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Development and psychometric properties of the Health Anxiety Behavior Inventory (HABI)

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Abstract

Background: Mainstream cognitive behavioural theory stipulates that clinically significant health anxiety persists over time at least partially due to negatively reinforced health-related behaviours, but there exists no broad and psychometrically valid measure of such behaviours.
Aims: To draft and evaluate a new self-report scale – the Health Anxiety Behavior Inventory (HABI) – for the measurement of negatively reinforced health anxiety behaviours.
Method: We drafted the HABI from a pool of 20 candidate items administered in a clinical trial at screening, and before and after cognitive behaviour therapy ($n = 204$). A psychometric evaluation focused on factor structure, internal consistency, convergent and discriminant validity, test–retest reliability, and sensitivity to change.
Results: Based on factor analysis, the HABI was completed as a 12-item instrument with a four-dimensional factor structure corresponding to the following scales: (i) *bodily preoccupation and checking*, (ii) *information- and reassurance-seeking*, (iii) *prevention and planning*, and (iv) *overt avoidance*. Factor inter-correlations were modest. The internal consistency ($\alpha = .73–.87$) and 2-week test–retest reliability ($r = .75–.90$) of the scales was adequate. The *bodily preoccupation and checking*, and *information- and reassurance-seeking* scales were most strongly correlated with the cognitive and emotional components of health anxiety ($r = 0.41$, 0.48), and to a lower extent correlated to depressive symptoms and disability. Change scores in all HABI scales correlated with improvement in the cognitive and emotional components of health anxiety during cognitive behaviour therapy.
Conclusions: The HABI appears to reliably measure negatively reinforced behaviours commonly seen in clinically significant health anxiety, and might be clinically useful in the treatment of health anxiety.

Keywords: factor analysis; health anxiety; health behaviour; hypochondriasis; illness anxiety disorder; psychometrics; somatic symptom disorder

Introduction

Health anxiety exists on a spectrum, from mild and typically benign concerns about health, to very high levels that imply substantial distress and functional impairment (Asmundson et al., 2012; Bräscher et al., 2023; Ferguson, 2009; Longley *et al.*, 2010). Clinically significant health anxiety is the psychiatric condition where the individual's fear of, or preoccupation with, having or acquiring a serious health condition has become persistent and excessive, but without developing

into psychosis. Higher levels of health anxiety imply an increased propensity to respond strongly to health-related stimuli, and to interpret these in catastrophic terms (Leonidou and Panayiotou, 2018). This is usually coupled with an increased focus on bodily processes (Höfling and Weck, 2013), and a more pronounced fear of death (Aan de Stegge *et al*., 2018). The most widely recommended treatment for clinically significant health anxiety is cognitive behaviour therapy (CBT), which has been studied in approximately 19 randomised controlled trials (Axelsson and Hedman-Lagerlöf, 2019).

Many common behavioural responses to health threats – such as the evaluation of physical symptoms – have obvious potential evolutionary advantages, and can typically be expected to improve health outcomes. In clinically significant health anxiety, however, responses to health concerns are likely to become excessive, and problematic for the individual. Mainstream cognitive behavioural theory stipulates that the condition persists over time at least partially due to negatively reinforced health-related behaviours (Furer *et al*., 2007; Warwick and Salkovskis, 1990). Such a health behaviour is characterised by being a response to an aversive stimulus – some health-related thing or situation that gives rise to unwanted thoughts or emotions – and the behaviour persists due to the resulting short-term success in avoidance or neutralisation of that stimulus (Abramowitz and Moore, 2007). One reason why negatively reinforced health-related behaviours can contribute to increased, rather than reduced, health anxiety over time may be that unless the individual approaches situations that give rise to health anxiety in the short term, there is no way to form competing associations to such stimuli, or to broaden the behavioural repertoire in similar situations (Gropalis *et al*., 2018). Another perspective could be that unless the individual is willing to experience anxiety-evoking situations more fully, new, and potentially corrective, information is unlikely to challenge the individual's beliefs about the self, health outcomes, and health protective behaviours (Bennett-Levy *et al*., 2004). In unfortunate cases, excessive health behaviours may even directly give rise to new triggers for health anxiety, such as when frequent dietary changes produce gastrointestinal symptoms, or excessive pinching and scratching causes inflammation of the skin (Warwick, 1989). As part of theoretical work based on clinical observation, we have suggested that negatively reinforced behaviours in clinically significant health anxiety commonly belong to one of four types (Hedman-Lagerlöf and Axelsson, 2019):

(1) Bodily preoccupation and checking behaviours, i.e. attempts at monitoring and evaluating changes in physical processes and sensations to reduce health anxiety. Examples include checking for lumps, examining rashes, and pulse checks.
(2) Information- and reassurance-seeking, i.e. attempts at gathering information or seeking reassurance from others such as family members or medical personnel to reduce health anxiety. Examples include excessive health-care consumption, frequent internet searches, and discussions of symptoms with friends or family.
(3) Preventive behaviours, i.e. attempts at preventing negative health-related outcomes or reducing future health anxiety by proactive strategies. For example, planning trips to remain close to healthcare, excessive consumption of dietary supplements or certain healthy foods, or carrying a mobile phone in order to be able to contact healthcare services in case of distressing symptoms.
(4) Overt avoidance, i.e. attempts at avoiding situations or phenomena that give rise to health anxiety. Examples include the avoidance of physical exercise when this gives rise to feared physical sensations, and the avoidance of healthcare settings or health-related media when this evokes thoughts about serious illness.

A cornerstone of CBT for health anxiety is the systematic reduction of negatively reinforced health behaviours. Nevertheless, there exists no broad, valid, and widespread self-report measure of negatively reinforced health behaviours in clinically significant health anxiety. In the existing literature, the closest to a widespread self-report process measure of health anxiety behaviours is

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probably certain items of the Illness Attitude Scale (IAS) (Kellner, 1986). Another relevant scale is the Multidimensional Inventory of Hypochondriacal Traits (MIHT) (Longley *et al.*, 2005). The behaviour subscale of the MIHT – '*Hypochondriacal reassurance*' – focuses exclusively on information- and reassurance-seeking. Only one item of the MIHT, namely item #31 ('*I try to avoid things that make me think of illness or death*') concerns outright overt avoidance, but belongs to the affective subscale. No item of the MIHT concerns body-focused or checking behaviours, or prevention and planning.

