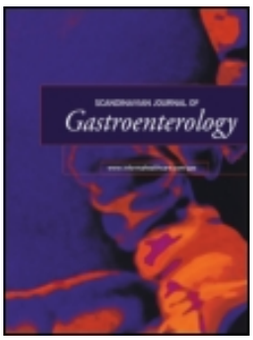

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Stool Form Scale as a Useful Guide to Intestinal Transit Time

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Background: Stool form scales are a simple method of assessing intestinal transit rate but are not widely used in clinical practice or research, possibly because of the lack of evidence that they are responsive to changes in transit time. We set out to assess the responsiveness of the Bristol stool form scale to change in transit time. *Methods:* Sixty-six volunteers had their whole-gut transit time (WGTT) measured with radiopaque marker pellets and their stools weighed, and they kept a diary of their stool form on a 7-point scale and of their defecatory frequency. WGTT was then altered with senna and loperamide, and the measurements were repeated. *Results:* The base-line WGTT measurements correlated with defecatory frequency ($r = 0.35$, $P = 0.005$) and with stool output ($r = -0.41$, $P = 0.001$) but best with stool form ($r = -0.54$, $P < 0.001$). When the volunteers took senna ($n = 44$), the WGTT decreased, whereas defecatory frequency, stool form score, and stool output increased (all, $P < 0.001$). With loperamide ($n = 43$) all measurements changed in the opposite direction. Change in WGTT from base line correlated with change in defecatory frequency ($r = 0.41$, $P < 0.001$) and with change in stool output ($r = -0.54$, $P < 0.001$) but best with change in stool form ($r = -0.65$, $P < 0.001$). *Conclusions:* This study has shown that a stool form scale can be used to monitor change in intestinal function. Such scales have utility in both clinical practice and research.

Key words: Constipation; diarrhoea; intestinal transit; stool form score

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The rate of passage of intestinal contents is of central importance in gut physiology and is a major determinant of bowel symptoms. Fast intestinal transit impairs absorptive function in both the small and large intestine (1–3), alters bacterial turnover (4), acidifies the distal colon (5), and leads to diarrhoea with its distressing symptoms of urgency, tenesmus, and incontinence. Slow transit markedly alters bacterial growth and metabolism (4), bile acid metabolism (6), and oestrogen metabolism (7) and leads to the annoyance of straining at stool and to many of the symptoms of the irritable bowel syndrome (IBS) (8). It also increases the risk of bowel cancer (9) and of gallstones (10). Despite all this, intestinal transit time is seldom measured either in clinical practice or in epidemiologic studies. One reason for this is the cumbersome or unpleasant nature of standard techniques for measuring transit time, relying, as they do, on collection of stools or radiation exposure, or both (11). However, this reason may no longer exist.

The recent invention of stool form scales (12, 13) has provided a simple tool for measuring transit time in non-hospitalized people. The technique involves no exposure to radiation, no stool handling, and no discomfort except the mild unpleasantness of subjects having to inspect their own faeces and decide which of several descriptions fits best. The scales have been validated by showing a significant correlation between the scale number of a subject's stools and the mean transit time measured previously. With the original scale this correlation was very close ($r = 0.93$) (12), but this must have been partly because all the observations were made by one trained observer. Her 8-point scale was too complicated for untrained observers, and some of the descriptions were appropriate only for stools seen on a flat, dry surface and not for stools seen as they are in real life under water in the bowl of the water closet. We therefore devised a simpler, water closet-relevant scale with seven items and with the descriptions couched in everyday language (Table I). This 'Bristol Stool Form Scale' has proved acceptable both to subjects in epidemiologic surveys and to patients attending gastrointestinal clinics. Reasonable correlations have been observed between subjects' scale scores and their measured whole-gut transit time (r values around 0.7) (13–15). The validity of the scale has been confirmed by workers at the Mayo Clinic (16), and the scale has been recommended for research by an international working party (17). Its clinical utility has also been suggested by the finding that symptoms of straining and urgency are linearly related to scale score (18). In the clinic or surgery, stool form recordings can be used to distinguish true diarrhoea and true constipation from the pseudo-diarrhoea and pseudo-constipation of IBS (13, 17).

