Outcome Measures for Dysfunctional Breathing: A Scoping Review of Use, Validation, and Research Gap.

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Title	Study Design	Aim	Population	Outcome Measure	Conclusion
Novel assessment tool to detect breathing pattern disorder in patients with refractory asthma (28)	Retrospective observational cohort study	To evaluate the utility of the Breathing Pattern Assessment Tool (BPAT) in detecting breathing pattern disorder (BPD) among patients with treatment-refractory asthma, and to assess its sensitivity and specificity compared with physiotherapy diagnosis.	Adults >16 years old, referred for systematic assessment of treatment refractory asthma at a tertiary hospital.	BPAT score. NQ score AQLQ. D12. 6MWT distance. Spirometry.	Sensitivity analysis indicated that a BPAT sensitivity of 0.92 and a specificity of 0.75 for diagnosis of BPD in this cohort.
The development of a palpation-based clinical assessment of breathing motion: A Nominal Group Technique approach (29)	Qualitative study using Nominal Group Technique (NGT) consensus methodology.	To develop a palpation-based clinical assessment of breathing motion and create a simple notation format for its use in clinical practice.	Physiotherapists and osteopaths.	HI - LO,	Produced a consensus-based description of palpation-based breathing assessment for clinical use, highlighting Hi-Lo palpation in seated position as central.
DYSFUNCTIONAL BREATHING: ITS PARAMETERS, MEASUREMENT AND RELEVANCE (30)	Doctoral thesis consisting of a series of seven empirical studies - mixed methods: observational, cross-sectional, correlational, quasi-experimental, and validation studies.	To explore definitions and parameters of dysfunctional breathing (DB), evaluate and validate assessment tools, examine relationships between measures of DB, and investigate possible mechanisms by which breathing therapy exerts therapeutic effects.	Healthy volunteers, osteopaths, students, and patients with concerns about their breathing or medically unexplained dyspnoea. Age range: adolescents to older adults. Included both healthy individuals and clinical populations with mild conditions or unexplained dyspnoea.	(MARM, Hi Lo). Factor structure and validity of SEBQ. Relationships between BHT, ETCO2 questionnaires, and breathing pattern measures. Associations between DB patterns and HRV coherence. Symptom change (dyspnoea, NQ scores) after Whole Body Breathing therapy.	DB is multidimensional and requires comprehensive assessment; breathing therapy likely works through multiple mechanisms (biomechanical, biochemical, psychological).
Dysfunctional breathing: what do we know? (4)	Narrative review	To summarize the available evidence on dysfunctional breathing (DB), including definitions, classifications, diagnostic tools, physiological/functional/psychosocial characteristics, and treatment, in order to improve understanding and diagnostic accuracy among healthcare professionals.	Review of studies across multiple populations, including: Adults. Individuals with asthma. Both primary DB (psychogenic) and secondary DB (related to cardiopulmonary/neurological disease).	NQ,HVPT, CPET	DB is multifactorial and often misdiagnosed; multidimensional assessment (biochemical, biomechanical, psychological, social, physiological) is needed. Further clinical trials and standardized outcome measures are recommended.
Relationships between measures of dysfunctional breathing in a population with concerns about their breathing (31)	narrative review	This study investigates whether screening tools for dysfunctional breathing measure distinct or associated aspects of breathing functionality.	84 self-referred or practitioner-referred individuals with concerns about their breathing	NQ, SEBQ, MARM, RR, ETCO2, Spirometry, BHT,	Comprehensive evaluation of breathing dysfunction should include measures of breathing symptoms, breathing pattern, resting CO(2) and also include functional measures such a breath holding time and response of breathing to physical and psychological challenges including stress testing with CO(2) monitoring.
Effect of Breathing Retraining in Improving Dysfunctional Breathing in Patients with Asthma (82)	Randomized controlled trial - experimental study with control group.	To evaluate the effect of breathing retraining using the Buteyko Breathing Technique (BBT), in combination with	Adults aged 17 - 65 years with clinically diagnosed asthma Recruited from K.C. General	Nijmegen Questionnaire - dysfunctional breathing symptoms.	Breathing retraining with BBT significantly improves dysfunctional breathing and asthma-related quality of life compared with asthma education alone.

		asthma education, on dysfunctional breathing and quality of life in patients with asthma.	Hospital, ESIC Hospital, and KTG Multispecialty Hospital, Bangalore, India	Asthma Quality of Life Questionnaire (AQLQ(S)) â€“ total and domain scores (symptoms, activity limitation, emotional function, environmental stimuli). Control Pause - breath-hold time, intervention group only.	
Dysfunctional breathing phenotype in adults with asthma - incidence and risk factors. (32)	cross-sectional survey	Describe the incidence and risk factors for the dysfunctional breathing pheno-type in adults with asthma evaluated in a specialized asthma centre	Adult patients aged 17 - 65 with diagnosed asthma	Nijmegen, MARM, CPET, RIP	The Need for standardised outcome measures is still at the forefront of DB.
Use of the Nijmegen Questionnaire in asthma. (33)	Correspondence/commentary	To clarify the intended use and limitations of the Nijmegen Questionnaire (NQ), particularly in patients with asthma, and to discuss its role in assessing dysfunctional breathing and stress-related breathing patterns.	Patients with asthma. Patients with hyperventilation syndrome.	conceptual evaluation of NQ validity and scope. consideration of whether NQ results in asthma patients reflect dysfunctional breathing or stress-related factors.	The NQ is better interpreted as reflecting stress and symptom burden rather than a diagnostic tool for asthma patients. Authors recommend further study into definitions of functional breathing and assessment methods beyond the NQ.
Getting to grips with 'dysfunctional breathing'. (7)	Narrative review	To explain the concept of dysfunctional breathing (DB) and its clinical importance. Highlight how DB is under-recognised and often misdiagnosed as asthma, especially in children and young people To provide guidance for clinicians on recognising DB and management	Children and adolescents with respiratory symptoms disproportionate to objective findings Clinicians managing such patients in primary and secondary care	MARM, Electromyography, Spirometry, Ultrasound, plethysmography, NQ,	Electromyography, Spirometry, Ultrasound, plethysmography good for cluster testing but not widely available for clinical practice. NQ has some value in detecting thoracic DB but is very limited in children and those with co morbidities. Not validated for all forms of DB. No sensitive to HVS in asthma patients. Laryngoscopy is considered gold standard currently for extra thoracic DB but is expensive and very invasive.
