

Getting the consistency right in thickened liquids using Viscgo Sticks: A validation study

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Abstract

Background: Dysphagia is a condition whereby a person's ability to swallow, eat and drink is impacted. One strategy to manage dysphagia and aid safe swallowing is the modification of food and drink, including using thickening agents to thicken drinks. Drinks are thickened to levels appropriate to a person's swallowing abilities and the underutilised 'syringe flow test' is currently the recommended method for checking thickness levels. Viscgo Sticks were developed as a practical alternative to the flow test.

Methods: This is a real-world validation study designed to determine validity and reliability of Viscgo Sticks. Independent researchers and healthcare professionals tested Viscgo Sticks (Viscgo Limited) against the flow test in three levels of thickened drinks. Researchers also conducted tests with different thickening agents and different drink types: water, milk, orange juice and hot tea.

Results: The intra- and inter-rater reliability of Viscgo Sticks was moderate to almost perfect ($\kappa = 0.45\text{--}0.98$) within and between researchers and substantial ($\kappa = 0.66\text{--}0.67$) within and between healthcare professionals. When tested by researchers and healthcare professionals against the flow test, Viscgo Sticks correctly classified 83.33%–100% of thickened drinks with high accuracy (area under curve = 0.70–1.00).

Conclusions: A simple and reliable tool like Viscgo Sticks, which can verify a prescribed thickness level of liquid, is invaluable in healthcare settings where day-to-day drink preparation occurs. Overall, Viscgo Sticks provide a reliable and valid means to test thickened drinks in clinical practice with a few exceptions identified.

KEYWORDS

agreement, dehydration, dysphagia, swallowing difficulties, validity, Viscgo Sticks

Highlights

- Viscgo Sticks are available as a practical alternative to the International Dysphagia Diet Standardisation Initiative (IDDSI) flow test for assessing the level of thickened drinks.
- This was a real-world validation study designed to determine the reliability of validity of Viscgo Sticks when tested in thickened drinks by independent researchers and healthcare professionals.
- Viscgo Sticks correctly classified 83.33%–100% of thickened drinks with high accuracy.

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- Viscgo Sticks provide a reliable and valid means to test thickened drinks, which is invaluable in healthcare settings where day-to-day drink preparation occurs.

INTRODUCTION

Dysphagia is a term used to describe a swallowing disorder, which can affect an individual's ability to eat and drink.¹ Dysphagia can be caused by a wide range of factors but is usually a symptom of old age or diseases, including mouth or throat cancer, functional disorders, brain tumours, stroke and other neurological conditions.^{2–5} It is a serious condition and, if left untreated, can lead to pulmonary aspiration, malnutrition, dehydration, pneumonia and death.^{3,4,6} Effective management of dysphagia is crucial for reducing serious health risks and improving patients' quality of life.

Dysphagia management often involves dietary modification strategies to ensure adequate nutrition and hydration.⁵ Diet modification is not a standalone approach and patients can require additional supportive strategies, including oral nutritional support, enteral feeding and targeted feeding.^{7–9} A frequently used diet modification strategy is the provision of texture-modified foods and thickened drinks. Thickened fluids are more cohesive and move more slowly in the mouth than non-thickened, which may make it easier to swallow and can reduce the risk of aspiration and choking.^{1,3,10–15} However, it is also important to provide drinks that are not over thickened but of the correct viscosity for a person's swallowing abilities. If a drink is too thick, it increases the risk of residue being left in the throat after swallowing, which may be aspirated or cause choking.^{13,16} Thicker drinks are also often perceived as less palatable and lead to a feeling of fullness, which may result in drinks being left and an increased risk of dehydration.¹⁷

