

Condition	Minute ventilation	N. of patients	Prevalence of CHV	All references or click below for abstracts
Normal breathing	6 l/min	-	0 %	Medical textbooks
Heart disease	15 (±4) l/min	22	100%	Dimopoulou et al, 2001
Heart disease	16 (±2) l/min	11	100%	Johnson et al, 2000
Heart disease	12 (±3) l/min	132	100%	Fanfulla et al, 1998
Heart disease	15 (±4) l/min	55	100%	Clark et al, 1997
Heart disease	13 (±4) l/min	15	100%	Banning et al, 1995
Heart disease	15 (±4) l/min	88	100%	Clark et al, 1995
Heart disease	14 (±2) l/min	30	100%	Buller et al, 1990
Heart disease	16 (±6) l/min	20	100%	Elborn et al, 1990
Pulm hypertens	12 (±2) l/min	11	100%	D'Alonzo et al, 1987
Cancer	12 (±2) l/min	40	100%	Travers et al, 2008
Diabetes	12-17 l/min	26	100%	Bottini et al, 2003
Diabetes	15 (±2) l/min	45	100%	Tantucci et al, 2001
Diabetes	12 (±2) l/min	8	100%	Mancini et al, 1999
Diabetes	10-20 l/min	28	100%	Tantucci et al, 1997
Diabetes	13 (±2) l/min	20	100%	Tantucci et al, 1996
Asthma	13 (±2) l/min	16	100%	Chalupa et al, 2004
Asthma	15 l/min	8	100%	Johnson et al, 1995
Asthma	14 (±6) l/min	39	100%	Bowler et al, 1998
Asthma	13 (±4) l/min	17	100%	Kassabian et al, 1982
Asthma	12 l/min	101	100%	McFadden et al, 1968
COPD	14 (±2) l/min	12	100%	Palange et al, 2001
COPD	12 (±2) l/min	10	100%	Sinderby et al, 2001
COPD	14 l/min	3	100%	Stulbarg et al, 2001
Sleep apnoea	15 (±3) l/min	20	100%	Radwan et al, 2001
Liver cirrhosis	11-18 l/min	24	100%	Epstein et al, 1998
Hyperthyroidism	15 (±1) l/min	42	100%	Kahaly, 1998
Cystic fibrosis*	13 (±2) l/min	10	100%	Bell et al, 1996
Cystic fibrosis	11-14 l/min	6	100%	Tepper et al, 1983
Epilepsy	13 l/min	12	100%	Esquivel et al, 1991
CHV	13 (±2) l/min	134	100%	Han et al, 1997
Panic disorder	12 (±5) l/min	12	100%	Pain et al, 1991
Bipolar disorder	11 (±2) l/min	16	100%	MacKinnon et al, 2007
Dystrophia myotonica	16 (±4) l/min	12	100%	Clague et al, 1994

Table 1. Western scientific evidence about prevalence of CHV (chronic hyperventilation) in patients with various chronic conditions