DEVELOPMENT OF A SCREENING PROTOCOL TO IDENTIFY INDIVIDUALS WITH DYSFUNCTIONAL BREATHING. (34)	Matched controlled trial	The purpose of this study was to develop a breathing screening procedure that could be utilized by fitness and healthcare providers to screen for the presence of disordered breathing. A diagnostic test study approach was utilized to establish the diagnostic accuracy of the newly developed screen for DB.	Subjects ages 18-45 who were free of known respiratory disease and had no current musculoskeletal pain complaints were recruited by fliers and word of mouth.	Capnography, Hi - lo, NQ and SEBQ.	Home exercises were effective in reversing the biomechanical category of DB in 78% of young, otherwise healthy adults versus no exercise. However, the exercises did not affect the biochemical category of DB. Performing a set of home exercises may be an effective option for fitness and rehabilitation providers to suggest for clients to normalize biomechanical breathing dysfunction.
The Nijmegen Questionnaire and dysfunctional breathing. (35)	Editorial/commentary	to review the development, validity and limitations of the NQ as a tool for assessing dysfunctional breathing. To clarify what an elevated	Referenced populations - Hyperventilation syndrome patients. Non-HVS medical outpatients Healthy controls.	NQ total score. Symptom severity - dyspnoea, dizziness, palpitations, stress or anxiety. Response to breathing	High NQ score does not indicated a specific syndrome. NQ reflects subjective or psychological aspects of DB not the Biomechanical.

		score represents and to discuss its role in screening treatment evaluation.	Patients with asthma and other respiratory conditions	regulation - pre vs post treatment NQ score.	The Nijmegen Questionnaire is useful to quantify and assess the normality of subjective sensations
Prevalence of dysfunctional breathing in patients treated for asthma in primary care: cross sectional survey. (36)	Cross sectional survey	To estimate the prevalence of dysfunctional breathing (DB) in adults with asthma managed in primary care.	Adult aged 17-65 years with a diagnosis of asthma. 132 women, 87 men.	Nijmegen Questionnaire. Cut-off score >23 used to indicate dysfunctional breathing.	About a third of women and a fifth of men had scores suggestive of dysfunctional breathing. Although further studies are needed to confirm the validity of this screening tool and these findings, these prevalences suggest scope for therapeutic intervention
Relationships between measures of dysfunctional breathing in a population with concerns about their breathing. (37)	cross-sessional observational design	This study investigates whether screening tools for dysfunctional breathing measure distinct or associated aspects of breathing functionality.	self-referred or practitioner-referred individuals with concerns about their breathing	ETCO2, MARM, spirometry, HI LO breathing assessment, Nijmegen questionnaire, breath holding time tests, SEBQ	This study did not show an association between general symptoms of dysfunctional breathing, as measured by the SEBQ or the NQ and breathing pattern.
An observational investigation of dysfunctional breathing and breathing control therapy in a problem asthma clinic. (38)	Observational cohort study with follow up at 6 months.	To assess the prevalence of dysfunctional breathing (DB) in patients attending a problem asthma clinic, examine the relationship between DB (Nijmegen Questionnaire) and asthma-related quality of life (Mini-AQLQ), and evaluate the impact of breathing control therapy (BCT).	Adults with moderate to severe asthma attending a problem asthma clinic in Glasgow Royal Infirmary. Mean age: 48 years (range 13.5 - 83).	Nijmegen Questionnaire scores (23 = DB). Mini-AQLQ (overall and domain scores). RCP asthma morbidity score. Progressive Exercise Testing results Inspiratory breath hold time (BHT). Compliance and response to BCT.	High prevalence of DB in problem asthma clinic patients. Strong quality of life correlation suggests NQ may partly reflect QoL rather than DB. Moderate-intensity BCT showed limited effect overall, though some subgroups benefited.
Dysfunctional breathing in asthma: is it common, identifiable and correctable? (39)	Narrative review.	To evaluate the prevalence, identification, and treatment options for dysfunctional breathing (DB) in asthma, and to discuss methodological and clinical challenges in defining DB as a distinct entity.	Adults and children with asthma, with or without comorbid dysfunctional breathing.	Prevalence estimates of DB in asthma populations. Validity and limitations of NQ and other diagnostic tools. Reported effectiveness of treatment strategies (e.g., Buteyko trial, physiotherapy abstracts).	Dysfunctional breathing is relatively common in asthma and may contribute to symptoms and overtreatment. However, definition, diagnosis, and evidence for effective treatment remain limited.
Normalizing CO2 in chronic hyperventilation by means of a novel breathing mask: a pilot study. (40)	Interventional pilot study (single-group)	To perform a preliminary test of the hypothesis that by periodically inducing normocapnia over several weeks, it would be possible to raise the normal resting level of CO2 and achieve a reduction of symptoms	Chronic idiopathic hyperventilation patients	Spirometry and NQ	NQ able to detect HVS in these patients.
The impact of dysfunctional breathing on the level of asthma control in difficult asthma. (60)	Cross-sectional observational study	To investigate the prevalence of dysfunctional breathing (DB) in patients with difficult asthma and assess its impact on asthma control and quality of	patients with asthma diagnosis	Prevalence of DB (NQ, BPAT). ACQ score. Mini-AQLQ score.	DB is common in difficult asthma and significantly worsens symptom control and quality of life. Routine assessment for DB (NQ + BPAT) is recommended to avoid misattribution of symptoms and potential over treatment with steroids/biologics.

		life, using both subjective and objective measures of DB.		Lung function (FEV1, FEV1/FVC, FeNO). Inflammatory markers (sputum and blood eosinophils). Exacerbations and treatment intensity.	
Factors Associated with Dysfunctional Breathing in Patients with Difficult to Treat Asthma. (41)	Cross-sessional observational study	To characterize the presence of dysfunctional breathing in a cohort with difficult asthma and to identify risk factors that may contribute to its development	difficult to treat asthma	NQ, Asthma Quality of Life Questionnaire,	NQ may be used to help diagnose DB in asthma but tool is lacking validation in the literature.