We developed the Health Anxiety Behavior Inventory (HABI): a broad self-report instrument for the measurement of negatively reinforced health behaviours typical of clinically significant health anxiety. This study aimed to finalise and assess the psychometric properties of the HABI in terms of factor structure, internal consistency, convergent and discriminant validity, test–retest reliability, and sensitivity to change.

Method

Design

This was a psychometric study based on data from a randomised controlled trial (RCT) of internet-delivered and face-to-face CBT for clinically significant health anxiety (Axelsson *et al.*, 2020). The RCT recruited 204 patients at Gustavsberg University Primary Health Care Center, Stockholm, Sweden, in collaboration with Karolinska Institutet, Stockholm, Sweden. The trial was approved by the regional ethics review board of Stockholm (reference no. 2014/1530-31/2); this psychometric evaluation was approved by the Swedish Ethical Review Authority (reference no. 2023-07309-02), and all participants provided informed consent via a secure web form. The trial was preregistered at ClinicalTrials.gov (NCT02314065), and this psychometric evaluation was pre-registered in the Open Science Framework (https://osf.io/p2gv6/).

Participants

The trial employed a combination of routine care- and self-referrals. Recruitment was advertised in regional newspapers, and directly to primary care and psychiatric clinics in Stockholm, Sweden. The caption read, '*Do you worry a lot about your health?*'; a phrasing that was adopted from a key item of the Whiteley Index, which is a recognised measure of health anxiety (Pilowsky, 1967). Out of 105 items from widespread health anxiety questionnaires, this question alongside a minor variation from the IAS, recently emerged as the most central item to capture the latent health anxiety construct (Axelsson *et al.*, 2023). Applicants provided informed consent via the online web platform, and then completed a broad screening battery that consisted of validated questionnaires and routine clinical questions. The study information made clear that the study focused on clinically significant health anxiety: the recurrent and excessive fear of, or preoccupation with, having or developing a serious health condition. A structured interview based primarily on the Mini International Neuropsychiatric Interview (MINI) (Sheehan *et al.*, 1998) and the Health Preoccupation Diagnostic Interview (HPDI) (Axelsson *et al.*, 2016) was then held with a clinical psychologist, in order to assess common psychiatric diagnoses, collect clinical data, and determine eligibility for the trial. Participants were required to meet full criteria for either *DSM-5* somatic symptom disorder or illness anxiety disorder (this distinction was of limited importance; see Axelsson and Hedman-Lagerlöf, 2023), to be at least 18 years old, and to be living in Stockholm, Sweden. Exclusion criteria were: a substance use-, psychotic-, or bipolar disorder, severe depression, recurrent suicidal ideation, a personality disorder that made treatment unfeasible, changes to continuous psychotropic medication in the past 2 months, another ongoing psychological treatment, CBT during the past year, and a serious somatic condition such as terminal cancer that made the treatment unfeasible. For more details about the eligibility criteria, see the supplement of the primary publication (Axelsson *et al.*, 2020). Based on the clinical

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Table 1. Sociodemographic and clinical characteristics ($n = 204$)

Characteristic	
Sociodemographic variables	
Female, *n* (%)	143 (70%)
Age, mean (*SD*), range	39 (12), 18–78
Education, *n* (%)	
Primary	5 (2%)
Secondary	45 (22%)
Tertiary	154 (75%)
Married or *de facto*, *n* (%)	168 (82%)
Employment, *n* (%)	
Working	137 (67%)
Student	22 (11%)
Unemployed	7 (3%)
Other	38 (19%)
Primary clinical problem	
Clinically significant health anxiety, *n* (%)[a]	
Clinical and mild	89 (44%)
Clinical and moderate	81 (40%)
Clinical and substantial	34 (17%)
Health anxiety (HAI-14), mean (*SD*)	27.9 (4.9)
Total duration in years, mean (*SD*)	9.2 (9.4)
Other clinical variables	
Depression symptoms (MADRS-S), mean (*SD*)	14.2 (7.0)
Disability (SDS), mean (*SD*)	11.5 (7.1)
Antidepressant medication, *n* (%)	39 (19%)
Experience of non-communicable disease	52 (25%)
... of which cancers	13 (6%)
... of which cardiovascular disease	8 (4%)

HAI-14, 14-item Health Anxiety Inventory; MADRS-S, Montgomery-Åsberg Depression Rating Scale – Self-report version; SDS, Sheehan Disability Scale. [a]As based on the HAI-14 and the categories suggested by Österman *et al.* (2022).

interview, the clinician noted the presence of somatic conditions. For the present study, these data were used to determine the rate of non-communicable disease as defined by the World Health Organization (WHO) (Hunter and Reddy, 2013; World Health Organization, 2023), with subcategories for cancer and cardiovascular disease.

Sample characteristics are presented in Table 1. The average participant was a 39-year-old female who had suffered from clinically significant health anxiety for 9 years (total duration) and had symptoms in the mild to moderate clinical range according to the criteria suggested by Österman *et al.* (2022). Although we did not systematically collect information about ethnicity, we can say with confidence that the majority of this sample was from the Swedish majority population.

Instruments

Candidate items for the Health Anxiety Behavior Inventory (HABI)

Three researcher-clinicians with an interest in cognitive behavioural theory and extensive experience in assessing health anxiety behaviours and treating health anxiety with exposure-based CBT (including EHL and EAn) drafted an initial pool of 50 items for a new health anxiety behaviours scale. In order to ensure that this was grounded in the experiences of patients with clinically significant health anxiety, we reviewed patient worksheets and prioritised behaviors that had previously been reported by patients receiving CBT, where data collection of such behaviours is a central part of the treatment. The over-arching idea was to design a scale that would cover a broad range of health anxiety behaviours commonly seen in clinically significant health anxiety and that, based on cognitive behavioural theory, could be assumed to play a role in the

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exacerbation of symptoms. Items were phrased as statements, each of which prompted the respondent to choose among the options of '*0. Not at all accurate*', '*1. Somewhat accurate*', '*2. Mostly accurate*', and '*3. Completely accurate*'. To make the scale sensitive to short-term changes, participants were instructed to base their responses on their experiences over the past week. This 50-item pool was administered to 126 individuals with clinically significant health anxiety, of whom 95 completed the items also after CBT (Hedman *et al.*, 2016). Based on these data, the initial item pool was then trimmed down to 20 items, which were used as the basis for the current study. In this process, we prioritised items based on high correlations with the cognitive and emotional aspects of health anxiety (Salkovskis *et al.*, 2002), and items were also dropped if found to be ambiguously phrased or redundant. Among the initial 50 items, cross-sectional correlations with the cognitive and emotional aspects of health anxiety spanned from 0.14 to 0.61. We considered keeping a total of 20 items for the finalisation phase as this was a reasonably comprehensive list of candidate behaviours, while the draft instrument was also brief enough to be easily administered and useful. In the selection data ($n = 126$), the 20 candidate items showed promise in that their sum had adequate test–retest reliability ($r = 0.86$) and these 20 candidate items also exhibited good internal consistency ($\alpha = 0.83$–0.86).