- Dimopoulou I, Tsintzas OK, Alivizatos PA, Tzelepis GE, Pattern of breathing during progressive exercise in chronic heart failure, *Int J Cardiol.* 2001 Dec; 81(2-3): p. 117-121.
- Johnson BD, Beck KC, Olson LJ, O'Malley KA, Allison TG, Squires RW, Gau GT, Ventilatory constraints during exercise in patients with chronic heart failure, *Chest* 2000 Feb; 117(2): p. 321-332
- Fanfulla F, Mortara , Maestri R, Pinna GD, Bruschi C, Cobelli F, Rampulla C, The development of hyperventilation in patients with chronic heart failure and Cheyne-Stokes respiration, *Chest* 1998; 114; p. 1083-1090.
- Clark AL, Volterrani M, Swan JW, Coats AJS, The increased ventilatory response to exercise in chronic heart failure: relation to pulmonary pathology, *Heart* 1997; 77: p.138-146.
- Banning AP, Lewis NP, Northridge DB, Elborn JS, Henderson AH, Perfusion/ventilation mismatch during exercise in chronic heart failure: an investigation of circulatory determinants, *Br Heart J* 1995; 74: p.27-33.
- Clark AL, Chua TP, Coats AJ, Anatomical dead space, ventilatory pattern, and exercise capacity in chronic heart failure, *Br Heart J* 1995 Oct; 74(4): p. 377-380.
- N P Buller and P A Poole-Wilson, Mechanism of the increased ventilatory response to exercise in patients with chronic heart failure, *Heart* 1990; 63; p.281-283.
- Elborn JS, Riley M, Stanford CF, Nicholls DP, The effects of flosequinan on submaximal exercise in patients with chronic cardiac failure, *Br J Clin Pharmacol.* 1990 May; 29(5): p.519-524.
- D'Alonzo GE, Gianotti LA, Pohil RL, Reagle RR, DuRee SL, Fuentes F, Dantzker DR, Comparison of progressive exercise performance of normal subjects and patients with primary pulmonary hypertension, *Chest* 1987 Jul; 92(1): p.57-62.
- Travers J, Dudgeon DJ, Amjadi K, McBride I, Dillon K, Laveneziana P, Ofir D, Webb KA, O'Donnell DE, Mechanisms of exertional dyspnea in patients with cancer, *J Appl Physiol* 2008 Jan; 104(1): p.57-66.
- Bottini P, Dottorini ML, M. Cordoni MC, Casucci G, Tantucci C, Sleep-disordered breathing in nonobese diabetic subjects with autonomic neuropathy, *Eur Respir J* 2003; 22: p. 654–660.
- Tantucci C, Bottini P, Fiorani C, Dottorini ML, Santeusano F, Provinciali L, Sorbini CA, Casucci G, Cerebrovascular reactivity and hypercapnic respiratory drive in diabetic autonomic neuropathy, *J Appl Physiol* 2001, 90: p. 889–896.
- Mancini M, Filippelli M, Seghieri G, Iandelli I, Innocenti F, Duranti R, Scano G, Respiratory Muscle Function and Hypoxic Ventilatory Control in Patients With Type I Diabetes, *Chest* 1999; 115; p.1553-1562.
- Tantucci C, Scionti L, Bottini P, Dottorini ML, Puxeddu E, Casucci G, Sorbini CA, Influence of autonomic neuropathy of different severities on the hypercapnic drive to breathing in diabetic patients, *Chest.* 1997 Jul; 112(1): p. 145-153.
- Tantucci C, Bottini P, Dottorini ML, Puxeddu E, Casucci G, Scionti L, Sorbini CA, Ventilatory response to exercise in diabetic subjects with autonomic neuropathy, *J Appl Physiol* 1996, 81(5): p.1978–1986.
- Chalupa DC, Morrow PE, Oberdörster G, Utell MJ, Frampton MW, Ultrafine particle deposition in subjects with asthma, *Environmental Health Perspectives* 2004 Jun; 112(8): p.879-882.