Disruption of Pathological Patterns in a Young Population with Dysfunctional Breathing. (42)	Cross-sectional observational study	To examine the relationship between dysfunctional breathing (DB) and pathological patterns (qi deficiency, yin deficiency, phlegm, cold-heat) in a young population, and to evaluate how these patterns are associated with psychological disturbance.	Healthy college students at Kyung Hee University, Seoul, Republic of Korea Mean age: ~21 years Excluded if self-reported respiratory or psychiatric disorders related to DB	KNQ score (DB vs non-DB classification). Pathological pattern scores (LJQ, YDS, PPQ, CHPQ). K-GHQ-30 (psychological disturbance). Effects of age, gender, and DB group on pathological patterns.	DB in young adults is associated with aggravation of multiple pathological patterns (qi deficiency, yin deficiency, phlegm, cold-heat) and psychological disturbance. Pattern questionnaires may support individualized alternative therapies (e.g., acupuncture, herbal medicine) for DB.
Dysfunctional Breathing in Children and Adults With Asthma. (43)	narrative review	review how the asthma phenotype might be impacted upon by dysfunctional breathing problems throughout the life course	children, adolescents, and adults with asthma, across both primary care and specialist settings.	NQ, Asthma Control Test (ACT), FEV - 1 peak flow, Exercise provocation tests	The diagnosis and treatment of dysfunctional breathing has mostly evolved through observational experience and a growing realization about the importance of this problem in all age groups. Further studies are needed to help define the optimal approach to treatment in all age groups and to clearly delineate the long-term outcomes for different types of dysfunctional breathing across the lifecourse
Dysfunctional breathing: a review of the literature and proposal for classification. (89)	Narrative literature review with proposed classification framework.	To review the existing literature on dysfunctional breathing (DB), summarise presentation, epidemiology, assessment, and treatment, and propose a classification system for common dysfunctional breathing patterns.	Adults and children with dysfunctional breathing. Focus on populations with asthma, COPD, panic disorder, neuromuscular disease, and those with unexplained dyspnoea.	Nijmegen, CPET, MARM, BPAT, SEBQ, HVPT	Lack of validation in tools for subtypes of DB due to poorly understood condition. Nijmegan, HVPT and CPET only validated for HVS. Need for consensus on definition of DB
Reliability and preliminary reference values for the Total Faulty Breathing Scale (TFBS): A cross-sectional study. (18)	Cross-sectional observational study	To determine the intra- and inter-rater reliability of the Total Faulty Breathing Scale (TFBS) in females and to establish preliminary reference values for TFBS in healthy participants.	Convenience sample of healthy adults aged 18 - 24 years (for reference values). Female volunteers aged 18 years for reliability testing. Excluded if medical, neurological, or musculoskeletal impairments could affect breathing measurement.	Totally faulty breathing scale (TFBS)	Interrater and interrater reliability of the TFBS showed a kappa value of 0.769 and 0.751, respectively, indicating substantial agreement for female participants. The preliminary reference categories for TFBS were reported to be normal for 20 (45.5%) participants and mild faulty breathing for the remaining 24 (54.4%) participants The findings of this study suggested that TFBS was reliable to measure

					breathing function among female participants, and the reference categories may be helpful in the identification of normal and faulty breathing.
Medically unexplained dyspnea: partly moderated by dysfunctional (thoracic dominant) breathing pattern. (45)	prospective	to investigate relationships between breathing pattern abnormalities and the various categories of NQ symptoms including respiratory or dyspnea symptoms	Patients with unexplained breathing complaints	NQ, MARM	both MARM and NQ returned to normal values after treatment. Changes in NQ were largest for subjects with abnormal MARM pre-treatment. There was a large interaction between the change in the NQ sub score dyspnea and initial MARM values.
Clinical Breathing Mechanics Differ Based on Test and Position. (46)	Prospective cross-sectional study	To compare outcomes of two clinical breathing assessment tools the hi-lo test and the lateral rib expansion (LRE) test. When conducted in varying test positions, and to examine how postural demands affect classification of functional vs dysfunctional breathing.	31 females, 19 males. Mean age: 29.3 Â± 4.1 years. Physically active (â‰¥ brisk walking twice per week). Excluded: respiratory conditions, musculoskeletal injury preventing testing, vestibular/balance disorders, recent head injury, pregnancy	Hi-lo and LRE tests	The hi-lo test and LRE tests assess different breathing mechanics. Clinicians should use these tests in combination to gain a comprehensive understanding of a person's breathing pattern. The hi-lo test should be administered in multiple testing positions.
Increased ventilatory variability and complexity in patients with hyperventilation disorder. (48)	observational study	To describe the variability, stability, and chaotic-like complexity of resting ventilation in patients with hyperventilation disorder, and to determine whether increased variability is linked to instability of respiratory control or to increased ventilatory complexity.	Patients: adults with symptoms suggestive of hyperventilation disorder (air hunger, deep inspirations, persistent hypocapnia during CPET). Mean age ~56 years; 20 women, 3 men. Controls: 14 healthy subjects, age- and sex-matched. Patients had normal spirometry, lung volumes, DLCO, and echocardiography.	CV of VT (%) Slope of VT probability distribution Complexity (Kappa values, noise limit) Loop gain, controller gain, plant gain ROC analysis of complexity for DB diagnosis	Hyperventilation disorder patients show increased resting ventilatory variability due to heightened ventilatory complexity rather than instability of chemical drive. Complexity analysis may have diagnostic value.
A comparison between patients with dysfunctional breathing and patients with asthma. (49)	cross sessional	The objective of this study was to investigate similarities and differences in patients with DB, and patients with well-controlled asthma regarding health-related quality of life, anxiety, depression, sense of coherence (SOC), hyperventilation and effects on daily life.	patients with DB and asthma 25 of each	HRQoL, SOC, NQ, SF-36 subscales, Hospital anxiety and depression (HAD) scale	Patients with DB are more disabled than patients with well-controlled asthma. There is a great need for more knowledge about breathing symptoms of a dysfunctional nature, to be able to identify and manage these patients adequately
Recognising dysfunctional breathing in asthma consultations. (50)	narrative review	To raise awareness among healthcare professionals about the presence and impact of dysfunctional breathing (DB) in patients with asthma, and to	Patients with asthma	NQ	NQ can be useful to clinicals in diagnosing DB in patients with asthma but more education around DB is needed to improve speed of recognition.

