Reference Predicted Normals
used in EasyOne, EasyWare and EasyWare Pro

This document describes in detail which predicted normals are implemented in the current version of EasyOne and the PC software EasyWare and EasyWare Pro. The following tables show implementation details and the publications on which the reference values are based.

The tables have the following entries:

Reference: Name of predicted normal reference used in EasyOne or the software. The name is the study name, or the name of the authors of the publication.

Publ. Year: Year when the study was published.

Abbrev.: Abbreviation for the study. The abbreviation is used if parameters from other studies are copied. Example: For most studies 'Cherniak' (CH) values are used for the MVV parameter.

Age Range: Age range of the study. If range was extended beyond the study range the extended range is shown in parenthesis.

Height Range: Height range of the study. Extended range also listed in parenthesis, as in age range.

Weight Range: Weight range of the study. In most studies weight is not used.

Built in: Predicted normals marked with an X are integrated into EasyOne. Studies that are not marked can be loaded into EasyOne by ndd or a local dealer.

Ethnic: Ethnic group that is supported by the study.

Parameter: In the parameter list the following indicators are used:

O	the parameter is available in the study
O (green)	the parameter is available in the study and it is used in EasyOne
O (orange)	the LLN of the parameter (see below) is computed according to the ATS recommendations: LLN = Predicted - 1.645 * SEE (Standard Error of Estimate)
FVC, IVC	the value of the parameter is copied from listed parameter of the same source
FEV1/FVC	FEV1/FVC% is computed from the predicted of FEV1 and FVC of the same source

Lower Limit of Normal of Parameter: This table lists which lower limits of normal (LLN) are provided by the study. If the study does not have a formula for LLN, the LLN is set to 80% of the predicted for normal parameters (FVC, FEV1 etc.) and 90% of predicted for relative parameters like FEV1/FVC%.

Additional remarks:

Lung Age: Lung Age is computed according to the following publication: Spirometric "Lung Age" Estimation for Motivating Smoking Cessation. J.F. Morris, W. Temple. Prev Med 14, 655-662 (1985).

Scandinavian References: These predicted normals are always combined with the Zapletal references for children.