Psychometric scales used to assess construct validity

We measured the cognitive and emotional components of health anxiety using the 14-item Health Anxiety Inventory (HAI-14) (Salkovskis *et al.*, 2002). On the HAI-14, for each item, the respondent choses one out of four alternatives that was deemed most correct, for example from '*I do not worry about my health*' to '*I spend most of my time worrying about my health*'. Each item is then scored 0–3, which gives a sum score between 0 and 42. The HAI-14 has typically been found to possess excellent psychometric properties (Alberts *et al.*, 2013). At the baseline, we used the following subset of the Illness Attitude Scales (IAS) (Kellner, 1986) to give some indication of the relationship to another measure of health anxiety behaviours: item #5 ('*If a pain lasts for a week or more, do you see a physician?*'), item #7 ('*Do you avoid habits which may be harmful to you such as smoking?*'), item #8 ('*Do you avoid foods which may not be healthy?*'), item #9 ('*Do you examine your body to find whether there is something wrong?*'), and the Treatment experience subscale which consists of item #22 ('*How often do you see a doctor?*'), item #23 ('*How many different doctors, chiropractors or other healers have you seen in the past year?*'), and item #24 ('*How often have you been treated during the past year? (for example, drugs, change of drugs, surgery, etc.)*').

We measured depression symptoms using the Montgomery-Åsberg Depression Rating Scale – Self-report version (MADRS-S) (Svanborg and Åsberg, 1994). The MADRS-S has 9 items, an example spanning from '*I can feel happy or sad, depending on the circumstances*' to '*I am so totally depressed and unhappy that I cannot imagine feeling worse*', and is scored as sum between 0 and 54. As was reported in the supplement of the primary publication for the RCT (Axelsson *et al.*, 2020), in these data we found the MADRS-S to be unifactorial, with adequate internal consistency ($\alpha = 0.84$). Last, we also measured disability using the Sheehan Disability Scale (SDS) (Leon *et al.*, 1997). The SDS has three items: one about occupation, one that concerns social life, and one that focuses on the family and home situation. For example, the occupation item reads '*The symptoms have disrupted your work/studies*', with responses from '*Not at all*' to '*Extremely*'. The SDS is scored from 0 to 30, and based on data used here, was unifactorial with adequate internal consistency ($\alpha = 0.83$) (Axelsson *et al.*, 2020).

Procedure

Administration of questionnaires

The participants were given a personal login to the secure study web platform and completed all questionnaires via their web browser. This was a simple interface with white background, black

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text, and radio buttons to indicate responses. The 20 candidate items were administered at screening, before treatment, and after treatment. The HAI-14, MADRS-S and SDS were also administered before and after treatment.

Cognitive behaviour therapy for clinically significant health anxiety

Half of the sample ($n = 102$) was randomised to receive CBT via the internet, and the other half ($n = 102$) was randomised to traditional face-to-face CBT. Because both were based on the same treatment protocol and had about the same average effect (Axelsson *et al.*, 2020), the treatment groups were pooled in the evaluation of sensitivity to change for the purpose of the present study. CBT was 12 weeks long and the participants were encouraged to systematically approach situations and phenomena that give rise to health anxiety in the short term (exposure), while refraining from behaviours intended to reduce health anxiety in the short term (response prevention) (Hedman-Lagerlöf and Axelsson, 2019). For example, a participant who, due to a fear of neurological disorders, commonly avoided talking about illness, and repeatedly performed own neurological exams, could be encouraged to practise talking with others about multiple sclerosis while abstaining from further self-exams. The participants were encouraged to conduct exposure exercises on a daily basis, and also to maintain a detailed plan for the reduction of bodily preoccupation and checking behaviours, information- and reassurance-seeking, and prevention and planning behaviors. Such plans commonly involved goals such as 'stop doing this entirely' (if realistic, and not medically problematic), 'wait for 30 minutes from the impulse' or 'no more than two times a day'. Such goals were revised continuously, so as to be both challenging and possible to meet. The treatment also consisted of mindfulness exercises, introduced as a means of achieving exposure to physical sensations, while abstaining from verbal strategies and subtle changes in attention that could serve as negatively reinforced health behaviours. Thus, the mindfulness component was intended to enhance the willingness to engage in exposure, and was fundamentally a form of exposure and response prevention.

Statistical analysis

Analyses were conducted in Jamovi 2.3.21, Stata 15.1, and R 4.3.2, and proceeded in accordance with the pre-registered statistical analysis plan (Open Science Framework; https://osf.io/p2gv6/). All analyses were based on the 20-item candidate pool. The finalisation of the HABI began with a broad assessment of the 20 item distributions, primarily to ensure that these were suitable for factor analysis. Values for skewness and kurtosis were calculated using the Jamovi standard procedures, with 0 being indicative of no skewness or excess kurtosis (Navarro and Foxcroft, 2019).

We then proceeded to an exploratory factor analysis of the 20 candidate items as based on the pre-treatment data and principal axis factoring with promax rotation. The number of factors to retain was based on the knee of the scree plot and parallel analysis. The iterative selection of items and evaluation of the factor structure was also aided by theory. Two clinicians experienced in the assessment and treatment of health anxiety (D.B. and E.A.) independently classified all items as probing one of four behaviour classes – bodily preoccupation and checking, information- and reassurance-seeking, prevention and planning, or overt avoidance – based on theoretical work (Hedman-Lagerlöf and Axelsson, 2019).

