Breathe Well, Be Well: Development and Validation of the Perceived Breath Mastery Scale (PBM-S)

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Abstract

Breathing interventions are a commonly used and effective tool for improving well-being. However, assessments of breathing are seldom included within these interventions, which limits understanding of how specific aspects of breathing contribute to specific changes in well-being. Existing assessments of breathing are not well suited for use in well-being interventions because they typically only capture negative aspects of breathing, such as dysfunction. The present study aimed to address this gap by developing and evaluating the first positive, self-report breathing measure (the Perceived Breath Mastery Scale [PBM-S]). Expert panel review and exploratory factor analysis led to a 3-factor, 23-item scale that showed good structural validity. Criterion, discriminant, incremental, and known-group validity were also established. The PBM-S proved to be a better predictor of flourishing than well-established measures, such as mindfulness and self-efficacy. We also used a machine learning algorithm to construct a 9-item version of the PBM-S and a 12-item version that included dysfunctional breathing as a fourth factor. We recommend using the PBM-S instruments in breathing interventions to deepen insights into the psychological processes they affect and to customize, assess, and enhance interventions for targeted well-being outcomes.

Introduction

Breathing has been considered central to health and well-being for thousands of years (Zaccaro et al., 2018). In recent times, breathwork, which involves deliberate awareness and/or control of breathing patterns and rhythms, has become a core element in a range of interventions aimed at improving physical (Russo et al., 2017) and psychological well-being (Zaccaro et al., 2018; Balban et al., 2023; Fincham et al., 2023b). Such interventions operate on the principle that skillful breathing initiates beneficial psychophysiological processes, leading to enhanced well-being. However, most interventions fail to examine the specific breathing-related mechanisms, or mediators, that link breathwork to well-being. This lack of mechanistic understanding limits the ability to refine and tailor breathing interventions for specific well-being outcomes.

A key barrier to understanding the relationship between breathing and well-being is the lack of appropriate measurement tools. Existing assessments of breathing fall into two broad categories: objective and subjective. Objective measures—such as respiratory rate, tidal volume, and capnometry—capture specific physiological aspects of breathing, and are the most frequently used in research. However, these measures have shown weak and inconsistent associations with subjective well-being (Darkins, 2024), limiting their utility in explaining how improvements in breathing contribute to improvements in well-being. Subjective assessments—typically self-report questionnaires—tend to demonstrate stronger associations with well-being but, to date, have focused exclusively on dysfunction. These include symptoms such as breathlessness (Meek et al., 2012), dysfunctional breathing (Courtney & Greenwood, 2009), hyperventilation (van Dixhoorn & Duivenvoorden, 1985), and fear of breathing-related sensations (Steinmann et al., 2023). While deficit-oriented tools are clinically useful and have been linked to adverse outcomes such as stress (Stephen et al., 2022), anxiety (Steinmann et al., 2023), and poor mental health (Ok et al., 2018), they offer little insight into how breathing relates to positive aspects of well-being, such as life satisfaction, vitality, and flourishing. These limitations of available assessments may help explain why many breathing interventions do not include any assessment of breathing, especially in non-clinical populations.

As positive psychology research has shown, the absence of dysfunction does not equate to optimal functioning (Keyes, 2005). Applied to breathing, this distinction suggests that psychological benefits arise not simply from resolving symptoms, but from cultivating the capacities that allow breathing to support well-being. Despite the prominence of breathwork in well-being interventions, no validated measure currently exists to assess the positive psychological dimensions of breathing. To address this gap, we introduce *perceived breath mastery* (hereafter, *breath mastery*)—a construct designed to capture the psychological mechanisms through which breathing may promote well-being. Rather than focusing on dysfunction, breath mastery reflects the presence of skills, habitual patterns, and perceptions, that enable individuals to relate to and utilize their breath—both consciously and unconsciously—as a reliable resource for positive psychological functioning.

Emerging evidence supports the view that psychological factors—such as expectations, beliefs, and perceptions—play a critical role in the outcomes of breathwork interventions. For instance, the benefits of mindful breathing appear to depend, in part, on an individual's level of spirituality (Hunt et al., 2021), and those who expect breathing practices to be helpful tend to report greater improvements in well-being than those with lower expectations (Szabo & Kocsis, 2017). Likewise, breathing interventions that include human guidance are more effective than those without (Bentley et al., 2023). These findings align with self-efficacy theory (Bandura, 1997), which posits that confidence in one's abilities shapes motivation, emotional responses, and behavior. More broadly, research on mindset has demonstrated that beliefs can influence physiological processes—from perceptions of hunger (Crum et al., 2011), to stress responses (Crum et al., 2013), and even treatment efficacy (Howe et al., 2017). It is therefore plausible that beliefs and perceptions about breathing may similarly influence well-being.

Despite the lack of a validated measure, the idea that breathing can be optimized for well-being is widely accepted in both scientific and applied domains. Programs such as biofeedback (Lehrer et al., 2020), acceptance and commitment therapy (ACT) (Hayes et al., 2006), and mindfulness-based stress reduction (MBSR) (Kabat-Zinn, 2003) include various forms of intentional breathing. Likewise, a wide range of standalone breathwork interventions—including physiologically opposing techniques—produce similar psychological benefits that are not fully explained by physiological change. For example, Balban et al. (2023) tested four distinct practices—cyclic hyperventilation with breath holds, box breathing, cyclic sighing, and mindful breathing—and found that all improved mood and reduced anxiety, despite minimal effects on physiological markers such as resting heart rate, heart rate variability, and sleep. We propose that the similar psychological well-being benefits produced by these (and other) diverse breathing practices may be explained by how each practice effects breath mastery. For instance, slow breathing and biofeedback-based practices may enhance both perceived efficacy and habitual efficiency; hyperventilation-based techniques may increase efficacy of breathing without improving efficiency, while mindful breathing may primarily cultivate more positive breath awareness.

Importantly, we conceptualize breath mastery as distinct from related constructs such as mindfulness and interoception. While mindfulness practices often involve breath awareness, they emphasize open, non-judgmental attention to a range of internal experiences, including thoughts and emotions (Baer et al., 2012), rather than the development of breathing-specific skills. Similarly, interoception refers to the perception of internal bodily sensations more broadly (Mehling et al., 2018), without a focus on the regulation or positive evaluation of those sensations. In contrast, breath mastery encompasses the habitual patterns, positive perceptions, and intentional control of breathing that may collectively contribute to well-being.

A mechanistic understanding of how breathing influences well-being is crucial for moving beyond the prevailing one-size-fits-all approach to breathwork (Vlemincx and Cortez-Vázquez, 2024). This would allow researchers and practitioners to develop and apply interventions with greater precision for specific well-being outcomes. For example, if a client struggles to see the utility of breathing exercises, interventions could focus on building their confidence in the efficacy of breathwork, helping them understand its potential benefits. Conversely, if someone already feels confident in breathwork but displays inefficient breathing patterns, interventions might target improving their habitual breathing, such as encouraging diaphragmatic, nasal breathing at rest. For another individual who feels disconnected from their breath, the focus might shift toward cultivating positive awareness of their breathing.

A validated measure of breath mastery could also address a pressing challenge in breathwork research: the substantial variability in individual responses to breathing interventions. While breathwork is often promoted as universally beneficial, studies suggest meaningful individual differences in experience and effectiveness. For instance, Balban et al. (2023) found that while 90% of participants reported positive experiences during breathing exercises, 10% reported negative experiences. Similarly, Fincham et al. (2023a) observed that 76% of participants had a positive experience with a 4-week slow breathing protocol, while 6% reported a negative and 18% a neutral experience. Without a measure that accounts for individual differences in breath-related perceptions, competencies, and habitual patterns, predicting who will benefit most from various types of breathwork remains difficult.

In sum, while breathwork is widely used and believed to enhance well-being, the mechanisms linking breathing to well-being remain poorly understood due to a lack of suitable measures. The present study addresses this gap by developing and rigorously evaluating the Perceived Breath Mastery Scale (PBM-S), a tool designed to capture the positive psychological dimensions of breathing that contribute to well-being. By establishing the unique value of this measure in comparison to related constructs such as mindfulness, interoceptive awareness, and self-efficacy, we aim to advance understanding of how breathing interventions can be tailored to optimize individual well-being outcomes.

The Present Research

To achieve our overarching aim of developing and rigorously evaluating a measure of breath mastery, we undertook the following steps. First, we sought to define breath mastery, create initial items, and establish content validity through an expert panel review. Second, we evaluated its structural validity and reliability with exploratory factor analysis and exploratory structural equation modelling. Third, we assessed convergent, discriminant, and criterion validity through correlations with other theoretically relevant measures. Fourth, we evaluated incremental validity with multiple regression analysis to evaluate if our measure added value over and above other well-established measures. Finally, we created and evaluated short form alternatives.