In 2016, international terminology and definitions were released in response to the need for appropriate, consistent management of modified food and drink in dysphagia. This is known as the International Dysphagia Diet Standardisation Initiative (IDDSI).¹⁸ The IDDSI framework recommends different thicknesses of fluid, from thin (Level 0), to extremely thick (Level 4). The thin consistency (Level 0)

flows like water, whereas the extremely thick consistency (Level 4) is like pureed food and is consumed with a spoon. The IDDSI also devised a method that could be used to assess level of thickness in fluids; “the IDDSI syringe flow test”, referred to from this point as “the flow test”. In clinical practice, the flow test can be used as a criterion measure for testing that thickened drinks adhere to the consistency prescribed for each person with dysphagia. The flow test determines the level of thickness by allowing the liquid to flow through a 10-mL syringe for 10 s, then noting how much fluid remains in the syringe.¹⁸ Although this test is simple, it can reliably categorise a wide range of liquids in agreement with current laboratory tests, based on rate of flow.¹⁹ However, the authors of the published IDDSI framework acknowledge that they would not expect the flow test to be performed routinely¹⁸ and it is unlikely that hospital staff and care staff in the community would undertake this test every time an individual needs a drink. Moreover, the flow test requires the use of a certain type of syringe with a specific barrel length and all syringes should be tested before use to ensure accuracy. The syringe test can also be difficult to undertake when drinks are hot and, in general, testers need good hand dexterity.

In the absence of a practical method for testing drink thickness quickly and routinely, Viscgo designed and patented Viscgo Sticks (Viscgo Limited) (Figure 1),²⁰ with the aim being to make it easier to test thickened drink consistencies for people with dysphagia at the point of preparation and serving.

Viscgo's patented Drink Thickness Test Sticks (Viscgo Sticks) are medical devices that are commercially available and are a quick, easy and practical way to test thickened drinks for people with dysphagia and ensure the correct prescribed consistency. During development, proof of concept was established and Viscgo Sticks were calibrated against standardised liquids matching the IDDSI framework.

The present study is a real-world validation study designed to assess the validity of Viscgo Sticks against



FIGURE 1 Viscgo drink thickness test sticks. Image provided with permission from Viscgo Limited.

the current criterion measure (IDDSI flow test) and to test how reliable the sticks are when used by different healthcare professionals.

In the UK, there are several thickening products available that are prescribed for people with dysphagia. Thickeners are made from either starch or gum. The present study focuses on gum-based thickeners only, which are preferable for dysphagia management, offering better palatability and improved stability of thickness over time and different temperatures.^{21–25} In addition, experimental investigations with different types of thickener have confirmed the perception of gum-based liquids being ‘slippery’ compared to other types of thick liquid, making them a suitable option for successful swallowing.¹⁹

Aim and objectives

The aim of this project was to confirm the validity and reliability of Viscgo Sticks when undertaking independent testing using different types of thickened drinks, thickened to IDDSI Levels 1–3 with three thickening agents. The objectives included assessing the intra- and inter-rater reliability of Viscgo Sticks used by independent researchers and healthcare professionals and determining the validity of Viscgo Sticks against a criterion measure (the flow test).

METHODS

Study design

This is a validation study to test criterion validity and reliability to determine how accurate and reproducible Viscgo Sticks are when used by a range of healthcare professionals. The study was conducted and reported using the Guidelines for Reporting Reliability and Agreement Studies (GRRAS).²⁶ Viscgo Sticks were tested by independent researchers and healthcare professionals between March 2023 and May 2023. Healthcare professionals were recruited to the study by virtue of their professional role and were only asked to give their opinion in context of their work area. We therefore used the University of Manchester Ethics assessment flow chart to formally obtain ethical exemption from formal committee approval system. A data management plan was made in relation to data storage and dealing with any identifiable personal data.

Independent raters

Testing of Viscgo Sticks was conducted by independent raters, including researchers (DJ and KA) from the University of Manchester and healthcare professionals

working in Greater Manchester NHS Trusts and care homes, who had experience of managing dysphagia. We excluded NHS or care home staff who did not have suitable experience of managing dysphagia. Study details were advertised to healthcare professionals through emails, newsletters and paper-based posters. Those who were interested in participating contacted the researchers who then provided further details, a participant information sheet and consent form. Raters were given time to read the participant information sheet and ask any questions. If they wished to proceed, they were asked to sign and return the consent form before participating. All raters were offered a gift voucher in exchange for their time.