Despite all this, stool form scales are not widely used in clinical practice or research. One reason may be the lack of evidence that they are responsive to change—in other words, that, in an individual, a change in transit time is associated

Table I. Bristol Stool Form Scale

Type 1	Separate hard lumps, like nuts.
Type 2	Sausage-shaped but lumpy.
Type 3	Like a sausage or snake but with cracks on its surface.
Type 4	Like a sausage or snake, smooth and soft.
Type 5	Soft blobs with clear-cut edges.
Type 6	Fluffy pieces with ragged edges, a mushy stool.
Type 7	Watery, no solid pieces.

Table II. Base-line anthropomorphic measurements for volunteers ($n = 66$) (median, interquartile range, and range)

Age (years)	40	29, 50	15, 62
Height (m)	1.66	1.62, 1.70	1.49, 1.78
Weight (kg)	66.0	60.9, 71.3	47.5, 96.0
Body mass index (kg/m^2)	24.0	21.6, 26.4	18.4, 37.7
Waist (cm)	76.0	71.0, 83.0	63.0, 102.0
Hip (cm)	101.0	97.0, 106.3	72.0, 128.0
Waist/hip ratio	0.75	0.73, 0.78	0.64, 0.91

with a change in stool form. We have recently used the Bristol Stool Form Scale extensively in research in which we have artificially changed the transit time of volunteers. This gave us the opportunity to assess the responsiveness of stool form to change in transit time.

MATERIALS AND METHODS

As part of several randomized studies requiring assessment of colonic function in women (5, 19) 66 healthy omnivorous volunteers were recruited by advertisements placed in local hospitals. None had a significant medical history, were obese, or had taken antibiotics within the past 3 months (Table II). The premenopausal women ($n = 45$) all reported regular menstrual cycles, and none had lactated within the past 12 months or taken oral contraceptives. In these women all assessments were done during the early follicular phase of their menstrual cycle. The postmenopausal women ($n = 21$, confirmed by their serum luteinizing hormone (>30 IU/l) and follicular stimulating hormone (>30 IU/l) concentration) were not taking any hormone replacement therapy. At initial interview the aims of the project and the commitments required were explained, a medical history was taken, and height, weight, and waist and hip circumferences were recorded.

Volunteers underwent assessment of their base-line colonic function over 9 days while eating their normal diets. Using specially designed diaries, the subjects recorded times of defecation and the 'form' or appearance of each stool on a 7-point scale (13, 20) ranging from the discrete lumps of slow transit (type 1) to the non-cohesive (type 6) and liquid stools (type 7) of rapid transit (Table I).

Whole-gut transit time (WGTT) was measured as a proxy for colonic transit time by a modification of a published method (21). Twenty radiopaque marker pellets contained within a capsule were swallowed (different shapes each day) on each of four consecutive mornings. The first two stools passed at least 24 h after ingestion of the last set of markers were collected, flattened, and roengtenographed. By counting the number of markers in each stool and then applying the following formula, the mean WGTT was calculated from the two stools.

$$\text{WGTT (h)} = (t_1s_1 + t_2s_2 \ldots + t_8s_8)/(s_1 + s_2 \ldots + s_8),$$

where s = the number of markers of a given shape in a stool sample—that is, 0–20—and t = the time in hours since ingestion of this marker pellet to the passing of the stool.

The subscripts 1–8 identify the four different shapes of marker pellets in the two stool samples. Thus there are up to four types of pellets in each stool, identified by subscripts 1–4 in the first and 5–8 in the second stool. Stool output per week was calculated from the mean weight of the two stools and defecatory frequency.

