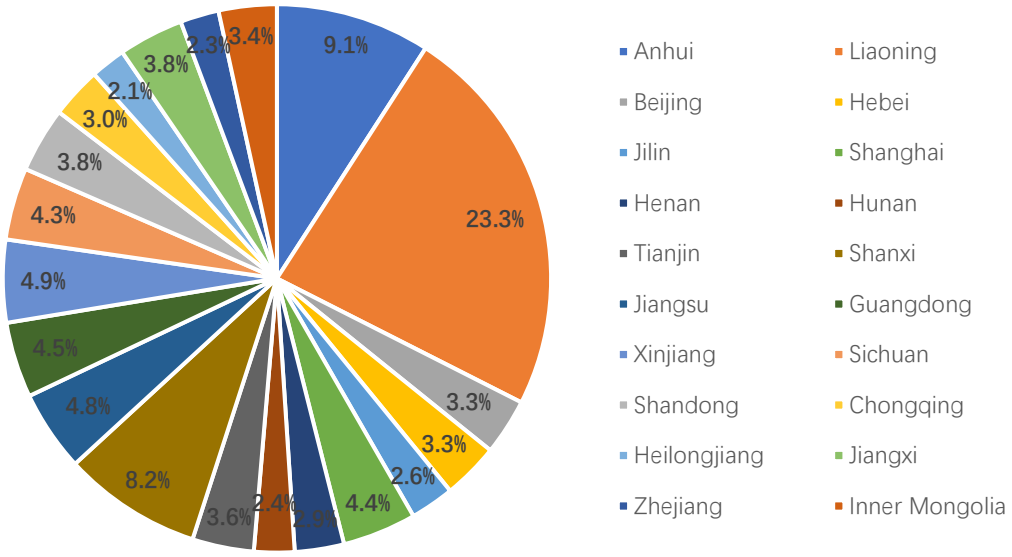

Fig 2. The percentage of participants in different provinces.

3.2. Prevalence in administration routes

As illustrated in Table 1, among 964 questionnaires received from both caregivers and children, 51.5% (496/964) of the participants indicated the use of oral dosage forms such as syrup and tablets while only 11.1% (107/964) selected the use of inhaled medicines alone and 31.5% (304/964) chose both administration routes. 5.9% (57/964) participants under study did not use oral or inhaled medicines.

Table 1. The number of participants who selected the use of oral and/or inhaled medicines.

Type of medicine used	Number	Percentage
Oral	496	51.5%
Inhaled	107	11.1%
Both	304	31.5%
None of the above	57	5.9%
Number of valid questionnaires	964	

3.2.1. Treatment duration

As seen in Fig.3, the majority of participants indicated oral medicines were taken for up to one week, accounting for 44.9% (359/800, $P = 0.028 < 0.05$). Only 6.4% (51/800) of participants reported that long-term medication (1 year or more) was required. Regarding inhaled medicines, 32.4% (133/411) of children used them for one week or less, while only 3.4% (14/411) of children were under inhalation medication for one year or more ($P = 0.009 < 0.05$). Overall, the number of children taking medication via both administration routes decreased with an increase in the length of treatment. As for 1 week or less and one year or more durations, the number of children using oral medicines was greater than that of inhaled medicines. In addition, one can conclude that the proportion of children with chronic diseases who required long-term medication was relatively small, with most children requiring only short-term treatment.

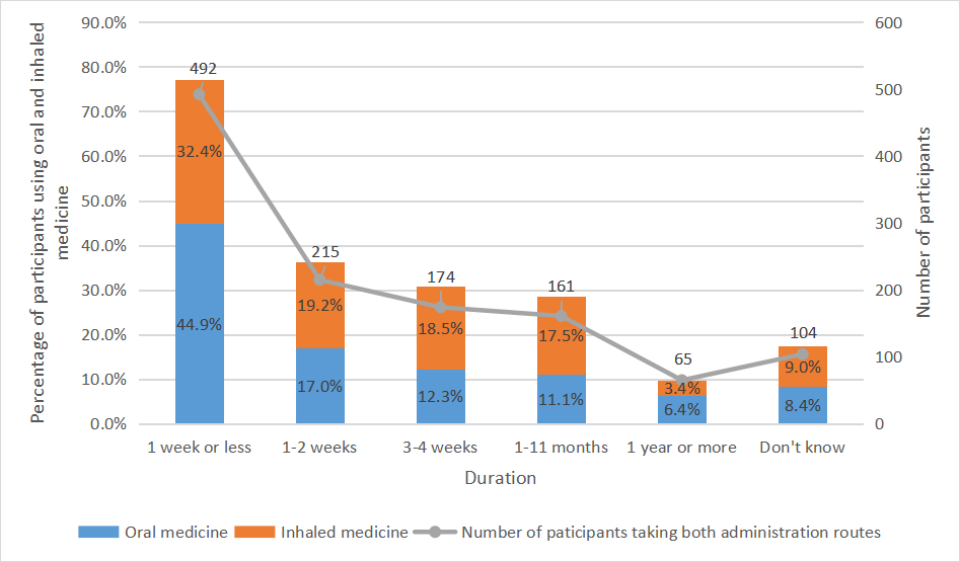

Fig 3. Number of participants using both administration routes according to duration of treatment.

3.2.2. Frequency of administration

Fig.4 shows the frequency of using an oral or an inhaled medicine among children studied. In terms of oral medicines, most of the children (42.1%; 337/800) took it twice daily. In contrast, four times a day was the least reported frequency for oral medications, accounting for only 0.8% (6/800). With regard to inhaled medicines, the percentage of children decreased as the frequency increased, and the percentages of four and three times a day were similar, accounting for 18.0% (74/411) and 19.0% (78/411), respectively. It is notable that some specific comments received implied that children only took inhaled medicines when suffering from chronic diseases, such as asthma. Moreover, only a few participants did not take medicines at a fixed frequency.