Study standards

During testing, documented standard operating procedures were followed. In brief, three levels of drink thickness (IDDSI framework Levels 1–3) were used for all tests, excluding Levels 0 and 4 (Level 0 being standard fluid without thickener that does not require validation and Level 4 being too thick to pour and so too thick for Viscgo Stick testing). Tests by both researchers and healthcare professionals were conducted at room temperature and on a flat surface. Where tests were repeated, they were conducted consecutively and immediately, unless stated that repeat tests were timed, in which case the time between tests is provided below under procedure explanations. During testing, the Viscgo Sticks were used first and the flow test second to ensure that the flow test did not affect the consistency of the fluid. Temperature was measured in all drinks using a calibrated thermometer to ensure that the drinks were tested at the intended serving temperature. Each researcher and each healthcare professional worked individually and tested each drink independently from other raters. To minimise discrepancies between drinks of the same thickness level, drinks for both the researcher testing and healthcare professional testing were made by the researchers who followed the manufacturer's instructions for each thickener and level.

Training on use of the Viscgo Sticks and flow test was undertaken by the independent researchers prior to the start of testing. One of the researchers (DJ) used this training to inform the healthcare professionals on the correct use of the Viscgo Sticks and flow test. Each thickness level of a drink (i.e., Levels 1–3) has corresponding Viscgo Sticks that test whether a liquid is too thin, too thick or of the correct thickness. Sticks will either remain standing in the liquid or fall over within a 10-s time frame to indicate whether a drink is of the correct consistency (Figure 2). Full details of how the sticks were used can be found in the Supporting information (Table S1).



FIGURE 2 Viscago Stick test results. Image provided with permission from Viscgo Limited.

For the flow test, thickness level is determined by allowing the liquid to flow through a 10-mL syringe for 10 s as described on the IDDSI website on the framework documents.^{18,27} The amount of liquid left in the syringe after 10 s quantifies the liquid's IDDSI level: Level 1 = 1–4 mL, Level 2 = 4–8 mL and Level 3 = 8–10 mL.²⁷ The IDDSI flow test can have inconsistencies despite experimental investigations confirming it to be reliable.¹⁹ To reduce the risk of these inconsistencies occurring during our testing, we followed the guidance of IDDSI as described in the IDDSI framework documents.^{27,28}

To fully test the Viscago Sticks for reliability and validity, we conducted three procedures as detailed below. The Viscago Sticks and flow test were used to test each level of drink within each procedure, where drinks were made consistently to each thickness level by the same researcher. It was assumed that drinks were of the consistency level that was intended, although it was also recognised that some drinks may not be of the consistency level they were made to, possibly as a result of error when making the drinks or inaccuracies in the manufacturer's measuring scoops or manufacturer's instructions. Therefore, each level was tested for agreement based on whether the sticks and flow test agreed, or not, on the drink consistency being of the assumed level being tested. We recorded a “pass” or “fail” result for each test to indicate whether the test was passed for the assumed level of drink. If both the stick test and flow test failed or both passed, then this was recorded as an agreement. However, the exception to this was when both the stick test and flow test failed but in opposite directions (i.e., the stick test suggests the drink is too thin for the level being tested but the flow test says too thick) and it was then assumed that there was an error in testing and the results were discarded and tests were performed again. One researcher was present at all healthcare professional tests to ensure that tests were repeated if the above scenario occurred.

Because of the nature of the study design, it was not possible to blind raters. This is attributable to the Viscago

Sticks and the way they have been designed. Within each set of sticks, there are three pairs of sticks. Each pair of sticks tests a particular level, and the rater is required to use the correct pair of sticks for the level being tested. Therefore, the assessor is required to know the level and cannot be blind to it.