Defining Breath Mastery

To create a measure of breath mastery, we first needed to conceptualize and operationally define it. To do this, we relied on the following sources: (a) published research on breathing, (b) popular breathing books (e.g., McKeown, 2015; Bostock, 2020; Vranich and Sabin, 2020; Clifton-Smith, 2021; Nestor, 2021), (c) discussions with a multidisciplinary panel of breathing experts, and (d) our own conceptual knowledge. These investigations were guided by the question ‘What are the characteristics of optimal/masterful breathing?’ This iterative process resulted in the conceptualization of breath mastery as a combination of three core components (Fig. 1): (1) *Perceived efficacy in using breathing*: This dimension captures an individual’s confidence in their ability to intentionally utilize their breath for various beneficial outcomes, such as reducing tension or enhancing energy. (2) *Perceived breathing efficiency*: This dimension reflects an individual’s belief in the optimality of their habitual breathing patterns, characterized by abdominally driven nasal breathing that is effortlessly maintained (at rest). (3) *Positive breath awareness*: This dimension involves noticing and being ‘in-tune’ with one’s breath, coupled with a belief in the benefits of such awareness. Theoretically, these components are interrelated yet distinct, meaning individuals may demonstrate proficiency in one aspect while lacking in others. For example, someone may breathe efficiently but lack awareness of their breathing or confidence in using it effectively. Alternatively, a person may confidently use specific breathing techniques but default to suboptimal habitual breathing patterns when not consciously practicing.

This conceptualization places an individual’s perceptions (or beliefs) about their breathing capacities as an important factor in breathwork and well-being. This is grounded in self-efficacy theory, which is concerned with perceived capabilities (Bandura, 2006). Perceived efficacy has been shown to play a key role in optimal functioning by influencing behavior both directly and indirectly. Beliefs, or perceptions of efficacy influence thinking, emotional states, and choices of action (Bandura, 2006). Furthermore, physiological feedback is considered one of the main sources of self-efficacy (Bandura, 1997). Given that breathing is an ever-present source of physiological feedback and has been shown to influence emotional states and cognitions (Philippot et al., 2002; Zaccaro et al., 2018), we hypothesize that positive perceptions of one’s breathing (perceived breath mastery) will be associated with positive well-being and engagement in well-being related behaviors.

Initial Item and Scale Development

Having identified self-efficacy as an important theory upon which to build our conceptualization of perceived breath mastery, we followed Bandura's (2006) recommendations for best practice in self-efficacy scale development. This involved writing positively worded items that aimed to capture all possible features of breath mastery, which resulted in an initial 45-items. For the perceived efficacy in using breathing items, the prompt was: ‘Please rate your degree of confidence for each of the following statements using the scale below. There are no right or wrong answers.’ This wording was adapted from established self-efficacy measures (Bandura, 2006). For all other items, the prompt read: ‘Please mark on the line how much you agree with each statement. Remember, there are no right or wrong answers.' All items were rated on a scale from 0 (not at all confident/disagree strongly) to 100 (very confident/agree strongly). We chose this wide-range scale as opposed to typical 5- or 7-point scales based on recommendations that even small changes in scores might reflect meaningful differences if the measure was used to assess change following a breathing intervention (Ciarrochi et al., 2022).

Expert Panel Review

We compiled a theoretically diverse expert panel consisting of eight members with expertise pertaining to breathing within the fields of physiology, Olympic sport performance, psychology, physiotherapy, mindfulness, education, contemplative traditions, and breathing assessment (see online supplemental materials for details). This diversity was deemed to be particularly important given that breathing has been studied and utilized across a wide variety of fields. The experts were presented with our conceptualization and initial 45-items and asked if each accurately captured an important aspect of what they considered to be 'optimal/masterful' breathing. Each expert was also asked if there were any important attributes of breath mastery missing that should be added to the item pool. Following 1–2 rounds of feedback with each expert, five items were removed for being too like other items, or not characteristic of optimal/masterful breathing in all contexts. A final item pool of 40 items for our three-factor model of breath mastery was agreed upon by all members of the panel. This consisted of 14 items for self-efficacy in using breathing, 17 items for perceived breathing efficiency, and 9 items for positive breathing awareness (see Table S1 of online supplemental material). This item development and expert review process provided initial content validity.

Method

Participants and Procedures

Data were collected from a nationally representative sample of 1,000 Australian adults, sourced by Qualtrics, an online survey enterprise platform. The following screening criteria were utilized: (a) aged between 18 and 50 years, (b) not suffering from any chronic health conditions, (c) residing in Australia, and (d) fluent in English. Ethical approval was granted from the Australian Catholic University Human Ethics Committee (HREC approval number: 2022-2491E). The average age of participants was 33.2 (SD 9.01). There was a near even-split between those who identified as male (49.3%) and female (50.2%). All participants had completed a minimum of primary school education. The total sample was then randomly split into training and testing samples using the 'createDataPartition' function in the 'caret' package (Kuhn, 2008) so that exploratory factor analysis (EFA) could be performed on the training sample (N = 702), and exploratory structural equation modelling (ESEM) on the testing sample (N = 298). There were minimal differences in the demographic breakdowns of the training and testing samples (see Table 1).

Table 1

Participant Demographics for all Three Samples

Participant characteristic	**Combined sample (*N* = 1000)**		**Training sample (*N* = 702)**		**Testing sample (*N* = 298)**	
	n	*%*	*n*	*%*	*n*	*%*
Gender						
Male	493	49.3%	343	48.9%	150	50.3%
Female	502	50.2%	356	50.7%	146	49.0%
Non-binary/third gender	2	0.2%	1	0.1%	1	0.3%
Prefer not to say	3	0.3%	2	0.3%	1	0.3%
Ethnicity						
Caucasian	645	64.5%	445	63.4%	200	67.1%
East and South East Asian	96	9.6%	74	10.5%	22	7.4%
South Asian	41	4.1%	26	3.7%	15	5.0%
Middle Eastern	20	2%	14	2%	6	2.0%
African	6	0.6%	5	0.7%	1	0.3%
Latin, Central and South American	11	1.1%	7	1.0%	4	1.3%
Caribbean	1	0.1%	1	0.1%	0	0.0%
Pacific Islander	21	2.1%	18	2.6%	3	1.0%
Indigenous Australian	101	10.1%	72	10.3%	29	9.7%
Other	40	4%	27	3.8%	13	4.4%
Prefer not to say	18	1.8%	13	1.9%	5	1.7%
Education						
Less than primary	0	0.0%	0	0.0%	0	0.0%
Primary	5	0.5%	4	0.6%	1	0.3%
Some secondary	55	5.5%	33	4.7%	22	7.4%
Secondary	197	19.7%	137	19.5%	60	20.1%
Vocational	179	17.9%	122	17.4%	57	19.1%
Some University	91	9.1%	70	10.0%	21	7.0%
University – Bachelor’s Degree	345	34.5%	246	35.0%	99	33.2%
Graduate or professional degree	120	12%	85	12.1%	35	11.7%
Prefer not to say	8	0.8%	5	0.7%	3	1.0%
State						
New South Wales	319	31.9%	233	33.2%	86	28.9%
Victoria	270	27%	185	26.4%	85	28.5%
Queensland	192	19.2%	129	18.4%	63	21.1%
South Australia	70	7%	47	6.7%	23	7.7%
Western Australia	101	10.1%	71	10.1%	30	10.1%
Tasmania	26	2.6%	17	2.4%	9	3.0%
Northern Territory	7	0.7%	7	1.0%	0	0.0%
Australian Capital Territory	15	1.5%	13	1.9%	2	0.7%
Participant characteristic	*M*	*SD*	*M*	*SD*	*M*	*SD*
Age	33.2 (18–50)	9.01	33.0	8.94	33.6 (18–50)	9.19

Note. Combined sample *N* = 1000. Train sample *N* = 702. Test sample *N* = 298.

Participant characteristic	Combined sample (*N* = 1000)	Training sample (*N* = 702)	Testing sample (*N* = 298)
		(18–50)	
Note. Combined sample *N* = 1000. Train sample *N* = 702. Test sample *N* = 298.			

Measures

Criterion validity: Correlations with Well-Being Measures

We hypothesized that breath mastery would be associated with better well-being. Specifically, we expected strong associations between all three dimensions of the PBM-S and all positive well-being measures (described below). We expected smaller inverse correlations between all three dimensions of the PBM-S and all negative dimensions of well-being. Because well-being is a multifaceted construct, we deemed it important to capture its many dimensions as comprehensively and efficiently as possible, hence chose the following measures:

Flourishing. We used the flourish index (Weziak-Bialowolska et al., 2019), which consists of 10 questions covering five domains of flourishing: Happiness and Life Satisfaction; Mental and Physical Health; Meaning and Purpose; Character and Virtue, and Close Social Relationships. Participants responded on a 0–10 scale to items such as ‘In general, how happy or unhappy do you usually feel?’. The overall scale showed high internal consistency ($a = 0.94$).

Vitality. We utilized three positively worded items from the Subjective Vitality Scale (Ryan and Frederick, 1997), including ‘I feel energized’, ‘I feel alive and vital’, and ‘I nearly always feel awake and alert’. Cronbach’s alpha was good ($a = 0.90$).

Positive and Negative Well-Being Behaviors. The Process-Based Assessment Tool (PBAT; (Ciarrochi et al., 2022) captures positive and negative well-being behaviors, or processes, that relate to well-being (e.g., ‘I used my thinking in ways that helped me live better’; ‘My thinking got in the way of things that were important to me’). Participants responded using a digital-analogue scale ranging from 0 (strongly disagree) to 100 (strongly agree). Cronbach’s alpha was 0.89 for the positive subscale and 0.90 for the negative subscale.