	Predicted Normals for Spirometry							Ethnicity					Parameter																				Lower Limit of Normal of Parameter																	
	Reference	Publ. Year	Abbrev.	Age Range [yr]	Height Range [cm]	Weight Range [kg]	Build In	Caucasian	African	Mexican	Asian	Other	FVC	FIVC	VC	FEV1	FEV1/FVC%	FEV1/VC%	FEV3	FEV6	FEV3/FVC%	FEV1/FEV6%	FEF25	FEF50	FEF75	FEF25-75	PEF	MVV	Lung Age	FVC	FIVC	VC	FEV1	FEV1/FVC%	FEV1/IVC%	FEV3	FEV6	FEV3/FVC%	FEV1/FEV6%	FEF25	FEF50	FEF75	FEF25-75	PEF
North America	NHANES III	1999	NH	8..80 (6..90)	110..195 (110..210)	unused	o	o	o	o			o	FVC	FVC	o	o			o		o				o	o	CH	o	o	FVC	FVC	o	o			o		o				o	o
	Knudson_83	1983 (1976)	KN83	6..85	107..183/196	unused	o	o					o	FVC	FVC	o	o		o 76					o	o	o	o 76	CH	o	o	FVC	FVC	o	o		-					o	o	o	-
	Knudson_76	1976	KN76	8..85	110..200 (110..210)	unused	o	o					o	FVC	FVC	o	o		o							o	o	CH	o	o	FVC	FVC	o	o										
	Crapo	1981	CR	15..91	146..195 (146..210)	unused	o	o					o	FVC	FVC	o	o		o		o					o		CH	o	o	FVC	FVC	o	o		o		o				o	
	Morris	1971 (1976)	MO	20..90	142..203 (142..210)	unused	o	o					o	FVC	FVC	o	o 76									o		CH	o	o	FVC	FVC	o	o								o	
	Hsu	1979	HS	7..20 (4..20)	110..195 (93..210)	unused	o	o	o	o			o	FVC	FVC	o	FEV1/FVC									o	o	CH	o	o	FVC	FVC	o									o	o
	Dockery (Harvard)	1993	DO	6..18	115..185 (115..210)	unused	o	o	o				o	FVC	FVC	o	o									o		CH	o	o	FVC	FVC	o	o								o	
	Polgar	1971	PO	4..17	109..170 (90..210)	unused	o	o					o	FVC	FVC	o	o		o							o	o	o		o	FVC	FVC	o	o									
	Cherniak	1972	CH	15..79	100..200	unused	o	o							o	o							o	o	o	o	o	o															
Latin America	Pereira	1992	PE92	20..78 (20..)	136..182 (90..220)	unused		o	o				o	FVC	FVC	o	o									o	o			o	FVC	FVC	o	o								o	o
	Pereira 2006	2006	PE06	6..86	n/a	used							o	FVC	FVC	o	o							o	o	o	o	o	o				o	o						o	o	o	o
Europe	ERS (ECCS / EGKS)	1993	ER	18..70 (18..90)	145..195 (145..210)	unused	o	o					o	FVC	IVC	o	o						o	o	o	o	o	CH	o	o	FVC	IVC	o	o						o	o	o	o	o
	Zapletal	1977	ZA	6..17 (4..17)	115..180 (93..210)	unused	o	o						VC	VC	o	o	o					o	o	o	o	o	CH		VC	VC	o	o	o							o	o	o	o	o
	Forche (Austria)	1988	FO	7..76 (7..90)	110..200 (110..210)	unused	o	o					o	FVC	FVC	o	o						ER	ER	ER	ER	ER	o		o	FVC	FVC	o	o						ER	ER	ER	ER	ER
	Sapaldia (Swiss)	1996	SA	18..60 (18..90)	n/a	unused		o					o	FVC	FVC	o	o						o	o	o	o	o			o	FVC	FVC	o	o						o	o	o	o	o
	Roca (Spain)	1982	BA	6..70	110-200 (110..210)	› 0	o	o					o	FVC	FVC	o	FEV1/FVC							o	o	o	o	CH		o	FVC	FVC	o	FEV1/FVC							o	o	o	o
Europe Scandinavia	Hedenström + ZA	1985 1986	HE	20..70 (18..90)	150..195 (150..210)	female: 45..94	o	o					o	FVC	o	o	FEV1/VC	o					o	o	o		o		o	o	FVC	o	o	FEV1/VC	o					o	o	o		o
	Gulsvik + ZA	1985	GU	20..70 (18..90)	150..190 (150..210)	unused	o	o						VC	VC	o	o	o								o			o	VC	VC	o	o	o									o	
	Berglund + ZA	1963	BE	20..70 (18..90)	154..191 (154..210)	unused	o	o						VC	VC	o	o	o											o	VC	VC	o	o	o										
	Finnish	1982 1998	FI	6..90	115..180 (90..220)	unused		o					o	FVC	o	o	o							o	o		o			o	FVC	o	o	o							o			o
Australia	Hibbert	1989	HI	8..19 (6..19)	120..190 (90..220)	unused		o						VC	VC	o	o	FEV1/FVC					o	o	o	o				VC	VC	o	o							o	o	o	o	
	Gore, Crockett	1995	GO	18..78 (18..)	145..195 (90..220)	unused		o					o	FVC	FVC	o	o									o	o			o	FVC	FVC	o	o									o	o
Asia	Asia 1 & 2		A1,2	6..90	115..180 (90..220)	unused					o			VC	VC	o	o	o					o	o	o	o	o																	
	Asia 3 & 4		A3,4	6..90	115..180 (90..220)	unused					o			VC	VC	o	o	o						o	o	o	o																	
	JRS 2001	2001	JR	18..92 (18..)	90..220	unused					o			o	FVC	o	o	o						o	o	o	o																	
	Fukuda Standard	n/a	FU	5..100	n/a	unused					o			VC	VC	o	o	o					o	o	o	o	o	o																