When a seemingly adequate factor solution had been reached, this was validated within a confirmatory factor analytic framework using the screening data. This was based on weighted least square mean and variance adjusted (WLSMV) estimation, i.e. diagonally weighted least squares estimation with a mean- and variance-adjusted test statistic and robust standard errors. This method treats the data as ordinal, and is commonly recommended for confirmatory analysis of data that deviates from normality, and for items with few response

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options (Sellbom and Tellegen, 2019). Rule-of-thumb criteria for adequate model fit were the following: a comparative fit index (CFI) ≥0.90 or ideally ≥0.95, a Tucker Lewis index (TLI) ≥0.90 or ideally ≥0.95, a root mean square error of approximation (RMSEA) <0.08 or ideally <0.06, and a standardised root mean square residual (SRMR) <0.08 (Hu and Bentler, 1999). We then proceeded to evaluate the corresponding adjusted item-total correlations (ITCs) with at least 0.50 being the target for adequacy. We also estimated internal consistency in terms of the α and ω, with an α target of at least 0.70; ≥0.8 typically being regarded as good, and ≥ 0.9 excellent. From the screening to the pre-treatment assessment, we evaluated the test–retest correlation over two time spans: first within 14 days, and then within 28 days, with a target Pearson correlation ≥0.70 and two-way mixed-effects intraclass correlation coefficient (ICC) ≥0.50 or ideally ≥0.75 (Koo and Li, 2016).

We formulated *a priori* hypotheses about the expected strength of correlations between health anxiety behaviours with other key psychiatric domains. We expected a correlation with the cognitive and emotional aspects of health anxiety (HAI-14) between 0.45 and 0.80, and a slightly stronger relationship with the behaviour items of the IAS. We expected correlations with depression symptoms (MADRS-S) and functional impairment (SDS) between 0.25 and 0.45. Pearson correlations around 0.10 are commonly regarded as weak, 0.30 as moderate, and 0.50 as strong (Cohen, 1992).

Last, we conducted an analysis to determine whether the HABI was sensitive to change and indicative of a reduction in health anxiety behaviours over the course of CBT. For this analysis, missing post-treatment observations were imputed by means of multiple imputation by chained equations (100 samples). Change over the treatment period was then tested using *t*-tests fitted on the multiply imputed data. Because in the assessment of responsiveness, the relationship to other indicators of change is more important than if change can be generalised *per se* (de Vet *et al.*, 2011), we also calculated the correlations between change in health anxiety behaviours (HABI) and change in the cognitive and emotional components of health anxiety (HAI-14), change in depression (MADRS-S), and change in disability (SDS).

Results

Rate of missing data

All 204 participants (100%) completed the screening and pre-treatment assessments, including the 20 health anxiety behaviour candidate items. At the post-treatment assessment, 194/204 (95%) completed the candidate items.

Frequency of health anxiety behaviours

An overview of the frequency of health anxiety behaviours is provided in Table 2. The most frequently endorsed item (at least '*Agree mostly*') was item #5 ('*If I notice a physical symptom that could be a sign of illness, I check it repeatedly*'; 173/204, 85%), followed by item #7 ('*I try to find the cause if I experience a new physical symptom without a clear explanation*'; 165/204, 81%). Ninety-four out of 204 (46%) reported probable current cyberchondriasis as based on the item '*I seek information from the internet or in books about different illnesses that I am afraid of being affected by*'. Of participants with children, 84/127 (66%) reported probable health anxiety by proxy as based on either the item '*I check up on my relatives' health*' or '*If I notice a physical symptom in a relative, I try to convince this person to seek health care*'. The mean number of endorsed health anxiety behaviours was 10 ($SD = 4$, median = 11), and all participants endorsed at least one behaviour (range = 1–20).

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Table 2. Health anxiety behaviors candidate item score distributions ($n = 204$)

Item (abbreviated)	Mean	*SD*	Skewness	Kurtosis	Response, *n* (%)				Corrected item-total correlation (ITC)		
										Finalised 12-item HABI	
					Do not agree	Agree slightly	Agree mostly	Agree completely	Initial 20 items	With total sum	With subscale
1. Seeks information about illness	1.42	1.13	0.11	−1.37	56 (27%)	54 (26%)	46 (23%)	48 (24%)	0.32		
2. Asks for medical advice	1.51	1.04	0.04	−1.16	39 (19%)	66 (32%)	54 (26%)	45 (22%)	0.58	0.56	0.77
3. Avoids media	1.75	1.07	−0.28	−1.20	33 (16%)	50 (25%)	56 (27%)	65 (32%)	0.35	0.39	0.77
4. Avoids conversations	1.41	1.08	0.15	−1.23	50 (25%)	63 (31%)	48 (24%)	43 (21%)	0.34	0.40	0.73
5. Checks symptoms repeatedly	2.30	0.78	−0.89	0.15	5 (2%)	26 (13%)	76 (37%)	97 (48%)	0.52	0.44	0.55
6. Always brings a phone	1.14	1.17	0.56	−1.18	82 (40%)	56 (27%)	22 (11%)	44 (22%)	0.22		
7. Tries to find cause of symptoms	2.23	0.81	−0.72	−0.33	5 (2%)	34 (17%)	74 (36%)	91 (45%)	0.51	0.41	0.62
8. Worries about future disease	2.06	0.86	−0.31	−1.14	4 (2%)	57 (28%)	65 (32%)	78 (38%)	0.45		
9. Tells other about symptoms	1.57	0.93	0.16	−0.90	21 (10%)	86 (42%)	56 (27%)	41 (20%)	0.40	0.41	0.70
10. Checks body for reassurance	1.87	0.94	−0.43	−0.71	19 (9%)	47 (23%)	79 (39%)	59 (29%)	0.50		
11. Avoids triggering situations	1.38	1.09	0.12	−1.28	56 (27%)	54 (26%)	54 (26%)	40 (20%)	0.40	0.43	0.77
12. Seeks promptly if new symptom	1.34	0.96	0.17	−0.92	44 (22%)	73 (36%)	60 (29%)	27 (13%)	0.39	0.32	0.52
13. Plans for illness	1.26	0.94	0.32	−0.74	45 (22%)	84 (41%)	51 (25%)	24 (12%)	0.34		
14. Careful about food and drink	1.36	0.94	0.15	−0.87	41 (20%)	75 (37%)	62 (30%)	26 (13%)	0.35	0.36	0.62
15. Seeks reassurance if feels pain	2.08	0.78	−0.40	−0.57	4 (2%)	42 (21%)	91 (45%)	67 (33%)	0.40		
16. Checks on family's health	1.49	0.96	0.18	−0.93	30 (15%)	83 (41%)	53 (26%)	38 (19%)	0.35		
17. Reads health advice	1.37	1.02	0.24	−1.03	45 (22%)	75 (37%)	48 (24%)	36 (18%)	0.41	0.37	0.61
18. Asks others for reassurance	1.45	1.11	0.13	−1.33	50 (25%)	62 (30%)	42 (21%)	50 (25%)	0.49	0.48	0.69
19. Tries to convince others to seek	1.64	0.91	-0.06	−0.81	21 (10%)	71 (35%)	73 (36%)	39 (19%)	0.38		
20. Makes plans to prevent disease	1.18	0.91	0.50	−0.46	47 (23%)	95 (47%)	40 (20%)	22 (11%)	0.55	0.49	0.60

All estimates are derived from the pre-treatment assessment. Values for skewness and kurtosis were calculated using the Jamovi standard procedures, with 0 being indicative of no skewness or excess kurtosis. The final 12-item questionnaire is provided in the Supplementary material. HABI, Health Anxiety Behavior Inventory.