Sleep Quality. We used the Sleep Quality Scale (SQS; Snyder et al., 2018), a single item measure of self-reported sleep quality based on the previous 7-nights. Participants responded to the item ‘During the past 7 days, how would you rate your sleep quality overall?’ using a 0–10 scale. The SQS has shown superior validity to longer measures of sleep quality (Snyder et al., 2018).

Physical Fitness. Self-ratings of physical fitness were attained using a single item ‘How would you rate your physical fitness?’, to which participants responded on a 5-point scale from 1 (poor) to 5 (excellent).

Negative Well-Being. The Screening Tool for Psychological Distress (STOP-D; Young et al., 2007) was used to assess negative well-being. This consists of five items measuring depression, anxiety, stress, anger, and lack of social support. Participants rated the extent to which they felt each of these states during the past week on a 10-point scale from 0 (not at all) to 9 (severely). A sample item was ‘Over the last week, how much have you been bothered by feeling stressed?’ The STOP-D has been shown to correlate closely with other validated measures of each of these constructs that are much longer (Young et al., 2007). In this sample, Cronbach’s alpha was 0.91.

Convergent Validity: Theoretically Related Constructs

We hypothesized that all three dimensions of perceived breath mastery would be positively associated with, but distinguishable from, the following measures related to optimal functioning:

Mindfulness. We used the Five-Facet Mindfulness Questionnaire short form (FFMQ-15; Baer et al., 2012). This 15-item version was preferred to the original 39-item questionnaire (Fernandez and Wood, 2009) to reduce participant burden. The FFMQ-15 includes the three highest loading items for each of the five subscales of mindfulness (observing, describing, acting with awareness, non-judgment, non-reactivity). Participants rated how true of them each item was from 0 (never, or very rarely true) to 5 (very often or always true). A sample item was ‘I find myself doing things without paying attention’. Cronbach’s alphas for each subscale were: observing ($a = 0.62$); describing ($a = 0.57$); acting with awareness ($a = 0.57$); non-judgment ($a = 0.79$); non-reactivity ($a = 0.69$).

General Self-Efficacy. A general measure of self-efficacy ‘New General Self-Efficacy Scale’ (NGSE; Chen et al., 2001) was used to determine whether breathing related self-efficacy is distinct from general self-efficacy. This is an eight item, unidimensional scale that has been shown to have better internal consistency, content validity and predictive validity than longer general self-efficacy scales (Chen et al., 2001). Participants rated the extent to which they agreed with each statement from 0 (strongly disagree) to 4 (strongly agree). A sample item was ‘Compared to other people, I can do most tasks very well’. Cronbach’s alpha was 0.92.

Nonattachment. Nonattachment refers to a flexible and balanced way of relating to one’s experiences without clinging to or suppressing them (Devine et al., 2022). The 7-item version of the nonattachment scale was used to determine whether perceived breath mastery is associated with the ability to relate flexibly to experience. Participants rated the extent to which each item reflects their experience from 0 (disagree strongly) to 6 (agree strongly). A sample item was, ‘I can enjoy pleasant experiences without needing them to last forever’. Cronbach’s alpha was 0.85.

Interoceptive Awareness. The Multidimensional Assessment of Interoceptive Awareness, Version 2 (MAIA-2; Mehling et al., 2018) is a 37-item state-trait measure of interoception across eight dimensions. To reduce participant burden, we utilized three high loading items for each dimension, resulting in 24 items. Participants indicated how often each statement applied to them in their general daily life from 0 (never) to 5 (always). A sample item was 'I notice where in my body I am comfortable'. Cronbach's alpha for the 24-item scale was 0.87.

Discriminant Validity: Dysfunctional Breathing

The Self Evaluation of Breathing Symptoms Questionnaire (SEBQ; Courtney and Greenwood, 2009) was used to measure dysfunctional breathing. We chose this measure because it has been validated (Courtney and Greenwood, 2009; Mitchell et al., 2016) and is commonly used to assess breathing dysfunction. It consists of 25 questions pertaining to self-perceptions of breathing dysfunction (e.g., 'My breathing is heavy', 'I can't catch my breath'). Participants responded on a scale from 0 (never/not true at all) to 3 (very frequently/very true). The internal consistency of this scale was high ($a = 0.96$). Given that our measure is also about self-perceptions of breathing, but in the positive, not dysfunctional sense, we felt it was important to establish that perceived breath mastery was unique and not simply the opposite of dysfunctional breathing. We expected F1 Perceived efficacy and F3 Breath awareness to be unrelated to dysfunctional breathing, and F2 Breath efficiency to be slightly negatively related to dysfunctional breathing.

Known Group Validity: Relationship between Breathwork Experience and Perceived Breath Mastery

Having conceptualized perceived breath mastery as a potential mechanism through which breathing interventions work, it was important to assess the extent to which it was positively associated with experience in using breath practices. We hypothesized that greater experience with breathing practices would be associated with higher scores in each dimension of the PBM-S. To assess experience, participants responded to the item 'Which best describes your level of experience with breathing practices?' on a scale from 0 (not experienced at all) to 4 (extremely experienced). For group analyses, scores of 0 and 1 were classified as 'Low experience', and scores of 3 and 4 classified as 'High experience'. Of the 1,000 respondents, 176 reported high experience, whilst 493 reported low experience. Table 2 provides an overview of these groups.

Table 2
Summary of Low and High Breath Experience Groups

Participant characteristic	**Low breath experience (N = 493)**		**High breath experience (*N* = 176)**	
	n	*%*	*n*	*%*
Gender				
Male	195	39.6%	124	70.4
Female	296	60%	50	28.4%
Non-binary/third gender	0	0%	1	0.6%
Prefer not to say	2	0.4%	1	0.6%
	M	*SD*	*M*	*SD*
Age	33.77 (18–50)	9.0	32.57 (18–50)	8.44

Statistical Analysis

Factor Structure

Analyses were conducted using the 'base R' and 'psych' packages in R (R Core Team, 2023; Revelle, 2023). Maximum likelihood factoring with promax rotation was chosen as the most relevant extraction method given that the items were assumed to correlate with each other. Parallel analysis (Horn, 1965), Scree tests (Cattell, 1966), and Kaiser's criterion (Braeken and van Assen, 2017) were used to determine the number of factors. Following EFA, exploratory structural equation modelling (ESEM; Marsh et al., 2014) was conducted in MPLUS version 8.9 (Muthen & Muthen, 2012–2022) to confirm the three-factor structure. We decided to use ESEM because traditional confirmatory factor analysis techniques can, in some cases, be overly restrictive as they do not allow for cross-loadings. Given that items in all three dimensions of the PBM-S are theoretically related, ESEM is well suited as a confirmatory technique. Goodness-of-fit was evaluated using the recommended criteria of Tucker-Lewis Index (TLI; Tucker and Lewis, 1973), comparative fit index (CFI), and root mean square error of approximation (RMSEA). Values greater than .90 for TLI and .95 for CFI represented acceptable and excellent fit, respectively. RMSEA values below .08 and .06 represented acceptable and good fits, respectively.

Incremental Validity: Does the PBM-S add value over and above existing measures?

For the PBM-S to have utility in research and practice it needs to predict positive outcomes over and above existing measures. To test this, we used multiple linear regression analysis to predict flourishing scores. In step 1, we entered gender, the five facets of mindfulness, general self-efficacy, nonattachment, interoceptive awareness, positive well-being behaviors, negative well-being behaviors, and dysfunctional breathing as control variables. The three dimensions of the PBM-S were then added as predictor variables. In this first regression model, the three dimensions of the PBM-S were competing against each other as well as the other measures, making it a particularly harsh model. In step 3, we kept the control variables the same but adjusted the model to include only one dimension of breath mastery at a time. We then did the same with the total PBM-S score as the predictor variable. To test whether the PBM-S would predict negative well-being, we used the same process with STOP-D scores as the outcome variable instead of flourishing. For known group validity, Welch Two Sample t-tests were conducted to evaluate the differences between high and low breath experience groups on each dimension of the PBM-S as well as total PBM-S scores. Correlational analyses (Pearson's *r*) were also conducted.

Development of a Short form of the PBM-S and a Combined Perceived Breath Mastery/Dysfunction Scale

Participant burden is an important consideration in research and practice; hence we aimed to create a short form version of the PBM-S. We also aimed to identify the best three dysfunctional breathing items to compliment the PBM-S so that both perceived breath mastery and dysfunction could be efficiently assessed in future interventions. To do this in the most efficient and rigorous manner, we used a freely available R package, 'GAabbreviate' (Sahdra et al., 2016), which implements a validated genetic algorithm method for scale reduction (Yarkoni, 2010; Sandy et al., 2014) (see online supplemental material for details). In line with best practice in using GA's (Sahdra et al., 2016; Noetel et al., 2019), we ran the GA procedure on our training sample (N = 702) to identify the best three items for each of the three dimensions of the PBM-S. We did the same for dysfunctional breathing to identify the best three of the 25-items in the Self Evaluation of Breathing Questionnaire (Courtney and Greenwood, 2009). After running the genetic algorithm 30 times, the resulting items were tallied and ranked according to the number of times they were selected in the GA solution (e.g., an item that was selected on 20 out of 30 runs received a rank of 20). The top three ranked items for each dimension of perceived breath mastery and dysfunctional breathing were used in subsequent confirmatory factor analysis (CFA) on the testing sample. The testing sample was holdout sample not used in the GA procedure to avoid overfitting. CFA was conducted using Maximum Likelihood Method (MLM), as implemented in the 'lavaan' package (Rosseel, 2012) in R.

