

# Test-Retest Reliability and Determinants of the Self Evaluation of Breathing Questionnaire (SEBQ): A Measure of Dysfunctional Breathing

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A research project submitted in partial fulfilment of the requirements  
for the degree of Master of Osteopathy  
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## Declaration

Name of candidate: Ashleigh Mitchell

This Research Project entitled “Test-Retest Reliability and Determinants of the Self Evaluation of Breathing Questionnaire (SEBQ): A Measure of Dysfunctional Breathing” is submitted in partial fulfilment for the requirements for the Unitec degree of Master of Osteopathy.

Candidate’s declaration

I confirm that:

- This Research Project represents my own work;
- Research for this work has been conducted in accordance with the Unitec Research Ethics Committee Policy and Procedures, and has fulfilled any requirements set for this project by the Unitec.

Research Ethics Committee. Research Ethics Committee Approval Number:  
2010-1089

Candidate Signature:

Date:

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## Abbreviations

<b>BMI</b>	Body Mass Index
<b>COPD</b>	Chronic Obstructive Pulmonary Disease
<b>DB</b>	Dysfunctional Breathing
<b>ICC</b>	Intraclass Correlation Coefficient
<b>MARM</b>	Manual Assessment of Respiratory Motion
<b>NQ</b>	Nijmegen Questionnaire
<b>RoBE</b>	Rowley Breathing
<b>SEBQ</b>	Self Evaluation of Breathing Questionnaire

## Introduction to thesis

Dysfunctional breathing (DB) has been long recognised as a condition affecting numerous people and influencing a range of health disorders. In the past, DB has been recognised as involving only hyperventilation syndrome with the presence of hypocapnia (Courtney & Greenwood, 2009; M. Thomas, McKinley, Freeman, & Foy, 2001; van Dixhoorn & Duivenvoorden, 1985). More recently it has been acknowledged that signs and symptoms of DB can occur with abnormal breathing patterns in the absence of hypocapnia (Burton, 1993; Courtney & Cohen, 2008; Hornsveld & Garsson, 1997). The recent acknowledgment, that DB may occur in the absence of hypocapnia, has sparked recent research that leads towards a new definition of DB and the development of valid and reliable diagnostic measures. The Self Evaluation of Breathing Questionnaire (SEBQ) has been recently developed by Courtney and co-workers (2009). It is a self-report questionnaire, which has been formulated in an attempt to more comprehensively recognise signs and symptoms of DB. Self-report measures have the potential to be useful in clinical contexts and may assist with diagnosis and management of DB.

This thesis is arranged in three main sections: Section 1 is a literature review that outlines normal breathing mechanics and breathing dysfunction; examines the validity and clinical utility of currently used diagnostic and assessment tools for varying breathing conditions; and reviews the variables associated or potentially associated with DB. Section 2 of the thesis contains a manuscript formatted for submission to the journal *Physiotherapy*. Section 3 (appendices) contains other material supplementary to the thesis. The aim of the study reported in this manuscript was to determine the test-retest reliability of the SEBQ and to investigate lifestyle or demographic variables that may be potentially associated with, or predict, SEBQ scores.

## **Section 1: Literature Review**

## 1. Introduction

Dysfunctional breathing (DB) is not currently well defined, but is a term that has recently been applied to a range of signs and symptoms that often occur together and may have a range of underlying causes. Classically, DB was only recognised to involve hyperventilation syndrome with the presence of hypocapnia (Courtney & Greenwood, 2009; M. Thomas et al., 2001; van Dixhoorn & Duivenvoorden, 1985). It has recently been acknowledged that DB signs and symptoms may occur with abnormal breathing patterns in the absence of hypocapnia (Burton, 1993; Courtney & Cohen, 2008; Hornsved & Garsson, 1997). Courtney (2009) describes DB as “breathing which is unable to perform its various functions efficiently and is inappropriate for the needs of the individual at that time”. Dysfunctional breathing is thought to have several contributing causative factors including biomechanical, biochemical and psychophysiological influences (Courtney, van Dixhoorn, Greenwood, & Anthonissen, 2011). It has been acknowledged that DB may occur as a functional problem in healthy individuals and may include hyperventilation, poor breathing control, breathing pattern abnormalities and presence of breathing symptoms (Courtney, Greenwood, & Cohen, 2011; Warburton & Jack, 2006). Dysfunctional breathing may also occur in people with diagnosed ‘pathology’ or respiratory conditions such as asthma. The diagnosed condition may be the primary cause of DB and DB may exacerbate symptoms of the underlying condition (M. Thomas, 2003). Dysfunctional breathing is thought to exaggerate the symptoms of a wide range of conditions treated commonly by healthcare practitioners. Some of these conditions include: asthma (Stanton, Vaughn, Carter, & Bucknall, 2008; M. Thomas et al., 2001; M. Thomas et al., 2003), chronic fatigue (Chaitow, 2007), cardiovascular symptoms (Courtney, Cohen, & van Dixhoorn, 2011; Courtney, van Dixhoorn, et al., 2011), myofascial pain syndromes (Bartley, 2011; Chaitow, 2007; Courtney, 2009), temporomandibular joint disorders (Bartley, 2011), altered spinal stability; and, headaches and migraines (Bartley, 2011; Courtney, 2009).

Due to the recent acknowledgment that DB is more complex than implied by earlier definitions, there is currently no criterion measure for it. A new diagnostic tool that is sensitive to the effects of both classical and non-classical forms of DB may be

beneficial in a clinical setting for the detection and management of DB. The Self Evaluation of Breathing Questionnaire (SEBQ) has been recently developed by Courtney & Greenwood (2009) to be a clinically applicable, self-report questionnaire that attempts to comprehensively cover signs and symptoms of DB. The SEBQ items have been developed from a wide variety of sources with the aim of including the broader range of DB symptoms that have now been acknowledged (Courtney & Greenwood, 2009).

This review explores the mechanisms of breathing, its various forms of dysfunction and how they may influence health conditions treated in routine clinical practice. The review also describes and critically evaluates the currently available diagnostic tools for the assessment of different forms of breathing dysfunction. Finally, the review considers variables associated, or potentially associated, with DB.

## 2. Breathing Mechanics

When the respiratory system is functioning normally, in a resting state, breathing should occur with a low perceived effort and at a frequency between 12 and 15 breaths/minute (Richardson, 2006). During 'ideal' inspiration, the diaphragm descends and the abdominal wall and lower intercostal muscles stretch passively (Chaitow, Bradley, & Gilbert, 2002, pp. 15-18; Richardson, 2006). Diaphragm and lower chest wall excursion can be measured during deep breathing and is typically between 4 to 7cm in healthy individuals (Wang et al., 2009). The diaphragm is often described as 'the primary muscle of inspiration' and provides an essential pumping action which is vital for numerous body functions, including homeostasis of thoracic and abdominal pressures, mobility and motility of organs, and lymphatic and cardiovascular pump movement (Bacchus, 2010; Bartley & Clifton-Smith, 2006, p. 56; West, 2000, p. 2). In the resting state, expiration occurs through elastic recoil of the lungs and the upper chest and accessory muscles of breathing including upper trapezius, intercostals, sternocleidomastoid, pectoralis muscles and scalenes should remain relaxed (Chaitow et al., 2002, pp. 15-18; Gilbert, 1998; Richardson, 2006; Schuenke, Schulte, & Schumacher, 2006, pp. 132, 258, 268).

The primary purposes of respiration are for gas exchange and homeostatic maintenance of pH balance within the body (Bacchus, 2010; Bartley, 2011; West, 2000, pp. 10-22). When inspiration occurs, air is inhaled and eventually oxygen is transferred into cells where it acts as a fuel to generate energy for all body functions (West, 2000, p. 17). During this process carbon dioxide is removed as a by-product of the energy-generating reactions. Carbon dioxide is then transported, from the cells by the blood and eventually back to the lungs where it is expelled into the atmosphere (Bartley & Clifton-Smith, 2006, pp. 40-44; West, 2000, p. 17). Acidity and alkalinity of blood is determined by the partial pressure of carbon dioxide ( $p\text{CO}_2$ ) and the concentration of bicarbonate molecules in the blood (Bacchus, 2010; Bartley, 2011; West, 2000, pp. 19-22). In a normally functioning system the pH of the human body should be relatively neutral, equalling 7.4; disturbances in the acid-base balance may result in either respiratory or metabolic alkalosis or acidosis (West,

2000, pp. 19-22). Respiratory alkalosis occurs when there is an increased arterial partial pressure of oxygen (pO<sub>2</sub>) and decreased pCO<sub>2</sub>, thus elevating the pH, this arises in a state of hyperventilation with hypocapnia (West, 2000, pp. 19-22). Respiratory acidosis may occur in hypoventilation leading to a decrease in pO<sub>2</sub> and subsequently an increase in pCO<sub>2</sub> resulting in hypoxia and a lowered pH level (West, 2000, pp. 19-22). The concentration of oxygen in the alveolar compartments of the lungs is determined by a balance between the rate of removal of oxygen from the lungs into the blood (known as perfusion) and the rate of replenishment of oxygen into the lungs (known as ventilation) (West, 2000, pp. 46-47). Therefore, in an ideally functioning respiratory system, ventilation and perfusion of lung tissues should be matched for efficient gas exchange (Hansen, Ulubay, Chow, Sun, & Wasserman, 2007). Oxygen is vital for all processes that occur within the body. Carbon dioxide is an important determinant of acid-base balance, it assists in the dissociation of oxygen from haemoglobin, the control of cerebral blood flow and neuronal excitability, and constriction of blood vessels and muscular contraction (Bartley & Clifton-Smith, 2006; Courtney, 2009).

### **3. Dysfunctional Breathing**

Dysfunctional breathing is not currently well defined, but is a term used to describe a complex phenomenon which is thought to have several contributing causative factors including biomechanical, biochemical and psychophysiological influences (Courtney, van Dixhoorn, et al., 2011). Various forms of DB have been recently acknowledged. These include the classical form of DB known as hyperventilation syndrome, and recently recognised forms such as poor breathing control, breathing pattern abnormalities and presence of unexplained breathing symptoms (Courtney, Greenwood, et al., 2011; Warburton & Jack, 2006). It has been acknowledged that DB may occur as a functional problem in healthy individuals resulting in unexplained breathing complaints (Courtney, van Dixhoorn, et al., 2011). Dysfunctional breathing may also occur in people with diagnosed pathology or respiratory conditions. The diagnosed condition may be the primary cause of DB which may exacerbate symptoms of the underlying condition (M. Thomas, 2003). Several previous studies

support the hypothesis that people with DB may benefit from breathing retraining programmes (Chaitow, 2007; Gilbert, 2003; Hagman, Janson, & Emtner, 2011; M. Thomas et al., 2003).

### *3.1. Hyperventilation Syndrome*

Dysfunctional Breathing was originally thought to occur only during hyperventilation syndrome with the presence of hypocapnia (Courtney & Greenwood, 2009; M. Thomas et al., 2001; van Dixhoorn & Duivenvoorden, 1985). Hyperventilation occurs when respiratory rate is increased, leading to the rate of ventilation being greater than the rate of perfusion, and the metabolic requirement for oxygen being exceeded, thus resulting in higher oxygen levels within the lungs (Bartley, 2011; Schleifer, Ley, & Spalding, 2002; West, 2000, pp. 18-20). During hyperventilation arterial carbon dioxide levels are lowered as excess carbon dioxide is expelled into the air during the over breathing process (Bartley, 2011; Schleifer et al., 2002). Clinically the term hyperventilation is used to describe two main clinical syndromes: the first syndrome is acute episodic hyperventilation which occurs in scenarios such as a 'panic attack' (Warburton & Jack, 2006). The second form of hyperventilation syndrome is chronic hyperventilation which commonly occurs in people with significant anxiety problems (Warburton & Jack, 2006). In both chronic and acute hyperventilation syndrome, arterial carbon dioxide levels are lowered resulting in increasing alkalosis and symptoms such as breathlessness, sensations of chest tightness, and feelings of parasthesia in fingers or toes (van Dixhoorn & Duivenvoorden, 1985; Warburton & Jack, 2006). Hyperventilation syndrome has been recognised for many years as the main form of DB, therefore, the Nijmegen Questionnaire has been developed and validated for the measurement of hyperventilation syndrome (van Dixhoorn & Duivenvoorden, 1985; van Doorn, Folgering, & Colla, 1982). Currently there is no validated tool for the recognition of the broader forms of DB that have now been acknowledged.

### *3.2. Non-classical Dysfunctional Breathing*

It has now been observed that DB-related symptoms such as breathlessness, tightness in the chest, inability to breathe deeply, and fast breathing can occur with abnormal breathing patterns when carbon dioxide levels remain normal within the body (Courtney & Cohen, 2008; Hornsveld & Garsson, 1997). The diagnosis of DB is currently made on the basis of symptoms, breathing patterns, and sometimes, but not always, the measurable presence of hyperventilation and hypocapnia (Courtney & Cohen, 2008; Courtney, Greenwood, et al., 2011). Signs of DB include asynchrony of breathing movement between thorax and abdomen, upper thoracic breathing, frequent or deep sighs, mouth breathing in low oxygen demand situations, and exaggerated use of accessory muscles of breathing (Bartley & Clifton-Smith, 2006, pp. 57-65; Chaitow et al., 2002, p. 2; Courtney & Greenwood, 2009). The most recognisable DB patterns include asynchronous and paradoxical motion between the ribcage and abdomen, lateral or upper chest breathing (Bartley & Clifton-Smith, 2006; Courtney, 2009). With any of these patterns the mechanics of the diaphragm and thorax will vary from normal physiological patterns and may result in symptoms of DB (Courtney, 2009). Some DB-related symptoms that have been reported include: changes to breathing sensations, sighing, yawning, periods of breath holding, and mouth breathing (Courtney & Greenwood, 2009). If diaphragm function is altered from its normal pattern there may be several effects on the body (Courtney, 2009).