Procedure 1

Procedure 1 was designed to test the reliability and validity of Viscago Sticks in different gum-based thickeners. Two independent researchers (DJ and KA) tested three consistencies (IDDSI framework Levels 1–3) of water thickened using three gum-based thickening agents (nine drinks). The temperature of the drinks was recorded and then thickness was tested in each drink using Viscago Sticks, followed by the flow test. For each drink this process was carried out 20 times with the fluid stirred after each flow test. Both researchers completed 60 tests for each thickening agent (three levels of thickness, tested 20 times) and therefore each completed 180 tests for all three thickening agents. For the intrarater reliability, one researcher (DJ) repeated all 180 tests.

The three gum-based thickening agents were Thick & Easy Clear (Fresenius-Kabi), ThickenUp Clear (Nestle) and Nutilis Clear (Nutricia), referred to from this point, in no particular order, as Thickeners ‘K46’, ‘T7X’ and ‘RL3’. The remaining two procedures (detailed below) all used one thickening agent, which was identified in this first procedure as having the greatest level of reliability and validity compared to the criterion measure.

Procedure 2

Procedure 2 was designed to test the reliability and validity of Viscago Sticks when used overtime in cold thickened orange juice, cold thickened whole milk, and

hot thickened black tea made with a splash of milk and one sugar. Two researchers (DJ and KA) tested three consistencies (IDDSI framework Levels 1–3) of orange juice, milk and tea (nine drinks). Because thickened milk and orange juice can take 30 min to stabilise and because the drinks will warm up or cool down gradually over this time, the drinks were also tested over time. Drinks were tested initially at Time 0 (T0) by recording the temperature of the drinks and then recording thickness in each drink level and each drink type using the Viscgo Sticks first, followed by the flow test. Temperature and testing was also recorded for each drink type and each level at T20, T40 and T60, with the drinks stirred after each flow test. Both researchers completed 36 tests each for all drink types (three thickness levels in three types of drinks at four-time intervals). To test intrarater reliability, one researcher (DJ) repeated all 36 tests.

Procedure 3

Procedure 3 was to determine reliability and the validity of Viscgo Sticks when used in thickened water by healthcare professionals (raters). The raters used the Viscgo Sticks and flow test to test three different consistencies of water (three drinks), which were prior thickened by the researcher (DJ). The raters then recorded the temperature of each drink then tested thickness with the Viscgo Sticks first, followed by the flow test. Raters tested each drink twice and so completed six tests each and 264 tests in total. Alongside the testing, raters were also asked to fill in a short survey to provide details about their job role, time qualified and their opinion of Viscgo Sticks.

Statistical analysis

Descriptive statistics were used to describe the characteristics of the drinks and care professionals. For nominal data, level of agreement (reliability) was assessed using Cohen's κ to evaluate the dependability within raters (repeatability) and the dependability between raters and between methods (reproducibility).²⁹ The κ value and standard error were reported. Agreement was considered perfect when κ was equal to 1 and no better than chance when κ was equal to 0. There is no formal scale for the interpretation of the κ value falling between 1 and 0; however, the following agreement levels are considered appropriate: poor $\kappa < 0.00$, slight $0.00 \leq \kappa \leq 0.20$, fair $0.21 \leq \kappa \leq 0.40$, moderate $0.41 \leq \kappa \leq 0.60$, substantial $0.61 \leq \kappa \leq 0.80$ and almost perfect $\kappa > 0.80$.³⁰ Any κ value below 0.60 was considered inadequate agreement for the present study.³⁰ Where reliability within raters and reproducibility between Viscgo Sticks and the flow test (criterion measure) were considered adequate and at least substantial or above, then validity was assessed by

calculating sensitivity, specificity and accuracy (correctly classified). Sensitivity of the Viscgo Sticks was expressed as the proportion of thickened drinks with a positive (correct) Viscgo Sticks test. Accuracy was calculated as the proportion of test status outcomes (positive and negative) that were correctly classified by Viscgo Sticks. For the resulting sensitivity coefficients, receiver operating characteristic (ROC) curves were produced and area under the ROC curve (AUC) was calculated. An AUC value of 0.5 indicates that the test is no better than chance alone, whereas an AUC value of 1 indicates a perfectly accurate test. All analyses were conducted in Stata I, version 14 (Stata Corporation).