Zero order correlations (Pearson's *r*) were calculated for the short form scales and relevant criterion and discriminant variables. These were compared with the correlations found using the long form scale. We hypothesized that the short form scale would correlate similarly to the long form. Note: the third factor of breath awareness contained the same three items in both short and long form, so they were excluded from this analysis.

To determine the predictive validity of the short form PBM-S, we used the same regression analysis used previously to assess the PBM-S long form in predicting flourishing scores. This enabled direct comparison of the short and long form versions of the PBM-S. For the short form version to have utility, it needed to be a unique predictor of flourishing scores, like the full scale. We hypothesized that it would be a significant predictor of flourishing. Similarly, we hypothesized that the three dysfunctional breathing items would significantly predict negative well-being. To assess this, we used the same regression model as previously used to predict STOP-D scores but substituted the full 25-item SEBQ for the 3-item version to compare the percentage variance explained by each.

Results

Factor Structure

EFA was conducted using the maximum likelihood method with Promax rotation. Parallel analysis suggested up to 6 factors. Scree analysis (Fig. 2) supported a 3-factor structure, with a clear 'elbow' after the third factor.

Eigen values were 17.62 for Factor 1, 3.18 for Factor 2, and 1.39 for Factor 3. All other eigen values were below 1. Using visual inspection of the scree plot as well as Kaiser's criterion of retaining eigen values of above 1, we concluded that 3 was the maximum number of reliable factors. To further refine the scale, we chose to only retain items loading above .65, which ensured a minimum of three items per factor. This resulted in fourteen items for Factor 1, six items for Factor 2, and three items for Factor 3, which together explained 59% variance (Table 3). Each factor showed strong internal reliability, with Cronbach's alphas as follows: F1 Breath efficacy a = .96; F2 Breath efficiency a = .88; F3 Breath awareness a = .87. Reliability of the total 23-item scale was also strong (a = .95).

Table 3
Results from Exploratory Factor Analysis of the Perceived Breath Mastery Scale (PBM-S)

Scale Item	Factor loading		
	1	**2**	**3**
Factor 1: Breath efficacy			
1. When I feel high stress or strong emotions, I can use my breathing to slow myself down and not overreact.	**.78**	.	.
2. I can use my breathing to stay composed when working out near my physical limit.	**.78**	.18	− .16
3. I can quickly return to easy breathing after hard physical activity.	**.71**	.21	− .21
4. I can use my breathing to stay composed when I need to perform under pressure.	**.79**	.	.
5. I can use breathing to quickly wind down and fall asleep even when my mind is busy.	**.75**	.	.
6. I can use breathing to re-focus on a task when there are distractions.	**.79**	− .14	.15
7. I can use my breathing to give me energy when I am tired or lethargic.	**.81**	− .12	.
8. I can use my breathing to help me manage or cope with pain.	**.77**	.	.
9. I can use my breathing to reduce physical tension when that's helpful.	**.85**	.	.
10. I can effectively control my breathing when that's helpful.	**.81**	.	.
11. I can count on my ability to breathe well in any situation.	**.82**	.10	.
12. I can use my breathing to connect with my best/wisest self.	**.76**	− .19	.25
13. I can use my breathing to be fully in the moment, regardless of what is happening.	**.77**	.	.16
14. I can use my breathing to ground myself in the present moment.	**.77**	.	.15
Factor 2: Breath efficiency			
15. My breathing is generally quiet (almost silent).	.	**.75**	− .13
16. My breathing is usually effortless.	.	**.82**	− .12
17. At rest, I can comfortably breathe through my nose.	− .15	**.88**	.
18. I primarily breathe through my nose in everyday life.	− .14	**.78**	.
19. My ribcage feels free and can expand easily when I breathe.	-	**.77**	.
20. I trust my body's natural ability to breathe well.	− .12	**.82**	.
Factor 3: Breath awareness			
21. Noticing my breath helps me to tune into my feelings.	.24	.	**.65**
22. My breathing helps me to connect more deeply with life.	.17	− .12	**.79**
23. Being aware of my breath benefits my life.	.	.	**.76**

Note. N = 702. The extraction method was maximum likelihood factoring with an oblique (Promax) rotation. Only items loading above .65 on a factor are in shown as this was the criteria for retaining items for subsequent ESEM.

ESEM was then conducted on the testing sample (N = 298) (see Table S3 of online supplemental materials). This supported the 3-factor structure of the PBM-S. The CFI was .965; TLI .953, and RMSEA .045, indicating good to excellent fit.

Criterion Validity

Correlations with Positive Well-Being Measures

We hypothesized that perceived breath mastery would positively correlate with all positive dimensions of self-reported well-being. Table 4 supports this, showing moderate to strong correlations (Pearson's *r*) between all three dimensions of the PBM-S and each domain of flourishing (range = + .32 to + .57) as well as total flourishing scores (range = + .44 to + .66), subjective vitality (range = + .37 to + .64), positive well-being processes (range = + .48 to + .61), sleep quality (range = + .32 to + .50), and physical fitness (range = + .25 to + .50).

Table 4

Correlations Between Dimensions the PBM-S and Positive Well-Being Measures.

Variable	M	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1. F1 Efficacy	60.04	19.12	—																
2. F2 Efficient	73.39	16.06	.41*	—															
3. F3 Aware	64.93	20.43	.73*	.41*	—														
4. Happy	6.49	2.13	.48*	.37*	.42*	—													
5. PHealth	6.43	2.22	.57*	.39*	.46*	.54*	—												
6. MHealth	6.35	2.35	.51*	.38*	.41*	.74*	.56*	—											
7. Meaning	6.74	2.13	.50*	.42*	.43*	.74*	.55*	.68*	—										
8. Purpose	6.36	2.55	.51*	.30*	.48*	.67*	.53*	.68*	.71*	—									
9. Character	6.97	1.91	.47*	.40*	.45*	.56*	.49*	.56*	.60*	.58*	—								
10. Delay Grat	6.8	1.94	.46*	.32*	.44*	.53*	.45*	.52*	.55*	.56*	.56*	—							
11. Friendship	6.83	2.26	.43*	.36*	.39*	.61*	.45*	.54*	.62*	.56*	.51*	.48*	—						
12. Relations	6.63	2.47	.44*	.32*	.41*	.64*	.46*	.59*	.61*	.60*	.50*	.50*	.79*	—					
13. Flourish	6.62	1.76	.61*	.45*	.55*	.85*	.71*	.83*	.85*	.83*	.74*	.71*	.79*	.81*	—				
14. PBAT	67.02	15.25	.61*	.48*	.57*	.60*	.57*	.60*	.64*	.60*	.59*	.55*	.53*	.54*	.73*	—			
15. Sleep	6.23	1.97	.50*	.33*	.32*	.49*	.46*	.48*	.43*	.39*	.35*	.31*	.38*	.38*	.51*	.42*	—		
16. Fitness	2.83	0.99	.50*	.25*	.34*	.37*	.66*	.38*	.34*	.39*	.31*	.31*	.28*	.33*	.47*	.39*	.42*	—	
17. Vitality	4.83	1.30	.64*	.37*	.52*	.67*	.66*	.63*	.64*	.62*	.54*	.54*	.52*	.54*	.75*	.64*	.51*	.54*	—
18. LSat	6.57	2.23	.52*	.38*	.44*	.83*	.59*	.73*	.75*	.70*	.57*	.52*	.62*	.61*	.87*	.63*	.52*	.43*	.69

Note. *N* = 1000. 1–3 = The dimensions of the Perceived Breath Mastery Scale (PBM-S) (F1 Efficacy = Factor 1: 'Breath Efficacy'; F2 Efficient = Factor 2: 'Breath Efficiency'; F3 Aware = Factor 3: 'Breath Awareness'). 4–12 are items from the Flourish Index (4 = Happiness; 5 = Physical Health; 6 = Mental Health; 7 = Meaning in life; 8 = Sense of Purpose; 9 = Character; 10 = Delayed Gratification; 11 = Friendship Satisfaction; 12 = Relationships Satisfaction; 13 = Total Flourishing Score). 14 = Total score on Positive Well-Being Behaviour items in the Process-Based Assessment Tool 'PBAT'. 15 = Sleep Quality; 16 = Perceived Fitness; 17 = Subjective Vitality; 18 = Life Satisfaction.

*$p < .01$.

Correlations with Negative Well-Being Measures

Our next hypothesis suggested that perceived breath mastery would be inversely related to negative aspects of well-being, but to a lesser extent than with positive aspects of well-being. Table 5 supports this hypothesis, showing small but significant negative correlations between all three dimensions of the PBM-S and STOP-D scores (range = − .07 to − .19) and negative well-being behaviours (range = − .07 to − .18). F2 Breath efficiency was significantly negatively correlated with anxiety, depression, stress, lack of social support and anger. F1 Breath efficacy was similar except uncorrelated with anger. F3 Breath awareness was significantly correlated with stress and anxiety but not the other negative well-being variables.

Table 5

Correlations Between Dimensions of the PBM-S and Negative Well-Being Measures.