		provide guidance on how to recognise and assess DB during asthma consultations			
Validation Criteria for P ET CO 2 Kinetics during the Hyperventilation Provocation Test in the Diagnosis of Idiopathic Hyperventilation Syndrome. (51)	observational study with validation cohort.	To determine objective diagnostic criteria for idiopathic hyperventilation syndrome (HVS) based on PETCO2 kinetics during the hyperventilation provocation test (HPTest), and to validate findings against the Nijmegen Questionnaire (NQ).	Adults referred by pulmonologists/cardiologists for evaluation of unexplained dyspnoea. Excluded: psychiatric disorders, antidepressant use, other identified causes of dyspnoea, confirmed/suspected COVID-19.	PETCO2 NQ	PETCO2, kinetics during recovery, particularly at 5 min, provides reliable, objective diagnostic criteria for HVS, outperforming reliance on symptom reproduction or NQ alone.
Cardiopulmonary Exercise Testing in the Assessment of Dysfunctional Breathing. (52)	narrative review	To consider the role of cardiopulmonary exercise testing (CPET) in the identification and management of DB	people with dysfunctional breathing	NQ, SEBQ, BPAT, MARM, CPET	NQ and SEBQ are most common in use BPAT and MARM much less common but used in conjunction CPET may be useful in accurately diagnosing DB in patients with easily triggered symptoms difficulty arises when people who have very mild symptoms
Use of Cardiopulmonary Stress Testing for Patients With Unexplained Dyspnea Post-Coronavirus Disease. (53)	Prospective observation cohort study.	Use cardiopulmonary exercise testing (CPET) to define unexplained dyspnea in patients with post-acute sequelae of severe acute respiratory syndrome-coronavirus-2 (SARS-CoV-2) infection (PASC).	Patients post acute SARS - CoV - 2	CPET Prevalence of dysfunctional breathing (rapid erratic breathing).	CPET is a valuable diagnostic tool to uncover abnormalities not evident on resting tests.
Minute ventilation/carbon dioxide production in patients with dysfunctional breathing. (54)	Narrative review (commissioned, peer-reviewed)	To explore how the ventilatory equivalent for carbon dioxide (VeqCO2,), measured by cardiopulmonary exercise testing (CPET), can aid in diagnosing dysfunctional breathing, particularly hyperventilation syndrome (HVS), and to propose its use in diagnostic algorithms	Adults with suspected dysfunctional breathing, especially hyperventilation syndrome. Included both normocapnic and hypocapnic patients before exercise testing. Compared to healthy controls in the cited studies.	VeqCO2,, values during rest, light exercise, and peak exercise. Vâ€²E/Vâ€²COâ,, slope. Arterial PaCO2 , and pH. Symptom severity (dyspnoea, Nijmegen scores).	VeqCO2, is a useful objective physiological marker within a diagnostic algorithm for dysfunctional breathing but cannot be used in isolation. More research is needed in subtypes beyond HVS.
Validating the Breathing Vigilance Questionnaire for use in dysfunctional breathing. (55)	Cross-sectional validation study with test - retest reliability analysis	To develop and validate the Breathing Vigilance Questionnaire (Breathe-VQ), a self-reported measure of breathing-specific vigilance, and to evaluate its reliability, validity, and ability to discriminate between individuals at high and low risk of dysfunctional breathing.	Healthy adults recruited online - Brunel University SONA and Testable Minds platform. 18-71 years old.	Breathing vigilance questionnaire (Breath - VQ).	The Breathe-VQ is a valid and reliable tool to measure breathing vigilance. High breathing vigilance may contribute to dysfunctional breathing and could represent a therapeutic target. Further research is warranted to test Breathe-VQ prognostic value and assess intervention effects.
Identification of Breathing Pattern Disorder in Athletes With Exercise-Induced	prospective observational study	To evaluate the diagnostic utility of the Milstein Breathing Pattern Assessment Index (M-BPAI) for	athletes referred for exercise induced laryngeal obstruction.	M-BPAI total score Sensitivity, specificity, and ROC	BPD frequently co-exists with EILO and may be the only contributor to dyspnoea in up to 25% of referred athletes. The M-

Laryngeal Obstruction: A Novel Assessment Tool. (56)		detecting Breathing Pattern Disorder (BPD) in athletes with suspected Exercise-Induced Laryngeal Obstruction (EILO), and to estimate the prevalence of BPD in this group.		(AUC) for BPD detection Inter- and intra-rater reliability (ICC) Prevalence of BPD (M-BPAI â‰¥8) Correlation with Dyspnea Index	BPAI shows strong reliability and diagnostic accuracy for identifying BPD during high-ventilatory tasks.
Physiotherapy assessment of breathing pattern disorder: a qualitative evaluation. (57)	Qualitative study using focus groups with reflexive thematic analysis and survey methods	To explore physiotherapists opinions of physiotherapy assessment of Breathing Pattern Disorder (BPD).	103 physiotherapists completed the survey and 15 physiotherapists participated in the focus groups	NQ, BPAT, SEBQ, breath hold assessment, MARM, dyspnea 12 when assessing DB	Lack of consistency in assessment, objective measures, definition limit physiotherapists ability to diagnosis DB accurately. Limiting treatment There is a clear need for consistency around the terms used, appropriate diagnostic tools and validated outcome measures NQ, BPAT are commonly used by clinicians
The Thai version of the Nijmegen questionnaire. (59)	Cross-sectional validation study with translation and cross-cultural adaptation.	To translate and cross-culturally adapt the Nijmegen Questionnaire (NQ) into Thai (NQ-TH) and test its psychometric properties for screening hyperventilation syndrome (HVS).	Adults aged 18 - 65 years. HVS group: patients with medical records of hyperventilation syndrome and symptoms in the past week. Control group: no history of hyperventilation or related complaints. Recruited from three hospitals in southern Thailand .	NQ	The NQ-TH is a valid, reliable, and practical screening tool for HVS in Thai adults, with optimal cut-off of 20.