RESULTS

Initial testing was conducted in March 2023 by two researchers, who tested the reliability and validity of Viscgo Sticks in thickened water, orange juice, milk and tea. Testing with 44 healthcare professionals (raters) was completed in May 2023, with each rater testing Viscgo Sticks against the flow test in three levels of thickened water.

Viscgo Sticks reliability and validity in three different thickeners (Procedure 1)

Two researchers thickened water to Levels 1–3 using three different thickening agents and recorded temperature, Viscgo sticks test and flow test. Mean temperatures ranged from 19.20°C to 22.96°C and the mean amount of liquid remaining in the syringe after the flow test ranged from 1.58 to 3.36 mL in Level 1, from 4.85 to 6.82 mL in Level 2 and from 7.93 to 9.49 mL in Level 3 (see Supporting information, Table S2). Test–retest (intrarater) agreement was determined to be almost perfect in drinks thickened with RL3, $\kappa = 0.93$ (95% confidence interval [CI] = 0.76–1.10) and K46, $\kappa = 0.86$ (95% CI = 0.69–1.02), and moderate in drinks thickened with T7X, $\kappa = 0.58$ (95% CI = 0.44–0.72). Because drinks thickened with T7X did not have adequate intrarater reliability, no further analysis was conducted with this thickening agent. For drinks thickened with RL3, agreement was determined to be almost perfect between researchers, $\kappa = 0.98$ (95% CI = 0.80–1.15) and between Viscgo Sticks and flow test, $\kappa = 0.98$ (95% CI = 0.80–1.15). For K46, agreement was determined to be moderate between researchers, $\kappa = 0.45$ (95% CI = 0.33–0.57) and almost perfect between Viscgo Sticks and flow test, $\kappa = 0.84$ (95% CI = 0.68–0.99). Because the reproducibility between Viscgo Sticks and flow test was adequate for both RL3 and K46, we assessed the criterion (flow test) validity of both of these thickeners. Details of sensitivity, specificity and correct classification are listed in Table 1. RL3 was considered to have the greatest reliability and validity out of all three thickeners and was used by the two researchers and 44 healthcare professionals in further testing.

TABLE 1 Sensitivity, specificity, accuracy and area under curve (AUC) values of Visco Sticks in drinks thickened to Levels 1–3 using two thickening agents.

Thickening agent and thickness level	Number of tests completed	Sensitivity %	Specificity %	Correctly classified %	AUC
RL3					
Level 1	60	100.00	100.00	100.00	1.0000
Level 2	60	95.00	100.00	98.33	0.9750
Level 3	60	100.00	100.00	100.00	1.0000
K46					
Level 1	60	100.00	100.00	100.00	1.0000
Level 2	60	100.00	100.00	100.00	1.0000
Level 3	60	84.62	89.36	88.33	0.8699

Abbreviation: RL3/K46, thickening agent identification.

TABLE 2 Sensitivity, specificity, accuracy and area under curve (AUC) values of Visco Sticks in orange juice and hot tea thickened to Levels 1–3.