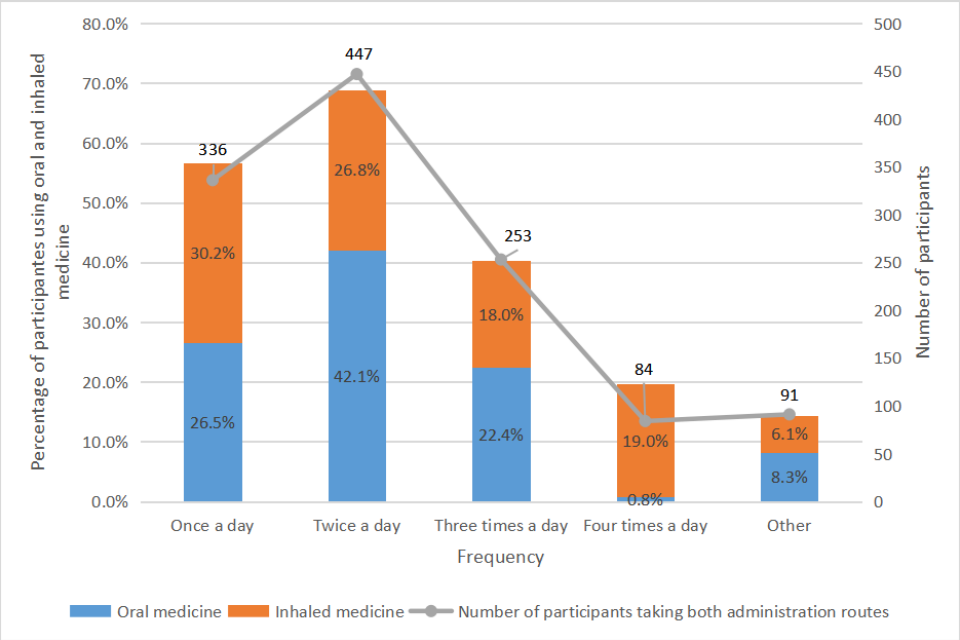

Fig 4. The frequency of children using oral and inhaled medicine

3.3. Oral administration

3.3.1. Oral dosage forms

Table 2 shows different oral dosage forms that children had recently taken according to 800 valid questionnaires. It was found that granules, syrup and tablets were the Top 3 commonly used oral dosage forms, accounting for 44.4% (355/800), 41.8% (334/800) and 36.1% (289/800), which may be due to the fact that such dosage forms were all relatively available and more commonly prescribed for children to take. As compared to other available oral dosage forms, capsules may be more difficult for children to swallow hence the smaller number of responses received for this dosage form Drops, on the other hand, were much less popular as a limited number of drugs were formulated in such dosage.

Table 2. Different oral dosage forms recently taken by children.

Oral dosage form	Number	Percentage*
Granule	355	44.4%
Syrup	334	41.8%
Tablet	289	36.1%
Suspension	272	34.0%
Capsule	223	27.9%
Drop	172	21.5%
Other	22	2.8%
Number of valid questionnaires	800	

*Calculation was based on multiple choices selected by each participant

3.3.2. Devices for oral administration

Measuring cups (47.3%; 378/800) and household spoons (41.1%; 329/800) were the two most commonly used devices for oral administration among all available devices according to data shown in Fig.5 In contrast, oral syringes (8.6%; 69/800) and droppers (17.4%; 139/800) both reported a smaller percentage of use. These observations reflect the accessibility of these particular oral administration devices in China. About 2.3% (18/800) of the participants used other devices such as water cups, bowls, or even bottle caps as the device to take oral medicines. Most of the participants who did not use any devices (5.5%; 44/800) explained that they received individual unit packages which were of great convenience while only one questionnaire commented that no precise measurement was required for the particular medicine taken by the participant. As shown in Fig 6, across all oral devices, the number of children

increased following the order 1- 4 < 5 - 9 < 10 - less than 18 years old. Interestingly, household spoons were the most commonly used (57.4%, 189/329) in the f 10 - less than 18 years old group but least used in the of 5 - 9 years old group who seemed to use measuring cups the most (41.8%, 158/378), which indicated that greater attention may be paid to accuracy of administered dose when selecting devices for younger children compared to older children and adolescents. Regarding ease of use, as illustrated in Fig 7, 74.1% (280/378) of measuring cup (the most commonly used oral device according to the above data analysis) children believed that it was very easy or easy to use. However, for oral syringes, only 50.7% (35/69) children thought they were easy or very easy to use, and 30.4% (21/69) found them to be very difficult or difficult to use.

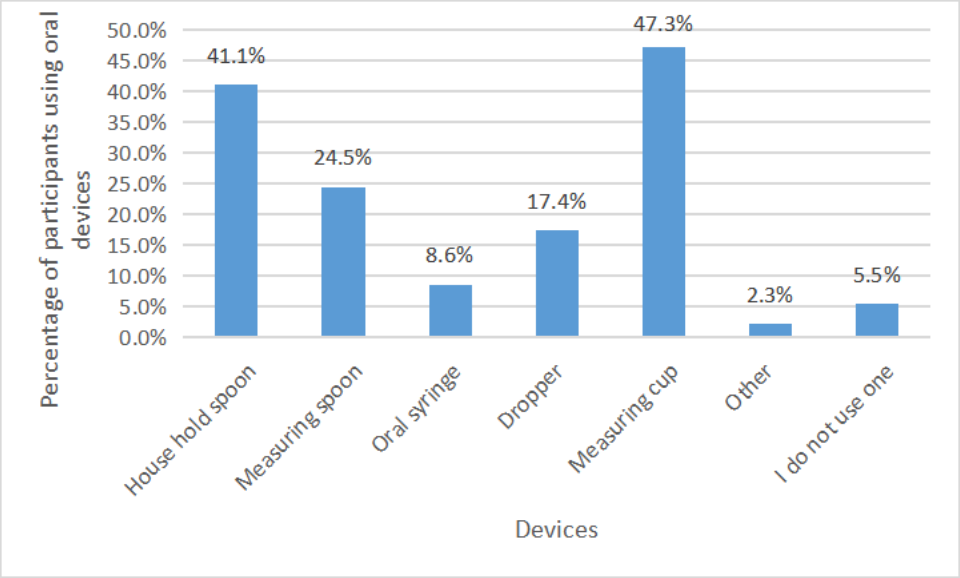

Fig 5. Devices for children to take oral medicines.