### *3.3. Effects of Dysfunctional Breathing*

If the diaphragm is not functioning ideally and the 'respiratory pump' is impaired there may be several effects. The accessory muscles of breathing including the upper trapezius, intercostals, sternocleidomastoid, pectoralis muscles and scalenes increase their activity, which can lead to postural changes of the trunk, head and shoulder girdle such as 'upper crossed syndrome' (Courtney, 2009; Moore, 2004). 'Upper cross syndrome' was first attributed to Janda (Liebenson, 2007, p. 40) and is described as tightness in the upper trapezius, pectoralis, sternocleidomastoid and levator scapulae muscles with weakness in rhomboids, serratus anterior, lower

trapezius and deep neck flexors (Liebenson, 2007, pp. 40-42; Moore, 2004). These muscular changes lead to characteristic elevation and protraction of the shoulder girdles, winging of the scapula, and a forward head posture (Moore, 2004). Other postural changes such as flattened spinal curvatures, and altered balance may also occur in DB due to the alteration in costal and spinal mechanics and muscular tone in the accessory muscles of breathing. Postural changes are considered to contribute to, and aggravate, numerous conditions including temporomandibular joint pain (Bartley, 2011), shoulder, neck, thorax, and lower back pain (Chaitow, 2007; Courtney, 2009); and headaches (Courtney, 2009; Hruska, 1997).

Alterations in the respiratory pump may lead to adjustments in rhythmic pressure fluctuations between thoracic and abdominal cavities (Courtney, 2009). In normal respiration there is a decrease in intra-thoracic pressure during inspiration, and an increase in intra-abdominal pressure during expiration (Courtney, 2009; DeBoer, Karemaker, & Strakee, 1987). Changes of intra-chest cavity pressures may occur with abnormal breathing patterns, and are thought to lead to hemodynamic and lymphatic pump rhythm changes (Courtney, 2009). The change in the lymphatic pump has been proposed to alter the lymphatic system's ability to filter cell debris, pathogens and cancer cells and decrease its ability to initiate an immune response to them, exacerbating illness and impairing normal healing ability (Courtney, 2009). However, direct evidence of these effects have not been directly linked to DB. Disease states that are thought to be exaggerated by DB include chronic pain syndromes (Chaitow, 2007), hypertension (Courtney, Cohen, et al., 2011), asthma (Hagman et al., 2011; M. Thomas, 2003; M. Thomas et al., 2001), anxiety, and depression (Gilbert, 2003), most of which have been seen to be improved by breathing retraining.

### *3.4. Breathing Retraining*

Breathing retraining may involve a practitioner providing education about ideal breathing, and breathing exercises to a patient with the aim of improving physiological function of breathing mechanics. There are at least two specific methods for breathing retraining including the Papworth method (Holloway & West,

2007) and the Buteyko Breathing Method (S. Thomas, 2004). Breathing retraining can also be performed as an individualised programme where a practitioner chooses specific exercises dependent on the needs of the patient at the time (Hagman et al., 2011; M. Thomas et al., 2003).

The Papworth method was developed in the 1960s and has mainly been used for retraining breathing in people suffering from hyperventilation syndrome (Holloway & West, 2007). The method involves educating patients about hyperventilation, ideal breathing, and recognition and management of stress. Patients are then shown and asked to perform diaphragmatic and nasal breathing exercises, and undertake relaxation techniques in different positions (Holloway & West, 2007). Holloway and West (2007) published a randomised controlled trial examining the effects of the Papworth method on quality of life and symptoms of asthmatics. This study randomly allocated 85 participants into a control or intervention group. The control group received no additional treatment for their asthma than what they were receiving prior to the study. The intervention group each received five breathing and relaxation training sessions with a respiratory physiotherapist using the Papworth method. The authors of the study reported that after both six and 12 month follow-ups the intervention group had improved their respiratory symptoms and health-related quality of life compared to the control group (Holloway & West, 2007). Although not reported by the authors, the magnitudes of the effects were 'moderate' for both respiratory symptoms and health related quality of life. No significant change was found in measures of lung function and this may suggest that breathing and relaxation training is not affecting the underlying pathology associated with asthma, but the symptoms and quality of life resulting from manifestations of dysfunctional breathing (Holloway & West, 2007).

The Buteyko Breathing Method was originally developed in the 1950s (Bruton & Lewith, 2005). Buteyko claimed that the breathing technique applied corrects chronic hyperventilation by raising arterial carbon dioxide levels (Courtney, 2008; Courtney & Cohen, 2008; S. Thomas, 2004). The Buteyko Breathing Method recommends five hours contact time with a trained Buteyko practitioner where exercises are given in an aim to decrease ventilation. Ventilation is decreased either

through slowing the breathing rate of the patient or reducing tidal volume of oxygen by adding pauses to breathing after expiration (S. Thomas, 2004). In a review of literature on the Buteyko method, Thomas (2004) concludes that there have been four trials investigating the effectiveness of the method for asthmatics (Bowler, Green, & Mitchell, 1998; Cooper et al., 2003; McHugh, Aitcheson, Duncan, & Houghton, 2003; Opat, Cohen, Bailey, & Abramson, 2000). All four of these studies concluded that the Buteyko method is effective in reducing the frequency of use of bronchodilators in patients with asthma (Bowler et al., 1998; Cooper et al., 2003; McHugh et al., 2003; Opat et al., 2000). A difficulty in investigating the physiological effects of the Buteyko method on medication use is that the Buteyko method actively encourages a decreased use of asthma medication. Practitioners instruct patients to use their medication only when absolutely necessary (M. Thomas et al., 2003; S. Thomas, 2004). Due to the active encouragement in the Buteyko method to decrease medication use, frequency of bronchodilator use in participants may not be an accurate measure of the efficacy of the technique and further investigations into the efficacy and effectiveness of the Buteyko method are required.

Individualised breathing retraining programmes have been shown to improve quality of life in people with breathing complaints in at least two studies (Hagman et al., 2011; M. Thomas et al., 2003). Thomas, et al. (2003) performed a randomised controlled trial on 33 adult participants with both currently diagnosed and managed asthma, and diagnosed DB as identified using the Nijmegen Questionnaire for hyperventilation syndrome. Participants were split into two groups. The first received three individualised breathing retraining sessions with a physiotherapist over a 3-week period, and the second group received a one off asthma education session with an asthma nurse (M. Thomas et al., 2003). Authors reported that statistically significant and clinically meaningful improvements in quality of life scores (Asthma Quality of Life Questionnaire) were found at a one-month follow-up compared to those who did not receive the retraining (M. Thomas et al., 2003). At six month follow-up those who received the breathing retraining retained their improvements (M. Thomas et al., 2003).

A recent case-control study examined the long-term effects of breathing retraining in participants with diagnosed breathing dysfunction (Hagman et al., 2011). The study included two participant groups. The first group included 25 participants who were diagnosed with DB by clinical observation of breathing pattern, and on the basis of DB symptoms (Hagman et al., 2011). To be diagnosed with DB, participants were required to have at least 5 out of 10 of the following symptoms: 1) difficulty on inspiration; 2) inability to take deep breaths; 3) increased respiratory rate; 4) frequent sighing/yawning; 5) frequent throat clearing; 6) muscle and joint tenderness in the upper chest; 7) cough; 8) chest tightness; 9) feeling of a lump in the throat; and 10) previous or current stress (Hagman et al., 2011). The second group consisted of 25 participants, age and gender matched to the first group, with well managed asthma and without the presence of DB. The DB group received between one and four individualised physiotherapy-based breathing retraining sessions, where participants were educated about breathing and taught diaphragmatic breathing techniques in different postures (Hagman et al., 2011). All participants were required to complete five self-report questionnaires at baseline and at a 5-year follow up. The authors did not report effect sizes for results but reported that statistically significant changes to physical function scores on the 'Medical Outcomes Survey Short Form 36 questionnaire' were found (estimated as 'small to medium' effects from published results). Additionally, participants had fewer breathing problems in everyday activities (small to medium effect sizes) and the number of emergency room visits decreased in the DB group that received the intervention (Hagman et al., 2011). The asthma group who did not receive the intervention recorded significantly lowered quality of health, and bodily pain at the 5-year follow-up (Hagman et al., 2011).

Chaitow (2007) and Gilbert (2003) both provide reviews of the literature surrounding the benefits of breathing retraining on common conditions. Chaitow (2007) mainly discusses the benefits of breathing modification for hyperventilation syndrome for decreasing chronic pain and anxiety. Chaitow (2007) states that there is ample evidence to support the possibility that hyperventilation syndrome may be a contributing factor to chronic pain and anxiety. He concludes "breathing pattern

disorders are common, easily recognised, and commonly correctable via retraining and manual soft tissue (and sometimes osseous) mobilisation of respiratory structures” (Chaitow, 2007, p. 44). The evidence Chaitow (2007) refers to throughout his review is largely anecdotal rather than higher quality evidence from epidemiological designs or controlled trials.

Gilbert (2003) recognises that breathing retraining has been used for many years and there is evidence to support its use in the treatment of anxiety. Gilbert (2003) discusses the potential worth of breathing modification for purposes other than anxiety, such as rehabilitation from cardiovascular diseases, and decreasing symptoms of Chronic Obstructive Pulmonary Disease (COPD). Gilbert (2003) concludes that there is some evidence that breathing retraining may benefit these conditions, however, more research is required. Gilbert’s conclusion that further research is required into the effectiveness of breathing retraining for conditions such as cardiovascular disease, or COPD appears justified as there is currently minimal supporting literature and existing evidence is largely anecdotal.

Two high quality randomised controlled trials (Holloway & West, 2007; M. Thomas et al., 2003), and one recently published case-control study (Hagman et al., 2011) support the efficacy of breathing retraining for improvement of asthma symptoms and quality of life in asthma sufferers. There is also a large amount of anecdotal evidence available demonstrating the potential benefits of breathing retraining for other conditions. The available literature supports the possibility that DB may affect large numbers of people, and may influence many common conditions. In healthy adults approximately 21,000 breaths are taken per day, therefore, because of the frequent repetitive motions of breathing, severe DB can have numerous implications on bodily functions, and some authors posit that even subtle forms of DB may be important (Courtney, 2009). It is currently difficult to assess subtle changes in mechanical functions of breathing, therefore a valid diagnostic measure that is sensitive to a broad range of DB symptoms, may be beneficial for the early detection and appropriate management of DB.

## 4. Measures of Breathing Dysfunctions

Several tools for the measurement of various forms of pathological breathing problems are available. These tools include questionnaires mainly designed to measure the severity of diseases and quality of life in disease sufferers for specific respiratory conditions including COPD (Jones, Quirk, Baveystock, & Littlejohns, 1992; Meek, 2004; Wijkstra et al., 1994), emphysema (Eakin, Resinkoff, Prewitt, & Kaplan, 1998), and asthma (Lee et al., 2009). Five questionnaires have been identified that aim to recognise and quantify specific symptoms of breathing problems, these include: the Nijmegen Questionnaire (van Dixhoorn & Duivenvoorden, 1985; van Doorn et al., 1982); the Breathing Descriptor tool (Courtney & Greenwood, 2009; Meek, 2004); the Breathing Problems Questionnaire (Haave, Hyland, & Engvik, 2005; Hyland, Singh, Sodergren, & Morgan, 1998); the Rowley Breathing (RoBE) self-efficacy scale (Rowley & Nicholls, 2006); and the SEBQ (Courtney & Greenwood, 2009). There are also manual assessment techniques available for the recognition of abnormal breathing patterns. Examples of clinically applicable manual techniques include the Manual Assessment of Respiratory Motion (MARM) (Courtney, van Dixhoorn, & Cohen, 2008); the Hi Lo Breathing Assessment (Courtney, Cohen, & Reece, 2009); and Breath Holding Time (Courtney & Cohen, 2008). Currently there is no comprehensively validated diagnostic tool for identifying the wide range of DB signs and symptoms that have now been described. The SEBQ has been developed with the aim to be a clinically applicable, self-report questionnaire that attempts to cover signs and symptoms of DB in detail.

### 4.1. *Questionnaires for Specific Conditions*

Most identified questionnaires related to breathing have been developed as assessments of severity, or quality of life of sufferers for specific pathological conditions. Examples of disease-specific questionnaires include: the University of California, San Diego Shortness of Breath Questionnaire for the measurement dyspnea in daily activities, for moderate to severe chronic lung disease (Eakin et al., 1998); the St. Georges Questionnaire for chronic respiratory disease (Jones et al., 1992); and, the Chronic Respiratory Questionnaire, which both assess quality of life

in COPD sufferers (Meek, 2004; Wijkstra et al., 1994); and the Asthma-Specific Quality of Life Questionnaire which assesses quality of life in asthma patients (Lee et al., 2009). These disease-specific questionnaires are designed with the aim of quantifying secondary events occurring in response to the dyspnea sensations caused by the condition. They do not directly quantify an individual's perception of dyspnea sensations (Meek, 2004). The design of these disease-specific questionnaires may not be appropriate for the identification of DB because their items are tailored specifically to quantify secondary events of pathological diseases and they fail to specifically describe dyspnea sensations.

