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A Validation Study of a Locally Adapted Brussels Infant and Toddler Stool Scale of the Chinese Version

ABSTRACT

The Brussels Infant and Toddler Stool Scale was developed to improve the reliability of constipation diagnosis in non-toilet-trained children. The aim of this study was to evaluate the validity of simplified Chinese versions of the Brussels Infant and Toddler Stool Scale when used by parents, community doctors, pediatricians, and nurses. Photographs of the Scale were categorized into four categories (hard stools, formed stools, loose stools, and watery stools) and subjects assigned each photograph to a category. The study included two stages. In the first stage (n = 237 observers), percent correct allocations of the seven photographs ranged from 68.4% to 93.2%. We observed poorer recognition of the three hard stool items (77.4%, 85.8%, and 74.0%) than had been reported in the original Brussels Infant and Toddler Stool Scale validity study (95.9%, 93.4%, and 96.2%). Because hard stool items were commonly miscategorized as formed stools (21.6%, 9.5%, and 26.0%), we modified the descriptors "hard stools" and "formed stools" into "dry/hard stools" and "formed loose stools," respectively, and examined the performance of the modified Chinese Brussels Infant and Toddler Stool Scale in stage 2 of our study. The proportions of correct allocations of the three "hard stool" items in the modified Chinese Brussels Infant and Toddler Stool Scale increased to 94.7%, 90.4%, and 84.6%, values that were statistically similar to those reported previously in the original Brussels Infant and Toddler Stool Scale publisher. Renaming these categories to remove ambiguity in Chinese improved the identifiability of these items. The resultant Chinese Brussels Infant and Toddler Stool Scale was found to be valid for use with Chinese observers.

Chronic constipation is common in infants and toddlers. Functional constipation is the main etiological presentation of chronic constipation. The symptoms of chronic constipation, such as fecal incontinence, abdominal pain, and dry hard stools, can have drastic negative effects on the quality of life of affected children and their parents.

Fecal rigidity is a basic diagnostic and treatment efficacy monitoring index of constipation that should be evaluated with a simple, clinically feasible objective criterion (Hyams et al., 2016; Kuizenga-Wessel, Benninga, & Tabbers, 2015; Tabbers et al., 2014). The Bristol Stool Form Scale (BSFS), which was published in 1992, is a visual stool scale that is widely used in adults. However, the reliability of the BSFS in young

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children who are not yet toilet trained was reported to be unsatisfactory (Lewis & Heaton, 1997).

Background

To address the lack of a stool form scale for use in pre-toilet-trained children, a team (BITSS Study Group) led by Vandenplas and Szajewska developed the Brussels Infant and Toddler Stool Scale (BITSS) as a counterpart to the BSFS (Vandenplas et al., 2017). The BITSS Study Group (Huysentruyt et al., 2019) conducted a large multicenter trial (18 centers) representing a variety of countries in Europe, Asia, and the Americas in which they examined the interobserver reliability of the BITSS in parents, nurses, and medical doctors (2,462 participants) (Huysentruyt et al., 2019). They observed percent correct allocations of BITSS photographs in the range of 83%–96% and their data indicated that the BITSS is a reliable tool for the assessment of stools of non-toilet-trained children in clinical practice and research (Huysentruyt et al., 2019). Since this demonstration of good performance, the BITSS has been translated into several languages including Chinese. The English version of the BITSS and its 14 different language translation versions including Chinese were formally released in 2019 (https://bitss-stoolscale.com/translated-versions/).

Similar to other countries, chronic constipation is also a common ailment among infants and toddlers in China, where some 10 million babies are born each year. Thus, there is a need for a reliable stool form scale for Chinese infants and toddlers. Unfortunately, China has neither participated in the establishment of the BITSS nor validated the original translated Chinese version of the BITSS (C-BITTS). Any newly introduced scale should undergo a process of localization that reflects the particular features of the target culture. Therefore, the objective of this study was to evaluate the validity of the C-BITSS, and then adapt it for use in China based on the evaluation findings.

METHODS

Subjects

This is a questionnaire study. The design was based on the scheme of the BITSS Study Group (Huysentruyt et al., 2019). The invited respondents included parents of children with constipation, community doctors, hospital pediatricians, and nurses. The study consisted of two phases: Phase 1 was the evaluation of the original translated C-BITTS and Phase 2 was the evaluation of our modified C-BITTS, which was formed based on the results of Phase 1. Phase 1, which was conducted from July through October of 2019, was conducted with 237 participants from Nanshan District, Shenzhen, China, including 44 parents (18.6%), 101 community doctors (42.6%), 42 pediatricians (17.7%), and 50 nurses (21.1%). Phase 2, which was conducted from December of 2019 through March of 2020, was conducted with 486 also from Nanshan district, including 75 parents (15.4%), 216 community doctors (44.5%), 75 pediatricians (15.4%), and 120 nurses (24.7%). Participants from Phase 1 were not allowed to participate in Phase 2 of the study. This study was approved by the Nanshan Hospital Ethics Committee.