The impact of mental toughness and postural abnormalities on dysfunctional breathing in athletes. (60)	Narrative review	provides the groundwork to recognize and treat DB in athletes of all skill levels by addressing the psychological factors and gait abnormalities that tend to accompany this condition	athletes with DB, exertional dyspnoea and asthma	NQ, SEBQ and MARM for DB	Nijmegen questionnaire was shown to have a sensitivity of 91% and specificity of 95% (24) which is significantly better than other questionnaires and tests that have been developed to evaluate DB including the Self Evaluation of Breathing Questionnaire (SEBQ), end-tidal carbon dioxide measurement, breath holding time, and manual assessment of respiratory motion (MARM) But only for HVS not other forms of DB
Paroxysmal dyspnoea in asthma: Wheeze, ILO or dysfunctional breathing?(61)	narrative review	summarise the clinical features of DB and ILO with an especial focus on their identification in the context of individuals treated for asthma.	patients with asthma who experience paroxysmal (sudden, episodic) breathlessness. It specifically focuses on how this symptom might be due to asthma, inducible Laryngeal Obstruction (ILO) or Dysfunctional Breathing (DB).	NQ, SEBQ, BPAT, MARM, CPET, capnography, FeNO	NQ specificity of 95% and sensitivity of 91%, not designed to detect anything but HVS. Capnography will give an expected low-end tidal CO2 in some patients with hyperventilation syndrome, however its usefulness is limited as not all effortful breathing leads to sufficient increase in minute ventilation to reduce end tidal CO2. MARM very little validation across all types of DB. BPAT - ? does not say anything specific

					Cardiopulmonary exercise testing (CPET) is considered the gold standard for evaluation of exertional dyspnoea and exercise intolerance (31) Over all very little validation of all techniques Plthysmography evaluate breathing mechanics by measuring the changes in volume of the chest wall, ribcage and abdomen. Such techniques appear potentially very useful in identifying and classifying DB, and in particular thoraco-abdominal asynchrony that may be missed by other approaches These tools are, however, not in routine clinical practice and are currently primarily employed for research
Pulmonary recovery directly after COVID-19 and in Long-COVID. (62)	Prospective observational study	To assess pulmonary recovery in patients directly after COVID-19 infection and those with Long COVID, focusing on diaphragm function, dysfunctional breathing patterns, and the effectiveness of a structured rehabilitation program	patients from a single centre COVID rehabilitation program having undergone CPET	CPET, VO2 max, Anxiety and depression scales, Borg scale	directly after COVID-19 infection as well as in long Covid, 20 months after COVID-19 dysfunctional breathing patterns in cardiopulmonary exercise testing and diaphragm dysfunction on ultrasound are common and need diagnostic awareness and therapy measures.
A decrease in plant gain, namely CO 2 stores, characterizes dysfunctional breathing whatever its subtype in children. (47)	Retrospective cohort study	1) whether the children suffering from different subtypes of DB exhibit decreased plant gain and 2) the relationships between HVPT characteristics and plant gain	Children with DB	CPET, HVPT, chest radiography, echo cardiograpy	Unable to distinguish between subtypes of DB based of HPVT and Plant gain
Changes in cardiopulmonary exercise capacity and limitations 3-12 months after COVID-19. (63)	Prospective, longitudinal, multicentre cohort study	To describe cardiopulmonary function during exercise 12 months after hospital discharge for coronavirus disease 2019 (COVID-19), assess the change from 3 to 12 months, and compare the results with matched controls without COVID-19	Originally, in the atient-Reported Outcomes and Lung Function after Hospitalization for COVID-19 study in Norway, hospitalised COVID-19 patients aged â‰¥18 years, discharged before 1 June 2020 from 6 hospitals in different parts of Norway	CPET	1 year after hospital discharge for COVID-19, the majority (77%), had normal exercise capacity. Only every fourth had exercise intolerance and in these circulatory limiting factors were more common than ventilator factors. Deconditioning was common. Vâ€²O2 peak and oxygen pulse improved significantly from 3 months.
Exercise responses and mental health symptoms in COVID-19 survivors with dyspnoea. (64)	Cross-sectional	To examine dyspnoea quality, intensity, mental health symptom burden, and differences in exercise responses in COVID-19 survivors with and without persistent dyspnoea.	Adults above 18 years, previously diagnosed with COVID-19 (mild to critical illness). Mean age ~48 years; mix of hospitalised and non-hospitalised patients. Excluded: pre-existing cardiopulmonary disease, malignancy, inability to perform CPET.	Dyspnoea, Peak VO2 work rate, anaerobic threshold, ventilatory efficiency (VE/VCO2, nadir), anxiety, depression, post-traumatic stress, quality of life measurement	Persistent dyspnoea post-COVID is associated with specific dyspnoea qualities, ventilatory inefficiency, reduced exercise tolerance, and increased mental health burden, despite preserved resting lung function.

			Assessments conducted ~4 months post-infection.		
Dysfunctional breathing symptoms, functional impact and quality of life in patients with long COVID-19: a prospective case series. (76)	a prospective case series	This study describes a prospective case series of 48 patients with dysfunctional breathing based on compatible symptoms and an abnormal breathing pattern during cardiopulmonary exercise testing	Adults and adolescents (above 15 years) with PCR-confirmed SARS-CoV-2 infection. Persistent dyspnoea and abnormal breathing pattern during CPET. Excluded if other cardiorespiratory disease explained symptoms. Mean age: 48.5 years (SD 15.0). 68.8% female. Mostly previously healthy, non-smokers, with mild acute COVID-19 (WHO severity score 1 in 70.8%)	NQ, CPET,	Difficulty diagnosing DB with NQ and CPET due to lack of objective criteria in research and lack of validation of tools. Both may be useful in diagnosis of DB however
Untangling asthma, inducible laryngeal obstruction, and dysfunctional breathing in a competitive sportsperson. (65)	case report	n.a.	ICE skater with known ICS/LABA	CEPT with continuous laryngoscopy	Effective in diagnosing ILO
Characterization of adolescents with functional respiratory disorders and prior history of SARS-CoV-2. (66)	Retrospective non-interventional study,	To retrospectively characterize whether functional respiratory breathing patterns in patients referred for evaluation of persistent dyspnea or cough after SARS-CoV-2 infection while resting or on exercise were present in patients presented to our out-patient clinic for pediatric pulmonology between January 1st and October 31st, 2022	Twenty-five patients (44% female) with mean (m) age=12.73 years (SD±1.86) who showed distinctive features of functional respiratory disorders after SARS-CoV-2 infection (onset at m=4.15 (±4.24) weeks after infection) were identified	Pulmonary function tests (PFTs):Spirometry, body plethysmography, and standardized treadmill exercise tests; and radiological and laboratory examinations	functional respiratory disorders are important differential diagnoses in persisting post-SARS-CoV-2 dyspnea in adolescents. Combination of clinical history, detailed examination of breathing patterns, and pulmonary function tests are helpful to correctly diagnose these conditions.