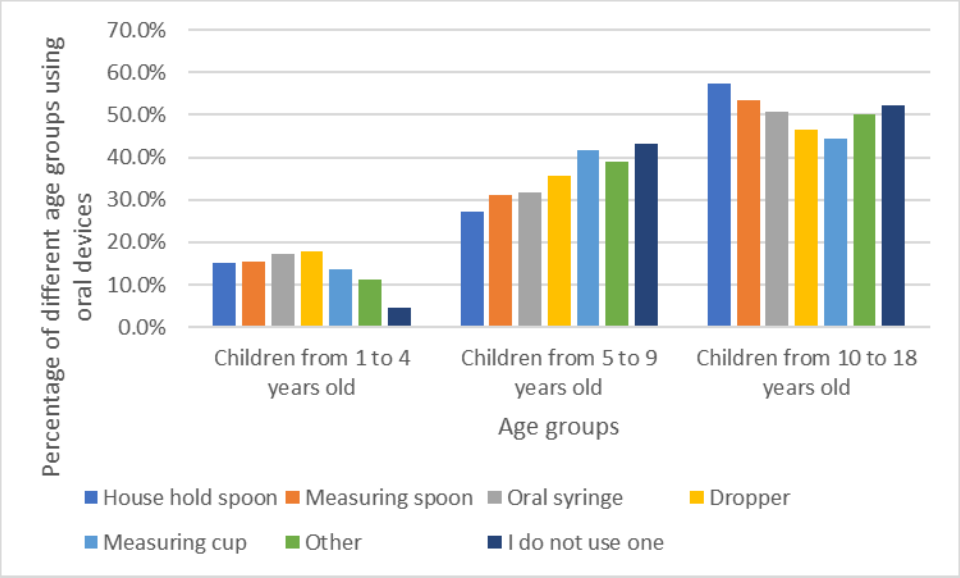

Fig 6. The use of oral devices in different age groups.

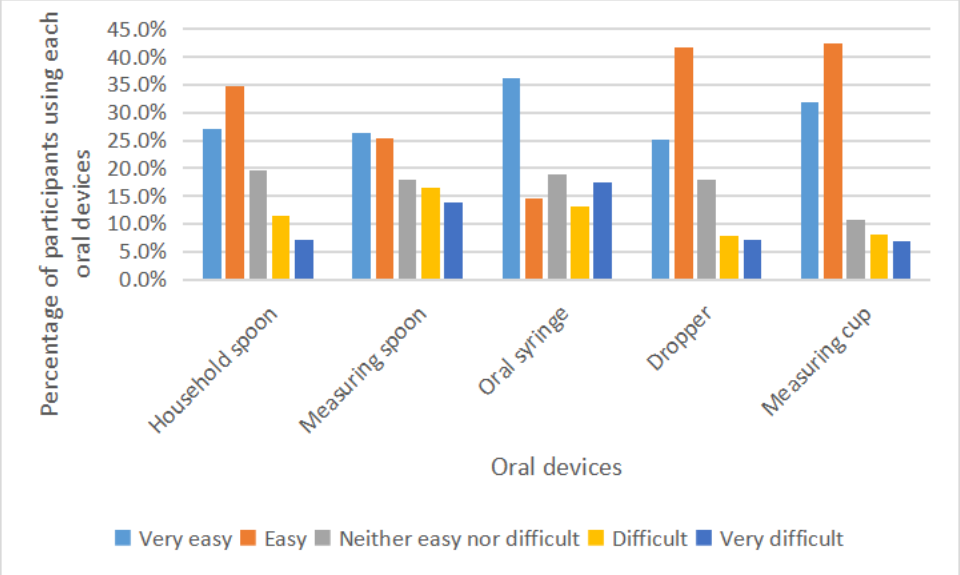

Fig 7. Ease of use of oral medicine devices.

Fig.8 shows the level of assistance provided by healthcare professionals on how to use oral devices. There was a consistent finding across all device groups that a significant percentage of children did not receive any demonstration. The percentage of 'No' was particularly high for those using household spoons (44.0%; 143/325) and measuring cups (44.4%; 168/378). This

might be partly because most healthcare professionals thought that measuring cups are relatively easy to use. Children who received demonstrations from healthcare professionals most often received them from doctors, followed by nurses and pharmacists. This may be due to the different roles of the three groups of healthcare professionals have been taking in China. For instance, when prescribing medicines, doctors are usually responsible for informing the children regarding precautions, dosing intervals, and administration methods, whilst the role of pharmacists is not very well defined. Overall, the role of pharmacists is less important in China compared to many western countries although the situation has been gradually improving over the past decade. Among those who chose "other", three participants said their parents would normally demonstrate for them and five mentioned that they usually learn how to use the oral device from the instructions provided.