- Johnson BD, Scanlon PD, Beck KC, Regulation of ventilatory capacity in asthmatics, *J Appl Physiol.* 1995 Sep; 79(3): p. 892.
- Bowler SD, Green A, Mitchell CA, Buteyko breathing techniques in asthma: a controlled trial, *Med J of Australia* 1998; 169.
- Kassabian J, Miller KD, Lavietes MH, Respiratory center output and ventilatory timing in patients with acute airway (asthma) and alveolar (pneumonia) disease, *Chest* 1982 May; 81(5): p.536-543.
- McFadden ER & Lyons HA, Arterial-blood gases in asthma, *The New Engl J of Med* 1968 May 9, 278 (19): 1027-1032.
- Palange P, Valli G, Onorati P, Antonucci R, Paoletti P, Rosato A, Manfredi F, Serra P, Effect of heliox on lung dynamic hyperinflation, dyspnea, and exercise endurance capacity in COPD patients, *J Appl Physiol.* 2004 Nov; 97(5): p.1637-1642.
- Sinderby C, Spahija J, Beck J, Kaminski D, Yan S, Comtois N, Sliwinski P, Diaphragm activation during exercise in chronic obstructive pulmonary disease, *Am J Respir Crit Care Med* 2001 Jun; 163(7): 1637-1641.
- Stulbarg MS, Winn WR, Kellett LE, Bilateral Carotid Body Resection for the Relief of Dyspnea in Severe Chronic Obstructive Pulmonary Disease, *Chest* 1989; 95 (5): p.1123-1128.
- Radwan L, Maszczyk Z, Koziorowski A, Koziej M, Cieslicki J, Sliwinski P, Zielinski J, Control of breathing in obstructive sleep apnoea and in patients with the overlap syndrome, *Eur Respir J.* 1995 Apr; 8(4): p.542-545.
- Epstein SK, Zilberberg MD; Facoby C, Ciubotaru RL, Kaplan LM, Response to symptom-limited exercise in patients with the hepatopulmonary syndrome, *Chest* 1998; 114; p. 736-741.
- Kahaly GJ, Nieswandt J, Wagner S, Schlegel J, Mohr-Kahaly S, Hommel G, Ineffective cardiorespiratory function in hyperthyroidism, *J Clin Endocrinol Metab* 1998 Nov; 83(11): p. 4075-4078.
- Bell SC, Saunders MJ, Elborn JS, Shale DJ, Resting energy expenditure and oxygen cost of breathing in patients with cystic fibrosis, *Thorax* 1996 Feb; 51(2): 126-131.
- Tepper RS, Skatrud B, Dempsey JA, Ventilation and oxygenation changes during sleep in cystic fibrosis, *Chest* 1983; 84; p. 388.
- Esquivel E, Chaussain M, Plouin P, Ponsot G, Arthuis M, Physical exercise and voluntary hyperventilation in childhood absence epilepsy, *Electroencephalogr Clin Neurophysiol* 1991 Aug; 79(2): p. 127-132.
- Han JN, Stegen K, Simkens K, Cauberghs M, Schepers R, Van den Bergh O, Clément J, Van de Woestijne KP, Unsteadiness of breathing in patients with hyperventilation syndrome and anxiety disorders, *Eur Respir J* 1997; 10: p. 167–176.
- Pain MC, Biddle N, Tiller JW, Panic disorder and respiratory variables, *Psychosom Med* 1988 Sep-Oct; 50(5): p. 541-548.
- MacKinnon DF, Craighead B, Hoehn-Saric R, Carbon dioxide provocation of anxiety and respiratory response in bipolar disorder, *J Affect Disord* 2007 Apr; 99(1-3): p.45-49.
- Clague JE, Carter J, Coakley J, Edwards RH, Calverley PM, Respiratory effort perception at rest and during carbon dioxide rebreathing in patients with dystrophia myotonica, *Thorax* 1994 Mar; 49(3): p.240-244.