Variable	M	SD	1	2	3	4	5	6	7	8	9
1. F1 Breath Efficacy	60.04	19.12	—								
2. F2 Breath Efficiency	73.39	16.06	.41**	—							
3. F3 Breath Awareness	64.93	20.43	.73**	.41**	—						
4. Depression	4.20	2.58	− .09**	− .17**	-0.06	—					
5. Anxiety	4.27	2.58	− .13**	− .15**	− .07*	.74**	—				
6. Stress	4.65	2.55	− .12**	− .12**	− .07*	.68**	.80**	—			
7. Anger	3.75	2.61	-0.04	− .16**	-0.04	.65**	.66**	.66**	—		
8. Lack of social support	3.99	2.77	− .07*	− .19**	-0.05	.67**	.64**	.61**	.63**	—	
9. Total STOP-D Score	4.17	2.25	− .11**	− .19**	− .07*	.87**	.89**	.87**	.84**	.83**	—
10. Negative well-being processes	54.63	20.31	.18**	− .07*	.18**	.50**	.44**	.39**	.47**	.47**	.53**

Note. N = 1000. Total STOP-D Score = the average of Depression, Anxiety, Stress, Anger, and Lack of social support. Negative well-being processes = the average of all negatively worded items on the Process-Based Assessment Tool (PBAT), which assesses well-being behaviours.

*p < .05. **p < .01.

Correlations with Convergent Measures

Consistent with our hypothesis, Table 6 shows moderate sized correlations between each dimension of the PBM-S and mindfulness, self-efficacy, and nonattachment. Correlations with interoceptive awareness were moderate to strong (range = + .31 to + .54). This provides evidence for the convergent validity of the PBM-S. However, the correlations suggest that there was at most, about 29% overlap between the scales, suggesting that they were also distinguishable.

Discriminant Validity: Correlations with Dysfunctional Breathing

We hypothesized that F1 and F3 of the PBM-S would be unrelated to dysfunctional breathing (SEBQ), and F2 only slightly negatively related. Table 6 mostly supports this prediction, showing small correlations between all three dimensions of the PBM-S and the SEBQ (-.26 to + .12). Whilst we were not expecting any positive correlations, their small size still supports the discriminant validity of the PBM-S by showing that it is clearly distinct from dysfunctional breathing.

Table 6

Correlations Between Dimensions of the PBM-S and Convergent and Discriminant Variables

Variable	M	SD	1	2	3	5	6	7	8	9	10	11	12	13
1. F1 Breath Efficacy	60.04	19.12	—											
2. F2 Breath Efficiency	73.39	16.06	.41**	—										
3. F3 Breath Awareness	64.93	20.43	.73**	.41**	—									
5. Mindful Observe	3.41	0.75	.26**	.19**	.31**	—								
6. Mindful Describe	3.13	0.71	.27**	.24**	.21**	.24**	—							
7. Mindful Aware	3.05	0.72	.14**	.11**	.09**	− .13**	.23**	—						
8. Mindful No Judge	3.1	0.89	0	.11**	-0.06	− .25**	.21**	.50**	—					
9. Mindful No React	3.11	0.74	.22**	.16**	.20**	.41**	.20**	− .23**	− .30**	—				
10. Mindfulness Score	3.16	0.39	.33**	.31**	.28**	.46**	.71**	.54**	.50**	.39**	—			
11. Nonattachment	4.35	0.81	.41**	.41**	.36**	.24**	.31**	.15**	.20**	.28**	.45**	—		
12. Interoception	2.84	0.6	.54**	.31**	.53**	.42**	.37**	.13**	.07*	.32**	.49**	.50**	—	
13. Self-Efficacy	3.74	0.67	.46**	.36**	.39**	.28**	.35**	.09**	.10**	.28**	.42**	.53**	.49**	—
14. Dysfunctional Breathing (SEBQ)	0.87	0.61	.12**	− .26**	.10**	.17**	− .13**	− .37**	− .52**	.22**	− .27**	− .14**	.06*	− .09**

Note. N = 1000. Items 5–10 each represent a facet of mindfulness from the Five Facet Mindfulness Questionnaire (Mindful Observe = Observing; Mindful Describe = Describing; Mindful Aware = Acting With Awareness; Mindful No Judge = Nonjudging of inner experience; Mindful No React = Nonreactivity to inner experience). Interoception = The Multidimensional Assessment of Interoceptive Awareness, Version 2. Self-Efficacy = General Self-Efficacy.

*p < .05. **p < .01.

Known group validity: Relationship between Breathwork Experience and Perceived Breath Mastery

Results from the Welch Two Sample *t*-test supported our hypothesis, showing significant differences in total PBM-S scores between the low and high breath experience groups, $t(342.64) = -15.71$, $p < .001$. The mean score for the high experience group (M = 76.21, SD = 13.41) was significantly greater than the low experience group (M = 57.09, SD = 15.03). This mean difference of 19.12, 95% CI [-21.51, -16.72]) translated to a large effect size (d = 1.31, 95% CI [1.12, 1.49]), indicating that greater experience with breathwork was associated with higher perceptions of breath mastery.

These associations were then analyzed for each of the three dimensions of the PBM-S, with the hypothesis being that high experience would be associated with higher scores on each of the PBM-S subscales. This hypothesis was supported, but interesting differences were found between the three dimensions. For F1 Breath efficacy, the high breath experience group's mean (M = 75.55, SD = 14.31) was 24.71 points above the low breath experience group. This was a significant difference, $t(393.87) = -18.17$, 95% CI [-27.38, -22.04], $p < .001$, and corresponded to a large effect size (d = 1.42, 95% CI [1.23, 1.61]). For F2 Breath efficiency, the high breath experience group's mean (M = 77.32, SD = 14.74) was 5.67 points above the low breath experience group (M = 71.75, SD = 16.89), which was also a significant difference $t(350.18) = -4.21$, 95% CI [-8.32 to -3.02], $p < .001$. However, the size of this effect was much smaller (d = 0.35, 95% CI [0.17, 0.52]). For F3 Breath awareness, the high breath experience group's mean (M = 77.06, SD = 16.20) was 19.9 points higher than the low breath experience group (M = 57.16, SD = 20.66). This also represented a significant difference, $t(390.48) = -12.96$, $p < .001$, 95% CI [-22.92, -19.89] and corresponded to a large effect size (d = 1.02, 95% CI [0.84, 1.20]). These findings suggest that F1 Breath Efficacy and F3 Breath awareness are strongly associated with breath experience, whilst F2 Breath efficiency is less strongly connected to experience.

Correlational analysis also supported our hypothesis, with total scores on the PBM-S significantly correlated with experience level (r = .50, p < .01). All three dimensions of the PBM-S were also significantly correlated with experience levels, with F1 Breath efficacy a large correlation (r = .54, p < .01), F3 Breath awareness a moderate correlation (r = .43, p < .01), and F2 Breath efficiency a small but still significant correlation (r = .11, p < .01). This provides further support for the construct validity of the PBM-S and highlights potentially important differences in how the three dimensions of the PBM-s related to breath experience.

Incremental Validity: Does the PBM-S Add Value Over and Above Existing Measures?

In the stepwise regression, we expected perceived breath mastery to predict positive well-being (flourishing) but not negative well-being (STOP-D). Table 7 supports this, showing that all three dimensions of the PBM-S were significant predictors of flourishing and weakly related to STOP-D scores. F1 Breath efficacy was a better predictor than all control variables except for positive well-being processes. F3 Breath awareness was a better predictor of flourishing than well-established measures, such as general self-efficacy, interoceptive awareness, nonattachment, each of the five facets of mindfulness, and dysfunctional breathing. F2 Breath efficiency was a stronger predictor than four of the five facets of mindfulness, negative well-being behaviours, and dysfunctional breathing. Interestingly, dysfunctional breathing was a significant predictor of STOP-D but not flourishing. These results demonstrate the incremental validity and relevance of the PBM-S for flourishing, whilst also highlighting the relevance of dysfunctional breathing for negative aspects of well-being.

Table 7
Results from Multiple Linear Regression Models Predicting Positive (Flourishing) and Negative (STOP-D) Aspects of Well-Being

Variable	**Predicting flourishing**		**Predicting STOP-D**	
	Estimate (β)	SE	Estimate (β)	SE
Step 1: Control variables only				
Gender	-0.02	0.04	0.17***	0.05
Positive well-being processes	0.39***	0.03	-0.09*	0.04
Negative well-being processes	-0.06*	0.02	0.36***	0.03
General Self-Efficacy	0.15***	0.03	-0.09**	0.03
Dysfunctional Breathing	0.04	0.03	0.24***	0.03
Interoceptive Awareness	0.00	0.03	0.04	0.03
Mindfulness act with Awareness	-0.03	0.02	-0.09**	0.03
Mindfulness Nonreact	0.00	0.02	0.01	0.03
Mindfulness Nonjudge	0.14***	0.03	-0.11**	0.03
Mindfulness Describe	0.02	0.02	0.01	0.03
Mindfulness Observe	-0.03	0.02	-0.05	0.03
Nonattachment	0.12***	0.03	-0.10**	0.03
Step 2A: Breath mastery variables entered simultaneously with control variables				
F1 Breath Efficacy	0.17***	0.03	-0.06.	0.04
F2 Breath Efficiency	0.05*	0.02	0.06*	0.03
F3 Breath Awareness	0.10***	0.03	-0.02	0.04
Step 2B: Breath mastery variables entered one at a time with control variables				
F1 Breath Efficacy	0.24***	0.03	-0.05	0.03
F2 Breath Efficiency	0.10***	0.02	0.04	0.03
F3 Breath Awareness	0.20***	0.03	-0.03	0.03
Total PBM-S Score	0.27***	0.03	-0.03	0.03
Note. The model used in step 2A had all three dimensions of perceived breath mastery entered together, which meant they were competing against each other as well as the control variables. In step 2B the model was repeated but with each of the perceived breath mastery dimensions individually so that they did not compete against one another.				