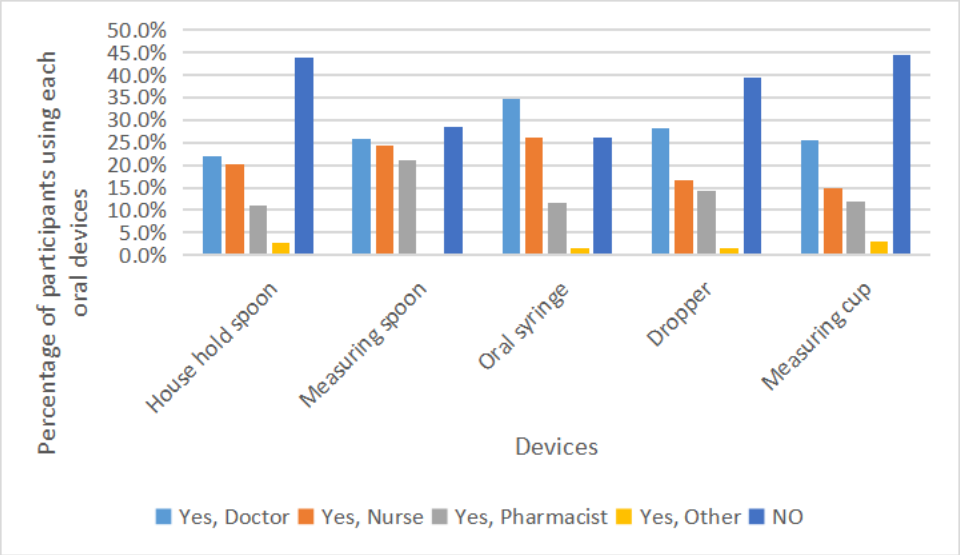

Fig 8. Healthcare professionals demonstrating how to use oral devices.

As seen in Fig. 9, more than 70% of participants received instructions with all oral devices except household spoons and, the clarity of oral device instructions was overall excellent. Most caregivers and children believed that oral device instructions were relatively easy to understand. Comparatively, instructions associated with the oral syringe group were the least satisfying in

terms of clarity where about 19% (12/63) children indicated "not clear".

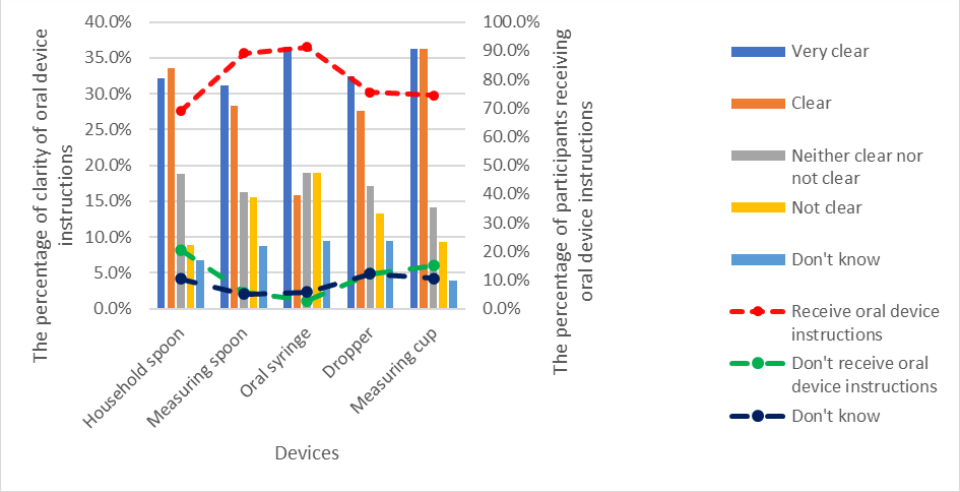

Fig 9. The percentage of participants receiving oral device instructions and clarity of such instructions.

3.3.3 Analysis of data among different age groups

Due to the wide age range of children investigated, a systemic analysis was carried out to better understand the difference in feedback on the ease of use of oral devices among three age groups, including Group A with children from 1 to 4 years old, Group B with children from 5 to 9 years old and Group C with children from 10 to 18 years old. The three age groups showed significant differences according to the Chi-Square statistical analysis ($P = 0.000367 < 0.05$).

As shown in Fig. 10, according to children and their caregivers, children aged 5-9 (Group B) found it are easier to use oral devices as compared to the other two groups. This finding was likely due to the fact that the feedback from children in this group was provided by their caregivers who were actually the ones operating the devices while a large proportion of children in Group C (10 – 18 years old) operated the devices on their own without any assistance and provided more negative feedback directly. As for Group A with the youngest children (1 – 4 years old), as expected, the caregivers found it difficult to manage the administration of

medicines to such small children using the oral devices provided. Fig. 11 illustrates the consistency between caregiver and child responses within the 10 - less than 18 years old group. According to the statistical analysis, P=0.242>0.05, there was no significant difference between caregivers and child responses in this year group and hence the consistency and accuracy of answers can be confirmed.

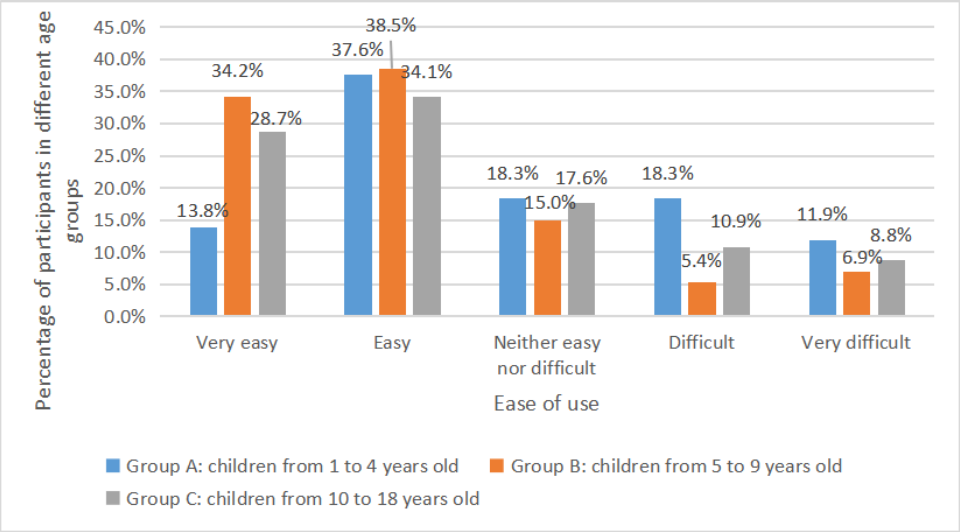

Fig 10. Ease of use with oral devices commented by different age groups.