**Table 2. Minute ventilation at rest
in modern healthy subjects (14 medical studies)**

Condition	Minute ventilation	N. of subjects	Reference
Healthy subjects	7.7 ± 0.3	19	Douglas et al, 1982
Healthy males	8.4 ± 1.3	10	Burki, 1984
Healthy males	6.3	10	Smits et al, 1987
Healthy males	6.1±1.4	6	Fuller et al, 1987
Healthy subjects	6.1± 0.9	9	Tanaka et al, 1988
Healthy students	7.0 ± 1.0	10	Turley et al, 1993
Healthy subjects	6.6 ± 0.6	10	Bengtsson et al, 1994
Healthy subjects	7.0±1.2	12	Sherman et al, 1996
Healthy subjects	7.0±1.2	10	Bell et al, 1996
Healthy subjects	6 ± 1	7	Parreira et al, 1997
Healthy subjects	7.0 ± 1.1	14	Mancini et al, 1999
Healthy subjects	6.6 ± 1.1	40	Pinna et al, 2006
Healthy subjects	6.7 ± 0.5	17	Pathak et al, 2006
Healthy subjects	6.7 ± 0.3	14	Gujic et al, 2007

References for Table 2 (in the same order)

- Douglas NJ, White DP, Pickett CK, Weil JV, Zwillich CW, Respiration during sleep in normal man, Thorax. 1982 Nov; 37(11): p.840-844.
- Burki NK, Ventilatory effects of doxapram in conscious human subjects, Chest 1984 May; 85(5): p.600.
- Smits P, Schouten J, Thien T, Respiratory stimulant effects of adenosine in man after caffeine and enprofylline, Br J Clin Pharmacol. 1987 Dec; 24(6): p.816-819.
- Fuller RW, Maxwell DL, Conradson TB, Dixon CM, Barnes PJ, Circulatory and respiratory effects of infused adenosine in conscious man, Br J Clin Pharmacol 1987 Sep; 24(3): p.306-317.
- Tanaka Y, Morikawa T, Honda Y, An assessment of nasal functions in control of breathing, J of Appl Physiol 1988, 65 (4); p.1520-1524.
- Turley KR,McBride PJ, Wilmore LH, Resting metabolic rate measured after subjects spent the night at home vs at a clinic, Am J of Clin Nutr 1993, 58, p.141-144.
- Bengtsson J, Bengtsson A, Stenqvist O, Bengtsson JP, Effects of hyperventilation on the inspiratory to end-tidal oxygen difference, British J of Anaesthesia 1994; 73: p. 140-144.
- Sherman MS, Lang DM, Matityahu A, Campbell D, Theophylline improves measurements of respiratory muscle efficiency, Chest 1996 Dec; 110(6): p. 437-414.
- Bell SC, Saunders MJ, Elborn JS, Shale DJ, Resting energy expenditure and oxygen cost of breathing in patients with cystic fibrosis, Thorax 1996 Feb; 51(2): 126-131.
- Parreira VF, Delguste P, Jounieaux V, Aubert G, Dury M, Rodenstein DO, Effectiveness of controlled and spontaneous modes in nasal two-level positive pressure ventilation in awake and asleep normal subjects, Chest 1997 Nov 5; 112(5): p.1267-1277.
- Mancini M, Filippelli M, Seghieri G, Iandelli I, Innocenti F, Duranti R, Scano G, Respiratory Muscle Function and Hypoxic Ventilatory Control in Patients With Type I Diabetes, Chest 1999; 115; p.1553-1562.
- Pinna GD, Maestri R, La Rovere MT, Gobbi E, Fanfulla F, Effect of paced breathing on ventilatory and cardiovascular variability parameters during short-term investigations of autonomic function, Am J Physiol Heart Circ Physiol. 2006 Jan; 290(1): p.H424-433.
- Pathak A, Velez-Roa S, Xhaët O, Najem B, van de Borne P, Dose-dependent effect of dobutamine on chemoreflex activity in healthy volunteers, Br J Clin Pharmacol. 2006 Sep; 62(3): p.272-279.
- Gujic M, Houssière A, Xhaët O, Argacha JF, Denewet N, Noseda A, Jespers P, Melot C, Naeije R, van de Borne P, Does endothelin play a role in chemoreception during acute hypoxia in normal men? Chest 2007 May; 131(5): p.1467.

Table 3. Historical changes in minute ventilation
(or minute breathing rates) at rest for normal subjects

Condition	Minute ventilation	Age	N. of subjects	Reference
Normal breathing	6 l/min	16	-	Medical textbooks
Normal subjects	4.9	-	5	Griffith et al, 1929
Normal males	5.3±0.1	27-43	46	Shock et al, 1939
Normal females	4.6±0.1	27-43	40	Shock et al, 1939
Normal subjects	6.9±0.9	-	100	Matheson et al, 1950
Normal subjects	9.1±4.5	31±7	11	Kassabian et al, 1982
Normal subjects	8.1±2.1	42±14	11	D'Alonzo et al, 1987
Normal subjects	6.3±2.2	-	12	Pain et al, 1988
Normal males	13±3	40 (av.)	12	Clague et al, 1994
Normal subjects	9.2±2.5	34±7	13	Radwan et al, 1995
Normal subjects	15±4	28-34	12	Dahan et al, 1995
Normal subjects	12±4	55±10	43	Clark et al, 1995
Normal subjects	12±2	41±2	10	Tantucci et al, 1996
Normal subjects*	11±3	53±11	24	Clark et al, 1997
Normal subjects	8.1±0.4	34±2	63	Meessen et a., 1997
Normal females	9.9	20-28	23	Han et al, 1997
Normal males	15	20-28	47	Han et al, 1997
Normal females	10	29-60	42	Han et al, 1997
Normal males	11	29-62	42	Han et al, 1997
Normal subjects	13±3	36±6	10	Tantucci et al, 1997
Normal subjects	12±1	65±2	10	Epstein et al, 1996
Normal subjects	12±1	12-69	20	Bowler et al, 1998
Normal subjects	10±6	39±4	20	DeLorey et al, 1999
Normal seniors	12±4	70±3	14	DeLorey et al, 1999
Normal elderly*	14±3	88±2	11	DeLorey et al, 1999
Normal subjects	17±1	41±2	15	Tantucci et al, 2001
Normal subjects	10±0.5	-	10	Bell et al, 2005
Normal subjects	8.5±1.2	30±8	69	Narkiewicz, 2006
Normal females	10±0.4	-	11	Ahuja et al, 2007
Normal subjects	12±2	62±2	20	Travers et al, 2008