BITSS Items and C-BITSS Scale Versions

Seven BITSS photographs (Figure 1) were used for categorization into four infant stool forms: hard stools, formed stools, loose stools, and watery stools. Each BITSS photograph corresponds to a BSFS type.

The original C-BITSS version used in Phase 1 of this study included the same seven color photographs (Figure 1) and four response options as in the original BITSS (hard stools, formed stools, loose stools, and watery stools), but the category names were written in simplified Chinese).

Questionnaire Investigation

The questionnaire consisted of a pamphlet of 7 random numbered BITSS pictures without word description (like Figure 1, but excluding word descriptions) and an answer sheet. The answer sheet consisted of 4 choices of stool hardness represented by each picture: hard stool, formed stool, loose stool and watery stool (written in Chinese). After a brief explanation, the invited subject was asked to select the answer after looking at the picture.

The responses obtained were analyzed and then several gastroenterologists and pediatricians were consulted to determine how the performance of the C-BITSS could be improved. Finally, the modified C-BITSS was created, and was validated in Phase 2.

Statistical Analysis

We used χ^2 tests to compare the proportions of participants who correctly identified the scale categories of each item between the two versions of the C-BITSS evaluated here, between each C-BITSS version and the proportions reported previously by Huysentruyt et al. (2019), and between the observer groups. The analyses were conducted in SPSS for Windows, Version 22 (SPSS, Chicago, Illinois). A calculated $p < .05$ was considered significant.

Results

Performance of the C-BITSS

The proportions of correct allocations for each item in Phase 1 (premodified Chinese translation) and Phase 2 (modified Chinese translation) of this study and in Huysentruyt et al.'s prior study (Huysentruyt et al., 2019)

FIGURE 1. Brussels Infant and Toddler Stool Scale (BITSS) images. The photographs are marked with a corresponding Bristol Stool Form Scale (BSFS) type and a random number. The original English and Chinese version of the BITSS (blue and black) and the modified BITSS version corresponding to the Chinese version (red) are shown on the right. That is, hard stools and formed stools were modified into dry and hard stools and formed loose stools, respectively.

are shown and compared in Table 1. In Phase 1 (n = 237 participants), proportions of correct image categorizations ranged from 68.4% to 93.2%, with the best-performing items being photograph 7 (BSFS4) and photograph 3 (BSFS5). Photographs 6 (BSFS1), 4 (BSFS2), and 1 (BSFS3) are supposed to represent constipation, but were identified as formed stools by 21.6%, 9.5%, and 26.0% of the participants. In comparison, in Phase 1 we obtained similar proportions ($p > .05$) of correct allocations for photograph 2 (BSFS6); worse performance ($p < .05$) for photographs 6 (BSFS1), 4 (BSFS2), 1 (BSFS3), and 3 (BSFS5); and better performance for photographs 7 (BSFS4) and 5 (BSFS7) ($p < .05$).

Thus, in Phase 1 of this study, we observed unsatisfactory performance of the non-modified C-BITSS compared with the data reported by Huysentruyt et al. (Table 1). Specifically, we found that some hard stool images were assessed as formed stools. Although hard stools and formed stools were intended to be distinguished by rigidity and humidity, these distinctions were not well represented in the simplified Chinese category descriptions in the directly translated C-BITSS (Phase 1) due to lack of clear indication of 'hard' or 'soft' in the Chinese written term for formed stools. Based on consultation with gastroenterologists and pediatricians, we changed "hard stools" and "formed stools" to "dry/hard stools" and "formed loose stools," respectively. The modified C-BITSS was assessed in Phase 2 of our study.

Performance of the Modified C-BITSS

As shown in Table 1, the proportions of correct allocations for each individual photograph in stage 2 (n = 486 participants) ranged from 72.0% to 94.7%. Compared with Phase 1, the proportions of correct allocations for photographs 6 (BSFS1) and 1 (BSFS3), which are intended to be used to diagnose constipation, improved in Phase 2 ($p \leq .05$). Photograph 3 (BSFS5) remained the worst performing image/description. In our Phase 2 data, photographs 6 (BSFS1) and 5 (BSFS7) performed similarly to their performance in Huysentruyt et al.'s (2019) study ($p > .05$). Meanwhile, compared with Huysentruyt et al.'s study, we observed better performance ($p < .001$) for

TABLE 1. Comparisons of BITSS Image Categorizations Across Prior and Current Analyses