#### 4.2. *Questionnaires for Dysfunctional Breathing*

Questionnaires developed for the potential assessment of dyspnea sensations or DB include the Nijmegen Questionnaire (van Dixhoorn & Duivenvoorden, 1985; van Doorn et al., 1982), the Breathing Descriptor tool (Courtney & Greenwood, 2009; Meek, 2004), the Breathing Problems Questionnaire (Haave et al., 2005; Hyland et al., 1998), the Rowley Breathing (RoBE) self-efficacy scale (Rowley & Nicholls, 2006), and the SEBQ (Courtney & Greenwood, 2009).

##### 4.2.1. The Nijmegen Questionnaire

The only validated questionnaire that identifies DB is the Nijmegen Questionnaire (NQ), however, the NQ has only been validated for hyperventilation syndrome – which is just one form of DB (Courtney & Greenwood, 2009; M. Thomas et al., 2001; van Dixhoorn & Duivenvoorden, 1985). The NQ was originally developed by van Doorn and colleagues (1982), who also performed a test-retest reliability study which showed the questionnaire to have high reliability ( $r = 0.87$ ). Validation studies of the NQ have involved comparison of NQ scores of participants diagnosed with hyperventilation syndrome using laboratory findings of hypocapnia, against participants without hyperventilation syndrome (Courtney & Greenwood, 2009; M. Thomas et al., 2001; van Dixhoorn & Duivenvoorden, 1985). The NQ was found to be highly sensitive ( $S_n = 91\%$ ) for the recognition of hyperventilation syndrome with hypocapnia (van Dixhoorn & Duivenvoorden, 1985). The NQ consists of 16 items each scored on a scale from 0, indicating the described symptom 'never occurs', to 4

indicating the symptom happens 'very often'. Normative values for the NQ are thought to be a mean score of 11 (SD 7.6) for a healthy population (Courtney, Cohen, et al., 2011), and a score of 23 or higher is thought to indicate hyperventilation syndrome (van Dixhoorn & Duivenvoorden, 1985). Of the 16 NQ items, only four relate to breathing sensations directly, the others relate to neurological, psychological and cardiovascular symptoms (Courtney & Greenwood, 2009; van Dixhoorn & Duivenvoorden, 1985). A recent study was performed on a sample of DB participants to determine the relationship between breathing pattern abnormalities and categories of NQ symptoms (Courtney, van Dixhoorn, et al., 2011). Dysfunctional breathing patterns were identified using a physical examination procedure involving palpation of the rib cage, the Manual Assessment of Respiratory Motion (Courtney, van Dixhoorn, et al., 2011). The 16 NQ items were grouped into four categories of symptoms: 'tension', 'central neurovascular', 'peripheral neurovascular' and 'dyspnea'. Of these categories, dyspnea had the highest and only statistically significant correlation to MARM values for abnormal breathing patterns ( $r_{(38)} = 0.32$ ;  $P = 0.04$ ) (Courtney, van Dixhoorn, et al., 2011). According to (Courtney, van Dixhoorn, et al., 2011), the NQ has been designed to mainly recognise symptoms of one form of DB, and does not sufficiently identify all possible symptoms of DB. Some of the symptoms of DB that are not incorporated into the NQ include: breath proportional to fitness, breath while talking, sighing, yawning, irregular breathing, breath holding, and mouth breathing (Courtney, Cohen, et al., 2011; Courtney & Greenwood, 2009). Therefore, a more detailed questionnaire that identifies a wider range of potential indicators of DB would be clinically useful.

#### 4.2.2. Other Measures of Dyspnea

The Breathing Descriptor Tool is a validated questionnaire for identifying qualities of dyspnea sensations (Courtney & Greenwood, 2009; Meek, 2004). Some of the Breathing Descriptor Tools items relate to DB, however, it has not been developed specifically for the use on DB individuals (Courtney & Greenwood, 2009; Meek, 2004). The Breathing Descriptor Tool has mainly been used to assess dyspnea sensations during laboratory manipulation of breathing, for example, during bronchoprovocation or exercise (Meek, 2004).

The Breathing Problems Questionnaire identifies some aspects of DB, however, the Breathing Problems Questionnaire has been designed as another disease-specific instrument to monitor the changes of self-perceived health status in individuals suffering from COPD (Haave et al., 2005; Hyland et al., 1998). The Breathing Problems Questionnaire contains 33 questions that address physical and psychological quality of life in COPD sufferers, questions are worded specifically toward COPD patients and very few of the questions relate to symptoms of DB (Haave et al., 2005; Hyland et al., 1998).

The only other questionnaire identified that has been developed to detect DB is the Rowley Breathing (RoBE) Scale for people with breathing pattern disorders (Rowley & Nicholls, 2006). The RoBE Scale was developed as part of a pilot study, its items are mainly formulated from anecdotal descriptors of breathing recognised by the developers, and no further investigations into the questionnaire have been published since the original study (Rowley & Nicholls, 2006). The RoBE Scale items refer to “your symptoms” rather than specifically detailing what the symptoms are and it appears to be more of an evaluation tool for the management of symptoms, rather than early detection of DB.

None of the questionnaires previously discussed are ideal tools for identifying and measuring the severity of DB. Disease-specific questionnaires may not be appropriate for the identification of DB because their items are tailored to quantify secondary events of pathological diseases and they fail to specifically describe dyspnea sensations. The Nijmegen questionnaire has been specifically developed and validity tested for the recognition of hyperventilation syndrome (van Dixhoorn & Duivenvoorden, 1985; van Doorn et al., 1982) and does not sufficiently identify all possible symptoms of DB (Courtney, van Dixhoorn, et al., 2011). The Breathing Descriptor Tool and the Breathing Problems Questionnaire identify some aspects of DB, however neither have been formulated specifically for DB. The RoBE scale has been developed in an aim to quantify symptoms of DB, however, it was developed in a pilot study and minimal sources were used for development of its items. There is currently no valid tool for the measurement of the broad range of signs and

symptoms of DB that have now been acknowledged. The SEBQ was developed in an aim to identify DB signs and symptoms.

#### 4.2.3. The Self Evaluation of Breathing Questionnaire (see Appendix A)

The SEBQ is a comprehensive questionnaire that has been developed taking questions related to breathing from a variety of sources, in an aim to cover a wider range of potential symptoms of DB (Courtney & Greenwood, 2009). Sources used for the development of the SEBQ include published studies by Burton (1993) and Howell (1990), which both proposed symptoms of DB, and other literature in the field that describes psychological and physiological aspects of breathing symptoms (Fried & Grimaldi, 1993; Wilhelm, Gertivz, & Roth, 2001). Other sources for SEBQ development included clinical experience of the development team (Courtney & Greenwood, 2009), and a popular online questionnaire “How Good is your Breathing Test, Take our Free Breathing Test and See” (White, 2005). In developing the SEBQ, Courtney and Greenwood (2009) required each SEBQ item to be supported by at least two sources in order to be included the questionnaire. The original SEBQ contained 17 items relating to possible DB symptoms. An exploratory study with preliminary investigation of the SEBQ was performed; factor analysis was carried out, and items with low factor loadings were removed from the questionnaire (Courtney & Greenwood, 2009). Items with the highest factor loadings facilitated the identification of two distinct dimensions within the questionnaire (Courtney & Greenwood, 2009). The two dimensions of the SEBQ that were identified were items related to a “lack of air” and items related to “perception of inappropriate or restricted breathing” (Courtney & Greenwood, 2009; Courtney, Greenwood, et al., 2011). The dimension “lack of air” was thought to be related to chemoreceptor inputs of DB or respiratory awareness of individuals with DB, all items in the SEBQ that contained descriptors about breathlessness loaded on this factor (Courtney & Greenwood, 2009). The dimension “perception of inappropriate or restricted breathing” was seen to be more related to biomechanical aspects of DB, with items relating to a feeling of altered thoracic motion loading on this factor (Courtney & Greenwood, 2009). The preliminary investigation also compared the SEBQ to the NQ in an aim to determine if the two measured different aspects of breathing

dysfunction to each other, it was concluded that the NQ does not strongly represent the two factors found on the SEBQ, therefore the SEBQ cannot be relied upon to identify hyperventilation syndrome (Courtney & Greenwood, 2009). According to results of the preliminary investigation, two SEBQ items were deleted due to low factor loadings (Courtney & Greenwood, 2009). One item “I sigh yawn or gasp” was changed into two separate items “I notice myself sighing” and “I notice myself yawning” to make the items more specific (Courtney & Greenwood, 2009). Eight additional items were added to the SEBQ from the Breathing Descriptor Tool in an aim to make the questionnaire more specific for DB symptoms; resulting in a revised 25-item version of the SEBQ (Courtney & Greenwood, 2009).

The SEBQ has been specifically developed from several sources in an aim to cover the broader range of signs and symptoms of DB that have now been acknowledged. Currently no reliability studies have been conducted on the SEBQ.

#### *4.3. Manual Assessments of Breathing*

The questionnaires previously discussed are patient-orientated, self-report measures of breathing dysfunctions. There are also practitioner-orientated, manual assessments of breathing available for the diagnosis of DB. Recently, studies have been conducted into the effectiveness of manual measures of DB. Some of these clinically applicable manual measures of DB include the ‘Manual Assessment of Respiratory Motion’ (MARM) (Courtney et al., 2008), ‘Hi Lo Breathing Assessment’ (Courtney et al., 2009), and ‘Breath Holding Time’ (Courtney & Cohen, 2008).

##### *4.3.1. The Manual Assessment of Respiratory Motion*

The MARM is a physical examination procedure in which examiners assess rib cage motion using palpation. A standardised graphical notation of the examiner’s impression of respiratory motion is used to record findings and from this a numerical value of amount and quality of movement of the rib cage can be derived (Courtney, Cohen, et al., 2011; Courtney et al., 2008). MARM values can range between 0 and 180 (Courtney et al., 2008) and two separate values can be determined. The first is a MARM balance measure, for measuring balance between different areas of rib cage

movement during breathing. The second measure is a MARM percentage of rib cage motion, for evaluating the extent of rib cage motion during breathing (Courtney, Greenwood, et al., 2011). A MARM balance value of 6 is considered to be normal and values over 30 are thought to be dysfunctional (Courtney, Greenwood, et al., 2011). A MARM percentage of rib cage motion value of 56 is considered to be normal and values over 70 are thought to be dysfunctional (Courtney, Greenwood, et al., 2011). A validation study of the MARM was completed where inter-examiner reliability was assessed, and MARM scores were compared to Respiratory Induction Plethysmography measures (Courtney et al., 2008). Respiratory Induction Plethysmography uses an electronic instrument used in research settings for the evaluation of breathing patterns; it involves two fitted motion detecting bands, one around the upper thorax and the other around the upper abdomen (Courtney et al., 2008). These motion detecting bands record measurements of chest expansion, the measurements are then automatically exported to data analysis software (Courtney et al., 2008). Results for the validation study of the MARM indicated that overall inter-examiner agreement using the MARM was good (ICC=0.85; 95% CI 0.78 to 0.89). The authors also reported and that there was a strong and statistically significant correlation between MARM balance and Respiratory Induction Plethysmography values ( $r = 0.597$ ;  $P = 0.01$ ). The correlation between MARM percentage of rib cage motion and Respiratory Induction Plethysmography was much lower ( $r = 0.21$ ;  $P < 0.05$ ) (Courtney et al., 2008). Based on the outcome of this study authors concluded that the MARM is a valid and reliable clinical tool for assessing breathing pattern (Courtney et al., 2008). There has only been one validation study of the MARM. It was conducted on a sample of people mimicking DB patterns, and the correlations between MARM percentage of rib cage motion and Respiratory Induction Plethysmography were weak. Before the MARM can be considered a valid tool for the identification of DB, further investigation should be performed to repeat and improve the validity findings. Performing a validation study in a sample of people with clinically observed DB would be useful.

#### 4.3.2. Hi Lo Breathing Assessment and Breath Holding Time

The Hi Lo Breathing Assessment is both a visual and manual technique used to determine the presence of paradoxical breathing and assess the rate and rhythm of breathing (Courtney et al., 2009). Examiners undertaking Hi Lo palpate the upper chest and the upper abdomen of the patient to qualitatively evaluate the dominance and coordination of the two areas during respiration (Courtney, Cohen, et al., 2011). The Hi Lo Breathing Assessment is considered to be a reasonably accurate measure of a paradoxical breathing pattern. However, patterns of DB other than paradoxical breathing such as abnormal lateral breathing patterns may be missed using this method (Courtney, Cohen, et al., 2011).

Breath holding time is thought to be of shorter duration in people with hyperventilation syndrome or DB patterns and has been used as a measure of DB (Courtney & Cohen, 2008). The results of breath holding time are strongly dependent on how the technique is performed, therefore breath holding time is not reliable unless examiners utilise a standardised protocol.