Drink type and thickness level	Number of tests completed	Sensitivity %	Specificity %	Correctly classified %	AUC
Orange juice					
Level 1	12	75.00	100.00	91.67	1.0000
Level 2	12	50.00	90.00	83.33	0.7000
Level 3	12	100.00	100.00	100.00	1.0000
Hot tea					
Level 1	12	100.00	100.00	100.00	1.0000
Level 2	12	100.00	100.00	100.00	1.0000
Level 3	12	75.00	100.00	91.67	0.8750

Visco Sticks reliability and validity in thickened milk, orange juice and tea (Procedure 2)

Two researchers mixed thickened whole milk, orange juice and hot black tea, using RL3 to Levels 1–3. As the cold drinks warmed up and the hot tea cooled down, researchers recorded temperatures, flow test and Visco Sticks test over four time points. The results are shown in the Supporting information (Table S3). Test–retest agreement was determined to be substantial in thickened milk, $\kappa = 0.65$ (95% CI = 0.32–0.99), orange juice, $\kappa = 0.77$ (95% CI = 0.44–1.11) and hot tea, $\kappa = 0.66$ (95% CI = 0.32–0.99). Cohen's κ was also used to assess reproducibility between two researchers (observer inter-rater reliability) and between Visco Sticks and flow test (method inter-rater reliability). Agreement between researchers was determined to be substantial for whole milk, $\kappa = 0.77$ (95% CI = 0.44–1.10), orange juice, $\kappa = 0.67$ (95% CI = 0.36–0.97) and hot tea, $\kappa = 0.77$ (95% CI = 0.42–1.11). Agreement between the flow test and Visco Sticks was determined to be moderate for whole

milk, $\kappa = 0.56$ (95% CI = 0.24–0.87), substantial for orange juice, $\kappa = 0.66$ (95% CI = 0.33–0.99) and almost perfect for hot tea, $\kappa = 0.88$ (95% CI = 0.51–1.25). Because the reproducibility between Visco Sticks and flow test was not adequate for whole milk, no validity analysis was conducted on this set of results. Details of sensitivity, specificity and correct classification are listed in Table 2.

Visco Sticks reliability and validity between healthcare professionals (Procedure 3)

All healthcare professionals had experience of managing dysphagia with many being involved in preparing drinks and food and some also completing swallowing assessments, providing care plans and carrying out swallowing therapy and instrumental assessments. In total, 44 raters participated from nine separate workplaces across the Northwest of England. Of these 19 (43.0%) worked in a care home setting, 17 (39.0%) worked in the community and eight (18.0%) were based in a hospital. Roles

TABLE 3 Sensitivity, specificity, accuracy and area under curve (AUC) values of Visco Sticks when used by healthcare professionals in drinks thickened to Levels 1–3.

Thickness level	Number of tests completed	Sensitivity %	Specificity %	Correctly classified %	AUC
Level 1	132	100.00	97.78	98.48	0.9889
Level 2	132	76.19	98.89	91.67	0.8754
Level 3	132	54.55	100.00	84.85	0.7727

included speech and language therapists at all grades $n = 25$ (56.9%), care home managers $n = 5$ (11.3%) and carers/care assistants $n = 14$ (31.8%). Overall, the mean (SD) length of time qualified for the job role each rater was currently occupying was 11.88 (8.89 years ($n = 42$)).

The researcher prepared a set of drinks for each rater, thickening water to Levels 1–3. Raters each recorded the temperature of their set of drinks with mean temperatures ranging from 21.24 to 21.31°C. For drinks thickened to Levels 1–3 the mean amount of liquid remaining in the syringe after the flow test ranged from 3.21 to 3.23 mL, 6.95 to 6.98 mL and 9.00 to 9.05 mL, respectively (see Supporting information, Table S4). Test–retest agreement by flow test was determined to be substantial across all drink thicknesses, $\kappa = 0.67$ (95% CI = 0.57–0.77). Agreement between flow test and Visco Sticks was also determined to be substantial across all drink thicknesses, $\kappa = 0.66$ (95% CI = 0.57–0.76). Because the reproducibility between Visco Sticks and flow test was adequate for all three thickness levels, we assessed the validity of the sticks at all thicknesses. Details of sensitivity, specificity and correct classification are listed in Table 3.