*p < .05, **p < .01., ***p < .001.

Development of a Short Form of the PBM-S and a Combined Perceived Breath Mastery/Dysfunction Scale

Item Selection using Genetic Algorithm

After running the genetic algorithm 30 times on the PBM-S, the three highest ranked items for each dimension were identified (Table 8). For F1 Breath efficacy, the top three items were selected in 20–23 (67–77%) of the 30 GA solutions, explained 91% variance and showed good internal consistency (*a* = .85). For F2 Breath efficiency, the top three items were selected in 26–28 (87–93%) of the 30 runs, explained 92% variance and had acceptable internal consistency (*a* = .78). Because F3 Breath awareness contains three items in the long form, these remained the same for the short form, hence did not require abbreviation (see Table S5 of online supplemental material for more details on the 9-item PBM-S Short Form).

Table 8
Ranking of PBM-S Items After 30 Runs of the GA Procedure

Item	Number of times selected out of 30 runs
Breath efficacy subscale	
I can effectively control my breathing when that's helpful	23
I can use my breathing to give me energy when I am tired or lethargic	21
I can use my breathing to be fully in the moment, regardless of what is happening	20
I can use my breathing to stay composed when working out near my physical limit	6
I can use my breathing to reduce physical tension when that's helpful	6
I can use my breathing to connect with my best/wisest self	6
I can use breathing to re-focus on a task when there are distractions	3
I can count on my ability to breathe well in any situation	3
I can use my breathing to stay composed when I need to perform under pressure	1
I can use my breathing to ground myself in the present moment	1
When I feel high stress or strong emotions, I can use my breathing to slow myself down and not overreact	0
I can quickly return to easy breathing after hard physical activity	0
I can use breathing to quickly wind down and fall asleep even when my mind is busy	0
I can use my breathing to help me manage or cope with pain	0
Breath efficiency subscale	
At rest, I can comfortably breathe through my nose	28
I trust my body's natural ability to breathe well	27
My breathing is usually effortless	26
My breathing is generally quiet (almost silent)	4
My ribcage feels free and can expand easily when I breathe	3
I primarily breathe through my nose in everyday life	2
Note. The highest three ranked items for each subscale were included in the Perceived Breath Mastery Scale – Short Form. The breath awareness subscale is not reported because it already contained only 3 items in the full scale.	
N = 702	

After running the genetic algorithm 30 times on the SEBQ, the three highest ranking dysfunctional breathing items were: 'My breath feels like it does not go in all the way'; 'I can't catch my breath'; and 'I notice that I am breathing irregularly' (Table 9). These items featured in 20–24 (67–80%) of the 30 GA solutions, explained 87% of the variance of the full 25-item scale and showed good internal consistency (a = .83).

Table 9

Ranking of Dysfunctional Breathing Items After 30 runs of The GA Procedure in the Training Sample (N = 702)

Item	Number of times selected out of 30 runs
My breath feels like it does not go in all the way	24
I can't catch my breath	21
I notice that I am breathing irregularly	20
My breathing requires work	5
My breathing feels stuck or restricted	4
I notice myself breathing quickly	3
I have trouble coordinating my breathing when I am speaking	3
My breath feels like it does not go out all the way	2
My breathing requires effort	2
I feel breathless in association with other physical symptoms	1
I get easily breathless out of proportion to my fitness	0
I notice myself breathing shallowly	0
I get short of breath reading and talking	0
I notice myself sighing	0
I notice myself yawning	0
I feel I cannot get a deep or satisfying breath	0
My ribcage feels tight and cannot expand	0
I get breathless when I'm anxious	0
I find myself holding my breath	0
I feel that the air is stuffy, as if not enough air in the room	0
I get breathless even when I am resting	0
My breathing is heavy	0
I feel that I am breathing more	0
I find myself breathing through my mouth during the day	0
I breathe through my mouth at night while I sleep	0

Note. The three highest ranked items were considered the 'best' dysfunctional breathing items and included in subsequent analyses.

Factor Structure and Reliability of the Short Form Scales

CFA of the 9-item PBM-S yielded good fit, CFI = 0.96, TLI = 0.97, RMSEA = 0.06, 90% CI = [0.044 0.080]. When the three dysfunctional breathing items were included as a fourth factor, the fit was similar, if not slightly better, CFI = 0.96, TLI = 0.97, RMSEA = 0.05, CI = [0.036 0.066] (see Table S7 of online supplemental materials).

Construct Validity of the Short Form Scales

Table 10 supports the hypothesis that the short form PBM-S would correlate similarly to the short form with all theoretically related variables. The size of the correlations tended to be the same, or only slightly smaller in the short form versions. When the difference in correlations between long and short form scales were averaged across all variables, the mean difference ranged from 0.003 for Dysfunctional Breathing to 0.038 for Breath Efficacy. This suggests that the short form scales perform almost identically to the short form in each dimension.

Table 10

Coefficient Alphas and Zero-Order Correlations for each Dimension of the Long and Short Form PBM-S and Other Relevant Constructs

	F1 Breath Efficacy LF	F1 Breath Efficacy SF	F2 Breath Efficiency LF	F2 Breath Efficiency SF	Breath Dysfunction (SEBQ-25)	Breath Dysfunction (3-items)
a	0.96	0.83	0.88	0.79	0.96	0.83
Happiness	0.48**	0.45**	0.37**	0.36**	− .06*	− .05
Physical Health	0.57**	0.52**	0.39**	0.38**	− .05	− .05
Mental Health	0.51**	0.47**	0.38**	0.37**	− .08**	− .06
Meaning	0.50**	0.46**	0.42**	0.42**	− .12**	− .13**
Purpose	0.51**	0.48**	0.30**	0.30**	− .02	− .01
Character	0.47**	0.44**	0.40**	0.38**	− .04	− .04
Delayed Gratification	0.46**	0.42**	0.32**	0.30**	− .02	− .01
Friendship Contentment	0.43**	0.40**	0.36**	0.37**	− .08*	− .09**
Relationship Satisfaction	0.44**	0.42**	0.32**	0.33**	− .04	− .03
Flourishing Score	0.61**	0.57**	0.45**	0.45**	− .07*	-06*
Vitality	0.64**	0.60**	0.37**	0.36**	− .02	− .01
Life Satisfaction	0.52**	0.49**	0.38**	0.38**	− .06	− .05
Positive PBAT	0.61**	0.59**	0.48**	0.47**	− .01	− .03
Negative PBAT	0.18**	0.21**	-0.07*	-0.08*	.49**	.46**
Depression	-0.09**	-0.07*	-0.17**	-0.17**	.42**	.40**
Anxiety	-0.13**	-0.11**	-0.15**	-0.15**	.42**	.38**
Stress	-0.12**	-0.10*	-0.12**	-0.12**	.36**	.33**
Anger	-0.04	-0.02	-0.16**	-0.17**	.44**	.41**
Lack of Social Support	-0.07*	-0.05	-0.19**	-0.20**	.43**	.41**
STOP-D Score	-0.11**	-0.08**	-0.19**	-0.19**	.48**	.45**
Interoception	.54**	.51**	.31**	.31**	.06*	.05
Mindfulness	.33**	.31**	.31**	.32**	− .27**	− .25**
Nonattachment	.41**	.37**	.41**	.40**	− .14**	− .12**
Fitness rating	.50**	.46**	.25**	.23**	.07*	.08*
Sleep quality	.50**	.46**	.33**	.32**	.00	0.02
Breath experience	.54**	.53**	.11**	.08**	.27**	.27**
SEBQ-25	0.12**	0.14**	-0.26**	-0.28**	NA	.93**

Note. LF = Long Form. SF = Short Form. SEBQ-25 = Self Evaluation of Breathing Questionnaire, full scale. Compare each cell across the table to note the similarity estimates. The mean of absolute values of the differences in the correlations between the short form and short form measures were (F1 Breath awareness = .038; F2 Breath efficacy = .007; Dysfunctional breathing = .003), suggesting that they perform nearly identically in their associations with other variables. F3 Breath awareness long and short form measures both contain the same three items, hence were not analysed.

$^{*}p < .05$. $^{**}p < .01$.

Incremental Validity of the PBM-S Short form: Does it Predict Flourishing?

Table 11 supports the hypothesis that the PBM-S short form would be a significant predictor of flourishing. Each of the three dimensions of the PBM-S were significant predictors, with the total short form PBM-S score explaining 25% variance in flourishing scores. This is only 2% less than the full scale and positions the short form PBM-S as a better predictor of flourishing than general self-efficacy, interoceptive awareness, mindfulness, and nonattachment.