Study Image	Stool Category (%)			
	Hard	Formed	Loose	Watery
Huysentruyt et al.'s (2019) *study*				
BSFS1	95.9	0.9	3	0.3
BSFS2	93.4	2	4.6	0.1
BSFS3	96.2	1.5	2.2	0.1
BSFS4	5.4	87.6	6.8	0.2
BSFS5	6.9	6.8	83.1	3.2
BSFS6	1.5	0.8	89.2	8.6
BSFS7	0.7	0.5	11.2	87.5
Present study, Phase 1: premodified C-BITSS				
BSFS1	77.4*	21.6	0.5	0.5
BSFS2	85.8*	9.5	4.7	0
BSFS3	74*	26	0	0
BSFS4	2.1	93.2*	0	4.7
BSFS5	0.5	8.4	68.4*	22.7
BSFS6	0	6	88	6
BSFS7	0.5	5.3	4.2	90*
Present study, Phase 2: modified C-BITSS				
BSFS1	94.7**	4.7	0	0.6
BSFS2	90.4*	8.4	0.8	0.4
BSFS3	84.6*,**	15.2	0.2	0
BSFS4	4.3	94.4*	0.9	0.4
BSFS5	1.2	9.1	72.0*	17.7
BSFS6	1.23	9.47	85.19*	4.11
BSFS7	1.2	2.3	6.6	89.9

Note. BSFS = Bristol Stool Form Scale; BITSS = Brussels Infant and Toddler Stool Scale. Correct categorizations are shaded.
*$p < .05$ vs. Huysentruyt et al.'s data.
**$p < .05$ vs. Phase 1 data (premodified Chinese BITSS).

photograph 7 (BSFS4), but still relatively worse performance for photographs 4 (BSFS 2), 1 (BSFS3), and 3 (BSFS5) (all $p < .05$). The correct identification percentages of each modified BITSS item relative to the premodified Chinese BITSS and Huysentruyt et al.'s data are summarized in Figure 2.

Performance of the Simplified Chinese Version of the BITSS in Different Groups

The portions of each participant group (parents, community doctors, pediatricians, and nurses) who made correct category allocations of the BITSS images are reported and compared across Phase 1 and Phase 1 versions in Table 2. Overall, with the Phase 1 version, we observed statistically similar correct allocation percentages for the parent, pediatrician, and nurse groups ($p > .05$), whereas the community doctors' performance was significantly lower than that of the other three groups ($p < .05$). Conversely, with the Phase 2 modified version of the C-BITSS, the parent group's performance was significantly lower than that of the other groups ($p < .001$). From Phase 1 to Phase 2, we found that the correct allocation percentage worsened for the parent group while improving significantly for

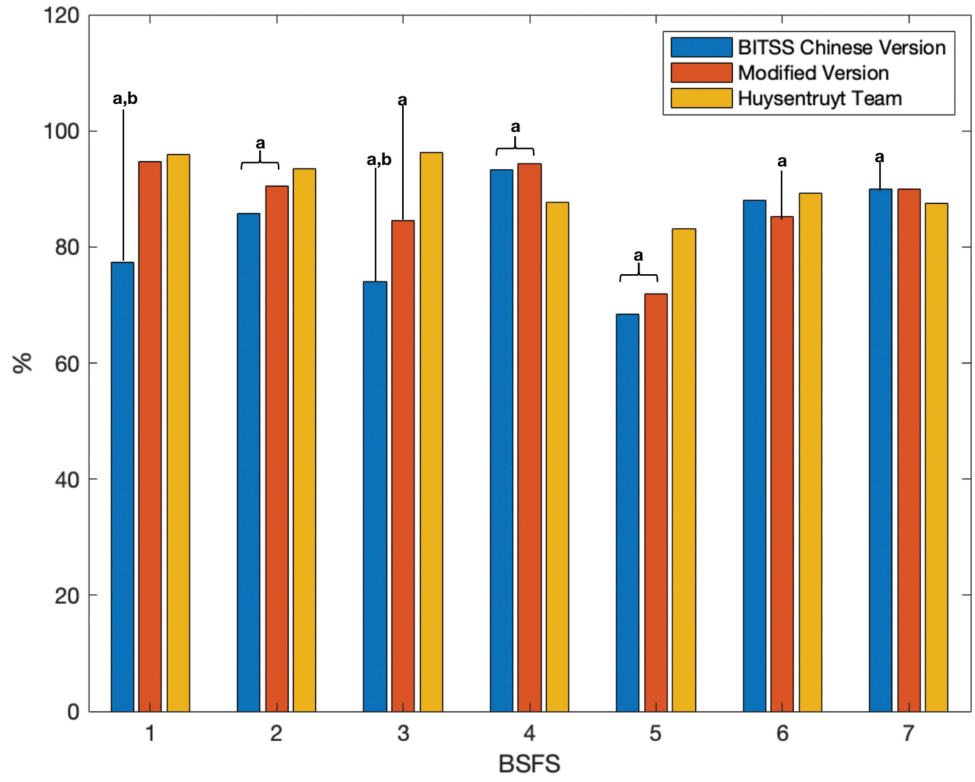

FIGURE 2. Performance of the modified Chinese Brussels Infant and Toddler Stool Scale (C-BITSS) compared with prior versions. Bristol Stool Form Scale (BSFS)1–7 on the *x*-axis are the evaluated images; proportions of correct allocation are shown on the *y*-axis. Markers "a" indicate significant differences in item performance compared with Huysentruyt et al. and markers "b" to our (Phase 2) modified C-BITSS.

the community doctor group (both $p < .05$). Pediatricians showed the best performance of the four groups on both versions.