Long-term reduced functional capacity and quality of life in hospitalized COVID-19 patients. (67)	prospective cohort study	To assess the long-term functional capacity and HRQoL in patients hospitalized due to COVID-19	Patients with SARS-CoV-2	cardiopulmonary exercise testing (CPET) and a HRQoL questionnaire	CPET May be able to help diagnose DB symptoms in SARS-CoV-2 patients
Cardiopulmonary Exercise Testing Distinguishes between Post-COVID-19 as a Dysfunctional Syndrome and Organ Pathologies. (68)	observational	to describe patterns of cardiopulmonary dysfunction of post-COVID-19 patients using CPET.	patients who have new-onset and persistent symptoms following COVID-19 disease or shortly thereafter. This had to be at least 3 months previous	CPET	CPET can identify patients with distinct limitation patterns, and potentially guide further therapy and rehabilitation.

Dysfunctional breathing diagnosed by cardiopulmonary exercise testing in 'long COVID' patients with persistent dyspnoea. (69)	Retrospective observational study (monocentric, outpatient clinic review)	To determine the occurrence of dysfunctional breathing (DB) in long COVID patients with persistent dyspnoea, describe specific ventilation patterns, and identify clinical predictors	Long COVID patients	CPET ventilatory pattern classification (DB, respiratory limitation, O2 delivery/utilisation impairment) Pulmonary function test results Arterial blood gases Exercise capacity (VO2 peak, workload) Dyspnoea (mMRC) Quality of life (HADS, CRQ)	DB with a chaotic ventilatory pattern observed at CPET can be distinguished from hyperventilation syndrome Evidence base lacking no gold standard at present but this study shows promise for CPET to detect other types of patterns of DB other than HVS.
Cardiopulmonary Exercise Test in the Detection of Unexplained Post-COVID-19 Dyspnea. (70)	Case report	Identify unexplained dyspnoea in post SARS-CoV-2 patient	Patient post SARS-CoV-2 infection	CPET	before SARS-CoV-2 infection, our patient had subclinical and asymptomatic preserved ejection fraction, which was triggered by COVID-19 and clinically manifested. The CPET may be a useful method for resolving these diagnostic dilemmas
The clinical utility of the Breathing Pattern Assessment Tool (BPAT) to identify dysfunctional breathing (DB) in individuals living with postural orthostatic tachycardia syndrome (POTS). (71)	Retrospective observational cohort study.	To assess the clinical utility of the Breathing Pattern Assessment Tool (BPAT) in diagnosing dysfunctional breathing in individuals with postural orthostatic tachycardia syndrome (POTS).	Patients with Postural orthostatic tachycardia syndrome	BPAT scores. Nijmegen Questionnaire scores. Respiratory rate (breaths/min). Presence/absence of DB - physiotherapist diagnosis = reference standard. ROC analysis - sensitivity, specificity, AUC.	The current study suggests BPAT is a useful clinical tool for identifying DB in patients with POTS and inappropriate breathlessness. Further research is required to assess the reproducibility of the BPAT and responsiveness of the BPAT to physiotherapy interventions in person and virtual environments Excellent inter - rater reliability has been reported for the BPAT for in-person assessments between physiotherapists (ICC = 0.95, 95 % CI 0.91 to 0.98) when measured in patients with asthma
Validity study of the Japanese version of the Nijmegen Questionnaire for verifying dysfunctional breathing in Japanese asthma patients. (72)	Cross-sectional validation study.	To prepare and validate a Japanese version of the Nijmegen Questionnaire (JNQ), assess its reliability and validity in asthma patients, and evaluate its association with asthma control, quality of life, and depression.	patients with asthma	NQ (Japanese)	The JNQ showed sufficient reliability (Cronbach alpha 5 0.875). Correlation analysis between the JNQ score and each questionnaire revealed negative correlations with the ACT score (r 5 0.262) and Mini-AQLQ score (r 5 20.453) and positive correlations with the ACQ score (r 5 0.337) and PHQ-9 score (r 5 0.539). All of these correlations were statistically significant.
Diagnostic tests and subtypes of dysfunctional breathing in children with unexplained exertional dyspnoea. (73)	Case-control study.	To assess whether the Nijmegen Questionnaire and Hyperventilation Provocation Test (HVPT) can differentiate inappropriate hyperventilation from other dysfunctional breathing subtypes in children with unexplained exertional dyspnea and normal cardiopulmonary investigations.	Children referred to a dyspnea clinic in Paris (2018â€“2020). Median age: 13.5 years. 36 girls, 14 boys. All had unexplained exertional dyspnea with normal spirometry, echocardiography, and cardiopulmonary exercise	Nijmegen, SHAPE, and STAI-C scores. CPET parameters: VE/VCO2, slope, tidal volume/VC ratio, dyspnea Borg scores. HVPT parameters: FETCO2, baseline, nadir, and recovery at 3 and 5 min; reproduction of symptoms.	Nijmegen and HVPT cannot discriminate inappropriate hyperventilation subtype from other DB subtypes in children. The concept of distinct DB subtypes based on hyperventilation alone may be questionable.

			testing (CPET) except for DB features.		
Pathophysiology and clinical evaluation of the patient with unexplained persistent dyspnea. (74)	Review	provide a practical overview on its evaluation and management, and to share authors' own diagnostic approach to patients with persistent breathlessness	patients who present with persistent or unexplained dyspnea	CPET, spirometry, chest radiograph, CT	Unexplained dyspnea is a challenging diagnosis and it requires a systematic approach.When diagnoses are not made during the initial evaluation, subsequent tests can include CPET and methacholine challenge. To be ensure a correct diagnosis, It is important that the clinician determines dyspnea response to a particular therapeutic intervention.