References for Table 3 (in the same order)

- Griffith FR, Pucher GW, Brownell KA, Klein JD, Carmer ME, Studies in human physiology. IV. Vital capacity, respiratory rate and volume, and composition of the expired air. *Am. J. Physiol* 1929, vol. 89, p. 555.
- Shock NW, Soley MH, Average Values for Basal Respiratory Functions in Adolescents and Adults, *J. Nutrition*, 1939, 18, p. 143.
- Matheson HW, Gray JS, Ventilatory function tests. III Resting ventilation, metabolism, and derived measures, *J Clin Invest* 1950 June; 29(6): p. 688–692.
- Kassabian J, Miller KD, Lavietes MH, Respiratory center output and ventilatory timing in patients with acute airway (asthma) and alveolar (pneumonia) disease, *Chest* 1982 May; 81(5): p.536-543.
- D'Alonzo GE, Gianotti LA, Pohil RL, Reagle RR, DuRee SL, Fuentes F, Dantzker DR, Comparison of progressive exercise performance of normal subjects and patients with primary pulmonary hypertension, *Chest* 1987 Jul; 92(1): p.57-62.
- Pain MC, Biddle N, Tiller JW, Panic disorder, the ventilatory response to carbon dioxide and respiratory variables, *Psychosom Med* 1988 Sep-Oct; 50(5): p. 541-548.
- Clague JE, Carter J, Coakley J, Edwards RH, Calverley PM, Respiratory effort perception at rest and during carbon dioxide rebreathing in patients with dystrophia myotonica, *Thorax* 1994 Mar; 49(3): p.240-244.
- Radwan L, Maszcyk Z, Koziorowski A, Koziej M, Cieslicki J, Sliwinski P, Zielinski J, Control of breathing in obstructive sleep apnoea and in patients with the overlap syndrome, *Eur Respir J*. 1995 Apr; 8(4): p.542.
- Dahan A, van den Elsen MJ, Berkenbosch A, DeGoede J, Olievier IC, van Kleef JW, Halothane affects ventilatory afterdischarge in humans, *Br J Anaesth* 1995 May; 74(5): p.544-548.
- Clark AL, Chua TP, Coats AJ, Anatomical dead space, ventilatory pattern, and exercise capacity in chronic heart failure, *Br Heart J* 1995 Oct; 74(4): p. 377-380.
- Tantucci C, Bottini P, Dottorini ML, Puxeddu E, Casucci G, Scionti L, Sorbini CA, Ventilatory response to exercise in diabetic subjects with autonomic neuropathy, *J Appl Physiol* 1996, 81(5): p.1978–1986.
- Clark AL, Volterrani M, Swan JW, Coats AJS, The increased ventilatory response to exercise in chronic heart failure: relation to pulmonary pathology, *Heart* 1997; 77: p.138-146.
- Meessen NE, van der Grinten CP, Luijendijk SC, Folgering HT, Breathing pattern during bronchial challenge in humans, *Eur Respir J* 1997 May; 10(5): p.1059-1063.
- Han JN, Stegen K, Simkens K, Cauberghs M, Schepers R, Van den Bergh O, Clément J, Van de Woestijne KP, Unsteadiness of breathing in patients with hyperventilation syndrome and anxiety disorders, *Eur Respir J* 1997; 10: p. 167–176.
- Tantucci C, Scionti L, Bottini P, Dottorini ML, Puxeddu E, Casucci G, Sorbini CA, Influence of autonomic neuropathy of different severities on the hypercapnic drive in diabetic patients, *Chest*. 1997 Jul; 112(1): 145.
- Epstein SK, Zilberberg MD; Facoby C, Ciubotaru RL, Kaplan LM, Response to symptom-limited exercise in patients with the hepatopulmonary syndrome, *Chest* 1998; 114: p. 736-741.
- Bowler SD, Green A, Mitchell CA, Buteyko breathing techniques in asthma: a blinded randomised controlled trial, *Med J of Australia* 1998; 169: p. 575-578.
- DeLorey DS, Babb TG, Progressive mechanical ventilatory constraints with aging, *Am J Respir Crit Care Med* 1999 Jul; 160(1): p.169-177.
- Tantucci C, Bottini P, Fiorani C, Dottorini ML, Santeusano F, Provinciali L, Sorbini CA, Casucci G, Cerebrovascular reactivity and hypercapnic respiratory drive in diabetic autonomic neuropathy, *J Appl Physiol* 2001, 90: p. 889–896.
- Bell HJ, Feenstra W, Duffin J, The initial phase of exercise hyperpnoea in humans is depressed during a cognitive task, *Experimental Physiology* 2005 May; 90(3): p.357-365.
- Narkiewicz K, van de Borne P, Montano N, Hering D, Kara T, Somers VK, Sympathetic neural outflow and chemoreflex sensitivity are related to spontaneous breathing rate in normal men, *Hypertension* 2006 Jan; 47(1): p.51-55.
- Ahuja D, Mateika JH, Diamond MP, Badr MS, Ventilatory sensitivity to carbon dioxide before and after episodic hypoxia in women treated with testosterone, *J Appl Physiol*. 2007 May; 102(5): p.1832-1838.
- Travers J, Dudgeon DJ, Amjadi K, McBride I, Dillon K, Laveneziana P, Ofir D, Webb KA, O'Donnell DE, Mechanisms of exertional dyspnea in patients with cancer, *J Appl Physiol* 2008 Jan; 104(1): p.57-66.

