



THE ACCURACY AND QUALITY OF HOUSEHOLD SPOONS AND ENCLOSED DOSING DEVICES USED IN THE ADMINISTRATION OF ORAL LIQUID MEDICATIONS IN GHANA

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ABSTRACT

Administering the right doses of oral liquid medications is crucial to achieving therapeutic goals. These doses are measured with household spoons and dosing devices enclosed in product packages. We investigated the types of household spoons currently available, the types and extent of inclusion of dosing devices in oral liquid product packages and assessed the accuracy, quality, reliability and acceptability of the household spoons and enclosed devices in dosing oral liquid medications. Close to half (46 %) of orthodox and almost all (97 %) herbal oral liquid remedies in the Ghanaian market did not have enclosed dosing devices and will require the use of other devices mostly household spoons to deliver the required doses in their administration. Many people (95 %) used household spoons in dosing oral liquid medications and some (39 %) actually preferred them to enclosed dosing devices. The household spoons were mostly teaspoons and dessertspoons; tablespoons were very rare. Aside other defects, all the categories of household spoons had maximum volumes significantly different from; 5 ml (teaspoonful) (4.3 ± 1.7), 10 ml (dessertspoonful) (8.25 ± 2.5) and 15 ml (tablespoonful) (13.5 ± 1.2), respectively ($P < 0.05$); hence were inaccurate and can lead to oral liquid medication dosing errors. The medicine cup was the most common (80 %) dosing device and measured relatively large volumes (5-20 ml) which were not significantly different ($P < 0.05$) from the expected calibrations. The enclosed medicinal spoons (12 %) had defects similar to their household counterparts and measured volumes (5-10 ml) which were different from expected ($P < 0.05$). The enclosed oral droppers and syringes (8 %) measured volumes (≤ 5 ml) more accurately. The oral syringe was the most accurate and convenient dosing device. The results strongly support the assertions that household spoons are inaccurate and their use for dosing oral liquid medications is anachronistic and should be discouraged.

Keywords: Household spoons enclosed dosing devices, oral liquid medications, dosing errors.

INTRODUCTION

Oral liquid pharmaceutical dosage forms are widely accepted and used, especially in paediatric and geriatric care. Their efficacy and effectiveness depend on the right dosaging. The dose in these products is determined and measured in terms of a certain volume of the product. With the advent of modern medicine, household spoons were established as standards used for measuring the doses of oral liquid medications, where the teaspoonful, dessertspoonful and tablespoonful were designated and accepted to measure 5 ml, 10 ml and 15 ml of liquid product, respectively^{1,2}. Since then, the shapes, sizes, forms and make of these household spoons, especially in the Ghanaian society, have varied tremendously with likely consequences of dosing errors. In recent times the inclusion of various forms of dosing devices in oral liquid medication packages is aimed at improving dosing efficiency^{3,4}. However, some products including herbal remedies do not come with enclosed dosing devices. As such, instructions are still being given to patients involving the use of household spoons as

measures for oral liquid medications. The current research therefore, sought to determine the types of household spoons currently available, the extent of inclusion of dosing devices in oral liquid product packages and to assess the quality, accuracy, reliability and acceptability of the current household spoons in Ghana and the manufacturers enclosed measures in delivering the required doses of oral liquid medications.

MATERIALS AND METHODS

Materials

A random sample of 1000 household spoons [i.e. 500 teaspoons and 500 non-teaspoons (dessert and tablespoons)] made of plastics, aluminum or mostly stainless steel were obtained from various homes, markets, chop bars, schools and restaurants in the Ho, Accra and Kumasi. Also, 500 dosing devices (i.e. 200 medicine cups, cylinders and wells; 200 medicine spoons and 100 medicine pipettes, droppers and syringes) found enclosed in oral liquid medications packages were randomly sampled from 100

Pharmacies in Accra and Kumasi. Distilled water and 5, 10 and 30 ml microburettes were also used in the experimentations. A 100 questionnaire was also administered to the inhabitants of Kumasi and its environs to which 97 responded.