Discussion

In the present two-phase study, we first observed worse performance of the pre-modified C-BITSS compared with the results obtained previously for the original BITSS by Huysentruyt et al. (2019). In particular, correct allocation percentages were lower for "hard stool" photographs (BSFS1, 2, and 3). At this stage, of the four participant groups, the community doctor group had the lowest correct allocation percentage. Our Phase 1 study data indicated that the validity of the C-BITSS should be improved. Modifications to category names resulted in improved performance of the C-BITSS. Consistent with the results of Huysentruyt's team (Huysentruyt et al., 2019), the best-performing observer group in both phases of the study was pediatricians.

The BITSS was developed principally for use by doctors and parents to assess defecation patterns and to assist in the diagnosis of constipation in non-toilet-trained children (Huysentruyt et al., 2019). Our observation of substantial incorrect categorization of three hard stool photographs indicated that the C-BITSS required modification to be a satisfactory tool for constipation diagnosis in China. This difference could have been related, perhaps in part, to different statistical analysis methods, with the former study having been done with indirect statistics. Additionally, it is likely that the performance difference that we observed in Phase 1 of the study compared with Huysentruyt et al. reflects

TABLE 2. Performance of Premodified and Modified C-BITSS Versions in Different Observer Groups

Group	Simplified Chinese BITSS Before Modification (Phase 1) *n* (%)	Modified Simplified Chinese BITSS (Phase 2) *n* (%)
Parents	44 (87.0)	75 (80.6*)
Community doctors	101 (78.4)	216 (89.0*)
Pediatricians	42 (88.3)	75 (90.9)
Nurses	50 (85.1)	120 (86.3)

*$p < .05$ vs. Phase 1 percentage.

inadequate adaptation of the scale to the Chinese language and culture. Commonly, our participants miscategorized "hard stool" photographs into the "formed stool" category. Conversely, we observed higher correct allocation of "formed stool" images than Huysentruyt's team. These outcomes indicate that Chinese users of the scale had trouble distinguishing hard stools from formed stools, leading us to modify the category names of "hard stools" and "formed stools" to "dry/hard stools" and "formed loose stools," respectively. These modifications were associated with substantially improved levels of correct categorizations in stage 2 of our study. Most notably, the percentages of correct categorization for the "hard stools" in photograph 6 (BSFS1) and photograph 1 (BSFS3) increased significantly relative to the premodified version of the scale, and became similar to those reported by Huysentruyt et al. (2019).

We were surprised that the "loose stool" item, photograph 3 (BSFS5), was commonly misallocated (22.7%) as belonging to the watery stool category, and only categorized correctly by 68.4% of the participants in Phase 1. Although its correct categorization reached 72.0% with the modified C-BITSS in Phase 2, it remained the lowest-performing item on the scale and its correct categorization percentage remained significantly lower than that reported by Huysentruyt et al. (2019), perhaps due to showing stool that was quite different in color from that shown in the other "loose stool" item, namely photograph 2 (BSFS6). Notwithstanding, it is important to note that mediocre performance of this "loose stool" item would not impact recognition of constipation.

Our finding of a lower correct allocation percentage in our Phase 1 data by community doctors, than by parents, pediatricians, and nurses, might reflect more exposure of the latter three groups to infant/toddler stools. Notwithstanding, the adaptations made in our modified C-BITSS enabled community doctors to improve their recognition of stool forms significantly in Phase 2 of the study.

A relatively small sample size is the main limitation of this study, especially parents of children with constipation. It is difficult to make further comparisons in demographic data, years in practice of parents, and other parameters. However, Shenzhen is a new metropolis with a booming population migrating from all over the country. The results of this study seem to be representative.

Conclusion

The modified C-BITSS examined in stage 2 of this study provides a convenient visual stool assessment scale that can be used to diagnose constipation in infants and toddlers. Clarification of the concept of "form" in Chinese removed ambiguity and thus improved the recognizability of "hard stool" items, especially photograph 6 (BSFS1) and 1 (BSFS3). The reliability of the modified C-BITSS should be assessed in larger cohorts in the future. ✪

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