Table 4. Control Pause in normal and healthy people

Types of people investigated	N. of subjects	Control Pause, s	Reference
US aviators	319	41 s	Schneider, 1919
Fit instructors	22	46 s	Flack, 1920
Home defence pilots	24	49 s	Flack, 1920
British candidates	23	47 s	Flack, 1920
US candidates	7	45 s	Flack, 1920
Delivery pilots	27	39 s	Flack, 1920
Pilots trained for scouts	15	42 s	Flack, 1920
Min requir. for flying		34 s	Flack, 1920
Normal subjects	20	39 s	Schneider, 1930
Normal subjects	30	23 s	Friedman, 1945
Normal subjects	7	44 s	Ferris et al, 1946
Normal subjects	22	33 s	Mirsky et al, 1946
Aviation students	48	36 s	Karpovich, 1947
Normal subjects	80	28 s	Rodbard, 1947
Normal subjects	3	41 s	Stroud, 1959
Normal subjects	16	16 s	Kohn & Cutcher, 1970
Normal subjects	6	28 s	Davidson et al, 1974
Normal subjects	16	22 s	Stanley et al, 1975
Normal subjects	7	29 s	Gross et al, 1976
Normal subjects	6	36 s	Bartlett, 1977
Normal subjects	9	33 s	Mukhtar et al, 1986
Normal subjects	20	36 s	Morrissey et al, 1987
Normal subjects	14	25 s	Zandbergen et al, 1992
Normal subjects	26	21 s	Asmudson & Stein, 1994
Normal subjects	30	36 s	Taskar et al, 1995
Normal subjects	76	25 s	McNally & Eke, 1996
Normal subjects	8	32 s	Sasse et al, 1996
Normal subjects	10	38 s	Flume et al, 1996
Normal subjects	31	29 s	Marks et al, 1997
Normal males	36	29 s	Joshi et al, 1998
Normal females	33	23 s	Joshi et al, 1998
Healthy subjects	20	38 s	Morooka et al, 2000
Normal subjects	6	30 s	Bosco et al, 2004
Normal subjects	19	30 s	Mitrouska et al, 2007
Healthy subjects	14	34 s	Andersson et al, 2009

References for Table 4 (in the same order)