Methods

Surveys were conducted in Ho, Accra and Kumasi to ascertain the types of household spoons currently in use, the extent of inclusion and types of dosing devices in oral liquid medication packages, from which the samples were obtained and evaluated. The maximum capacities of the 1000 household spoons and the volumes of the various graduations of the 500 different dosing devices were determined from the microburettes using distilled water. The physical quality of these devices in terms of the material of construction, size, shape, colour, design and transparency, ease of handling and reading of marks of calibration were also assessed and the responses to the questionnaire used to determine the public perception and preference of household spoons or enclosed dosing devices as measures for oral liquid medications. The frequency distributions and descriptive statistics for all the variables were then calculated and the results subjected to Chi-square analysis, grouped t-tests and analysis of variance techniques.

RESULTS AND DISCUSSION

The results of the survey revealed that close to half (46 %) of orthodox and almost all (97 %) herbal oral liquid remedies in the Ghanaian market did not have enclosed dosing devices and will require the use of other devices mostly household spoons to deliver the required doses in their administration. Many people (95 % respondents) used household spoons in dosing oral liquid medications and some (39 %) actually preferred them to enclosed dosing devices.

The American Academy of Pediatrics (AAP) Committee on Drugs in a 1975 study, reported 75 % of patients used a household teaspoon or kitchen measuring spoon when dosing liquid medication⁵. In another study from Israel, 80 % of the children were given medications by a household teaspoon⁶. A similar report in 2000 from Minnesota (USA) indicated a household teaspoon was the device most frequently used (73 %) for measuring liquid medications⁷.

However, both the investigators in this survey and the public had a difficulty in the physical identification and classification of the current household spoons as tea, dessert and tablespoons. 70 % of the respondents could identify only one spoon type correctly. So for ease of analysis we grouped them into teaspoons and non-teaspoons (Figs. 1 & 2).

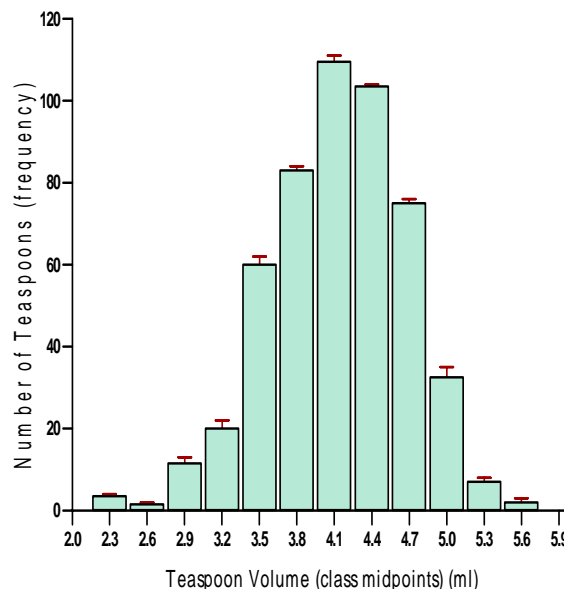


Fig. 1: It shows the maximum liquid volumes obtained from the household teaspoons: values are mean \pm SEM of n = 5.

All the categories of household spoons had maximum volumes significantly different from; 5 ml (teaspoonful) (mean \pm SD; 4.3 \pm 1.7) (Fig. 1), 10 ml (dessertspoonful) (mean \pm SD; 8.25 \pm 2.5) (Fig. 2) and 15 ml (tablespoonful) (mean \pm SD; 13.5 \pm 1.2 (Fig. 2), respectively ($P < 0.05$); hence were inaccurate and if used can lead to oral liquid medication dosing errors (underdosing). Although less serious than overdosing in terms of morbidity, underdosing is known to lead to ineffective therapy, drug resistance and unnecessary frequent clinical visits^{4,8}.