After completing testing with Visco Sticks the healthcare professionals completed a short survey to provide feedback on the practicalities and everyday usefulness of the sticks. Out of the 44 people who participated, 24 (54%) agreed and 17 (39%) strongly agreed that Visco Sticks were practical to use. None of the group disagreed that the sticks were practical to use and three people (7%) neither agreed nor disagreed. When asked about confidence when making thickened drinks, 23 (52%) agreed and 13 (30%) strongly agreed that the Visco Sticks would provide more confidence. None of the group disagreed with this and eight (18%) neither agreed nor disagreed. In terms of use, 19 (43%) agreed, 16 (36%) strongly agreed, six (14%) neither agreed nor disagreed and three (7%) disagreed that they would use the sticks often. The group was also asked which they preferred out of the flow test and the Visco Sticks. Out of 44 people, 43 (98%) said that the preferred Visco Sticks over the flow test for convenience, time and ease of use.

DISCUSSION

This is the first study to assess the use of Visco Sticks in thickened liquids in real world settings with independent researchers and healthcare professionals. The study was

designed to validate the use of Visco Sticks in different levels of thickened liquids, including assessing use with different thickening agents, in different types of drinks, with different temperatures, and with appropriate healthcare professionals from a range of healthcare settings. We demonstrated that Visco Sticks are reliable in assessing IDDSI thickness levels of liquids with high intra- and inter-rater reliability (moderate to almost perfect) within and between researchers and healthcare professionals. Visco Sticks were also found to be valid, with a high percentage of correct classification (83.33%–100%) when used by both researchers and healthcare professionals. Therefore, Visco Sticks can be used independently by healthcare professionals to assess the thickness level of thickened beverages.

The practical relevance of these results will be dependent on the users and the training provided to them before using the sticks. Although, healthcare professionals' ability to use Visco Sticks was demonstrated to be more than adequate, with substantial intra- and inter-rater reliability across all levels of drink thickness and a high percentage of correct classification, it is also apparent from the results that healthcare professionals had greater success with Level 1 Visco Sticks (98.48% correctly classified) and less success with Level 2 Visco Sticks (91.67% correctly classified) and Level 3 Visco Sticks (84.85% correctly classified). Thus, it is worth noting that the lower classification percentage may mean that ease of use is less in the Level 2 Visco Sticks compared to Level 1 sticks and even more so in the Level 3 Visco Sticks. Training and practice may help with this discrepancy.

Practical relevance may also be dependent on the type of drink being tested, with the results demonstrating that a reduction in reliability can occur if factors such as thickening agent or drink type change. The intra-rater reliability of the Visco Sticks when used in drinks thickened by T7X was less than substantial ($\kappa = 0.58$), which, for the present study, was considered inadequate, and lower than the other thickeners, which were both almost perfect ($\kappa > 0.85$). Because there was no obvious difference in results of the flow tests between thickening agents, we cannot attribute this result to errors in the mixing of the drinks. However, it may be worth considering the homogeneity of the drink because concern has been raised over the obtainability of homogeneous thickened liquids under realistic stirring

conditions.³¹ Additionally, there are various properties that can describe the behaviour of liquids (including fattiness, slipperiness, roughness, cohesiveness, elasticity, adhesiveness and homogeneity),³² which may affect the way the Viscgo Sticks behave in liquids and particularly in liquids made with different thickeners.

The inter-rater agreement of Viscgo Sticks against the flow test when used in cold whole milk was also less than substantial ($\kappa = 0.56$), although intra- and interrater agreement within and between researchers was considered substantial. However, we also note that the flow test millilitre results for milk and orange juice were close to or over the upper boundary for the level of the drink being tested. This may have resulted in errors because the actual thickness level of the drink may have been higher than what was being tested for. The increased thickness may be the result of a mixing error,³³ but also could be a result of thickening agents interacting differently in these drinks because of the presence of acids and pectin in orange juice and ions and protein in milk.²⁵ Because there are several thickening agents available on the market and because people diagnosed with dysphagia are more than likely to want different types of beverages, it would be prudent to consider the need for tool alteration or indeed development of more drink-type-specific or thickener-specific tools to combat these issues.