Item properties and suitability for factor analysis

Item score distributions (Table 2) were relatively symmetrical, although some were also relatively homogeneous, i.e. with all responses being chosen about as often. Fifteen out of the 20 corrected ITCs (75%) were lower than the minimum target of 0.50. Item #6 was most seldom endorsed, had a particularly unconvincing ITC of 0.22, and was therefore dropped from further analysis. The Kaiser–Meyer–Olkin (KMO) statistic for the 20 items was 0.79.

Factor analysis and selection of items

We evaluated the factor structure with the remaining 19 candidate items. The scree plot was indicative of up to five factors (see Supplementary material). Prior to this factor analysis, two clinicians classified all candidate items as belonging to one of four behaviour classes: bodily preoccupation and checking, information- and reassurance-seeking, prevention and planning, or overt avoidance (Hedman-Lagerlöf and Axelsson, 2019). Concordance was high, although not perfect, as one of the two clinicians argued for six of the candidate items not fitting precisely to any one behaviour class. When four factors were extracted, these corresponded to the *a priori* theoretical framework to a substantial degree; item #1 being the most clear exception (Table 3). There were no cross loadings $\geq$0.30.

We then proceeded to shorten the scale so that all factors would be strong and consist of an equal number of items. Items #8 and #13 did not have a loading of at least 0.30 on any factor and were therefore dropped from further analysis. Items #1, #15, #16 and #19 were dropped iteratively due to low factor loadings (<0.45). At this stage, three of the four theoretically grounded factors had three candidate items each, and all of these candidate items had a loading of at least 0.68. The fourth factor – *bodily preoccupation and checking* – had four candidate items (#5, #7, #10 and #12). Of these, item #10 (checks body for reassurance) and item #12 (seeks promptly if new symptom) had the lowest factor loadings (0.49, 0.60 *vs* 0.73, 0.81). Although item #10 had a relatively high ITC at the beginning of the process (Table 1) and appeared to lie closer to the *a priori* theoretical idea of the factor (Table 3), we ultimately decided to retain item #12 for three reasons. First, the phrasing of item #10 overlapped with that of item #5 (checks symptoms repeatedly) which introduced a risk of redundancy. Second, item #10 had the lowest factor loading. Third, and most importantly, healthcare seeking is a widely acknowledged health anxiety behaviour that would otherwise not be represented in the inventory as a whole.

This resulted in the 12-item Health Anxiety Behavior Inventory (HABI) with four theoretically grounded factors, and three items per factor. Based on these 12 items, the scree plot was clearly indicative of four factors. All factors appeared to add value, as the proportion of variance explained was 13% for *bodily preoccupation and checking*, 17% for *information- and reassurance-seeking*, 14% for *prevention and planning*, and 18% for *overt avoidance*. Notably, however, interfactor correlations were modest and not supportive of summing the full instrument as an aggregated score (see Table SD1 in the Supplementary material). The information-/reassurance-seeking and bodily/checking factors had the strongest correlation ($r = 0.49$–0.51).

The 12-item four-factor solution was replicated in a confirmatory factor analytic framework, based on WLSMV estimation and the screening data (robust CFI = 0.96, robust TLI = 0.94, SRMR = 0.06, robust RMSEA = 0.07 [90% CI: 0.04, 0.10]). Based on these findings, further analyses were primarily conducted on the level of the respective subscales. The final 12-item Health Anxiety Behavior Inventory can be found in Swedish and English in the Supplementary material.

Internal consistency

We found that the internal consistency was adequate for all four HABI scales, i.e. *bodily preoccupation and checking* ($\alpha = 0.73$, $\omega = 0.74$), *information- and reassurance-seeking* ($\alpha = 0.85$,

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Table 3. *A priori* versus empirical classification of items in terms of types and factors of negatively reinforced health behaviour

			Factor analysis				
			Selection/training data				Validation data
	A priori classification		Initial 4-factor model		Final 4-factor model, 12-item HABI		
Item (abbreviated)	Rater 1	Rater 2	Factor	Loading	Factor	Loading	Loading (CFA)
1. Seeks information about illness	Info/reassure	Info/reassure/prevent/plan	Check/body	0.46			
2. Asks for medical advice	Info/reassure	Info/reassure	Info/reassure	0.83	Info/reassure	0.87	0.81
3. Avoids media	Avoidance	Avoidance	Avoidance	0.89	Avoidance	0.87	0.78
4. Avoids conversations	Avoidance	Avoidance	Avoidance	0.84	Avoidance	0.80	0.82
5. Checks symptoms repeatedly	Check/body	Check/body	Check/body	0.80	Check/body	0.65	0.70
6. Always brings a phone	Prevent/plan	Prevent/plan	n/a				
7. Tries to find cause of symptoms	Info/reassure	Check/body/info/reassure	Check/body	0.85	Check/body	0.83	0.65
8. Worries about future disease	Prevent/plan	Unclear, possibly prevent/plan	—				
9. Tells other about symptoms	Info/reassure	Info/reassure	Info/reassure	0.78	Info/reassure	0.79	0.79
10. Checks body for reassurance	Check/body	Check/body	Check/body	0.49			
11. Avoids triggering situations	Avoidance	Avoidance	Avoidance	0.80	Avoidance	0.84	0.83
12. Seeks promptly if new symptom	Info/reassure	Info/reassure/check/body	Check/body	0.59	Check/body	0.62	0.49
13. Plans for illness	Prevent/plan	Prevent/plan	—				
14. Careful about food and drink	Prevent/plan	Prevent/plan	Prevent/plan	0.67	Prevent/plan	0.79	0.74
15. Seeks reassurance if feels pain	Info/reassure	Info/reassure/check/body	Check/body	0.43			
16. Checks on family's health	Check/body	Check/body/prevent/plan	Prevent/plan	0.58			
17. Reads health advice	Prevent/plan	Prevent/plan	Prevent/plan	0.73	Prevent/plan	0.72	0.72
18. Asks others for reassurance	Info/reassure	Info/reassure	Info/reassure	0.80	Info/reassure	0.77	0.81
19. Tries to convince others to seek	Info/reassure	Info/reassure	Prevent/plan	0.39			
20. Makes plans to prevent disease	Prevent/plan	Prevent/plan	Prevent/plan	0.67	Prevent/plan	0.68	0.76

Exploratory factor analyses based on principal axis factoring with promax rotation, and the pre-treatment data. The confirmatory factor analysis used the screening data. Factors loadings are listed if ≥0.30. Items #8 and #13 did not exhibit any such loading. There were no cross loadings ≥0.30. The final 12-item questionnaire is provided in the Supplementary material. Avoidance = overt avoidance; CFA, confirmatory factor analysis; Check/body, bodily preoccupation and checking; HABI, Health Anxiety Behavior Inventory; Info/reassure = information- and reassurance-seeking; n/a, not applicable because item #6 was not included in the factor analysis due to its questionable corrected item-total correlation with the other 19 items; Prevent/plan = prevention and planning.