#### 4.4. *Reliability of Assessment Tools*

Reliability can be defined as “the consistency or repeatability of measurements: the degree to which measurements are error-free, and the degree to which repeated measurements will agree” (Rothstein et al., 1991). High reliability indicates precision of single measurements and ensures better tracking of changes in measurements, either in a research or practical settings (Hopkins, 2000). The two most important aspects of determining measurement error of a tool are thought to be criterion-related validity and test-retest reliability (Hopkins, 2000). In a review of measures of reliability, Hopkins (2000) discusses the three most important types of measures for evaluating reliability, which he believes to be within-subject variation, change in the mean, and test-retest correlation. Within-subject variation is the variability in the test measure for a typical individual undergoing a series of repeated tests and has been suggested to be the most important type of reliability for practitioners wanting to monitor change in clients (Hopkins, 2000). Within-subject variation may be calculated as standard error of measurement (also termed

technical error of measurement or within-subject standard deviation) or as limits of agreement (Bland & Altman, 2010; Hopkins, 2000). In fact, standard error of measurement is proportional to the Bland-Altman statistic used to calculate the limits of agreement (Hopkins, 2001). Hopkins (2000) believes that standard errors of measurement are superior statistics to report in studies of reliability than limits of agreement. In his review and later website articles (Hopkins, 2000, 2001), Hopkins provides two main reasons for this. The first reason is that he believes that standard error of measurement calculations are easier to understand than Bland Altman limits of agreement in that they represent meaningful statistical concepts, i.e, both error in a single measurement or variability in measures obtained from multiple administrations of the test in the same individual. Bland-Altman limits of agreement, in contrast, are often incorrectly misinterpreted as 95% confidence intervals for the difference between two tests, although they are not such. For inferential statistical interpretation, or further statistical calculations, either the confidence intervals for limits of agreement must be calculated, or the limits must be converted to standard errors of measurement. Secondly, Hopkins (2000) believes that the range produced using Bland-Altman limits of agreement is too large for most purposes.

Change in the mean between tests is also a simple yet important measure of reliability (Hopkins, 2000). Test-retest correlations are also important and represent how closely the value of one trial tracks the value of another, and how well the ranking order of participants in one trial is replicated in a second trial (Hopkins, 2000). Hopkins (2000) points out that, whilst test-retest correlation is a very useful statistic to report in the evaluation of reliability, it is sensitive to the spread of values between participants and should thus be reported in conjunction with standard error of measurement and changes in the mean between tests. Intraclass Correlation Coefficient (ICC) is deemed an appropriate statistic to represent the correlation between two trials (Hopkins, 2000).

In summary, reliability testing is an essential part of the development of any tool. Manual techniques such as MARM (Courtney et al., 2008), Hi Lo Breathing Assessment (Courtney et al., 2009) and Breath Holding Time (Courtney & Cohen, 2008) require more time to perform than a questionnaire, therefore making a

questionnaire potentially, a more practical tool for the routine clinical detection and measurement of DB. Many of the questionnaires explored in this review may not be suitable assessment tools for the detection of DB. The SEBQ could be considered to be the most specific and clinically applicable tool for assessing DB. Although the revised version of the SEBQ has been developed specifically for the assessment of DB from a wide range of sources and has had a thorough preliminary investigation, to date, no reliability study of the SEBQ has been performed.

## **5. Potential Predictors of SEBQ Score**

There are currently no published data about the correlates or predictors of the SEBQ score. However, many lifestyle and demographic variables are thought to be affected by, or have influence over, breathing and therefore it would follow that they may affect SEBQ score. Dysfunctional breathing is potentially associated with a range of variables including age, gender, physical activity level, Body Mass Index (BMI), current smoking, occupation type, cardiovascular or respiratory disease, or recent respiratory illness.

### *5.1. Age and Gender*

There is currently no literature to suggest that either age or gender may correlate with DB. There is, however, evidence to suggest that gender has an association with the presence of psychological issues including anxiety and depression, with the prevalence being higher in females than males (Penninx et al., 2011). Anxiety is known to have a strong influence over breathing patterns and the presence of hyperventilation syndrome (Han, Schepers, Stegen, Van den Bergh, & Van de Woestijne, 2000; Han et al., 2004; Lum, 1987). Therefore, the association between gender and DB should be investigated.

### *5.2. Physical Activity and Obesity*

Previous studies have linked both low physical activity level and obesity with an increased risk of development of respiratory conditions such as asthma (Kilpelainen, Terho, Helenius, & Koskenvuo, 2006), obstructive sleep apnoea and obesity

hypoventilation syndrome (Murugan & Sharma, 2008). One crude measure of obesity is body mass index (BMI) which combines height and weight in a single metric and allows comparison to normative data. Using BMI, individuals are classified as underweight, normal, overweight, obese or morbidly obese (Murugan & Sharma, 2008). Physical activity level and obesity have been recognised to be highly inversely correlated, when one increases the other decreases and *vice versa* (Keim, Blanton, & Kretsch, 2004; Schoenborn & Stommel, 2011). Due to the correlations of physical activity level and obesity with respiratory conditions, it is possible that these two variables are also associated with the presence of DB. Occupation strongly influences the activity level of adults and certain occupations may therefore be linked to DB prevalence or severity (Keim et al., 2004).

### 5.3. *Smoking and Respiratory Conditions*

Smoking has a potent influence over the respiratory system, and is a strong risk factor for chronic respiratory conditions including COPD (Urrutia et al., 2005), chronic bronchitis, and emphysema (Vukovic, Nagorni-Obradovic, & Vukovic, 2010). Therefore, it would be unsurprising if smoking was also seen to be linked to the prevalence of breathing dysfunction. People with structural or pathological breathing problems are thought to be more at risk of developing DB patterns (M. Thomas, 2003). Several previous studies that investigate correlation between asthma and DB have been undertaken. The studies concluded that hyperventilation syndrome is more common in asthmatics than in non-asthmatic, and that hyperventilation syndrome may worsen asthma symptoms (Stanton et al., 2008; M. Thomas, 2003; M. Thomas et al., 2001; M. Thomas, McKinley, Freeman, Foy, & Price, 2005). Due to the strength of the correlations found between DB and respiratory conditions, respiratory conditions may also influence SEBQ scores. Cardiovascular problems are known to manifest with breathing difficulties, therefore, cardiovascular problems may influence DB patterns (Longmore, Wilkinson, Turmezei, & Cheung, 2007).

## **6. Conclusions**

Respiration is essential for all processes occurring within the body. Dysfunctional breathing appears to be common and may have a range of mild to severe adverse effects on the health of an individual. There is currently no validated tool for the diagnosis or measure of severity of the broader definition of DB that has recently been described. The SEBQ is a new tool that aims to assess the broader range of DB signs and symptoms that have recently been acknowledged. The SEBQ can be considered the most relevant and clinically applicable tool for the assessment of signs and symptoms of DB. To date no previous validation studies or investigations into the correlates or potential predictors of the SEBQ have been reported. A study determining the test-retest reliability, the correlates, and the potential predictors of SEBQ score is relevant and will provide the first essential step towards the validation process of the SEBQ. Section two of this thesis reports an investigation which aims to: determine the test-retest reliability of the SEBQ; and to investigate potential lifestyle or demographic variables that may be associated with, or may predict, SEBQ scores.

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## **Section 2: Manuscript**

# Test-Retest Reliability and Determinants of the Self Evaluation of Breathing Questionnaire (SEBQ): A Measure of Dysfunctional Breathing

Note:

This manuscript has been prepared in accordance with the Guide for Authors for the journal *Physiotherapy* [See Appendix B for Instruction for Authors]. For the purposes of completion of this thesis some guidelines from *Physiotherapy* have not been followed. The instructions suggest headings for a structured abstract that seem applicable mainly to clinical trials. In this manuscript, the suggested headings have been replaced with more conventional headings. Also, the instructions require a 3000 word count limit and a maximum of 40 references. These limits have been exceeded here to allow full and evaluative discussion of the results in this thesis.

## 1. Abstract

**Background:** Dysfunctional breathing (DB) is characterised by an abnormal breathing pattern leading to respiratory symptoms. However, DB is not currently well defined and has no criterion measure. The Self Evaluation of Breathing Questionnaire (SEBQ) has been recently developed to measure DB symptoms and their severity but lacks thorough evaluation. **Objectives:** To determine the test-retest reliability and to identify lifestyle or demographic predictors of SEBQ score. **Method:** A heterogeneous sample of participants (n=180) completed the SEBQ and lifestyle and demographic questions. Two weeks later, 156 participants completed the SEBQ and lifestyle questions again. **Results:** Test-retest correlation of the SEBQ was high (ICC=0.88; 95% CI 0.84 to 0.91). There was no difference in SEBQ score between test and retest ( $15.4 \pm 11.6$  versus  $14.7 \pm 12.4$ ; CI for difference -0.6 to 1.2;  $P = 0.53$ ) and had a standard error of measurement of 4.1. Variables found to be independently related to SEBQ score in a regression analysis included smoking status ( $P = 0.005$ ), reported respiratory disease ( $P \leq 0.001$ ) and recent respiratory illness ( $P = 0.04$ ). Multiple regression models included these three variables and female gender as predictors of SEBQ score which together explained 25.6% of variability in SEBQ scores ( $P \leq 0.001$ ). **Conclusions:** The SEBQ has high test-retest reliability. SEBQ scores may be predicted by current smoking, chronic respiratory disease, recent respiratory illness and female gender. Further studies to further validate the SEBQ are required. If shown to be valid, the SEBQ could be a useful clinical screening tool for early detection of DB.

**Keywords:** Dysfunctional breathing, Breathing symptom questionnaire, Test-retest reliability, Dysfunctional breathing determinants.

## 2. Introduction

Until recently, hyperventilation syndrome with the presence of hypocapnia was considered the only form of dysfunctional breathing (DB). However, it has recently been acknowledged that a broader definition is required as DB related symptoms and abnormal breathing patterns can occur with normal carbon dioxide levels in the body [1-3]. Current definitions of DB remain unclear. DB is a term that has recently been applied to a range of associated signs and symptoms that often occur together and may have a range of underlying causes. Dysfunctional breathing is thought to have several contributing causative factors arising from biomechanical, biochemical and psychophysiological influences [4]. In practice, DB may result in breathing which is either inefficient or inappropriate for the needs of the individual at the time [5]. It has been estimated that DB affects approximately 5-11% of the general population, 30% of asthmatics and up to 83% of anxiety sufferers [5-7]. Dysfunctional breathing is thought to be associated with many common conditions, such as asthma [3, 7, 8], cardiovascular disease [4, 9], myofascial pain syndromes [5, 10, 11], temporomandibular joint disorders [10], altered spinal stability, headaches and migraines [5, 10].

In the past DB has been imprecisely characterised as 'hyperventilation syndrome' therefore, no validated method exists for its assessment. In clinical practice DB may be identified using manual techniques such as the Manual Assessment of Respiratory Motion [12], the Hi Lo Breathing Assessment [13], and Breath Holding Time [1]. Clinical observations and symptom identifying questionnaires, such as the Self Evaluation of Breathing questionnaire (SEBQ) [2], or the Nijmegen Questionnaire [14, 15] are also used in clinical practice for identifying DB. The only validated questionnaire currently available for the measurement of symptoms of DB is the Nijmegen Questionnaire, which has been validated only for detection of hyperventilation syndrome [14, 15]. The Nijmegen Questionnaire has been validated by comparing the scores of participants who have been diagnosed via laboratory findings of hypocapnia with hyperventilation syndrome, against participants without hyperventilation syndrome [14]. The Nijmegen Questionnaire includes items about

psychological, neurological and cardiovascular symptoms, but contains only four items specifically related to breathing [2]. A recent study that compared results of the Nijmegen Questionnaire to those of the Manual Assessment of Respiratory Motion on DB patients, showed that breathing items and some items related to the 'feeling of tension' on the Nijmegen Questionnaire were related to DB patterns, but that the remaining 9 items were not [4].

The SEBQ was developed in response to a need for a comprehensive screening tool to identify potential indicators of DB [2]. The SEBQ includes items related to breathing drawn from a wide variety of sources, in an aim to cover the broader signs and symptoms of DB that have now been acknowledged [2]. Sources used for the development of the SEBQ include published studies by Burton [16] and Howell [17], who both proposed symptoms of DB and other literature in the field that describes psychological and physiological aspects of breathing symptoms [18, 19]. Other sources for SEBQ development included the clinical experience of the development team [2], and an online questionnaire [20]. Each SEBQ item was supported by at least two of these sources in order to be included in the questionnaire and preliminary investigations have been performed, resulting in a revised 25 item version of the SEBQ [see Appendix A] [2]. To date no previous reliability studies or investigations into the correlates or potential predictors of the SEBQ have been reported. A study determining the test-retest reliability, the correlates, and the potential predictors of SEBQ score is required and will provide an essential step towards validating the SEBQ.

The aims of this study were to: 1) determine test-retest reliability of the SEBQ as a measure of dysfunctional breathing; and, 2) identify determinants of SEBQ scores, and examine their relationship with demographic and lifestyle variables.

### **3. Methods**

#### *3.1. Study Sample*

Participants were recruited using convenience sampling through an online service that offers strategic online and social marketing assistance for study promotion and recruitment (<http://www.getparticipants.com>). All participants were required to be over 18 years and able to read and understand English. Exclusion criteria were planning major lifestyle changes during the 2-week duration of data collection (e.g., cessation of smoking, major changes to physical activity level or diet); and known disease or illness entailing incapacitation or considerable periods of bed rest. Prospective participants read information on the site about the study [see Appendix C], registered their interest, supplied their email address and then were emailed a link to a questionnaire hosted online (<http://www.surveymonkey.com>). The study was approved by the Unitec Research Ethics Committee (Approval number: 2010-1089) [see Appendix D].