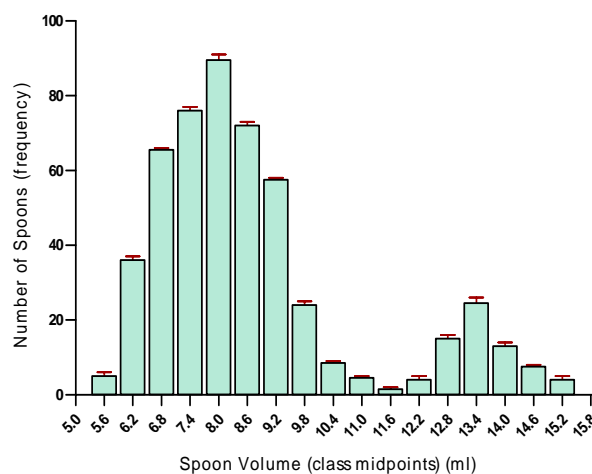


Fig. 2: It shows the maximum liquid volumes obtained from the household non-teaspoons: values are mean \pm SEM of n = 5.

The volume capacities of the household spoons indicated they were mostly teaspoons (50 %) and dessertspoons (47 %); tablespoons were very rare (3 %) (Fig. 3). The spoons in the last category were mostly made of aluminum and plastics, and were found with the low class societal groups such as the local chop bars. Those of stainless steel construction and special design were found with the elite and in the 3-5 stars rated hospitality concerns. The issues of poor identification of the correct spoon type, unavailability, profound variations, difficulty in handling and spillage during use have reduced further the reliability of household spoons to deliver accurate, safe and effective doses of oral liquid medications.

The American Academy of Paediatrics (AAP) Committee on Drugs described the inaccuracies of administering liquid medications by household spoons nearly 34 years ago, and recommended the use of more appropriate liquid administration devices⁵. Madlon-Kay and Mosch⁷, re-emphasized that clinicians need to be aware that many people continue to use inaccurate devices such as household spoons for measuring liquid medications. The United States Food and Drug Administration (FDA) have also warned that patients should put away their household spoons and use a more accurate measure when taking liquid medications⁹. However, to the best of our knowledge, the Food and Drugs Board (FDB) of Ghana has no regulation or warning on the use of household spoons for dispensing oral liquid medications.



Fig. 3: It shows some of the household spoons encountered in the Ghanaian market: from left to right; teaspoons (1-3); dessertspoons (4-8) and tablespoons (9-10).

Limited information is available about the current use of liquid medication dosing devices in Ghana. It is therefore, proper to envisage that the use of enclosed measures in packages of oral liquid pharmaceutical products could eliminate the difficulties and

inaccuracies associated with the use of household spoons as measures for oral liquid administration.

The medicine cups, wells and cylinders were the most common (80 %) enclosed dosing devices (Fig. 4) and measured relatively large volumes (5-20 ml) which were not significantly different ($P < 0.05$) from the expected calibrations (Table 1). Therefore, these devices were relatively accurate and can be relied upon to effectively and efficiently deliver specific doses of oral liquid medications, if used correctly. They also possessed other advantages including ease of handling and use and are less prone to spillage, especially if the volumes of the liquid or calibrations are well below the rim of the device.

However, some of these medicinal wells, cups and cylinders were either rough, non-transparent, deeply coloured, or had unclear and crowded calibration marks which made reading difficult. There is therefore, the need to overcome these defects in order to enhance their effective and efficient use.



Fig. 4: It shows dosing devices found enclosed in oral liquid medication packages: medicine cups, wells and cylinders (left); medicinal spoons (middle) and oral pipettes, droppers and syringes (right).

The enclosed medicinal spoons (12 %) had defects similar to their household counterparts and measured volumes (5-10 ml) which were significantly different from the expected ($P < 0.05$) (Table 1). The enclosed oral droppers and syringes (8 %) (Fig. 4) measured volumes (≤ 5 ml) that were not significantly different from the expected calibrations ($P < 0.05$) (Table 1). However, some of the droppers either did not function properly or leaked badly and could not be used, indicating the need to ensure quality.

The oral syringe was the most accurate and convenient dosing device. In fact its efficiency is enhanced by the ease of handling and lack of spillage during drug administration. It also reduces the risk of possible

gagging and aspiration of medication. Other reports have indicated that the oral dosing syringe is felt as the

best device for the delivery of oral liquid medications^{3,4,7,10}.

Table 1: It shows the volumes of liquid obtained with the dosing devices enclosed in oral liquid medication packages and the results of a one-way ANOVA.