Table 4. Pearson correlations between the Health Anxiety Behavior Inventory and other scales

		Health Anxiety Behavior Inventory			
Variable	Scale	Check/body	Info/reassure	Prevent/plan	Avoidance
HA cognition and emotion	HAI-14	0.48*	0.41*	0.22*	0.30*
Seeks physician for pain	IAS item #5	0.60*	0.26*	0.16*	0.01
Avoids harmful habits	IAS item #7	0.04	0.01	0.51*	0.22*
Avoids unhealthy foods	IAS item #8	0.09	0.06	0.70*	0.21*
Examines body	IAS item #9	0.47*	0.31*	0.31*	0.26*
Healthcare consumption	IAS-TE	0.37*	0.15*	0.11	–0.01
Depression symptoms	MADRS-S	0.27*	0.10	0.24*	0.18*
Disability	SDS	0.24*	0.21*	0.27*	0.23*

All correlations are derived from the pre-treatment assessment. HA, health anxiety; HAI-14, 14-item Health Anxiety Inventory; IAS, Illness Attitude Scale; IAS-TE, Illness Attitude Scale – Treatment experience subscale, i.e. the sum of IAS items #22, #23 and #24; MADRS-S, Montgomery-Åsberg Depression Rating Scale – Self-report version; SDS, Sheehan Disability Scale. *p<.05.

ω = 0.86), *prevention and planning* (α = 0.78, ω = 0.78), and *overt avoidance* (α = 0.87, ω = 0.87). For the four HABI scales, all corrected ITCs were also adequate (ITC = 0.52–0.77; see Table 2).

Test–retest reliability

For participants who completed the two assessments within 14 days, the mean time for completion of both was 7.1 days (SD = 3.5; range 1–14; n = 55). The test–retest reliability was adequate to good for all four HABI scales, i.e. *bodily preoccupation and checking* (r = 0.75, ICC = 0.75 [95% CI: 0.61, 0.85]), *information- and reassurance-seeking* (r = 0.85, ICC = 0.85 [95% CI: 0.75, 0.91]), *prevention and planning* (r = 0.88, ICC = 0.87 [95% CI: 0.79, 0.92]), and *overt avoidance* (r = 0.90, ICC = 0.90 [95% CI: 0.83, 0.94]). Over up to 28 days, the average participant had completed the two assessments within 14.0 days (SD = 8.5; range 1–28; n = 102). Again, the test–retest reliability was adequate for all four HABI scales, i.e. *bodily preoccupation and checking* (r = 0.75, ICC = 0.75 [95% CI: 0.65, 0.82]), *information- and reassurance-seeking* (r = 0.82, ICC = 0.82 [95% CI: 0.75, 0.88]), *prevention and planning* (r = 0.81, ICC = 0.81 [95% CI: 0.73, 0.87]), and *overt avoidance* (r = 0.86, ICC = 0.86 [95% CI: 0.81, 0.91]).

Convergent and discriminant validity

Correlations between the four HABI scales and other scales are presented in Table 4. The *bodily preoccupation and checking* and *information- and reassurance-seeking* scales were most clearly correlated with the cognitive and emotional components of health anxiety (r = 0.41, 0.48). Healthcare consumption was primarily related to the checking/body factor (r = 0.37).

Responsiveness

Within-group reductions were seen in all HABI scales over the course of CBT (g = 1.01–1.42; Table 5), and this correlated with a reduction in the cognitive and emotional aspects of health anxiety (r = 0.34-0.63; Table 5). The HABI *bodily preoccupation and checking* scale showed the largest effect size and change correlation with cognitive and emotional aspects of health anxiety.

Discussion

This article describes the development and initial psychometric evaluation of the Health Anxiety Behavior Inventory (HABI): a measure of negatively reinforced behaviours commonly seen in clinically significant health anxiety. This is a 12-item instrument that we found to be comprised of four distinct scales measuring *bodily preoccupation and checking*, *information- and reassurance-seeking*, *prevention and planning*, and *overt avoidance*. Each of these four scales demonstrated

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Table 5. Within-group reduction in health anxiety behaviours and relation to change other constructs over the course of cognitive behaviour therapy for clinically significant health anxiety

	Change over time								Correlation with change in other constructs		
	Pre			Post			Main outcome from linear mixed models			HA cog/em (HAI-14)	Depression (MADRS-S)	Disability (SDS)
Factor/scale	*M*	*SD*	*n*	*M*	*SD*	*n*	Change (95% CI)	*p*	*g*	*r*	*r*	*r*
Check/body	5.9	2.1	204	2.4	2.0	194	−3.4 (−3.8, −3.1)	<0.001	1.42	0.63	0.41	0.32
Info/reassure	4.5	2.7	204	1.6	2.2	194	−2.9 (−3.3, −2.5)	<0.001	1.09	0.44	0.32	0.29
Prevent/plan	3.9	2.4	204	2.0	1.9	194	−1.9 (−2.2, −1.6)	<0.001	1.01	0.39	0.38	0.28
Avoidance	4.5	2.9	204	1.1	1.8	194	−3.4 (−3.8, −3.0)	<0.001	1.22	0.34	0.25	0.27

Analyses of change including standardised effects and correlations with change in other outcomes are based on linear mixed effects models fitted on multiply imputed data. Hedges' *g* effect sizes are calculated as the negated model-implied coefficient for pre–post change, divided by the observed standard deviation of change, multiplied by the bias-correction factor. Avoidance = overt avoidance; Check/body = bodily preoccupation and checking; HA cog/em = cognitive and emotional components of health anxiety; HAI-14, 14-item Health Anxiety Inventory; Info/reassure = information- and reassurance-seeking; MADRS-S, Montgomery-Åsberg Depression Rating Scale – Self-report version; Prevent/plan = prevention and planning; SDS, Sheehan Disability Scale.

adequate internal consistency, adequate to good test–retest reliability, and changes in these scales were correlated with improvement following CBT for health anxiety. The *bodily preoccupation and checking*, and *information- and reassurance-seeking* scales appeared to have reasonable discriminant and convergent validity, whereas the *prevention and planning* and *overt avoidance* scales performed less well in this regard. This is one of the first attempts to develop and psychometrically evaluate a self-report instrument with the aim of measuring a broad range of clinically relevant behaviours in health anxiety.