#### *3.2. Data Collection*

Test-retest reliability of the SEBQ was assessed using measures recorded at a 14-day interval. Participants were asked to complete the two questionnaires at a 14-day interval on the same day of the week and as close to the same time of day as possible [see Appendices E and F]. SEBQ items were randomised for the retest in an attempt to minimise recall bias. In addition to the 25-item SEBQ, both questionnaires comprised lifestyle, demographic and health questions. Physical activity and smoking were assessed using questions adapted from the validated Life in New Zealand Survey [21, 22]. Other lifestyle, demographic and health variables were assessed using questions designed and trialled prior to recruitment. Occupational classifications were based on those established by Statistics New Zealand [23]. Physical activity level was estimated using validated energy expenditure tables for activities reported by participants in their questionnaire answers [24].

### 3.3. Data Analysis

Test-retest reliability was assessed by calculating the Intraclass Correlation Coefficient (ICC) and interpreted according to the descriptors of effect size suggested by Hopkins [25]. As recommended by Hopkins [26], bias between test and retest applications of the questionnaire was determined using paired t-tests and standard errors of measurement (proportional to Bland-Altman Limits of Agreement [27]) were also reported. Uniformity of error was assessed by visual inspection of a plot of the change in SEBQ score over the average SEBQ score [25].

Cross-sectional univariate relationships with the SEBQ score obtained from the first questionnaire were investigated using t-tests for dichotomous variables (gender, occupation type, smoking and reported cardiovascular and respiratory disease status and presence of respiratory illness within 2 weeks prior to the study) and Pearson's  $r$  for continuous variables (age, BMI, and physical activity level). First questionnaire responses (Test 1) were used both to determine univariate relationships, and in the regression analysis, as very few lifestyle changes were reported by participants between tests and appeared to have minimal influence over SEBQ scores.

Both dichotomous and continuous variables were entered as potential predictors of SEBQ score into a backward stepwise regression model using a level of significance for removal from the model of  $P \geq 0.05$ , and  $P < 0.05$  for retention. As suggested by Field, regression statistics were reported from a subsequent model that forced entry of all variables retained during backward regression [28]. Responses to individual SEBQ items, from first questionnaire responses were inspected for variability, or lack thereof, using descriptive statistics. All data were analysed using SPSS v18 (IBM Corp., NY). Data are expressed as mean  $\pm$  SD unless otherwise stated.

## 4. Results

A total of 180 participants were recruited for this study: three participants completed only demographic details and the SEBQ questionnaire itself, but did not provide lifestyle information for the original questionnaire. A total of 156 participants, 86.7% of the original sample, completed the follow-up questionnaire and retest SEBQ. Baseline characteristics for all participants are outlined in Table 1.

### 4.1. Test-Retest Reliability

The difference in SEBQ score from test to retest did not vary as a function of the magnitude of SEBQ (data not shown) [see Appendix G]. The Intraclass Correlation Coefficient of agreement for test-retest SEBQ scores indicated a high level of correlation between tests (ICC=0.88; 95% CI=0.84 to 0.91). There was no difference in SEBQ score between test and retest (SEBQ Test 1 =  $15.4 \pm 11.6$  compared to SEBQ at Test 2 =  $14.7 \pm 12.4$ ; 95% CI for the difference -0.6 to 1.2;  $P = 0.53$ ) (Figure 1). Standard error of measurement of SEBQ score was 4.1.

### 4.2. Baseline Univariate Data Analysis

Dichotomous variables that produced statistically significant differences in mean SEBQ scores were current smoking status ( $P = 0.005$ ); reported respiratory disease ( $P \leq 0.001$ ); and reported respiratory illness in the two weeks prior to the study (respiratory illness) ( $P = 0.04$ ). Reported cardiovascular disease, female gender and active occupation did not result in statistically significant differences in mean SEBQ scores; differences in the means for all variables are outlined in Table 2. Although BMI was weakly correlated with age ( $r = 0.163$ ;  $P = 0.030$ ) and physical activity level ( $r = 0.159$ ;  $P = 0.034$ ), none of these, or other demographic variables were related to SEBQ score (Table 3).

A total of 34 smokers participated in the study, 14 of these participants also reported having respiratory disease or illness. All participants with the presence of respiratory disease or illness were removed from the analysis to determine if smoking without the presence of respiratory problems influenced mean SEBQ score. Smoking without

the presence of respiratory disease or illness still produced statistically significant differences in mean SEBQ scores ( $P = 0.01$ ) (Table 2).

Frequency distributions are displayed for SEBQ score in the overall sample (Figure 2) and in asthmatics (Figure 3). The prevalence of DB has been estimated to be 5-11% of the general population; up to 30% of asthmatics and up to 83% of anxiety sufferers [5-7]. Specific statistics could not be calculated from the current data as there is not yet a specific SEBQ score that indicates an individual is a 'dysfunctional breather'. Figure 2, however, shows frequency distribution in the overall sample is slightly positively skewed (skewness= 1.5; 95% CI 1.1 to 1.9) compared to asthmatics (skewness= 1.3; 95% CI 0.5 to 2.1) (Figure 3) thus implying that there is a lower average SEBQ score in the overall sample than the asthmatic population.

#### 4.3. *Regression Model*

Predictor variables entered into the model included BMI, gender, age, physical activity level, smoking, occupational activity level, presence of cardiovascular disease, presence of respiratory disease, and presence of respiratory illness within two weeks prior to the study. Variables retained in the backwards regression model all positively predicted baseline SEBQ score and were; female gender, current smoking, reported respiratory disease, and presence of respiratory illness in the last two weeks. Cumulatively, these explained 25.6% of the variability in SEBQ scores ( $P \leq 0.001$ ). The same results were found when the entry method for the regression was 'forced' into a subsequent model.

In order to determine if any of the potential predictors had more influence in a population without respiratory complaints, the regression analysis was repeated, this time removing all participants with known respiratory problems. In this analysis the only predictor of SEBQ score remaining in the model was current smoking which explained 15.6% of variability in SEBQ scores ( $P \leq 0.001$ ).

#### 4.4. *Individual Item Analysis*

Particular symptoms from the 25-item SEBQ questionnaire were more commonly reported than others. Table 4 lists individual items in order of prevalence; details

the sum of total scores for each item; and shows the mean SEBQ score for participants who reported having some degree of the described symptom by scoring themselves  $\geq 1$  on the item. Items with a high response rate (number of positive answers and higher sum of scores) have a lower average SEBQ score for individuals with a positive response to this item and *vice versa*.

## 5. Discussion

Prior to this study there had been no research conducted investigating the reliability of the SEBQ as a measure of dysfunctional breathing. This research set out to determine the test-retest reliability and identify determinants of SEBQ score and has shown that the SEBQ has a high level of agreement in a sample drawn from a general population. Therefore, the SEBQ can be considered a reliable tool and data here contribute evidence towards validation of this instrument.

At present, it is difficult to evaluate the validity of any item relating to DB as there is neither a set definition of DB nor an established criterion measure for it.

Dysfunctional breathing has however been recognised in a clinical setting for many years and is considered to be a significant contributing factor to many conditions seen by healthcare practitioners [5]. Dysfunctional breathing has the potential to considerably lower quality of life for individuals experiencing its symptoms [29].

Dysfunctional breathing is thought to be associated with musculoskeletal conditions such as headaches [5, 30], temporomandibular joint pain [10], neck, shoulder, thorax and lower back pain [5, 11], and non-musculoskeletal conditions such as chronic fatigue [11], anxiety and depression [31], hypertension, irritable bowel syndrome, and hypersensitivity to pain [11]. Dysfunctional breathing is important clinically and, therefore, a valid, easy-to-use tool for its identification may be beneficial to help increase detection and encourage appropriate management such as breathing retraining.

Breathing retraining may involve a practitioner providing education about ideal breathing, and breathing exercises to a patient in an aim to improve the

physiological function of a person's breathing mechanics. Breathing retraining has been shown in previous studies to decrease the disabling affects of DB on the conditions stated above [11, 29, 32, 33]. A recent study conducted in Sweden examined the long-term effects of an individualised breathing retraining program on DB participants as compared to asthmatic participants with no intervention [32]. Participants at a 5-year follow up who had received the breathing retraining program had improved physical function health-related quality of life, had fewer breathing problems with every day activities and fewer emergency room visits compared to baseline and participants who did not receive the intervention [32]. The Swedish study [32] highlights the potential usefulness of an instrument for the early detection of DB, which may then lead to appropriate management.

### 5.1. *Predictors of SEBQ Score*

The current cross-sectional analysis revealed that few lifestyle and demographic variables were predictive of SEBQ scores. Unexpectedly, only three variables were found to produce significant differences in mean SEBQ score, including current smoking; the presence of chronic respiratory disease (respiratory disease); and participants reporting a history of respiratory illness within two weeks prior to the study (respiratory illness). These three variables, together with female gender were found to be predictors of SEBQ score. When all participants with respiratory problems were removed, the only variable that still influenced SEBQ score was smoking.

#### 5.1.1. Smoking

In the current study, participants who currently smoked scored, on average, 51% higher on the SEBQ than those who didn't smoke. Smoking has a potent influence on the respiratory system and is known to be a leading risk factor in respiratory diseases such as chronic obstructive pulmonary disease (COPD) [34], chronic bronchitis, and emphysema [35]. It is therefore unsurprising that smoking was found to be an important determinant of DB. When smokers who reported either having been diagnosed either with a chronic respiratory disease or had recently experienced an acute respiratory infection were removed from analysis smoking still

influenced SEBQ score. For people without respiratory problems smokers, on average, scored 90% higher than non-smokers on the SEBQ.

The mechanisms by which smoking might influence breathing symptoms and/or patterns, in the absence of detectable pathologies are unclear, however a number of theories have been investigated. There is evidence to suggest that smoking may alter the responsiveness of the respiratory centres to carbon dioxide levels [36]. A previous study measured respiratory centre regulation in non-smokers and in smokers without known disease [36]. In this study, measurements were made of mouth occlusion pressure during carbon dioxide (a respiratory stimulant) rebreathing and passive tilt from supine to standing; passive tilt is thought to increase ventilation volume in healthy individuals [36]. A reduced respiratory response to carbon dioxide stimulation and no increase in ventilation volume from supine to standing was reported in smokers [36]. This decreased respiratory drive in smokers may be one reason for the higher DB symptom scores observed in the current study.

It has also been shown that smoking in individuals without known disease may result in respiratory tract inflammation [37]. The presence of inflammatory cells in both the sputum and tissue biopsy have been observed in healthy smokers as compared to non-smokers [37]. Healthy smokers, however, have significantly less inflammatory mediators than symptomatic smokers (cough or sputum production) or smokers with respiratory disease [37]. There is a strong positive correlation between the number of cigarettes smoked per day and lung function, as measured in participants by forced expiratory volume in one second (FEV1) and forced vital capacity (FVC) [34]. The higher number of cigarettes participants smoke the more impaired their lung function and lung volume [34]. It is possible that decreased lung volumes and mild inflammatory processes occurring in the airways of healthy smokers may result in mild respiratory symptoms that manifest as DB and are therefore being detected by the SEBQ.

### 5.1.2. Respiratory Conditions

In the current study participants with reported respiratory disease scored, on average, 69% higher on SEBQ than those without. Participants with acute respiratory infection scored, on average, 29% higher on SEBQ than those without. It was anticipated that participants with diagnosed respiratory conditions or acute respiratory infections would have higher SEBQ scores than those without these conditions, as some of the symptoms of DB may result from respiratory pathology or infection. There are several studies that suggest that DB, when it was previously defined as hyperventilation syndrome, was prevalent in people with respiratory disease, particular asthma [3, 7, 8, 38]. It has been shown that hyperventilation syndrome is common in people with asthma, and is associated with more severe asthma symptoms [3, 7, 8, 38]. Asthma was specifically examined in the current study with the use of frequency distributions (Figure 2 and 3) that show that in this sample mean SEBQ score was slightly higher in the subgroup with asthma compared to the overall sample. Some symptoms of hyperventilation with hypocapnia, may overlap with symptoms of DB patterns [4]. In a recent study the Manual Assessment of Respiratory Motion (MARM) was used as a measure of DB in participants with medically unexplained dyspnea; MARM results were then compared to results of the Nijmegen Questionnaire for symptoms of hyperventilation syndrome to determine correlating factors [4]. Nijmegen Questionnaire items were grouped into four symptom factors 'dyspnea', 'peripheral', 'central' and 'tension' [4]. Participants with DB as measured by the MARM, were reported to have symptoms that related to 2 out of the 4 factors on the Nijmegen Questionnaire; including 'dyspnoea' and 'tension' [4]. On the basis of relating respiratory diseases to hyperventilation syndrome, and the relationships between symptoms of DB and hyperventilation syndrome; the association between respiratory issues and SEBQ score was expected.

### 5.1.3. Gender

Regression analysis in this study showed that female gender may predict higher SEBQ score. The reason for this association is unclear from these data. However, one explanation may be that male gender was underrepresented in the study sample.

Another possible reason for the association between female gender and DB may be due to the higher prevalence of anxiety and depression in females [39]. Anxiety is known to have a strong influence over breathing pattern and the prevalence of hyperventilation syndrome and DB patterns are also likely to be more prevalent in people with anxiety [40-42]. Psychological indices such as stress, distress, depression and anxiety were not measured in the current study and future investigation of links between psychological state and DB would be useful.