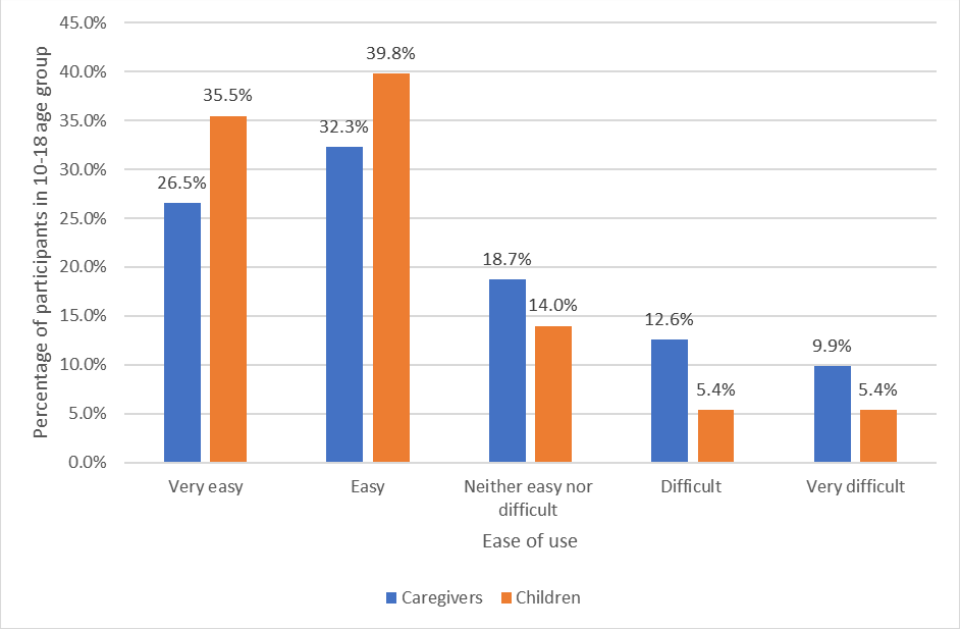

Fig 11. The responses from 10 - less than 18 years old children VS their caregivers about ease of use with oral devices.

3.3.4 Analysis of data between Northern and Southern regions

Data collated from southern and northern China where significant differences in living habits and culture exist have been analysed and compared. As shown in Table 3, granules and syrups became the Top 2 most often used oral dosage forms in each region. Children in the South seem to accept tablets well (Top 3), with a better acceptance of capsules than children from the north. However, tablets were one of the least administered/taken dosage forms in the North where suspension and drop were used more regularly. In terms of treatment duration, it can be observed from Table 4 that the majority of children (46.6% and 37.1%) in the South and North took oral medicines for up to one week. The proportion of children with chronic diseases who need long-term medication was relatively small across the country and only 4.7% required treatment for over 1 year in the South. There were no significant differences between the South and North with regard to the frequency of dosing. In terms of the selection of oral devices, as summarized in Table 5, people in the North used household spoons while a greater proportion in the South selected measuring cups. Fig. 12 shows that instructions on how to use oral devices

were better provided in the South (87%) than the North (77%, P = 0.014 < 0.05).

Table 3. Types of oral medicines used by children in different regions.

Area	Granules	Syrup	Tablet	Suspension	Capsule	Drop	Other
South	20.21%	19.95%	19.6%	15.93%	14%	8.42%	1.94%
North	22.72%	20.39%	10.87%	19.61%	9.90%	15.73%	0.78%

Table 4. Duration of oral medicines treatment for children in different areas.

Area	1 week or less	1-2weeks	3-4weeks	1-11months	1 year or more	Don't know	Total
South	46.6%	15.6%	12.1%	10.6%	6.8%	8.3%	59.7%
North	37.1%	20.3%	16.0%	16.0%	4.7%	5.9%	40.3%

Table 5. Types of oral devices used in different regions.

Region	Household spoon	Measuring spoon	Oral springe	Dropper	Measuring cup	Others	None
North	65	22	5	17	58	2	10
South	15	8	12	11	27	0	3

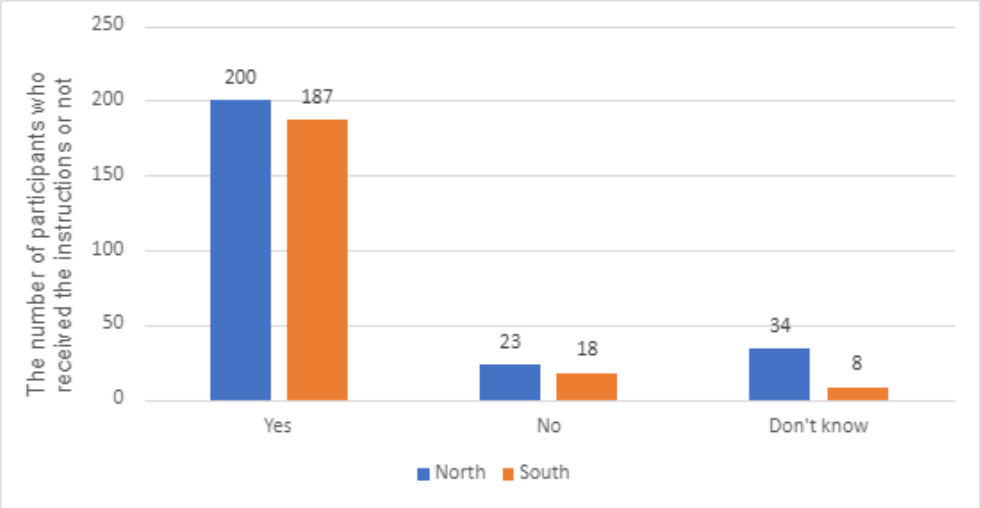

Fig. 12. Availability of instructions in different regions.