Apparent multi-dimensional structure of behaviours in health anxiety

A key finding of this study is that subtypes of health anxiety behaviours may not be particularly highly correlated, at least not in the clinical population. A similar pattern was seen by Jones *et al.* (2020), although without the inclusion of items for prevention and planning, and caring for relatives. The finding of relatively distinct subfactors of behaviour, where avoidance stands out from checking and information-seeking behaviours, also appears to generalise at least to some scales used to measure other domains of anxiety, such as the Social Behavior Questionnaire (Gray *et al.*, 2019) and the Worry Behaviors Inventory (Mahoney *et al.*, 2016). The multi-factorial structure having been corroborated indicates that when measuring common behaviours in health anxiety, it is probably necessary to make distinctions between subtypes of behaviours. Therefore, the HABI should be scored on the level of its four subscales, and not as one sum score.

Validity of measuring behaviour instead of specifying 'subtypes'

Through the introduction of diagnostic specifiers for illness anxiety disorder, the authors of the *DSM-5* introduced 'care-seeking' and 'care avoidant' subtypes for many sufferers of clinically significant health anxiety (American Psychiatric Association, 2022). Although the test–retest reliability estimates seen here suggest that common health anxiety behaviours are reasonably stable up to at least 2 weeks ($r = 0.75$–0.90), it is less clear to what degree such behaviours change within individuals over longer periods of time. Newby *et al.* (2017) found that 67/118 patients (57%) reported fluctuating between 'care-seeking' and 'care avoidant' behaviours. In line with this finding, evidence from the present study suggests that dividing this patient population by any form of dichotomous category such as 'care-seeking' *vs* 'care avoidant' is likely to be a crude simplification at best. The correlation between the *information- and reassurance-seeking* and *over avoidance* factors, albeit not focusing solely on healthcare seeking, was weak and positive ($r = 0.18$), rather than strong and negative. Also, the pre-treatment HABI *overt avoidance* scale had a range of 0 to 9, exhibited a homogenous distribution (i.e. each score was about as common as the other), with a mean of 5 ($SD = 3$), where 79/204 (39%) of the sample scored in the mid-range of 3–6 (see Fig. 1). This speaks for measuring health anxiety behaviours as a set of continuous, or at least ordered, variables.

Relationship to cognitive and emotional components of health anxiety

In this study, correlations between the HABI *bodily preoccupation and checking* and *information- and reassurance-seeking* scales and the cognitive and emotional components of health anxiety (HAI-14) were moderately strong ($r = 0.41$–0.48). The MIHT information- and reassurance-seeking subscale (called 'Hypochondriacal reassurance') has been found to behave in a similar manner, with a moderate correlation with the cognitive and emotional components of health anxiety ($r = 0.27$–0.53), and more modest correlations with other health behaviour such as prevention and planning ($r = 0.07$) (Longley *et al.*, 2005). Similarly, the Health Anxiety Behaviors Scale (HABS) body/checking and information-/reassurance-seeking items that are unrelated to healthcare (called 'General health reassurance seeking') have exhibited a relatively strong

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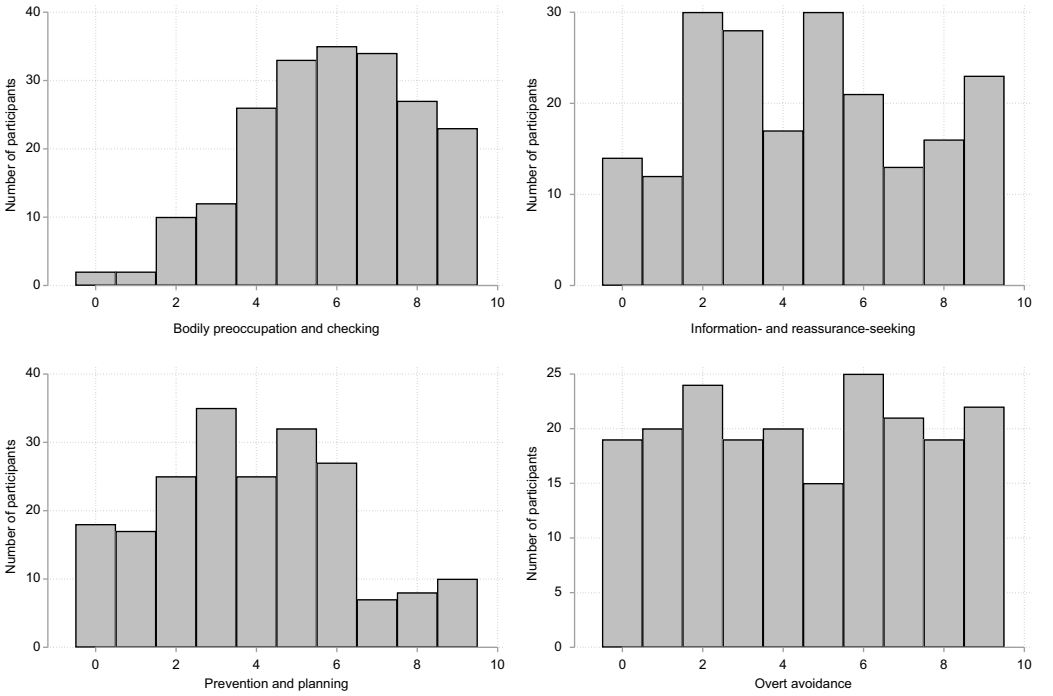

Figure 1. Distributions of the four scales of the Health Anxiety Behavior Inventory, in this sample with clinically significant health anxiety ($n = 204$), at the pre-treatment assessment. In factor analysis, correlations between the four scales (factors) varied from 0.06 (*Bodily preoccupation and checking vs Overt avoidance*) to 0.51 (*Bodily preoccupation and checking vs Information- and reassurance-seeking*).

correlation with a scale focusing primarily on the cognitive aspects of health anxiety ($r = 0.68$; an 8-item subscale of the Health Anxiety Questionnaire). A weaker correlation ($r = 0.34$) has been reported, however, for items related to healthcare (called 'Medical health reassurance seeking') (Jones *et al.*, 2020). Overall, the existing literature appears to speak for convergent validity in terms of a moderately strong relationship between *bodily preoccupation and checking* and *information- and reassurance-seeking* on the one hand, and the cognitive and emotional components of health anxiety on the other.