## *5.2. Variables Unrelated to SEBQ Score*

The very low correlation found between physical activity levels, BMI, age, occupation, and reported cardiovascular problems with SEBQ score was unexpected, but supports the possibility that DB affects a wide range of people and that lifestyle factors have little influence. No previous studies could be found investigating correlations between age and DB; age was found to have a low correlation with SEBQ score in the current study.

### *5.2.1. Physical Activity and BMI*

In previous studies physical activity level has been shown to be related to respiratory disease; those who are less active have an increased likelihood of developing diseases such as chronic bronchitis, emphysema and asthma [35, 43]. Activity, estimated in the current study as self-reported cumulative energy expenditure in regular physical activities, was not a predictor of SEBQ score. The reason for this lack of relationship between physical activity and SEBQ score is unknown; the accuracy of self-reports of physical activity are questionable [44]. The only variable that correlated with physical activity level was Body Mass Index (BMI) and it is well established that regular physical activity is associated with a lower BMI [45]. In this study there was a weak positive correlation between physical activity level and BMI leading to paradoxical findings; participants with a higher physical activity level tended to have a higher BMI and *vice versa*. The reason for this paradoxical finding is unclear, although, may be attributed to BMI being a poor measure of healthy body composition [46]. There is evidence to suggest that obesity influences breathing pattern, respiratory drive and gas exchange [47], however, in the current study BMI

was poorly correlated with SEBQ score. BMI is not an accurate measure of body composition [46] and further investigation into the relationship between obesity and DB should utilise accurate measures of body composition.

### 5.2.2. Occupation

In this investigation, occupation type was weakly correlated with SEBQ score. Occupations were classified according to activity level without other possible influences being taken into account. Since physical activity level was weakly correlated with SEBQ score, it follows that occupational activity level would also have a weak correlation. There is evidence to suggest that psychosocial occupational stressors may influence breathing patterns [48]. Future studies could usefully assess the relationship between DB and other characteristics of occupation not considered here such as occupational stressors.

### 5.2.3. Cardiovascular Problems

Based on the weak correlation between SEBQ score and presence of self-reported cardiovascular problems it could be that SEBQ discriminates between cardiovascular symptoms and DB; despite the observation that cardiovascular problems can manifest with breathing difficulties [49]. The Nijmegen Questionnaire for assessment of hyperventilation syndrome contains items that relate to cardiovascular symptoms, for example chest pain, tingling fingers and cold hands or feet [4, 14]. These cardiovascular symptom items have been seen to be to only relate to hyperventilation syndrome with presence of hypocapnia, and not DB with normal carbon dioxide levels [4].

## 5.3. *Limitations of the Study*

In this study one retest was performed; it is possible that a larger number of re-tests may provide a more accurate indicator of the reproducibility of the SEBQ [25]. The re-test timeframe may have also influenced results, a two week period was selected in an attempt to minimise errors caused by seasonal change that may influence participants' respiratory function. Participants were asked to complete the test and re-test questionnaires on the same day of the week and approximately the same

time of day, the assumption being that majority of participants would have a similar routine week to week and therefore, decreasing the chance of participants performing a different activity between questionnaires that may change their breathing symptoms. A longer period between retests may have further decreased the likelihood of bias of participants remembering previous answers.

Another possible limitation of this study is recruitment bias. Inclusion and exclusion criteria here were designed to recruit a heterogeneous population. However, the method of recruitment may have led to participants being similar in lifestyle choices and demographics. Some subgroups of the general population may have been inadequately represented and reliability may be different in another demographic group.

#### *5.4. Further research*

Dysfunctional breathing is challenging to research as there is currently little consensus surrounding its definition and optimal measurement. There is currently no standardised protocol for quantification of DB and this presents difficulties for further validation studies of the SEBQ. Construct validity of the SEBQ could be investigated by comparison of SEBQ scores of participants with DB against MARM results. Once validation studies of the SEBQ have been performed, future studies may use the SEBQ as a clinical measure of the effects healthcare modalities have on the symptoms of DB. The SEBQ may also be used in future for more clearly determining co-morbidities of DB.

In order for the SEBQ to become a clinically applicable tool for the assessment of DB, normative values need to be established for classifying DB into categories such as mild, moderate, and severe DB. A possible way to establish normative values of the SEBQ could be by testing the SEBQ on specific sample populations; for example testing a healthy group, a group with diagnosed DB, a group with medically unexplained dyspnea and a group with diagnosed cardiorespiratory disease and analysing the different scores.

The current study found a low level of variance amongst the lifestyle and demographic variables used as potential predictors of SEBQ score. Further studies may investigate a wider range of potential predictors of SEBQ score and if more potential predictors can be identified this may allow for the development of clinical prediction rules for the prediction of SEBQ scores, and therefore dysfunctional breathers.

## **6. Conclusions**

The Self Evaluation of Breathing Questionnaire has been shown to have high test-retest reliability in a heterogeneous sample. The presence of chronic respiratory disease, respiratory illness in the last two weeks and current smoking were independently associated with SEBQ scores. These three variables together with female gender may be predictors of SEBQ score and therefore dysfunctional breathing. Further studies determining validity of the SEBQ are now warranted.

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## 8. Tables

**Table 1.** Participant characteristics at baseline

	Female	Male	Total
n	133	47	180
SEBQ	16 ± 11	12 ± 8	15 ± 12
BMI (kg/m <sup>2</sup> )	28 ± 8	30 ± 6	29 ± 7
Age (years)	39 ± 14	39 ± 16	39 ± 14
Physical activity (MJ/week)	17 ± 17	22 ± 16	18 ± 16
Frequency (%)			
Smokers	21	13	19
Reported cardiovascular disease	10	17	12
Reported respiratory disease	28	26	27
Reported respiratory illness last 2 weeks	25	24	24
Occupation Type			
Active occupation	61	52	59
Sedentary occupation	31	39	33
Invalid/Retired	8	9	8

Data are mean ± SD except for those reported as percentage of respondents.

**Table 2.** Mean SEBQ scores with presence or absence of lifestyle, demographic and health variables.

Predictor Variables	Present variable	Absent variable	<i>P</i> value
Respiratory disease	22 ± 4	13 ± 2	0.001
Current smoking	22 ± 5	14 ± 2	0.005
Current smoking without respiratory problems*	19 ± 6	10 ± 2	0.01
Acute respiratory infection	18 ± 4	14 ± 2	0.04
Cardiovascular disease	15 ± 5	16 ± 2	0.92
Female gender	16 ± 2	14 ± 4	0.54
Active occupation	16 ± 2	14 ± 3	0.47

Data are mean ± 95% CI

\* Respiratory problems include both respiratory disease and acute respiratory infection

**Table 3.** Correlations of continuous lifestyle, demographic and health variables with SEBQ.

Predictor Variables	Pearson's r	<i>P</i> value
Age	-0.06	0.4
BMI	0.12	0.1
Physical activity	0.03	0.7

**Table 4.** Individual item analysis, ordered according to number of positive answers for each item.

Item	n Positive answers	Sum of scores	Mean $\pm$ SD*
I notice myself yawning (Q5)	162	253	17 $\pm$ 12
I breathe through my mouth at night while I sleep (Q25)	139	247	17 $\pm$ 12
I notice myself sighing (Q4)	129	177	18 $\pm$ 12
I get easily breathless out of proportion to my fitness (Q1)	126	172	19 $\pm$ 12
I notice myself breathing shallowly (Q2)	116	153	20 $\pm$ 12
I find myself breathing through my mouth during the day (Q24)	107	188	19 $\pm$ 12
I get breathless when I am anxious (Q11)	106	157	20 $\pm$ 12
I feel I cannot get a deep or satisfying breath (Q6)	92	120	22 $\pm$ 12
My breath feels like it does not go in all the way (Q18)	86	123	22 $\pm$ 12
I feel breathless in association with other physical symptoms (Q13)	84	108	22 $\pm$ 12
I find myself holding my breath (Q12)	79	101	20 $\pm$ 12
I notice that I am breathing irregularly (Q7)	77	102	24 $\pm$ 12
I notice that I am breathing quickly (Q10)	76	88	23 $\pm$ 13
My breathing feels stuck or restricted (Q8)	70	89	25 $\pm$ 12
I feel that the air is stuffy, as if not enough air in the room (Q16)	67	89	22 $\pm$ 13
My breath feels like it does not go out all the way (Q19)	65	83	24 $\pm$ 12
My breathing is heavy (Q20)	60	81	26 $\pm$ 12
My breathing requires effort (Q23)	58	70	26 $\pm$ 12
I feel that I am breathing more (Q21)	56	64	26 $\pm$ 12
My breathing requires work (Q22)	55	71	26 $\pm$ 13
My rib cage feels tight and can't expand (Q9)	55	67	27 $\pm$ 12
I have trouble coordinating my breathing when I am speaking (Q14)	42	50	26 $\pm$ 14
I can't catch my breath (Q15)	40	49	27 $\pm$ 14
I get short of breath reading and talking (Q3)	37	46	30 $\pm$ 14
I get breathless even when I am resting (Q17)	23	29	31 $\pm$ 15

\*Average SEBQ  $\pm$  SD for all participants who scored  $\geq 1$  on that item.