Finally, practical relevance and usefulness of Viscgo Sticks in the clinical setting was confirmed by the participants of this study who provided extremely positive feedback. In terms of practicality and usability, most healthcare professionals responded positively about Viscgo Sticks being practical to use (93% agreed or strongly agreed), providing more confidence when making thickened drinks (82% agreed or strongly agreed) and being something they would use often (79% agreed or strongly agreed). When asked about convenience, time and ease of use, 98% of the group preferred Viscgo Sticks to the flow test for all three attributes. Viscgo Sticks could therefore provide an easy and practical method for dysphagia management, which also contributes to the one of the top 10 priorities in malnutrition research, identified by a recent James Lind Alliance Priority Setting Partnership: “Should treatment be adapted depending on the disease and patient group”.³⁴

Limitations

In the present study, reliability was assessed using a test–retest method. Because of time constraints and practicalities with respect to accessing healthcare professionals, the test and retest occurred consecutively, with each participant completing the first and second tests back-to-back and in the same drink. Outcomes may have been different if the retest had occurred on a different day with different drinks. Nevertheless, testing the exact same drink meant that there were no discrepancies in drinks and the way they were

measured and mixed. Improvements could have also been made if the healthcare professionals had tested multiple times rather than just twice. However, because the testing conducted by researchers had included 20 repeats on each drink and because it would be difficult to secure multiple visits with the same healthcare professionals, it is unlikely that repeating testing more than twice would have been practical or even resulted in more robust data. Finally, all raters were aware of the level of drink they were testing, which could have influenced results. Because of the setup of the study, where a single researcher visited healthcare professionals, the blinding of the raters would have also blinded the researcher instructing the test, therefore making the testing outcome impossible to judge. However, future studies could consider an alternative setup where the drink level could be monitored by an independent person, allowing for the researcher instructing the test and the rater to be blinded to drink level.

CONCLUSIONS

Overall, Viscgo Sticks were able to correctly identify the correct thickness level of a thickened drink when used in real world settings by independent researchers and healthcare professionals. Despite two researcher tests showing less than adequate agreement, the general reliability and validity of Viscgo Sticks was high, providing the user with useful and objective information. In addition, the healthcare professionals' feedback, in relation to practicalities and usefulness of Viscgo Sticks, was extremely positive, suggesting that Viscgo Sticks would be well utilised across relevant care settings. Preparation of thickened liquids is essential for maintaining hydration in people diagnosed with dysphagia. Thus, access to simple and reliable tools such as Viscgo Sticks, which can verify a prescribed IDDSI level of liquid, is invaluable in healthcare settings where day-to-day drink preparation occurs.

AUTHOR CONTRIBUTIONS

Debra Jones contributed to the design, management, delivery of the study, data collection, analysis and interpretation of the data, and drafting and critically reviewing the paper. Karen Allsopp contributed to data collection and drafting and critically reviewing the paper. Sorrel Burden contributed to conception, design and critically reviewing the paper.

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CONFLICT OF INTEREST STATEMENT

The authors declare that there are no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICAL STATEMENT

We used the University of Manchester Ethics assessment flow chart to formally obtain ethical exemption from formal committee approval system. A data management plan was made in relation to data storage and dealing with any identifiable personal data. A letter of exemption was provided.

TRANSPARENCY DECLARATION

The lead author affirms that this manuscript is an honest, accurate and transparent account of the study being reported. The reporting of this work is compliant with Guidelines for Reporting Reliability and Agreement Studies (GRRAS). The lead author affirms that no important aspects of the study have been omitted and that any discrepancies from the study as planned (Protocol agreed with Visco prior to project commencing) have been explained.

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PEER REVIEW

The peer review history for this article is available at <https://www.webofscience.com/api/gateway/wos/peer-review/10.1111/jhn.13268>.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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