Volunteers had up to four sets of base-line measurements done. These measurements were also repeated after the volunteers had been randomized to take either senna tablets (Senokot®, Reckitt & Coleman) or loperamide capsules (Imodium®, Janssen Pharmaceuticals) for a minimum of 9 days. Both were taken at the maximum tolerated dose. Volunteers undergoing further cycles of study had a minimum of a 2-week washout period between agents to obviate any carry-over effects.

Data were assessed as parametrically or non-parametrically distributed, using histograms and Ryan Joiner tests. Changes were analysed as appropriate by using two-tailed Student's t and Wilcoxon rank sum tests. Correlations were calculated with Spearman's correlation coefficients, as WGTT was non-parametrically distributed.

The study was approved by the Research Ethics Committee of the United Bristol Healthcare Trust.

RESULTS

Table III. First base-line whole-gut transit time and faecal measurements in volunteers ($n = 66$) (median, interquartile range, and range)

Whole-gut transit-time (h)	62.7	47.9, 74.6	20.9, 197.7
Stool output (g/week)	923	646, 1430	104, 4218
Stool form score	3.6	3.2, 4.1	1.4, 5.7
Interdefecatory interval (h)	24.0	17.7, 26.7	8.7, 56.0

Replicated base-line measurements ($n = 194$) within an individual did not differ significantly from each other. The coefficients of variation were 17.5% for WGTT, 39.3% for stool output, 13.6% for stool form, and 17.9% for defecatory frequency. Thus stool form was the least variable measurement.

When the first set of base-line data obtained for each volunteer was analysed (Table II), WGTT correlated with

Table IV. Changes in whole-gut transit time (WGTT) and faecal measurements with senna ($n = 44$) and loperamide ($n = 43$) (median, 95% confidence interval (CI) of the difference)

	Change with senna				Change with loperamide			
	Base	Active	95% CI	*P* value	Base	Active	95% CI	*P* value
Whole-gut transit time (h)	67	41	−26, −14	<0.001	52	72	10, 24	<0.001
Interdefecatory interval (h)	24	19	−7.2, −3.2	<0.001	24	31	0.57, 8.3	0.015
Stool form score	3.6	4.6	0.77, 1.30	<0.001	3.9	2.8	−1.38, −0.79	<0.001
Stool output (g/week)	784	1482	324, 763	<0.001	1143	656	−761, −318	<0.001

defecatory frequency ($r = 0.35$, $P = 0.005$) and with stool output ($r = -0.41$, $P = 0.001$) but best with stool form ($r = -0.54$, $P < 0.001$).

When volunteers took senna ($n = 44$) or loperamide ($n = 43$), all the measured factors of intestinal transit changed (Table IV). By chance, the base-line measurements of WGTT ($P = 0.045$, 95% confidence interval (CI), 0.1, 18.4) was higher and stool output ($P = 0.028$, 95% CI, 35.0, 552.4) was lower before senna than before loperamide. However, in the 23 volunteers who took both senna and loperamide their base-line measurements of WGTT, stool form, defecatory frequency, and stool output were similar before both agents, and changes in these factors were all highly significant.

Change in WGTT from the base-line measurements correlated with change in defecatory frequency ($r = 0.41$, $P < 0.001$) and change in stool output ($r = -0.54$, $P < 0.001$) but best with change in stool form ($r = -0.65$, $P < 0.001$) (Fig. 1).

DISCUSSION

This study has confirmed again that stool form is a better predictor of intestinal transit time than defecation frequency. In fact, in some studies bowel frequency has had no predictive value at all (13, 22, 23). We have gone on to show that change in stool form score correlates with change in transit time. This implies that stool form scales can be used with confidence both in the clinical setting and in research. For example, it can now be confirmed that the widely fluctuating stool form scores of patients with IBS mean that they have an objective abnormality in intestinal function (18). A practical implication is that clinicians can use stool form scales to monitor the response to treatment of their patients with constipation, diarrhoea, or IBS.