Correlation coefficient (Mean SEBQ & sum of scores)  $r = -0.91$

Correlation coefficient (Mean SEBQ & N positive answers)  $r = -0.94$

## 9. Figures

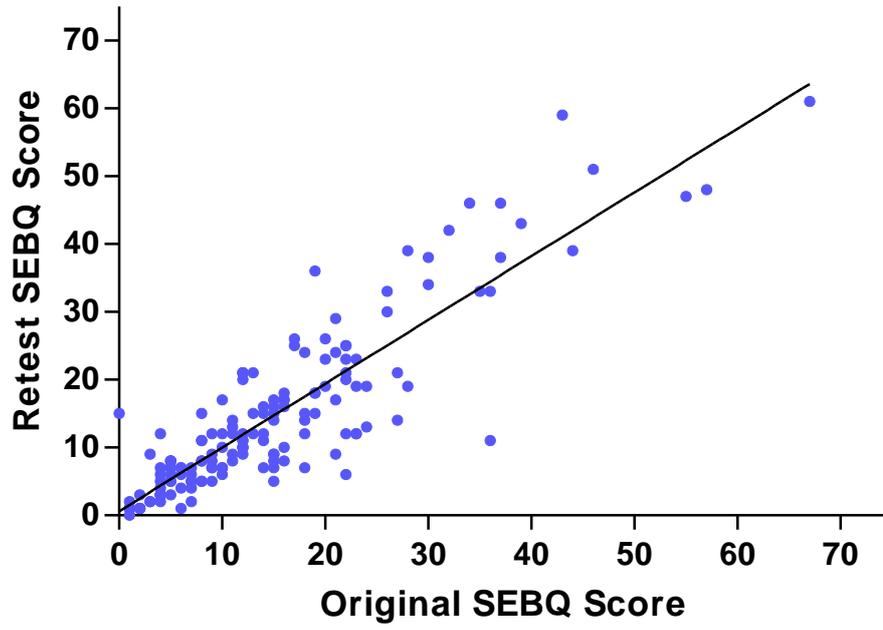
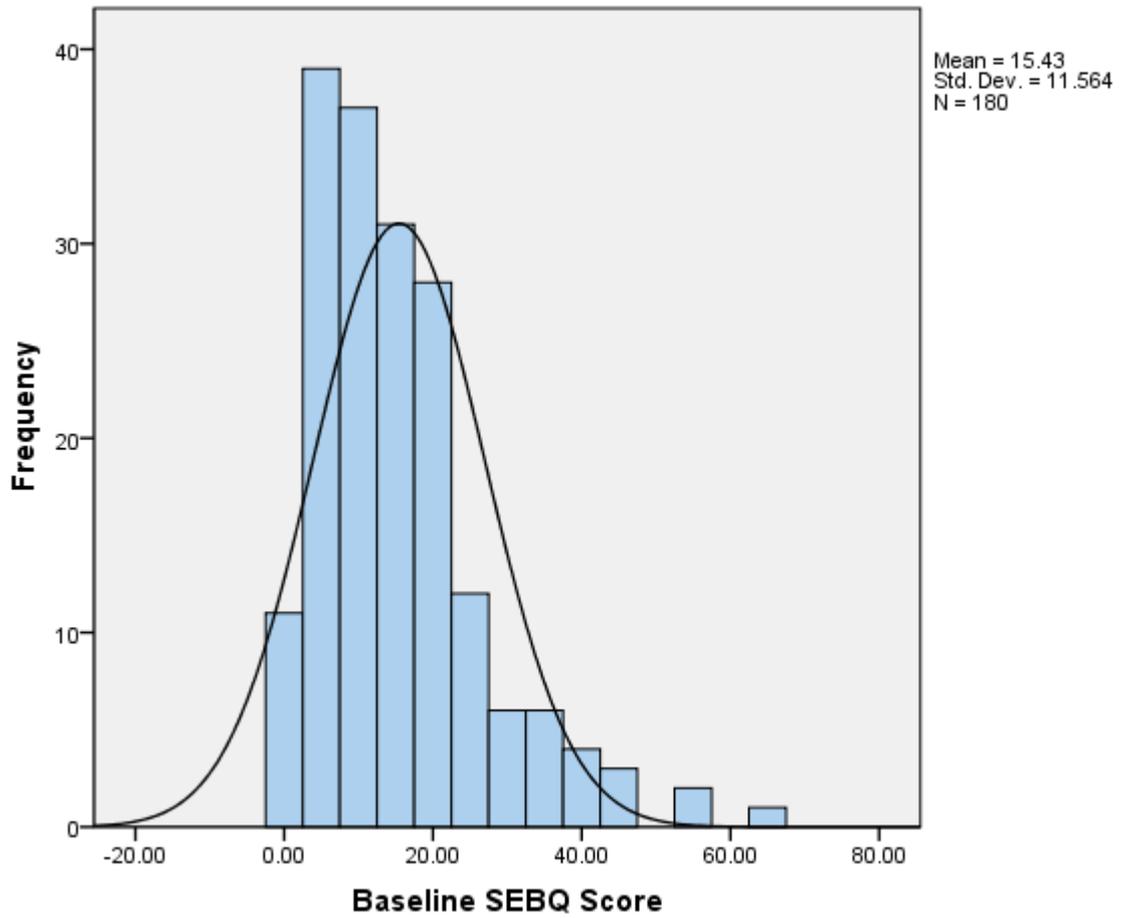
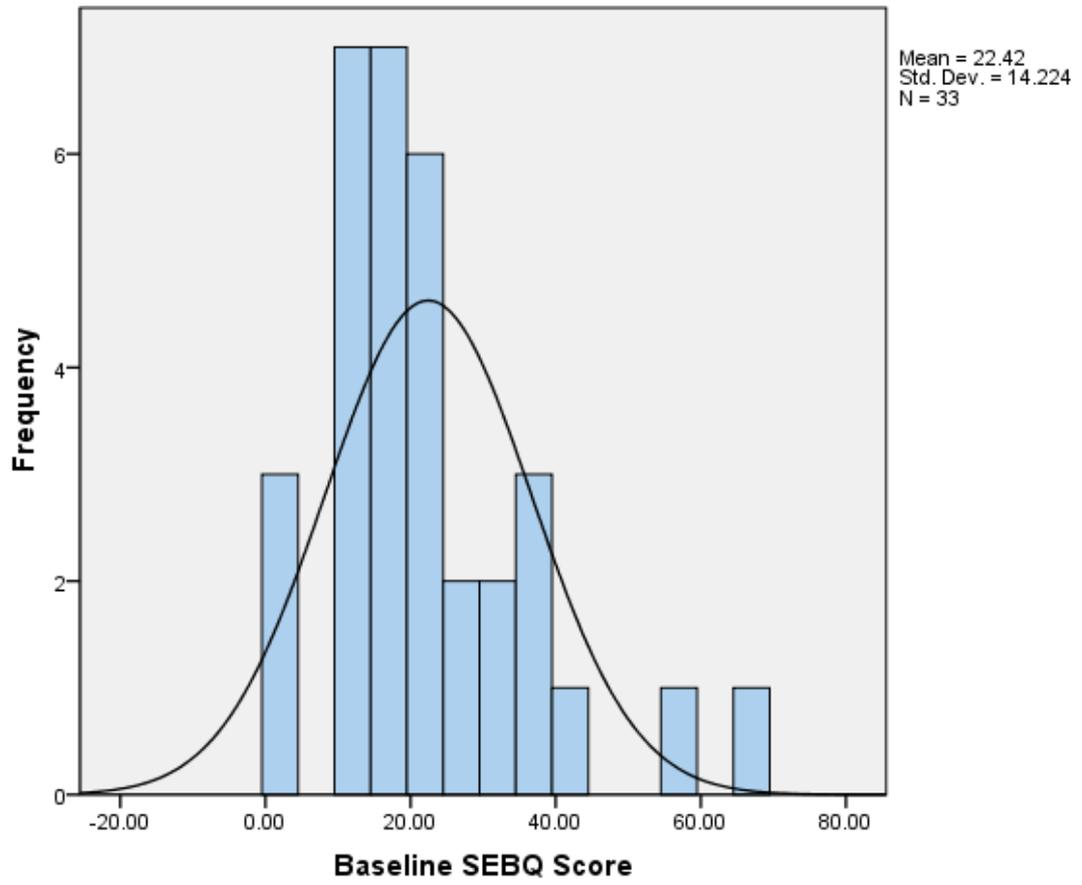


Figure 1. Test-retest reliability scatter plot.



**Figure 2.** Frequency distributions of SEBQ score in overall sample.



**Figure 3.** Frequency distributions of SEBQ score in asthmatic sample.

## **Section 3: Appendices**

**Appendix A: The Self Evaluation of Breathing Questionnaire  
(SEBQ)**

## The Self Evaluation of Breathing Questionnaire (SEBQ): Version 2

Scoring this questionnaire: (0) never/not true at all; (1) occasionally/a bit true; (2) frequently/mostly true; and, (3) very frequently/very true

1. I get easily breathless out of proportion to my fitness
2. I notice myself breathing shallowly
3. I get short of breath reading and talking
4. I notice myself sighing
5. I notice myself yawning
6. I feel I cannot get a deep or satisfying breath
7. I notice that I am breathing irregularly
8. My breathing feels stuck or restricted
9. My rib cage feels tight and can't expand
10. I notice that I am breathing quickly
11. I get breathless when I am anxious
12. I find myself holding my breath
13. I feel breathless in association with other physical symptoms
14. I have trouble coordinating my breathing when I am speaking
15. I can't catch my breath
16. I feel that the air is stuffy, as if not enough air in the room
17. I get breathless even when I am resting
18. My breath feels like it does not go in all the way
19. My breath feels like it does not go out all the way
20. My breathing is heavy
21. I feel that I am breathing more
22. My breathing requires work
23. My breathing requires effort
24. I find myself breathing through my mouth during the day
25. I breathe through my mouth at night while I sleep

Resource: (Courtney & Greenwood, 2009)

**Appendix B: *Physiotherapy* guide for authors**

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Numbered style of referencing should be used. Authors should aim for 75% of their references to be within the preceding 5 years, with a limit of 40 references (5 references for case reports, 10 references for short communications, 20 references for technical reports).

*Citations in the text:* Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Any references cited in the abstract must be given in full. Unpublished results and personal communications should not be in the reference list, but may be mentioned in the text. Citation of a reference as 'in press' implies that the item has been accepted for publication.

*Citing and listing of web references.* As a minimum, the full URL should be given. Any further information, if known (author names, dates, reference to a source publication, etc.), should also be given. Web references can be listed separately (e.g., after the reference list) under a different heading if desired, or can be included in the reference list; in square brackets in line with the text.

*Text:* Indicate references by numbers in the text. The actual authors can be referred to, but the reference number(s) must always be given.

*List:* Number the references in the list in the order in which they appear in the text.

*Examples:*

*Reference to a journal publication:*

[1] Van der Geer J, Hanraads JAJ, Lupton RA. The art of writing a scientific article. *J Sci Commun* 2000;163:51-9.

*Reference to a book:*

[2] Strunk Jr W, White EB. *The elements of style*. 3rd ed. New York: Macmillan; 1979.

*Reference to a chapter in an edited book:*

[3] Mettam GR, Adams LB. How to prepare an electronic version of your article. In: Jones BS, Smith RZ, editors. *Introduction to the electronic age*, New York: E-Publishing Inc; 1999, p. 281-304

Note shortened form for last page number. e.g., 51-9, and that for more than 6 authors the first 6 should be listed followed by 'et al.'

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- One author designated as corresponding author:
- E-mail address
- Full postal address
- Telephone and fax numbers

#### **At the end of the paper, but before the references, please provide three statements:**

- Ethical Approval: The organisation providing ethical approval and ethics protocol reference number where appropriate.
- Funding: any sources of funding should be stated.
- Conflict of Interest: Disclosed conflicts will be published if they are believed to be important to readers in judging the manuscript. If there are no conflicts of interest, authors should state that there are none.

### **Further considerations**

- References are in the Vancouver style
- All references mentioned in the Reference list are cited in the text, and vice versa
- Permission has been obtained for use of copyrighted material from other sources (including the Web)

## **Appendix C: Information for participants**

## Information for participants

**Test-Retest Reliability and Determinants of the Self  
Evaluation of Breathing Questionnaire (SEBQ): A Measure  
of Dysfunctional Breathing**

My name is Ashleigh Mitchell and I am currently in the fourth year of a program in Osteopathy at Unitec. Part of my Master of Osteopathy degree requires me to complete a research thesis on a subject of my choice. My research project is investigating the reliability and determinants the Self Evaluation of Breathing Questionnaire (SEBQ). Anyone over the age of 18 who can read and understand English, is not incapacitated or on bed rest for illness, and is not planning a major lifestyle change over the period of data collection of the study can participate in this study. This study has been approved by the Unitec Research Ethics Committee.

### ***What I am doing***

I want to find out if the measurements obtained by the SEBQ (Breathing Questionnaire) are reproducible if the questionnaire is repeated at different times. In addition, an aim of this study is to find out if there are any lifestyle or demographic factors associated with minor breathing dysfunction detected by this questionnaire. By taking part in this research project you will be helping me to determine these things. This study may help us gain a more comprehensive understanding about breathing problems which are estimated to affect many, otherwise healthy, people. If this study is shows that the questionnaire is reproducible, this questionnaire may be suitable for screening large numbers of people in health clinics internationally, to help identify dysfunctional breathing.

### ***What it will mean for you***

If you choose to take part in this study, you will be asked to:

- Provide your email address.
- You will then be sent a link to the first questionnaire which will contain general questionnaire about yourself and your lifestyle, and the SEBQ (Breathing Questionnaire) which contains questions about how you breathe.
- You will be asked to complete this questionnaire as soon as possible. Completion of the questionnaire should take you approximately five minutes each time.
- 12 days after this you will either receive an email with a link to the follow up questionnaire containing similar questions as previously and will be asked to fill it out on the same day of the week and approximately the same time of the day as the first. Completion of this should also take approximately five minutes.
- You will receive reminders by email to complete the questionnaires at the required times.
- If you agree to participate, and begin the questionnaire this will be taken as implied consent. This does not stop you from changing your mind if you wish to withdraw from the project. However, any withdrawals must be done within two weeks after you have completed your second questionnaire.

Your name and any information that may identify you will be kept completely confidential. All information collected from you will be stored on a password protected file or locked filing cabinet and only you, my two supervisors and I (the primary researcher) will have access to this information.

Please contact us if you need more information about the project or if at any time if you have any concerns about the research project you can contact my supervisor or I:

My supervisor is Rob Moran email [rmoran@unitec.ac.nz](mailto:rmoran@unitec.ac.nz)

My phone number is 021 899 496 and email address is, [SEBQresearch@gmail.com](mailto:SEBQresearch@gmail.com)

**UREC REGISTRATION NUMBER: 2010-1089**

**This study has been approved by the UNITEC Research Ethics Committee from (date) to (date). If you have any complaints or reservations about the ethical conduct of this research, you may contact the Committee through the UREC Secretary (ph: 09 815-4321 ext 6162. Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.**

## **Appendix D: Ethics approval for this project**



Ashleigh Mitchell  
84 Konini Street  
RD5  
Whangarei

22 July 2010

Dear Ashleigh

Your file number for this application: 2010-1089

**Title: Reliability and Determinants of the Self Examination of Breathing Questionnaire (SEBQ): A Measure of Dysfunctional Breathing**

Your application for ethics approval has been reviewed by the Unitec Research Ethics Committee (UREC) and has been **approved** for the following period:

Start date: 14 July 2010  
Finish date: 13 July 2011

Please note that:

1. the above dates must be referred to on the information AND consent forms given to all participants
2. you must inform UREC, in advance, of any ethically-relevant deviation in the project. This may require additional approval.

You may now commence your research according to the protocols approved by UREC. We wish you every success with your project.

Yours sincerely

A handwritten signature in blue ink, appearing to read 'Lyndon Walker'.

Lyndon Walker  
Deputy Chair, UREC

CC: Craig Hilton  
Cynthia Almeida

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Waitakere campus  
5-7 Ratanui St  
Henderson  
Auckland 0612  
New Zealand

## **Appendix E: First (test) questionnaire**

## 1. Information for Participants

My name is Ashleigh Mitchell and I'm a Master of Osteopathy student at Unitec. I am conducting a research project to investigate the reliability and determinants the Self Evaluation of Breathing Questionnaire (SEBQ). Anyone over the age of 18 who can read and understand English, is not incapacitated or on bed rest for illness, and is not planning a major lifestyle change over the next 2 weeks can participate in this study. This study has been approved by the Unitec Research Ethics Committee.

Research objectives.

To find out if the measurements obtained by the SEBQ (Breathing Questionnaire) are reproducible over time. Your support with this research project will also help to determine if lifestyle or demographic factors maybe associated with minor breathing dysfunction's within the participant group.

This study may also help develop a more comprehensive understanding of breathing problems currently thought to affect many otherwise healthy people.

If this questionnaire is proven reproducible and valid in identifying dysfunctional breathing in otherwise healthy individuals, it may be further developed for use as screening tool for large numbers of people in health clinics on an international basis.

What it will mean for you...

If you choose to take part in this study, you will be asked to:

- 1) Complete this online questionnaire which should take approximately 10 minutes of your time.
- 2) Complete another online questionnaire which should also take only 10 minutes in two weeks time.
- 3) You will be sent a reminder via email about completing the second questionnaire prior to the two week mark.
- 4) You will be sent a reminder email if the second questionnaire is not completed at the appropriate time.
- 5) If you complete the two questionnaires at the required time you go in the draw to win a 8GB iPod nano!