Expected volume (ml)	Range of volumes measured (ml)	Average volume (mean ± SD of n=5)	One-way ANOVA (P<0.05)
Medicinal cups, wells and cylinders			
2.5	2.1 – 3.5	2.4 ± 0.3	n/s
5.0	4.0 – 6.2	5.3 ± 0.4	n/s
10.0	8.7 – 11.0	9.7 ± 0.5	n/s
15.0	14.0 – 16.0	14.8 ± 0.6	n/s
20.0	19.0 – 20.5	19.5 ± 0.5	n/s
Medicinal spoons			
2.5	2.7 – 3.2	2.8 ± 0.4	s/d
5.0	5.3 – 6.1	5.8 ± 0.3	s/d
10.0	9.0 – 10.2	9.4 ± 0.6	s/d
Medicinal Pipettes, droppers and Syringes			
0.2	0.19 – 0.22	0.20 ± 0.02	n/s
0.4	0.39 – 0.40	0.40 ± 0.01	n/s
0.5	0.50 – 0.53	0.52 ± 0.03	n/s
0.6	0.61 – 0.62	0.61 ± 0.02	n/s
0.8	0.80 – 0.84	0.82 ± 0.04	n/s
1.0	0.98 – 1.18	1.10 ± 0.05	n/s
2.0	1.95 – 2.20	2.00 ± 0.21	n/s
3.0	3.00 – 3.25	3.10 ± 0.25	n/s
4.0	3.98 – 4.25	4.00 ± 0.20	n/s
5.0	5.05 – 5.10	5.00 ± 0.10	n/s

s/d – significantly different from the expected value; n/s – not significantly different

CONCLUSION

The results strongly support the assertions that household spoons are inaccurate and their use as measures for 5 ml (teaspoonful), 10 ml (dessertspoonful) and 15 ml (tablespoonful) of oral liquid medications is anachronistic, inappropriate and should be discouraged. The oral medicinal syringe should be the device of choice for all small dose (≤5 ml) oral liquid medications and the medicinal cups for relatively large (5-20 ml) doses. All such devices should be neat and transparent with clear, easy to read, accurate marks of calibration located well below the rim, and designed to fit the bottle, jacket or package appropriately. Physicians and Pharmacists should therefore, insist on the use of the most appropriate dosing device when prescribing and dispensing oral liquid medications.

ACKNOWLEDGEMENT

The authors wish to thank the technical staff of the Department of Pharmaceutics, College of Health Sciences, KNUST, Kumasi, Ghana.

REFERENCES

1. Carter SJ, editor. Cooper and Gunn's dispensing for pharmaceutical students. 12th ed. London: Pitman Medical Publishing Ltd; 1975: 4-8.
2. Ansel HC, Popovich NG, Allen LV. Pharmaceutical dosage forms and drug delivery systems. New York: Lippincott William and Wilkins Publishers; 1995: 20-25.
3. McKenzie M. Administration of oral medications to infants and young children. *US Pharmacist* 1981; 55-67.
4. John JM. Preventing medication errors at home. *Journal of Pharmacy Practice* 2005; 18 (3): 141-44.
5. Committee on Drugs. Inaccuracies in administering liquid medication. *Pediatrics* 1975; 56: 327-28.
6. Hyam E, Brawer M, Herman J, Zvieli S. What's in a Teaspoon? Underdosing with acetaminophen in family practice. *J Fam Pract* 1989; 6: 221-23.
7. Madlon-Kay DJ, Mosch FS. Liquid medication dosing errors. *J Fam Pract* 2000; 49 (8): 741-44.
8. Jonville A, Autret F, Bavoux F, Bertrand P, Barbier P, Gauchez A. Characteristics of medication errors in pediatrics. *Ann Pharmacotherapy* 1994; 25: 1113-17.
9. Kurtzweil P. Liquid Medication and Dosing Devices. *FDA Consumer* 1994: 6-9.
10. Sobhani P, Christopherson J, Ambrose PJ, Corelli RL. Accuracy of oral liquid measuring devices: comparison of dosing cup and oral dosing syringe. *Ann Pharmacotherapy* 2008; 42 (1): 46-52.