- Schneider, 1919, Observations were made in 1919, published in Schneider, 1930, see below.
- Flack M, Some simple tests of physical efficiency, *Lancet* 1920; 196: p. 210-212.
- Schneider EC, Observation on holding the breath, *Am J Physiol*, 1930, 94, p. 464-470.
- Friedman M, Studies concerning the aetiology and pathogenesis of neurocirculatory asthenia III. The cardiovascular manifestations of neurocirculatory asthenia, *Am Heart J* 1945; 30, p. 378-391.
- Ferris EB, Engel GL, Stevens CD, Webb J, Voluntary breathholding, III. The relation of the maximum time of breathholding to the oxygen and carbon dioxide tensions of arterial blood, with a note on its clinical and physiological significance, *J Clin Invest* 1946, 25: 734-743.
- Mirsky I A, Lipman E, Grinker R R, Breath-holding time in anxiety state, *Federat. proceed.* 1946; 5: p. 74.
- Karpovich PV, Breath holding as a test of physical endurance, *Am J Physiol*, 1947, 149: p. 720-723
- Rodbard S, Effect of oxygen, altitude and exercise on breath-holding time, *Am J Phys* 1947, 150: p. 142.
- Stroud RC, Combined ventilatory and breath-holding evaluation of sensitivity to respiratory gases, *J Appl Physiol* 1959, 14: p. 353-356.
- Kohn RM & Cutcher B, Breath-holding time in the screening for rehabilitation potential of cardiac patients, *Scand J Rehabil Med* 1970; 2(2): p. 105-107.
- Davidson JT, Whipp BJ, Wasserman K, Koyal SN, Lugliani R, Role of the carotid bodies in breath-holding, *New England Journal of Medicine* 1974 April 11; 290(15): p. 819-822.
- Stanley NN, Cunningham EL, Altose MD, Kelsen SG, Levinson RS, Cherniack NS, Evaluation of breath holding in hypercapnia as a simple test of respiratory chemosensitivity, *Thorax* 1975 Jun; 30(3): p. 337.
- Gross PM, Whipp BJ, Davidson JT, Koyal SN, Wasserman K, Role of carotid bodies in the heart rate response to breath holding in man. *J of Amer Physiol* 1976, 41 (3); p. 336-339.
- Bartlett D, Effects of Valsalva and Mueller maneuvers on breath-holding time, *J Appl Physiol: Respiratory, Environ. & Exercise Physiol* 1977 May, 42(5): p. 717-721.
- Mukhtar MR, Patrick JM, Ventilatory drive during face immersion in man, *J. Physiol.* 1986, 370; p. 13-24.
- Morrissey SC, Keohane K, Coote JH, The effect of acetazolamide on breath holding at high altitude, *Postgrad Med J* 1987, 63; p. 189-190
- Zandbergen J, Strahm M, Pols H, Griez EJ, Breath-holding in panic disorder, *Compar Psychiatry* 1992 Jan-Feb; 33(1): p. 47-51.
- Asmundson GJ & Stein MB, Triggering the false suffocation alarm in panic disorder patients by using a voluntary breath-holding procedure, *Am J Psychiatry* 1994 Feb; 151(2): p. 264-266.
- Taskar V, Clayton N, Atkins M, Shaheen Z, Stone P, Woodcock A, Breath-holding time in normal subjects, snorers, and sleep apnea patients, *Chest* 1995 Apr; 107(4): p. 959-962.
- McNally RJ & Eke M, Anxiety sensitivity, suffocation fear, and breath-holding duration as predictors of response to carbon dioxide challenge, *J Abnorm Psychol* 1996 Feb; 105(1): p. 146-149.
- Sasse SA, Berry RB, Nguyen TK, Light RW, Mahutte CK, Arterial Blood Gas Changes During Breath-holding From Functional Residual Capacity, *Chest* 1996, 110; p.958-964.
- Flume PA, Eldridge FL, Edwards LJ, Mattison LE, Relief of the 'air hunger' of breathholding. A role for pulmonary stretch receptors, *Respir Physiol* 1996 Mar; 103(3): p. 221-232.
- Marks B, Mitchell DG, Simelaro JP, Breath-holding in healthy and pulmonary-compromised populations: effects of hyperventilation and oxygen inspiration, *J Magn Reson Imaging* 1997 May-Jun; 7(3): p. 595-597.
- Joshi LN, Joshi VD, Effect of forced breathing on ventilatory functions of the lung, *J Postgrad Med.* 1998 Jul-Sep; 44(3): p.67-69.
- Morooka H, Wakasugi Y, Shimamoto H, Shibata O, Sumikawa K, Hyperbaric Nitrogen Prolongs Breath-Holding Time in Humans, *Anesth Analg* 2000; 91: p.749 –751.
- Bosco G, Ionadi A, Data RG, Mortola JP, Voluntary breath-holding in the morning and in the evening *Clinical Science* (2004) 106, p. 347–352
- Mitrouska I, Tsoumakidou M, Prinianakis G, Milic-Emili J, Siafakas NM, Effect of voluntary respiratory efforts on breath-holding time, *Respiratory Physiology Neurobiology* 2007, 157; p. 290–294.
- Andersson JPA, Schagatay E, Repeated apneas do not affect the hypercapnic ventilatory response in the short term, *Eur J Appl Physiol* 2009, 105: p.569–574.