3.4. Inhalation administration

The two regional groups of participants showed dramatic differences in their answers about inhalation administration in the questionnaire, hence data analysis was carried out for caregivers and children separately in this section. As demonstrated in Table 8, the most often used inhalation device according to the caregiver group was nebuliser combined with facemask, accounting for 26.8% (85/317). The pressurised metered-dose inhaler (pMDI) combined with spacer was the least commonly used one, accounting for 13.2% (42/317), which was very similar to the breath-actuated pressurised metered-dose inhaler (43/317). This may be because nebuliser combined with facemask is less complicated and more accessible for children to operate, and this combination does not usually require demonstration or correction from healthcare professionals. As for the children group, nebuliser, spacer, and facemask were the Top 3 devices for inhalation administration, accounting for 37.2% (35/94), 36.2% (34/94) and 36.2% (34/94), respectively. In contrast, only 13.8% (13/94) of children reported using breath-actuated pressurised metered-dose inhalers, which showed the same trend as the caregiver group ($P = 0.018 < 0.05$).

Table 8. Type of inhalation devices children recently used.

	Caregiver participants		Children participants	
	Number	Percentage	Number	Percentage
Dry powder inhalers	55	17.4%	32	34.0%
Manually-actuated pressurised metered-dose inhalers	49	15.5%	33	35.1%
Spacer	74	23.3%	34	36.2%
Nebuliser	71	22.4%	35	37.2%
Breath-actuated pressurised metered-dose inhalers	43	13.6%	13	13.8%
Mist inhalers	49	15.5%	22	23.4%
Pressurised metered-dose inhalers & Spacer	42	13.2%	NA	NA
Nebuliser and Facemask	85	26.8%	NA	NA
Facemask	NA	NA	34	36.2%
Others	9	2.8%	NA	NA
Number of valid questionnaires	317		94	

Fig. 13 shows the responses from the caregivers and children over 10 years old in terms of the ease of use of inhalation devices. In the caregiver group, 29.7% (22/74) of spacer users thought it was very easy to use while 24.5% (12/49) of mist inhaler users felt it was very difficult to operate. In the children survey, however, breathing-actuated pressured metered dose inhalers

and mist inhalers were the Top 2 devices which were thought by most of their users to be very easy to use. It was interesting to find in the survey that a large proportion of breath-actuated pressured metered dose inhaler users also thought it was very difficult to use. These polarised opinions were the most obvious with this device as compared to others under investigation, which might be closely associated with the accessibility of instructions and/or demonstration provided by healthcare professionals, as discussed below.

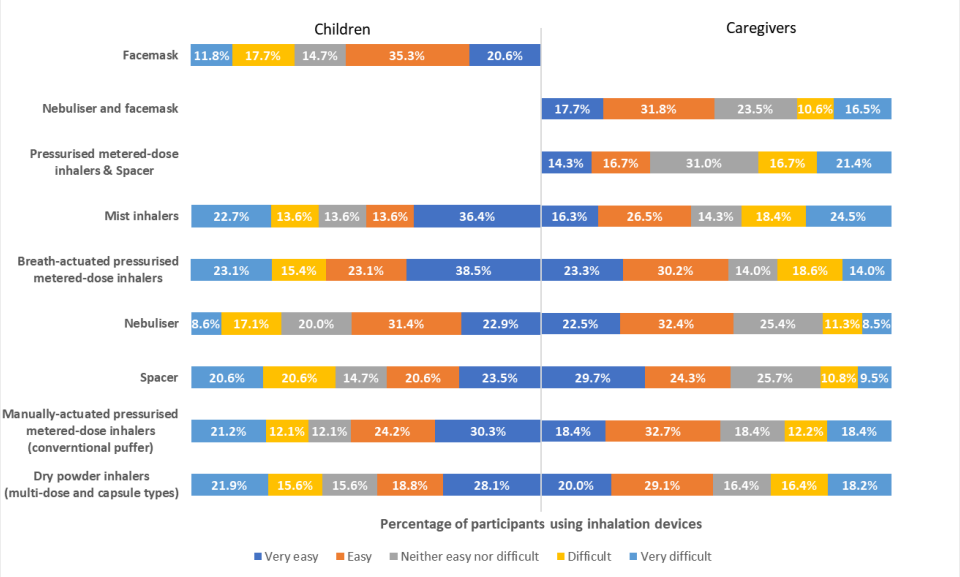

Fig 13. Ease of use of inhalation devices evaluated by caregivers and children.

Similar to the provision of oral devices by healthcare professionals, doctors and nurses were found to play a more important role in demonstrating inhalation device use compared to pharmacists. As shown in Fig. 14, according to the caregiver survey, the number of doctors demonstrating how to use spacers was the greatest, accounting for 41.9% (31/74, $P = 0.012 < 0.05$). In contrast, the percentage of doctors demonstrating the use of spacers in children survey was the lowest, only 23.5% (8/34, $P = 0.018 < 0.05$). In both the caregiver and children surveys, nebuliser and mist inhalers were found to be mainly demonstrated by the nurses and the role the pharmacists played in inhalation devices demonstration was very limited. Comparatively, the pharmacists were more involved in the demonstration of breath-activated pressured metered

dose inhalers, accounting for 34.9% (15/43, P = 0.018 < 0.05).