Your name and any information that may identify you will be kept completely confidential. All information collected from you will be stored on a password protected file or locked filing cabinet and only you, my two supervisors and I (the primary researcher) will have access to this information.

If you have any further questions regarding the study please don't hesitate to contact me on [SEBQresearch@gmail.com](mailto:SEBQresearch@gmail.com).

If you continue on with the survey the next page will be considered your consent form and thank you so much for your help!

If you don't wish to continue simply close this window now and you will not be contacted again.

## 2. Participant consent

I have had the research project explained to me and I have read and understood the information on the previous page.

I understand that I don't have to take part in this study if I don't want to and I may withdraw at any time up to two weeks after filling out my second questionnaire.

I understand that everything I say is confidential and none of the personal information I give will be displayed in public documents.

The only persons who will read the responses to my questionnaires or will see this information linked to an individual will be the researcher and their academic supervisors. I also understand that all the information that I give will be stored securely on a permanent staff member's computer at Unitec for a period of 5 years, where it will be destroyed after.

I understand that I will be emailed a link required to fill out a general questionnaire about my lifestyle and the breathing questionnaire on two occasions.

I understand that I can see the finished research document.

I have had time to consider everything and I give my consent to be a part of this project.

Please consider this information and if you consent to participate in this study, continue with the survey. A completed survey will be taken by the researchers that you are willing to participate in this study.

### **\*1. Do you wish to continue with this survey?**

Yes

### 3. General Information

#### 1. Your name

Family name

First name(s)

#### 2. What is your email address?

#### 3. What is your approximate height? (In centimetres or feet. Please specify what unit you are using)

#### 4. What is your approximate weight? (In kilograms,pounds,or stones. Please specify what unit you are using)

#### 5. Gender

Male

Female

#### 6. Date of Birth

DD MM YYYY

Please enter your  
date of birth

 /  /

## 4. SEBQ

### \* 1. Descriptions about your breathing

Please tick the box most applicable to you

	Never/ not true at all.	Occasionally/ a bit true.	Frequently/ mostly true.	Very frequent/ very true.
I get easily breathless out of proportion to my fitness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I notice myself breathing shallowly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I get short of breath reading and talking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I notice myself sighing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I notice myself yawning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel I cannot get a deep or satisfying breath	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I notice that I am breathing irregularly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My breathing feels stuck or restricted	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My rib cage feels tight and can't expand	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I notice that I am breathing quickly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I get breathless when I am anxious	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find myself holding my breath	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel breathless in association with other physical symptoms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have trouble coordinating my breathing when I am speaking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can't catch my breath	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that the air is stuffy, as if not enough air in the room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I get breathless even when I am resting	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My breath feels like it does not go in all the way	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My breath feels like it does not go out all the way	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My breathing is heavy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that I am breathing more	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My breathing requires work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My breathing requires effort	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find myself breathing through my mouth during the day	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I breathe through my mouth at night while I sleep	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 5. Physical Activity

**1. On average over the last two weeks how many hours or minutes have you spent doing physical activity? (Please include moderate or vigorous exercise in this estimate, activities that make you puff a little to a lot. Please specify whether it is hours or minutes)**

on a normal Saturday?

on a normal Sunday?

on a normal weekday?

**2. Please list in the boxes below up to 3 physical activities you are most likely to engage in on an average week. Please state the duration of each time you engage in it also. (For example: running 1 hour)**

Activity 1 (most performed activity)

Activity 2 (second most performed activity)

Activity 3 (third most performed activity)

Activity 4 (fourth most performed activity)

**3. Please tick the appropriate box that relates to how often you would engage in the activities listed above.**

	less than once a week	once a week	a few times a week	once or more a day
Activity 1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Activity 2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Activity 3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Activity 4	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 6. Smoking

### 1. Do you smoke? (including cigarettes, roll-your-own, pipe, cigars, other)

- Yes, if yes please answer the following two questions before continuing onto the next page
- No, if no please continue onto the next page now

### 2. Have you smoked regularly for a period of 6 months or more?

- Yes
- No

### 3. On average, how many times do you smoke?

Per day? OR

Per week?

## 7. Occupation

**1. What is your occupation?**

**2. Do you wear a protective mask at work?**

- Yes  
 No

**3. Is it recommended that you wear a protective mask for some of the jobs you engage in during the course of your employment?**

- Yes  
 No

## 8. Health

### 1. Do you suffer from any known medical illness, disease, or recent or longstanding troublesome injury?

- Yes  
 No

If yes please specify. If you have asthma please state what category you have; mild (symptoms less than daily), moderate (daily symptoms) or severe (continuous symptoms).

### 2. Are you currently on any medications? (including tablets, syrups, inhalers, injections, vitamins, nutritional supplements and herbal remedies)

- Yes  
 No

If yes please specify the name, dosage, frequency and reason for use if known.

### 3. Illnesses (this may include but is not limited to any colds, flu's or infections)

Approximately what date was your last illness?

What was this illness?

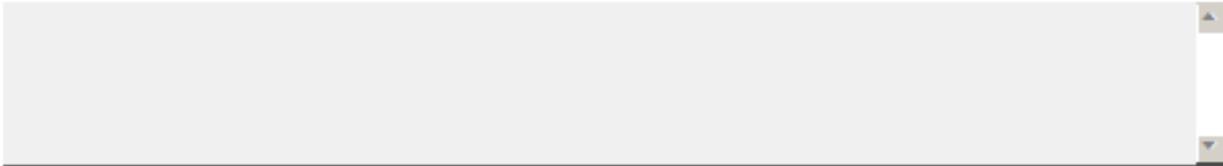
Approximately how long did this illness last for?

## 9. Thank you for completing this questionnaire

Thank you for taking the time to complete this questionnaire. In 12 days time you will be emailed the link to the follow up questionnaire that I ask you if possible to complete on the same day of the week and if possible approximately the same time of the day.

Please now click DONE. The next page is advertising from the Survey host we use to collect data - please feel free to disregard, it's completely unrelated to our study. Have a great day and thank you again.

**1. Please leave any questions or comments you may have for the researcher in the below box and she will endeavor to get back to you asap.**

A large, empty text input box with a light gray background and a thin black border. On the right side, there is a vertical scrollbar with a small arrow pointing up and down, indicating that the box is scrollable. The box is currently empty, intended for the user to type any questions or comments.

## **Appendix F: Second (retest) questionnaire**

## 1. Information for Participants

Hi everyone,

Ashleigh here again, its time to do your 2 week follow up questionnaire.

I ask you if possible to complete this questionnaire as close as possible to the same day of the week and the same time of day as the first one you did. If this is not possible it is just essential that you complete this questionnaire at some point as determining the reproducibility of the breathing questionnaire is the main objective of this project. If you complete this questionnaire you go in the draw to win the 8GB iPod nano so get clicking!! It should take no longer than 10 minutes.

Once again, if you have any further questions regarding the study please don't hesitate to contact me on [SEBQresearch@gmail.com](mailto:SEBQresearch@gmail.com).

Thank you so much for your help!

## 2. General Information

### 1. Your name

Family name

First name(s)

### 3. SEBQ

#### \* 1. Descriptions about your breathing

Please tick the box most applicable to you

	Never/ not true at all.	Occasionally/ a bit true.	Frequently/ mostly true.	Very frequent/ very true.
My breath feels like it does not go out all the way	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My breathing requires effort	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I get short of breath reading and talking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My breath feels like it does not go in all the way	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I notice that I am breathing irregularly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My breathing requires work	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I get breathless when I am anxious	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find myself holding my breath	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I get breathless even when I am resting	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I notice that I am breathing quickly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I breathe through my mouth at night while I sleep	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that I am breathing more	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel breathless in association with other physical symptoms	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My breathing is heavy	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find myself breathing through my mouth during the day	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I get easily breathless out of proportion to my fitness	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel I cannot get a deep or satisfying breath	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My breathing feels stuck or restricted	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I notice myself yawning	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can't catch my breath	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I notice myself breathing shallowly	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My rib cage feels tight and can't expand	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I notice myself sighing	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I have trouble coordinating my breathing when I am speaking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I feel that the air is stuffy, as if not enough air in the room	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 4. Physical Activity

**1. On average over the last two weeks how many hours or minutes have you spent doing physical activity? (Please include moderate or vigorous exercise in this estimate, activities that make you puff a little to a lot)**

**Please state whether it is HOURS OR MINUTES.**

on average over the last 2 Saturdays?

on average over the last 2 Sundays?

on a normal weekday?

**2. Please list in the boxes below the 3 physical activities you have most engaged in over the last 2 weeks. Please state the duration of each time you engage in it also. (For example: running 1 hour)**

Activity 1 (most performed activity)

Activity 2 (second most performed activity)

Activity 3 (third most performed activity)

Activity 4 (fourth most performed activity)

**3. Please tick the appropriate box that relates to how often you would engage in the activities listed above.**

	less than once a week	once a week	a few times a week	once or more a day
Activity 1	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Activity 2	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Activity 3	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Activity 4	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

## 5. Smoking

**1. Please tick the box below that relates most to your smoking habits. (This may include cigarettes, roll-your-own, pipe, cigars, other)**

- I am a smoker and have been for over 2 weeks
- I have taken up smoking in the last 2 weeks
- I have quit smoking in the last 2 weeks
- I do not smoke

**2. If you are currently a smoker, on average over the last 2 weeks how many times would you have smoked?**

Per day? OR

Per week?

## 6. Occupation

### 1. Have you changed your occupation over the last 2 weeks?

- Yes, if so please answer the following questions
- No, if so please continue onto the next page

### 2. What is your new occupation?

### 3. Do you wear a protective mask in your new occupation?

- Yes
- No

### 4. Does your new occupation recommend that you wear a protective mask for some of the jobs you engage in during the course of your employment?

- Yes
- No

## 7. Health

**1. Have you started taking any new medications over the last 2 weeks? (including tablets, syrups, inhalers, injections, vitamins, nutritional supplements and herbal remedies)**

Yes

No

If yes please specify the name, dosage, frequency and reason for use if known.

**2. Have you been ill over the last 2 weeks?**

Yes, if so please answer the following questions

No, if so please continue onto the next page

**3. Illnesses (this may include but is not limited to any colds, flu's or infections)**

Approximately what date  
did your last illness start?

What was this illness?

Approximately how long  
did this illness last for?

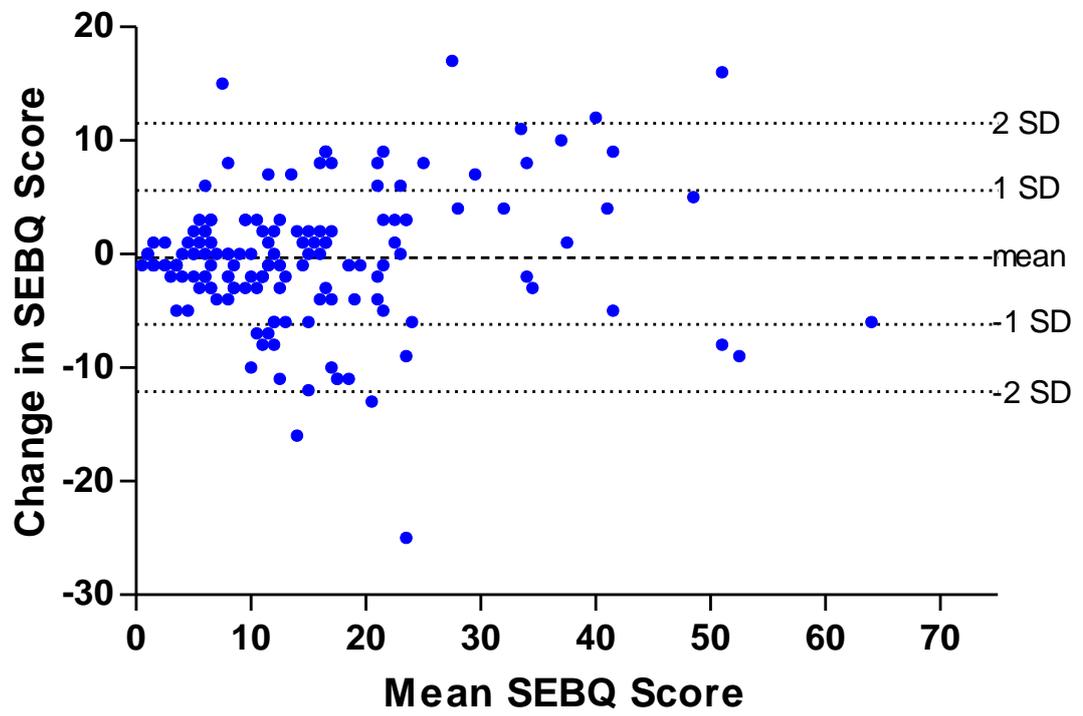
## 8. Thank you for completing this questionnaire

Thank you for taking the time to complete your follow up questionnaire.

Please now click DONE. Once you have submitted this questionnaire you will go into the draw to win the iPod! The next page you will see is advertising for the Survey Monkey website. Registering with Survey Monkey is completely optional and unconnected with this study so please disregard if you are not interested. Have a great day and thank you again.

**1. Please leave any questions or comments you may have for the researcher in the below box and she will endeavor to get back to you asap.**

**Appendix G: Figure representing bias of mean SEBQ scores  
between test and retest.**



**Figure.** Bias of mean SEBQ score between test and retest questionnaires.