Table 5. Control Pause in sick people

Condition	N. of subjects	Control Pause, s	Reference
Hypertension	95	12 s	Ayman et al, 1939
Neurocirculatory asthenia	54	16 s	Friedman, 1945
Anxiety states	62	20 s	Mirsky et al, 1946
Class 1 heart patients	16	16 s	Kohn & Cutcher, 1970
Class 2 and 3 heart patients	53	13 s	Kohn & Cutcher, 1970
Pulmonary emphysema	3	8 s	Kohn & Cutcher, 1970
Functional heart disease	13	5 s	Kohn & Cutcher, 1970
Asymptomatic asthmatics	7	20 s	Davidson et al, 1974
Asthmatics with symptoms	13	11 s	Perez-Padilla et al, 1989
Panic attack	14	11 s	Zandbergen et al, 1992
Anxiety disorders	14	16 s	Zandbergen et al, 1992
Outpatients	25	17 s	Gay et al, 1994
Inpatients	25	10 s	Gay et al, 1994
COPD or CHF (congenital heart failure)	7	8 s	Gay et al, 1994
12 heavy smokers	12	8 s	Gay et al, 1994
Panic disorder	23	16 s	Asmundson & Stein, 1994
Obstructive sleep apnoea syndrome	30	20 s	Taskar et al, 1995
Successful lung transplantation	9	23 s	Flume et al, 1996
Successful heart transplantation	8	28 s	Flume et al, 1996
Outpatients with COPD	87	8 s	Marks et al, 1997
Asthma	55	14 s	Nannini et al, 2007

References for Table 5 (in the same order)

- Ayman D, Goldshine AD, The breath-holding test. A simple standard stimulus of blood pressure, Archives of Intern Medicine 1939, 63; p. 899-906.
- Friedman M, Studies concerning the aetiology and pathogenesis of neurocirculatory asthenia III. The cardiovascular manifestations of neurocirculatory asthenia, Am Heart J 1945; 30, 378-391.
- Mirsky I A, Lipman E, Grinker R R, Breath-holding time in anxiety state, Federation proceedings 1946; 5: p. 74.
- Kohn RM & Cutcher B, Breath-holding time in the screening for rehabilitation potential of cardiac patients, Scand J Rehabil Med 1970; 2(2): p. 105-107.
- Davidson JT, Whipp BJ, Wasserman K, Koyal SN, Lugliani R, Role of the carotid bodies in breath-holding, New England Journal of Medicine 1974 April 11; 290(15): p. 819-822.
- Perez-Padilla R, Cervantes D, Chapela R, Selman M, Rating of breathlessness at rest during acute asthma: correlation with spirometry and usefulness of breath-holding time, Rev Invest Clin 1989 Jul-Sep; 41(3): p. 209-213.
- Zandbergen J, Strahm M, Pols H, Griez EJ, Breath-holding in panic disorder, Compar Psychiatry 1992 Jan-Feb; 33(1): p. 47-51.
- Gay SB, Siström CIL, Holder CA, Suratt PM, Breath-holding capability of adults. Implications for spiral computed tomography, fast-acquisition magnetic resonance imaging, and angiography, Invest Radiol 1994 Sep; 29(9): p. 848-851.
- Asmundson GJ & Stein MB, Triggering the false suffocation alarm in panic disorder patients by using a voluntary breath-holding procedure, Am J Psychiatry 1994 Feb; 151(2): p. 264-266.
- Taskar V, Clayton N, Atkins M, Shaheen Z, Stone P, Woodcock A, Breath-holding time in normal subjects, snorers, and sleep apnea patients, Chest 1995 Apr; 107(4): p. 959-962.
- Flume PA, Eldridge FL, Edwards LJ, Mattison LE, Relief of the 'air hunger' of breathholding. A role for pulmonary stretch receptors, Respir Physiol 1996 Mar; 103(3): p. 221-232.
- Marks B, Mitchell DG, Simelaro JP, Breath-holding in healthy and pulmonary-compromised populations: effects of hyperventilation and oxygen inspiration, J Magn Reson Imaging 1997 May-Jun; 7(3): p. 595-597.
- Nannini LJ, Zaietta GA, Guerrero AJ, Varela JA, Fernandez AM, Flores DM, Breath-holding test in subjects with near-fatal asthma. A new index for dyspnea perception, Respiratory Medicine 2007, 101; p.246-253.