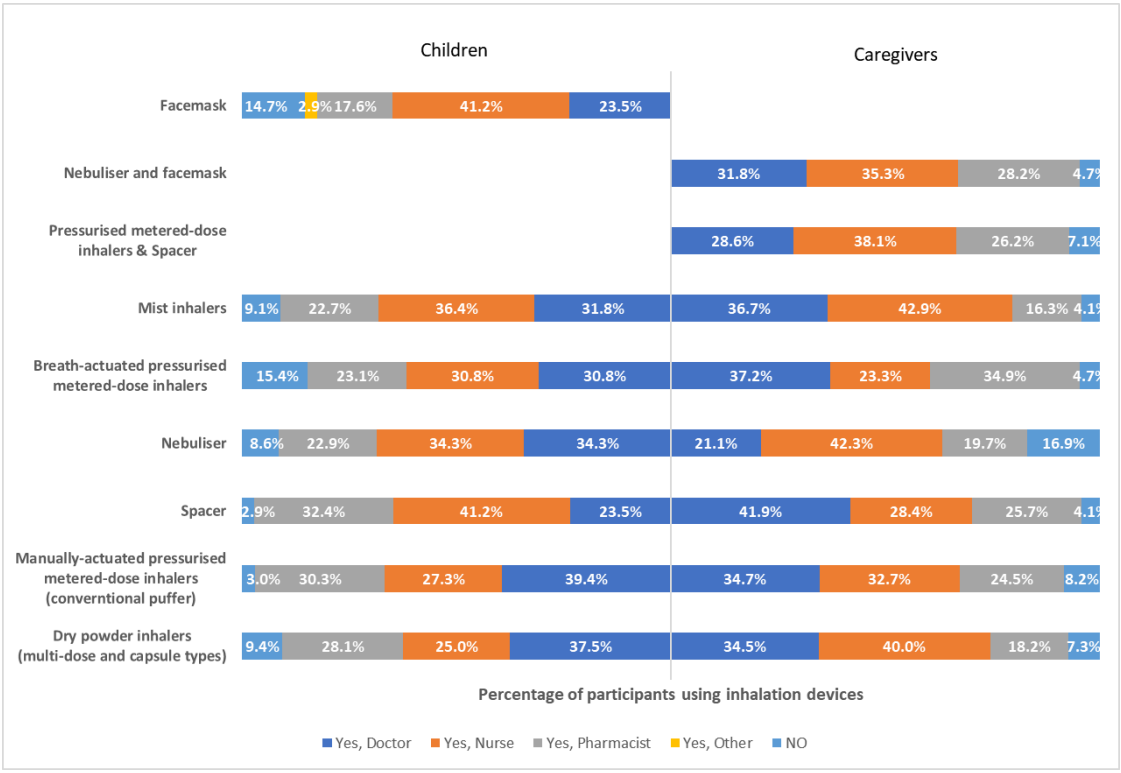

Fig 14. Healthcare professionals demonstrating how to use inhalation devices.

As indicated in Fig. 15, 62.5% of caregivers thought the instructions for dry powder inhalers were either clear or very clear. According to the children survey, however, this best place was replaced by manually-actuated pressurised metered-dose inhalers where positive comments were received from 63.6% children who used such a device.

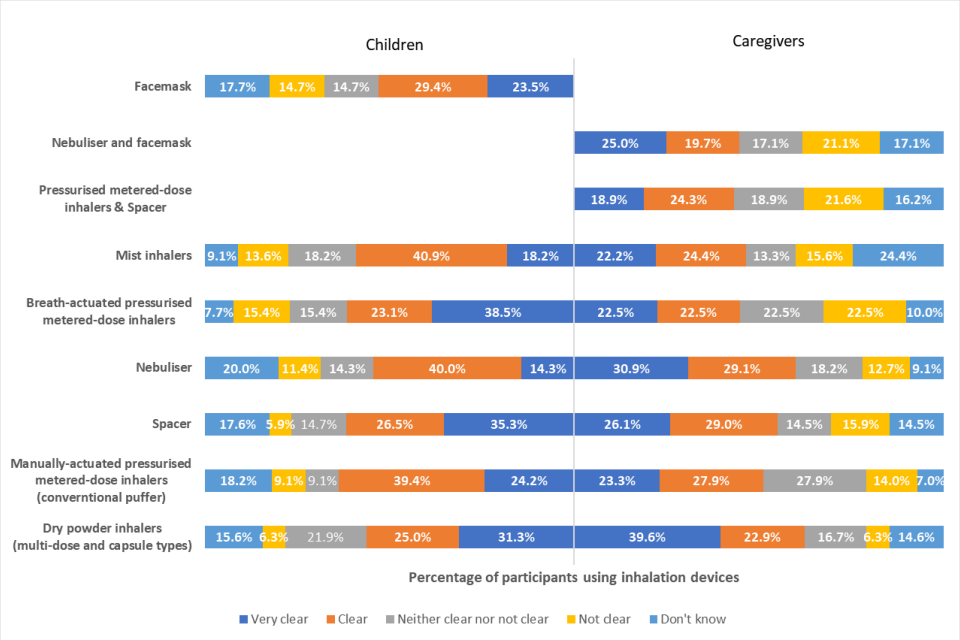

Fig 15. Clarity of instructions for inhalation devices.

3.5 Suggested improvement approaches

The questionnaire also collected suggestions from both caregivers and children on how to further improve oral and inhalation devices with a final view to making them more "user friendly". Some caregiver participants wanted to improve the clarity of the instruction manuals as well as the level of convenience in using them by introducing a video demonstration QR code. They believed that learning from the video can significantly improve the correctness, especially for children who use the devices by themselves and hence reduce dosage errors. As for the group of children participants, some would like to see an increased number of liquid medicines with improved taste. A common approach proposed by both groups was to use cartoon images and video animations when designing the devices and preparing instructions to reduce children’s resistance to taking medicines.

4. Discussion

This study provides valuable insights into the current use of oral and inhaled paediatric medicines and administration devices in China through a survey in children and their caregivers across various regions.

It is well known that oral liquid dosage forms may be preferred by and prescribed for children due to ease of swallowing and dose flexibility, which is consistent with our survey results where the number of syrup users exceeded the number of those taking tablet or capsule [16]. The research has also demonstrated the main groups using liquid formulations are children from 1-6, especially those who do not require long-term medication, which indicates that some non-chronic disease e.g. fever, cough, etc. mainly provide in the form of liquid [16]. In terms of oral devices, measuring cups, household spoons and measuring spoons were found to be commonly used in this survey. However, as inferred from the subjective feedback from a number of participants, the accuracy of dosing was indicated to be an important matter with the use of oral medicine devices, which is consistent with the study of Walsh, Math, Breitkreutz, Zerback and Wachtel [13]. More specifically, the accuracy of the household spoon was found to be worse than the measuring cup and the measuring spoon. Although the accuracy of the oral syringe is known as the best and it is also the most frequently oral device supplied in Europe [13], according to the survey results in China, an oral syringe was the least used device. It is interesting to note that during questionnaire collection, some participants asked what an oral syringe was, which indicated that this administration device is not commonly available and used in China.