Given the central importance of transit time in gut physiology and disease, we recommend that recordings of stool form be incorporated in gastrointestinal research protocols, in

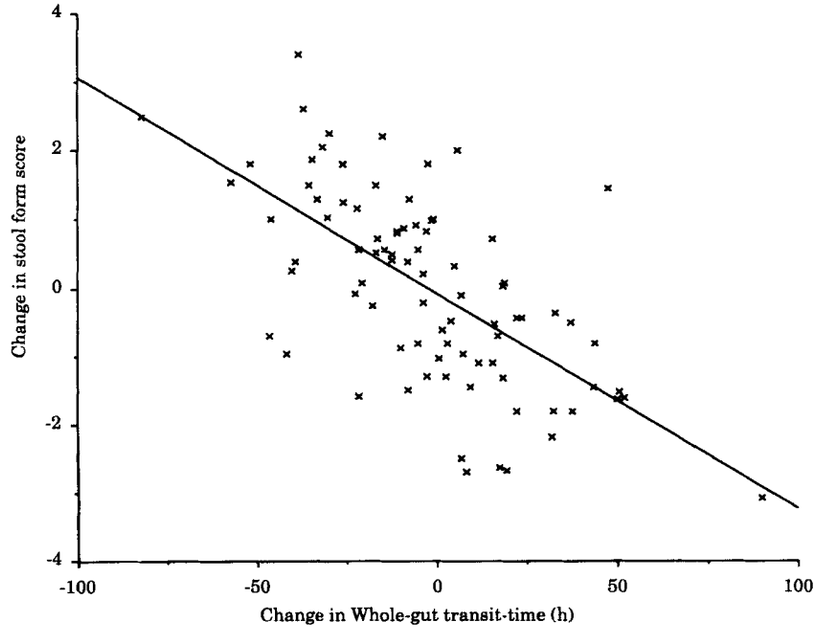

Fig. 1. Change in whole-gut transit time and change in stool form of volunteers given senna laxative and loperamide ($r = -0.65$).

which they add virtually nothing to the expense and potentially a good deal to the relevance of the research. As an example, we used stool forms to show that in the community, there is a large amount of unsuspected, asymptomatic constipation (in the sense of slow intestinal transit) and that, conversely, many people who think they are constipated are not (24). We have also shown by the use of the Bristol scale (now also translated by Buddhist monks into Ladakhi) that slow intestinal transit is surprisingly common in a peasant population eating a very high fibre diet, which might explain the equally surprising fact that these slim, hardy people are very prone to cholesterol gallstones (25). In a hospital setting we demonstrated faster intestinal transit (using the Bristol scale) in a study examining the effects of proton pump inhibitors on duodenal bacterial counts (26).

The correlation between stool form score and transit time is very significant but not perfect. There are several possible reasons for this imperfection. One is observer error; this is made likely by the very close correlation observed by Davies et al. (12) in a study in which Davies scored all her volunteers' stools herself ($r = 0.93$). Another is that stool form is determined not so much by overall colonic passage time as by residence time in one particular segment of the colon, such as the sigmoid, whose contractions must mould the stool into its final shape. However, Degen & Phillips (16) found no correlation between stool form and any particular colonic segment. A third reason is that there are other unidentified factors beside transit time. The findings of Davies et al. (12) make it unlikely such factors are important. If observer error is the main factor, then there must be scope for improving the utility of the scale by acclimatizing subjects to it or by changing its wording so that untrained (and unmotivated) people are less likely to choose the wrong type number. For example, type 2 and type 5 are easily confused but could perhaps be distinguished by reference being made to the usually easier passage of type-5 stools (18).

One possible criticism of this study is that the base-line measurements before senna reflected a slower intestinal transit speed than before loperamide and that this could have biased the findings in our favour. However, the difference in base-line measurements, a chance finding, merely reflects the fact that only 23 volunteers were common to both interventions. In the subgroup of 23 volunteers the base-line measurements were similar, but equally impressive changes in measured variables were seen. The correlations between changes were similar to those in the group as a whole.

In conclusion, this study has confirmed the validity of stool form as a guide to whole-gut transit time and has shown that a stool form scale can be used to monitor change in intestinal function. Such scales deserve to be used more widely.

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