Translation and cross-cultural adaptation of the self evaluation of breathing questionnaire (SEBQ) into Danish. (75)	Qualitative - interview based	to translate and cross-culturally adapt the SEBQ into Danish and to assess the face validity of the Danish version of the questionnaire in individuals with DB-related symptoms	adults with DB related symptoms	the face validity of the Danish SEBQ, assessed through participant feedback	The SEBQ is the first available Danish questionnaire to measure DB-related symptoms, following an internationally acknowledged cross-cultural adaptation and face validity evaluation approach. This promising validation should be followed by an assessment of measurement properties in individuals with DB-related symptoms to investigate the adequacy of the SEBQ in a Danish context.
Unraveling persistent dyspnea after mild COVID: insights from a case series on hyperventilation provocation tests. (76)	Brief research report â€“ case series.	To investigate the role of dysfunctional breathing and hyperventilation provocation tests (HVPT) in patients with persistent dyspnea after mild COVID-19, despite normal cardiopulmonary function.	unexplained persistent dyspnoea.	Pulmonary function parameters (FEV1, FVC, DLCO). CPET parameters (VO2 workload, VE/VCO2). Nijmegen Questionnaire scores. HVPT outcomes: PETCO2 recovery kinetics, respiratory rate, tidal volume, minute ventilation. Symptom reports during HVPT.	Persistent dyspnoea post-mild COVID may reflect respiratory dysregulation detectable by HVPT, even when routine lung/cardiac tests are normal. HVPT may be a useful diagnostic adjunct in unexplained post-COVID dyspnoea.
Cardiopulmonary exercise testing to indicate increased ventilatory variability in subjects with dysfunctional breathing. (77)	Exploratory cross-sectional study (caseâ€“control design)	To provide objective criteria using cardiopulmonary exercise testing (CPET) to identify increased ventilatory variability in patients with dysfunctional breathing (DB) compared with matched controls.	dyspnoeic patients	CPET	CPET-derived variability measures, particularly breathing frequency, provide objective criteria for identifying DB. Larger studies needed to confirm thresholds.
The Breathing IQ: an anthropometric index of diaphragmatic breathing efficiency. (78)	Original research â€“ cross-sectional with pre - post intervention assessment	This paper aims to introduce the Breathing IQ (BIQ) as a novel anthropometric index of abdominothoracic flexibility for identifying biomechanical breathing patterns and assessing diaphragmatic breathing efficiency	Adults 18+ years old, community-based volunteers. No breathing difficulties and not under care for respiratory conditions. Mean age: 44.2 years (SD 17.0). Broad age distribution (<30 to 60+).	BIQ grade distribution ROM percentage (thoracic excursion) LOM classification (apical, mixed, diaphragmatic) Breath hold duration (seconds) Binary improvement in BIQ grade (yes/no)	The BIQ shows preliminary potential as an effective screening tool for mechanical breathing dysfunction
Eucapnic voluntary hyperventilation test in children. (79)	Experimental trial	To investigate the feasibility of the EVH test in children aged between 10 and 16 years, and to evaluate our EVH test equipment allowing the real-	Children aged 10 - 16 with history of exercise induced dyspnea	Eucapnic voluntary hyperventilation test	The EVH test was successful in the 10-16-year-old children having participated in the study and the test was well tolerated. Possible to provoke both dysfunctional breathing disorder and bronchoconstriction in the symptomatic patients. EVH test seems to be usable in the diagnostics of paediatric exercise-

		time minute ventilation measurement			induced dyspnea but larger studies are needed
Quantification of breathing irregularity for the diagnosis of dysfunctional breathing using proportional tidal volume variation: a cross-sectional, retrospective real-world study. (80)	Cross-sectional, retrospective, real-world study	To develop a statistical approach that provides a quantitative index measuring the magnitude of the irregularity of the breathing response to exercise for the diagnosis of dysfunctional breathing	Patients with unexplained exhurtional dyspnoea	CPET, index - proportional tidal volume variation (PTVV)	PTVV can easily be implemented in the clinical routine. Our study suggests a possible further simplification for the diagnosis of DB with two objective criteria including PTVV and one single criterion for
Physiotherapy assessment of breathlessness and disordered patterns of breathing: Defining a consensus on terminology and assessment. (19)	Mixed qualitative methodology	To establish expert physiotherapists' consensus on terminology to describe this condition and provide guidance for its physiotherapy assessment	10 respiratory physiotherapists 9 other clinicians with 2 years experience working with patients with this condition 5 patients who had been diagnosed with breathing pattern disorder (BrPD) 11 expert physiotherapists (UK-based) with significant clinical experience treating BrPD / disordered breathing patterns	MARM, NQ, and CPET. Opto electronic plethysmography (OEP).	With improved consistency in its description and assessment, the adoption of breathing pattern disorder may help to further develop clinical and research priorities in this area within physiotherapy services.
Validity and reliability of outcome measures to assess dysfunctional breathing: a systematic review. (81)	Systematic review	To systematically review and appraise the psychometric properties (validity, reliability, measurement error) of outcome measures used to assess dysfunctional breathing (DB) in adults, using COSMIN methodology.	Adults with dysfunctional breathing (including asthma, hyperventilation syndrome, post-COVID breathlessness, refractory asthma, athletes with EILO). Some studies also included healthy controls.	NQ, SEBQ, MARM, BPAT, Breathe-VQ, SLP, EtCO2, CPET, RIP	NQ is currently the only outcome measure with strong evidence supporting use in DB (particularly in asthma and HVS). Other measures show promise but lack comprehensive psychometric validation. Future research should focus on content validity, structural validity, and broader testing across DB populations.
Comparing methods to measure the dispersion of breathing parameters during exercise testing: A simulation study based on real-life parameters from patients with dysfunctional breathing. (83)	case series	To evaluate the accuracy and precision of two methods for assessing the dispersion of VT and BF: (1) the moving standard deviation (MSD) and (2) the locally estimated scatterplot smoothing (LOESS).	patients diagnosed with DB after COVID-19	CPET	standard deviation of the residuals from a LOESS seems to be an appropriate method to measure the dispersion of both VT and BF at rest and during exercise. MSD performed globally less well than LOESS except for extreme trends associated with a very low dispersion of data.