The other two HABI scales – *prevention and planning* and *overt avoidance* – showed more modest, weak-to-lower-moderate range, correlations with the HAI-14 ($r = 0.22$–0.30). This is in line with previous psychometric evaluations indicating that such behaviours do not lie as near the core of the health anxiety construct (Axelsson *et al.*, 2023; Fergus and Valentiner, 2011; Jones *et al.*, 2020). This said, correlations were weaker than expected. For *prevention and planning*, one potential explanation could be that a healthy lifestyle, even when pursued to reduce the risk of illness, is not typically the result of attempts at reducing the fear of serious disease, in the short term specifically, even in the clinically significant health anxiety population. Rather, as suggested by Kellner *et al.* (1987), patients may be 'so distressed by their belief of having undiagnosed and neglected disease that behaviors that may yield benefits in the distant future appear to them irrelevant'. Overall, there appears to be enough relevance of *prevention and planning* and *overt avoidance* for the cognitive and emotional components of health anxiety to study this relationship further.

Strengths of the Health Anxiety Behavior Inventory

Cognitive behavioural conceptualisations of health anxiety tend to emphasise the interplay of cognitions, emotions, and behavioural responses over time (Furer *et al.*, 2007; Warwick and

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Salkovskis, 1990). While the most widespread measure of health anxiety – the Health Anxiety Inventory – does cover cognitive and emotional aspects, the Health Anxiety Behavior Inventory (HABI) enables the parallel assessment of health anxiety behaviours. Importantly, the HABI enables clinicians and researchers to measure a broad spectrum of health anxiety behaviours in an efficient manner (three items per scale) that acknowledges the continuous distribution of behaviours within and between individuals. Currently widespread health anxiety measures either lack items about behaviour (e.g. HAI-14) or do not capture as broad a scope of behaviour (e.g. IAS, MIHT). We suggest that the HABI could be administered both for the purpose of facilitating assessment, and for following progress, whenever health anxiety is a part of the clinical picture. The HABI's focus on behaviours and apparent sensitivity to change make it suitable as a process measure in treatments where these behaviours are thought to play a role for improvement. Our clinical experience from working with the HABI in exposure-based CBT is that it has been a highly useful tool in determining whether patients engage in behavioural change. As such, it provides a helpful additional source of information in discussions with the patient on how treatment is progressing.

Limitations of this study

Primary limitations were the limited sample size ($n = 204$), and that it is not clear how the scale would behave in a non-clinical sample or in another patient group. The evaluation was also conducted in Swedish only, based entirely on scoring of the 20 candidate items, and the 12-item HABI was never administered in its final form. This sample reported relatively high levels of health anxiety, but the burden of non-communicable disease was limited and it is conceivable that inter-relationships between behaviours could be different in groups with higher rates of such conditions. Moreover, average educational attainment of the sample was high, and we had only limited information about certain sociodemographic aspects, notably ethnicity and race, which is rarely surveyed in Sweden. All this underscores the need for replication. Another limitation is that despite our efforts to develop a broad and clinically relevant item pool, we had a limited number of candidate items pertaining to certain types of behaviour. For example, it is conceivable that acting on relatives' health could have formed a separate factor, had the number of candidate items been higher (see above and Ingeman et al., 2021). Although item development was informed by patient worksheets, there was also no formal, more extensive, patient or public involvement. A broader, systematic, perhaps qualitative, approach to build expert consensus on key concepts, had strengthened content validity and is a viable topic of future research in this area. Notably, lack of expert agreement on key theoretical terms is a common problem in the field of behavioural and psychosomatic medicine. Although it could be said that some item distributions were not ideal for conventional exploratory factor analysis, the factor solution was validated in the screening data, where it achieved clearly acceptable fit based on mean and variance adjusted weighted least squares (WLSMV) estimation, which is a robust method when data are not fully normal, and when items have few response options (Sellbom and Tellegen, 2019). In future studies, it would be ideal to validate the HABI against non-self-reported outcomes such as observed behaviour, or a psychiatric interview with questions about behaviour such as the Hypochondriasis Yale-Brown Obsessive-Compulsive Scale (Greeven *et al.*, 2009).

Conclusion

The Health Anxiety Behavior Inventory (HABI) is a promising measure of negatively reinforced behaviours commonly seen in clinically significant health anxiety. Such behaviours appear to have a multi-factorial structure.

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Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S1352465824000377

Data availability statement. Data and results are made available to the extent that this is deemed to be consistent with Swedish and European Union (EU) data protection and privacy legislation. Decisions pertaining to the sharing of data are taken upon reasonable request, on a case-by-case basis, and in accordance with judicial expertise.

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Author contributions. **Erik Hedman-Lagerlof:** Conceptualization (lead), Investigation (equal), Methodology (supporting), Project administration (equal), Writing - original draft (supporting), Writing - review & editing (supporting); **Daniel Björkander:** Formal analysis (supporting), Investigation (equal), Writing - review & editing (supporting); **Erik Andersson:** Investigation (supporting), Writing - review & editing (supporting); **Erland Axelsson:** Conceptualization (supporting), Data curation (lead), Formal analysis (lead), Investigation (equal), Methodology (lead), Project administration (equal), Writing - original draft (lead), Writing - review & editing (lead).

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Competing interests. The authors have developed and evaluated cognitive behaviour therapy protocols for the treatment of clinically significant health anxiety. E.H.-L. and E.A. have also co-authored books and book chapters on the topic of clinically significant health anxiety. E.H.-L. is a shareholder of Hedman-Lagerlöf och Ljótsson psykologi AB: a company that licenses treatment manuals for irritable bowel syndrome.

Ethical standards. The trial was approved by the regional ethics review board of Stockholm (reference no. 2014/1530-31/2); this psychometric evaluation was approved by the Swedish Ethical Review Authority (reference no. 2023-07309-02). All participants provided informed consent for participating in research. All procedures were also in accordance with Swedish and European Union (EU) data protection and privacy legislation, and the Declaration of Helsinki.

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