Table 11

Results from Multiple Linear Regression Models Comparing PBM-S Long and Short Form Scales in Predicting Flourishing

Variable	**Predicting flourishing PBM-S long form**		**Predicting flourishing PBM-S short form**	
	Estimate (β)	SE	Estimate (β)	SE
Step 1: Control variables only				
Gender	-0.02	0.04	-0.03	0.04
Positive well-being processes	0.39***	0.03	0.40***	0.03
Negative well-being processes	-0.06*	0.02	-0.06*	0.03
General Self-Efficacy	0.15***	0.03	0.16***	0.03
Dysfunctional Breathing	0.04	0.03	0.07**	0.02
Interoceptive Awareness	0.00	0.03	0.00	0.03
Mindfulness act with Awareness	-0.03	0.02	-0.02	0.02
Mindfulness Nonreact	0.00	0.02	0.00	0.02
Mindfulness Nonjudge	0.14***	0.03	0.14***	0.03
Mindfulness Describe	0.02	0.02	0.02	0.02
Mindfulness Observe	-0.03	0.02	-0.04	0.02
Nonattachment	0.12***	0.03	0.12**	0.03
Step 2A: Breath mastery variables entered simultaneously with control variables				
F1 Breath Efficacy	0.17***	0.03	0.13***	0.04
F2 Breath Efficiency	0.05*	0.02	0.05*	0.03
F3 Breath Awareness	0.10***	0.03	0.12***	0.04
Step 2B: Breath mastery variables entered one at a time with control variables				
F1 Breath Efficacy	0.24***	0.03	0.20***	0.03
F2 Breath Efficiency	0.10***	0.02	0.10***	0.02
F3 Breath Awareness	0.20***	0.03	0.19***	0.03
Total PBM-S Score	0.27***	0.03	0.25***	0.03

Note. The model used in step 2A had all three dimensions of the PBM-S entered together, which meant they were competing against each other as well as the control variables. In step 2B the model was repeated but with each of the PBM-S dimensions individually so that they did not compete against one another. Compare across the rows to see the differences between long and short form versions of the PBM-S.

$^{*}p < .05$, $^{**}p < .01$., $^{***}p < .001$.

Do the Three Dysfunctional Breathing Items Predict Negative Well-Being?

The purpose of including three dysfunctional breathing items in a combined breath mastery/dysfunction scale was for their ability to predict negative well-being. Table 12 supports the hypothesis that the GA derived dysfunctional breathing items would significantly predict negative well-being, with the three items explaining 19% variance in STOP-D scores. This was more than every other measure except for negative well-being processes, and only 6% less than what was explained by the full 25-item dysfunctional breathing measure (SEBQ).

Table 12

Results from Multiple Linear Regression Model Predicting Negative Well-Being as Assessed Using the Screening Tool for Psychological Distress (STOP-D)

Variable	**Predicting STOP-D**	
	Estimate (β)	SE
Step 1: Control variables[a]		
Gender	0.19***	0.05
Positive Well-Being Behaviours	-0.07*	0.04
Negative Well-Being Behaviours	0.36***	0.03
General Self-Efficacy	-0.10**	0.03
Dysfunctional Breathing (3-items)	0.19***	0.03
Interoceptive Awareness	0.03	0.03
Mindfulness act with Awareness	-0.10**	0.03
Mindfulness Nonreact	0.01	0.03
Mindfulness Nonjudge	-0.13***	0.03
Mindfulness Describe	0.01	0.03
Mindfulness Observe	-0.04	0.03
Nonattachment	-0.09**	0.03
PBM-S short form	-0.03	0.03

Note. Positive Well-Being Behaviours = Positive items in the Process-Based Assessment Tool (PBAT). Negative Well-Being Behaviours = Negative items in the Process-Based Assessment Tool (PBAT). STOP-D = combined stress, depression, anger, lack of social support, and anxiety experienced in past 7 days. Interoceptive Awareness = The Multidimensional Assessment of Interoceptive Awareness, Version 2 (MAIA-2).

PBM-S short form = The Perceived Breath Mastery Scale.

[a]This model only required step 1 because the SEBQ, from which the dysfunctional breathing items were sourced, is a unidimensional scale.

*$p < .05$, **$p < .01$., ***$p < .001$.

Discussion

The current research aimed to create and validate a measure of breath mastery—the Perceived Breath Mastery Scale (PBM-S)—and establish its relevance for well-being. We conceptualized breath mastery as comprising three distinct but related dimensions: (1) perceived efficacy in using breathing, (2) perceived efficiency of breathing, and (3) positive awareness of breathing. Guided by this framework, which was confirmed by an expert panel, we generated items reflecting what an 'optimal/masterful breather' would perceive about their breathing. An initial pool of 40 items was endorsed by a globally diverse expert panel, providing support for construct validity. These items were included in an exploratory factor analysis (EFA), which supported the three-factor structure and led to refinement of the scale to 23 items. Subsequent exploratory structural equation modelling (ESEM) yielded excellent fit, confirming this three-factor structure.

All three dimensions of the PBM-S significantly correlated with all positive well-being measures. In most cases, these were moderate to large positive correlations. Among the three dimensions, F1 (breath efficacy) tended to show the strongest correlations with positive well-being, while F2 (breath efficiency) showed the weakest. This difference may stem from the nature of breath efficiency, which reflects more automatic, unconscious aspects of breathing (e.g., "At rest, I can comfortably breathe through my nose"). In contrast, both breath efficacy (F1) and breath awareness (F3) involve more conscious engagement with one's breathing. Deliberate awareness and a positive perception of breath (F3), alongside confidence in using it effectively (F1), are likely to have a more immediate and direct impact on subjective well-being than the more passive, habitual breathing captured by F2. Interestingly, these two dimensions were also the most strongly associated with breathwork experience, indicating that breathwork may primarily influence efficacy and awareness. All three dimensions were also consistently negatively correlated with negative well-being measures; however, these correlations were notably smaller than those observed with positive well-being. The consistent pattern of correlations in the expected directions across a wide range of well-being indicators provides support for the criterion validity of the PBM-S.

The PBM-S was meaningfully related to, yet conceptually distinct from, all theoretically relevant constructs examined—including mindfulness, interoceptive awareness, nonattachment, and general self-efficacy. Moderate correlations suggest that breath mastery shares common ground with these well-established well-being constructs while occupying a unique conceptual space. Notably, the PBM-S was as strong, or stronger, a predictor of flourishing than any of these measures—a striking result given their widespread use in flourishing research and interventions (Carr et al., 2021). These findings position perceived breath mastery as a promising, yet underexplored, construct within positive psychology and related fields.

Importantly, the PBM-S was clearly distinct from dysfunctional breathing, with only small (mostly inverse) correlations between the two. This distinction matters because existing self-report breathing measures primarily assess dysfunction or related symptoms. Breath mastery appears to lie on a separate continuum than dysfunctional breathing, echoing the dual continua model of mental health proposed by Keyes (2005) and findings from process-based approaches (Ciarrochi et al., 2022). As shown in our regression analyses, both the PBM-S and the SEBQ (a measure of dysfunctional breathing) uniquely predicted well-being outcomes—positive and negative, respectively. Practically, this means that the two measures may serve complementary roles. While dysfunctional breathing is relevant in many clinical settings due to its established links with stress (Stephen et al., 2022) and various aspects of mental ill-health (Ok et al., 2018), the PBM-S may be especially valuable in non-clinical settings where the aim is to enhance well-being. Its use could help identify opportunities for growth across the three dimensions of breath mastery and inform targeted interventions. Furthermore, changes in PBM-S scores could offer insight into the psychological mechanisms through which certain breathing interventions work and how they can be tailored to individuals. Using the PBM-S in this way may help move beyond the inconsistent results of the current one-size-fits-all model in breathwork (Vlemincx and Cortez-Vázquez, 2024).

While we recommend assessing both breath mastery and dysfunction, administering the full versions of both scales may be impractical due to participant burden. To address this, we used a genetic algorithm to identify the best three items for each dimension of perceived breath mastery and dysfunctional breathing. The resulting short forms demonstrated strong validity, with correlational analyses yielding results nearly identical to those from the full scales. Multiple regression analyses also supported their predictive validity: the short form PBM-S explained a similar proportion of variance in flourishing as the long form, and the short form dysfunctional breathing scale predicted negative well-being nearly as well as the 25-item SEBQ. These findings support the validity of both short form scales and offer efficient alternatives for use in research and practice. Without these abbreviated versions, assessing both constructs would require nearly 50 items, which is likely impractical in many applied settings. Furthermore, choosing only one scale could limit insights, as each uniquely predicts different aspects of well-being. By combining both into a 12-item measure, researchers and practitioners can more efficiently assess the full spectrum of breathing-related psychological functioning, facilitating a more nuanced understanding of how breathing interventions work and for whom they are most effective. However, where participant burden isn't a concern, we encourage the full scales to be utilized due to their greater sensitivity.

Several limitations of the current research should be acknowledged. First, the cross-sectional design limits causal inferences. While we propose that increases in breath mastery may enhance well-being, it is also possible that individuals with high well-being perceive their breathing more positively. Future research employing longitudinal designs—both within and between individuals—is needed to better establish directionality. Second, the reliance on self-report introduces potential for common method variance (CMV), including social desirability bias. However, because all positively framed self-report measures were similarly affected, this concern was mitigated in our regression models, where variables were entered as covariates, thus controlling for CMV effects (Lindell & Whitney, 2001). Future studies should explore the relationship between perceptions of breathing and objective assessments, such as physiological measures or ratings by trained breathing professionals, to enhance the validity of these findings. Third, all participants resided in Australia, hence, may not be a globally representative population. Finally, we have not yet examined the test–retest reliability of the PBM-S. Establishing this form of reliability is an important next step in scale validation.