Analysis of the breathing pattern in patients with asthma during physical exercise: A cross-sectional study. (84)	Cross sectional study	Investigate individual breathing patterns of 15 well-controlled asthma patients and 15 healthy subjects during a cardiopulmonary exercise test (CPET)	Adults aged 18â€“60 years. Asthma group: confirmed diagnosis, stable asthma (post-salbutamol FEV1 >80% predicted, no exacerbation in prior 6 weeks), daily inhaled corticosteroids, no other pulmonary disease. Healthy group: no pulmonary disease or lung medication. Both groups matched for age,	BP angle (Â°) CPET parameters: VO2 max, VT/FVC, BF, VE/VCO2 Borg dyspnoea score (before/after CPET) VAS dyspnoea (before/after CPET, past 7 days) Questionnaire results (NQ, ACQ-7, Mini-AQLQ)	A shallow, fast breathing pattern during moderate exercise (low BP angle) is strongly associated with higher exercise-induced dyspnoea in both asthma and healthy individuals. CPET with BP angle measurement may help identify dysfunctional breathing patterns contributing to EID.

			height, and sex; asthma group had higher BMI.		
Dysfunctional breathing and reaching one's physiological limit as causes of exercise-induced dyspnoea. (11)	narrative review	to help clinicians recognise when referral to a respiratory physiotherapist or speech pathologist is useful, and highlights the need for awareness of rare but important structural or pathological causes	young people, adolescents, competitive athletes, and deconditioned individuals, as well as those with suspected or diagnosed asthma or other respiratory symptoms whose exercise-induced breathlessness is not well explained by asthma alone	CPET, CLE, Breathing pattern observation	Dysfunctional breathing (thoracic pattern disordered breathing / extra thoracic issues) is a common contributor to EID and is often underrecognized. CPET is very helpful to distinguish between disease limitation vs reaching physiological limit vs dysfunctional breathing
Identification and management of dysfunctional breathing in primary care. (12)	Narrative review or Clinical practice overview	To provide primary care nurses with an overview of dysfunctional breathing (DB), including its signs, symptoms, differential diagnosis, prevalence, and management strategies, to support early identification and effective treatment in clinical practice.	Adults and children in primary care who present with unexplained breathlessness or symptoms resembling neurological, respiratory, or cardiac disease. Includes patients with asthma, COPD, obesity, post-viral conditions, and anxiety-related disorders.	Prevalence of DB in different groups. Validity of screening tools (e.g., Nijmegen Questionnaire as indicator of symptoms). Reported clinical signs and symptoms of DB. Examples of retraining interventions and their evidence base.	NQ - validated for one subtype of DB HVS but good indicator for change post intervention for DB.
Improvements in multi-dimensional measures of dysfunctional breathing in asthma patients after a combined manual therapy and breathing retraining protocol: a case series report. (85)	case series report	To examine whether a combined manual therapy and breathing retraining protocol can improve measures of dysfunctional breathing (DB) in people with asthma	adults with asthma	MARM, chest expansion, SEBQ, NQ, End-Tidal CO2 capnometry, FEC, FEV1, AQLQ, PCAQ	Changes in MARM values have been shown to correlate with reductions in dyspnea after breathing retraining There are no established cut-scores but expert opinion suggest a score of 25 can be used as an appropriate cut-score to differentiate normal from dysfunctional breathers. MCID has not been established for the SEBQ. MCID has not been established for the NQ, however NQ values in healthy individuals range from 10 to 12â€¯Â±â€¯7 and values do tend to decrease towards these levels after breathing retraining. These OM could be sensitive to change post treatment with therapies but data is unclear at present.
Does manual therapy provide additional benefit to breathing retraining in the management of dysfunctional breathing? A randomised controlled trial. (86)	RCT	To investigate the hypothesis that MT produces additional benefit when compared with breathing retraining alone in a group of patients with primary DB.	Adults with primary dysfunctional breathing	NQ	Sufficient to detect change is severity of DB on this population.
Dysfunctional Breathing in Children: A Literature Review. (2)	Literature Review	To review the existing literature to provide a summary of classification of DB and epidemiological data concerning the pediatric population, comorbidities,	Children and adolescents with suspected or confirmed dysfunctional breathing.	NQ, CPET, end-tidal CO2, Laryngoscopy Spirometry / bronchodilator tests / FeNO / imaging to exclude organic lung disease	Structured light plethysmography (SLP), has demonstrated its effectiveness as a useful screening method for cases of DB in children. Cardiopulmonary exercise testing (CPET) has its own role to the identification and management of DB, and

		diagnostic tools and therapeutic approaches to enhance the comprehension and management of DB in children			ramp-incremental CPET can be highly beneficial in exploring unexplained dyspnea, enabling the identification of any underlying physiological reasons for exertional breathlessness that may not be evident in tests conducted at rest flexible nasal laryngoscopy gold standard for EILO. The Nijmegen Questionnaire primarily captures the subjective, psychological aspect of breathing and its reactions to stress. Validated for HVS. Lacks validation for children and adolescents.
Long COVID respiratory symptoms in non-hospitalised subjects a cross-sectional study. (88)	Cross-sectional observational study (prospective, single-centre)	To describe and analyse the variety of respiratory appearances in non-hospitalised subjects with Long COVID.	Post Acute SARS - CoV - 2	Functional limitation (PCFS). Respiratory symptoms (CAT, chest tightness). Physical activity level. Lung function (spirometry). Respiratory muscle strength (MIP, MEP). Physical capacity (6MWT, STS, oxygen saturation). Thoracic expansion. Respiratory movement (RMMI). Breathing pattern (ocular evaluation). Lung sounds. Chest pain.	Long COVID in non-hospitalised patients often involves abnormal breathing pattern, reduced respiratory muscle strength, chest mobility, and physical capacity, beyond what spirometry/oximetry alone reveal.
EXERCISE INTERVENTION FOR INDIVIDUALS WITH DYSFUNCTIONAL BREATHING: A MATCHED CONTROLLED TRIAL. (5)	observational	to describe and classify patterns of cardiopulmonary dysfunction in post-COVID-19 patients, using CPET	Individuals with DB and a control group	Peak VO2, VE/VCO2 slope, Capillary blood gas measures, Workload achieved in CPET	CPET can identify patients with distinct limitation patterns, and potentially guide further therapy and rehabilitation.