Overall, oral medicines are more commonly used than inhaled medicines and more participants believed that oral devices are easy to use compared to inhalers. Whilst inhaled medicines have certain advantages over traditional medicine administration with regard to for example side effects [17], failure to use inhalation devices correctly is an important cause of problems in pulmonary administration [18]. Also, a low prescription rate may contribute to the seldom use of inhaled medicines. In addition, adherence to healthcare professionals' dosing instructions will also affect treatment outcomes [19]. In particular, it is very difficult for young children to learn to use inhalation devices correctly. For example, they may not be able to coordinate

inhalation with device actuation. Time and required dose can be a challenge for caregivers as well as children, and caregivers may forget to give a dose. Most children require the supervision and assistance of their caregivers and forgetting to take medicine is a frequent occurrence. Therefore, it is necessary to provide very clear instructions and it was previously suggested that using pictures to demonstrate the use of medical devices can effectively reduce dosing errors and therefore may improve adherence [20]. For instance, children can view the relevant animation by scanning the two-dimensional code, which can reduce children's fear of medicine. It is believed that pictures not only make the instruction more visual but also help healthcare professionals to better understand the operation and provide demonstrations accordingly [21, 22]. This suggestion agreed well with those put forward by the participants in the present survey.

Data analysis showed that the proportion of doctors and nurses demonstrating how to use the administration devices is much larger than that of pharmacists, for both oral and inhaled medication. This was similar to the previous findings in other countries [14] but more obvious in China. Although pharmacists play a very important role in western countries, including patient consultation, providing medicine information, and medicine supply management [23, 24], the role of pharmacists in China is still not very well defined and accepted by the public although they are more approachable to the children. It is hoped that with the development of paediatric pharmacists and an increasing emphasis on their roles in China, children and their caregivers will find it easier to secure assistance on medical device operation from the healthcare professional team.

The treatment duration of both oral and inhaled medicines showed a trend of fewer people with longer treatments. This trend was previously reported by Alessandrini, Walsh and Salunke [14] where oral medicines were used to treat minor illnesses while inhaled medicine was used for relatively long-term treatments for 1 year or above. In this study, the number of people who used an oral medicine for one year or longer was greater than those using an inhaled medicine for this time period, indicating that chronic respiratory diseases are not very common in Chinese children. In fact, the longest duration of inhaled medicine use was found to be several weeks or months but not longer than one year.

It is noted that responses on device use differed significantly among different age groups. As

compared to Groups A (Age 1-4) and C (Age 10-18), children in Group B (Age 5-9) show a tendency to use measuring devices for oral medicines most easily. Only 5.4% of caregivers and 6.9% of children in Group B thought the device was difficult or very difficult to use. Surprisingly, the percentage of caregivers and children from Group C (Age 10- <18) who thought the device was difficult or very difficult to use was more than those from Group B (Age 5-9). In order to clarify whether this result was due to a difference in subjective perception between caregivers and children in Group C, the data on the ease of use of the oral device completed by caregivers and children were separately analyzed and further compared in this study. However, the consistency of questionnaire responses between caregivers and children was reassured according to the statistical analysis, showing the responses of caregivers can well represent the responses of children. In this case, children from Group C found it more difficult to use oral devices probably due to lack of caregivers' guidance and assistance as a greater proportion of children in Group B (younger) found them very easy to use. Compared to smaller children, they are probably more independent in taking oral preparations without a caregiver. It would be interesting to provide more evidence regarding this hypothesis in our future studies by including a question to the children-caregiver pair group on "whether caregivers provide support to their children on using the administration devices".

In terms of regional differences, statistical analysis showed a majority of P values were greater than 0.001, indicating no significant differences in general. One difference was identified in the selection of oral devices where more caregivers in the North chose to use a household spoon for oral administration while those in the South preferred to use a measuring cup, which may be due to cultural differences between the North and South resulting in participants in the South placing more emphasis on dose accuracy.

This study has some limitations. Firstly, the sample size of the survey remains insufficient, with an uneven distribution of participants in terms of age and geographical location. Although the survey attempted to reach the vast majority of regions in China through internet platforms, the number of participants involved was still relatively small compared to the total population in the country, thus potentially not fully representing the current situation. Secondly, the survey did not address the influence of administration devices on patient adherence. In China, the

variety of paediatric medicine administration devices available is more limited than in Europe and the United Kingdom. Different devices may affect children's willingness to use them, especially among children, thus influencing adherence. Lastly, participants were asked to recall their experiences with medicine administration devices over a certain period, which may have introduced some recall bias.

To address these limitations, future research will attempt to focus on larger sample sizes and collect data from children of various age groups and from different regions more evenly, thereby better representing the overall paediatric device usage landscape in China. Additionally, the impact of medicine administration devices on patient adherence, such as Ease of long-term use, will be incorporated into the questionnaire to better guide the manufacturing and usage of paediatric devices. Furthermore, future surveys may try to gather information from healthcare professionals in medical institutions alongside the data collected from children, thus validating paediatric device usage from both perspectives and enhancing the credibility of the data. Finally, the present results collected from China should be systemically compared with other countries around the world, such as the UK, Europe and Japan, in order to better reflect the current scenario of the use of paediatric medical devices globally.

5. Conclusion

This survey-based study obtained a large volume of information with 964 valid questionnaires from both children and their caregivers in China about the use and perception of oral and inhalation medicines and administration devices. Oral dosage forms, particularly granules, syrup and tablets were found to be used more often than inhaled medicines. Measuring cups and household spoons were more commonly used for oral administration than oral syringes. While most of the inhalation devices had clear instructions or guidance from health professionals, there was a lack of instructions or guidance for oral devices, which varied with the age of children and the region. More intuitive instructions with a video demonstration QR code could be potential approaches to improve the usability of paediatric administration devices. Further surveys in a wider range of regions are required to increase its persuasiveness and establish guidelines for more appropriate device selection.

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