Conclusion

In conclusion, the PBM-S is the first self-report breathing measure that captures positive psychological aspects of breathing, not just symptoms related to breathing. Initial evidence suggests it is a valid instrument that is moderately associated with positive measures of well-being and optimal functioning, such as flourishing. A key innovation of this work is the creation and validation of both the short form PBM-S and the combined dysfunction/breath mastery scale, which significantly improve the efficiency of assessing both positive and dysfunctional aspects of breathing. These tools not only reduce participant burden but also enable researchers and practitioners to explore the dual role of breathing in well-being and dysfunction. By integrating these measures into research and practice, interventions can be better tailored, assessed, and refined to target specific well-being outcomes. Given that breathing is a universally available, cost-free skillset, assessing and optimizing it could become a scalable component of future well-being interventions. We recommend using the PBM-S instruments to deepen insights into the psychological processes underlying breathing practices and to enhance the customization and efficacy of interventions aimed at promoting well-being.

Declarations

Conflict of Interest

The authors have no competing interests to declare that are relevant to the content of this article.

Ethical Approval

This study was approved by the Australian Catholic University Human Ethics Committee (HREC approval number: 2022-2491E)

Informed Consent

Informed consent was obtained from all participants before collecting data for this study.

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Author Contribution

R.J.D. wrote the main manuscript text, prepared all figures and tables, and conducted data analysis.J.C. and B.K.S. reviewed and edited the manuscript text, plus provided algorithms and expertise to support data-analyses.

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Data Availability

The datasets used in this research can be accessed at [https://osf.io/nb3xs/files/osfstorage?view_only=](https:/osf.io/nb3xs/files/osfstorage?view_only=)

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Figures

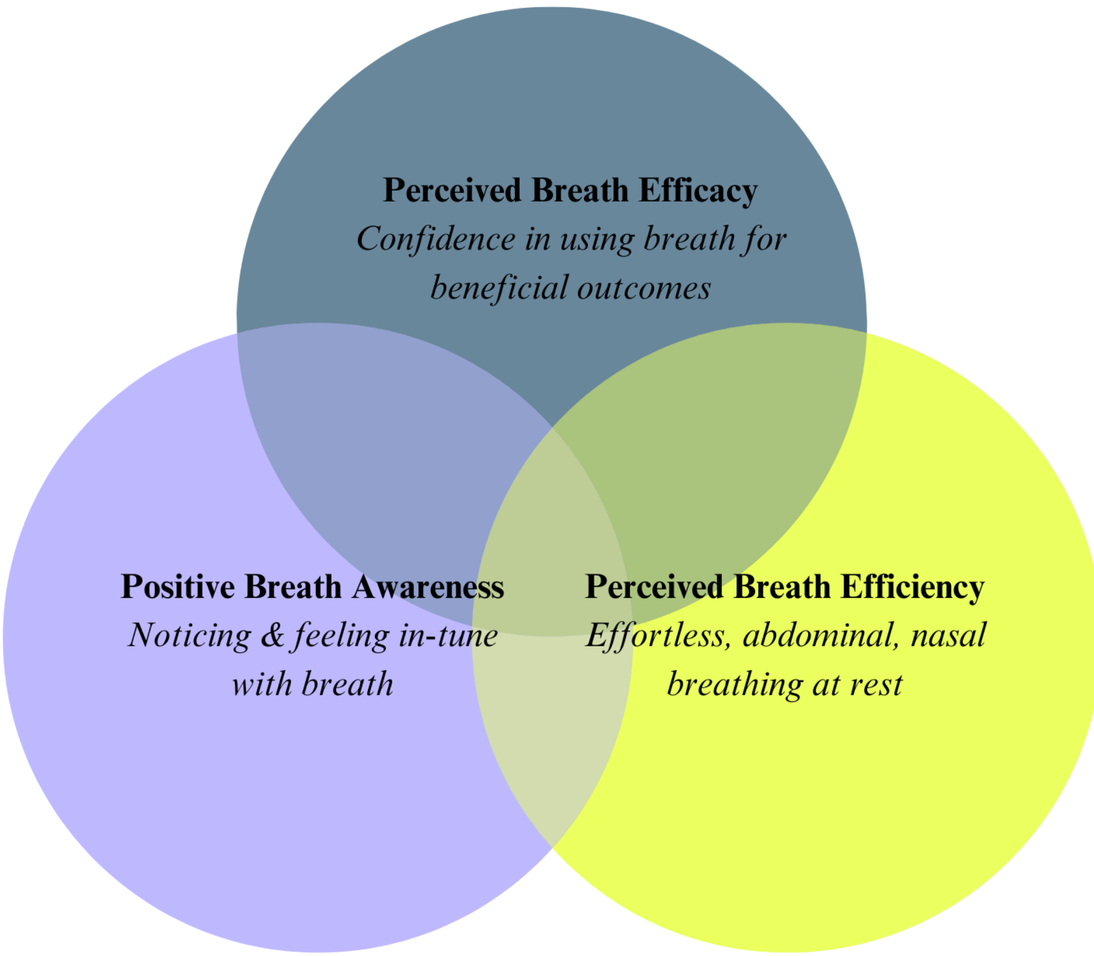

Figure 1

Three-Dimensional Model of Perceived Breath Mastery – a Conceptualization of Subjectively Optimal Breathing

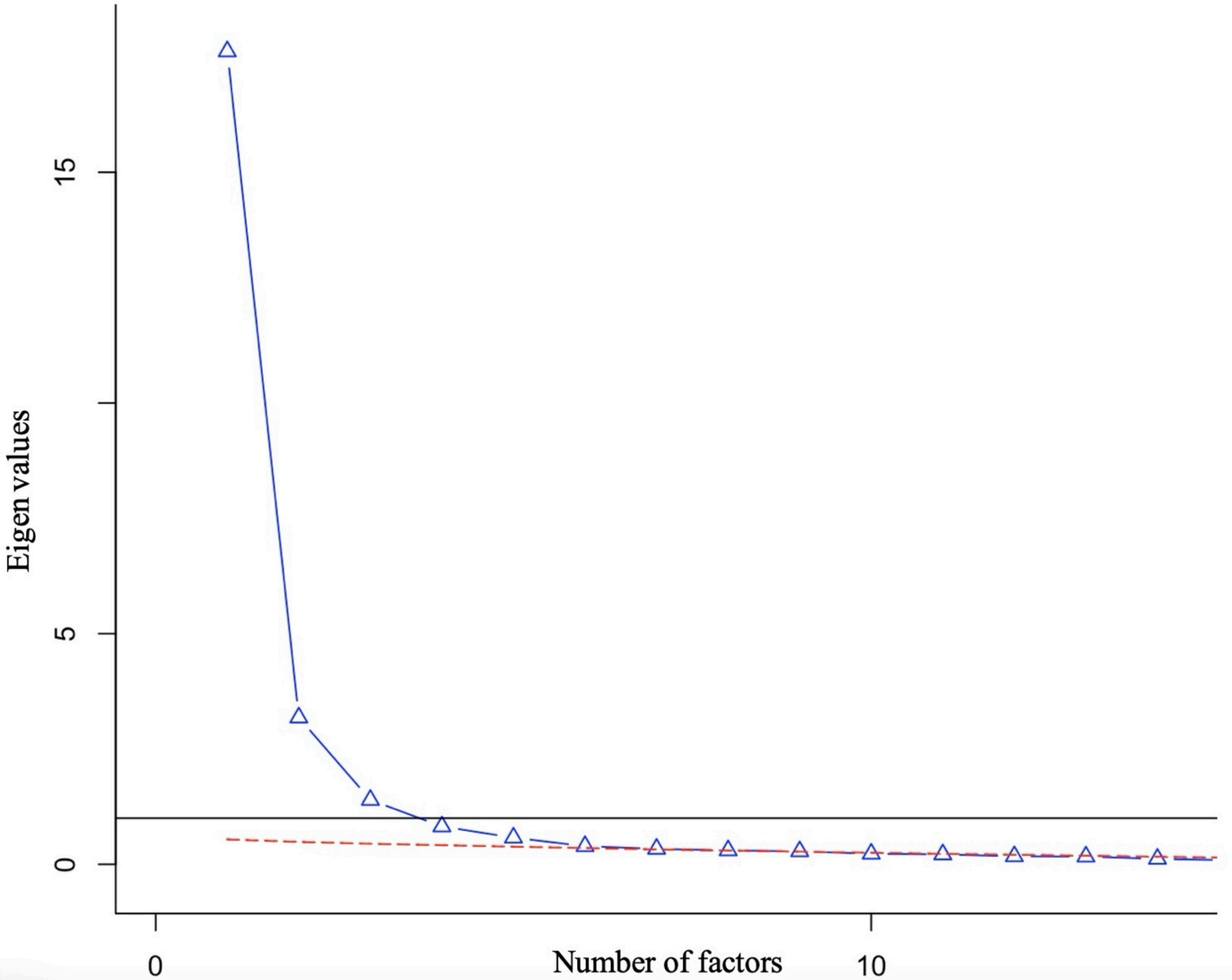

Figure 2

Parallel analysis Scree plot referred to in exploratory factor analysis

Note. N = 702. Eigen values are above one for the first three factors

Supplementary Files

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- PBMSSupplementarymaterialsSeptember2.docx