	Reference	Abbrev.	Publication
North America	NHANES III (Hankinson)	NH	John L. Hankinson, John R. Odencrantz, and Kathleen B. Fedan. Spirometric Reference Values from a Sample of the General U.S. Population. Am J Respir Crit Care Med, Vol 159, p 179-187, 1999.
	Knudson 1983	KN83	Knudson, Ronald J, Michael Lebowitz, Holberg Catherine J., Benjamin Burrows. Changes in the Normal Maximal Expiratory Flow-Volume Curve with Aging. American Review of Respiratory Disease, Volume 127, p. 725-734, 1983.
	Knudson 1976	KN76	Knudson, Ronald J, Ronald Slatin, Michael Lebowitz, Benjamin Burrows. The maximal Expiratory Flow-Volume Curve. American Review of Respiratory Disease, Volume 113, p. 587-600, 1976.
	Crapo	CR	Crapo RO, Morris AH, Gardner RM. Reference spirometric values using techniques and equipment that meets ATS recommendations. Am Rev Respir Dis Volume 123, p.659-664, 1981.
	Morris	MO	Morris, James F., Koski, Arthur, Lavon Johnson. Spirometric Standards for Healthy Non-Smoking Adults. American Review of Respiratory Disease, Volume 10-3, p. 57-67, 1971 Morris, J.F. West J. Med (1976) 125:110-118.
	Hsu	HS	Hsu KHK, Bartholomew PH, Thompson V, Hsieh GSJ. Ventilatory Functions of Normal children and Young Adults- Mexican- American, White, Black. I. Spirometry. J Pediatr Volume 95, p. 14-23, 1979.
	Dockery, Wang (Harvard)	DO	X. Wang, D.W. Dockery, D. Wypij, M.E. Fay, B.G. Ferris. Pulmonary Function Between 6 and 18 Years of Age. Pediatr Pulmonol. 1993; 15:75-88.
	Polgar	PO	Polgar, Promadhat, Pulmonary Function Testing in Children: Techniques and Standards. W.B. Saunders Co., Philadelphia, 1971.
	Cherniak	CH	Cherniak, R.M., and Raber M.B. Normal Standards for Ventilatory Function using an Automated Wedge Spirometer. American Review of Respiratory Disease. Volume 106, p.38-46, 1972.
Latin America	Pereira 1992	PE92	Carlos Alberto de Castro Pereira, Sueli da Penha Barreto, João Geraldo Simões, Francisco W.L. Pereira, José Gerson Gerstler, Joge Nakatani. Valores de referência para a espirometria em uma amostra da populacao brasileira adulta, Jornal de Pneumologia 18(1):10-22, maco de 1992.
	Pereira 2006	PE06	Pereira CAC et al. Espirometria em adultos 2006.
Europe	ERS (ECCS, EGKS)	ER	P.H. Quanjer. Lung Volumes and Forced Ventilatory Flows. Eur Respir J, Vol 6, Suppl 16, p. 5-40, 1993.
	Zapletal	ZA	A. Zapletal, T. Paul, M. Samanek. Die Bedeutung heutiger Methoden der Lungenfunktionsdiagnostik zur Feststellung einer Obstruktion der Atemwege bei Kindern und Jugendlichen. Z. Erkrank. Atm.-Org., Volume 149, 343-371, 1977.
	Austria (Forche)	FO	G. Forche, K. Harnoncourt, E. Stadlober. Neue spirometrische Bezugswerte für Kinder, Jugendliche und Erwachsene. Öst. Ärzteztg. 43, 15-16, 1988.
	Sapaldia	SA	SAPALDIA team, O Brändli, CH. Schindler, N. Künzli, R. Keller, A.P. Perruchoud. Lung function in healthy never smoking adults: reference values and lower limits of normal of a Swiss population. Thorax 1996; 51:277-283.
	Spain (Roca)	BA	J. Roca et al. spirometric reference values for a Mediterranean population. Bull Eur Physiopathol Respir, 18:101-102, 1982.
Scandinavia	Hedenström	HE	H. Hedenström, P. Malmberg, K. Agarwal. Reference values for lung Function tests in females. Bull. Eur. Physiopathol. Respir. 21, p. 551-557, 1985. H. Hedenström, P. Malmberg, H.V. Fridriksson. Reference values for lung function tests in men. Upsala J. Med. Sci., 91:299-310, 1986.
	Gulsvik	GU	A. Gulsvik. Spirometri (Korrespondanser). Tidsskr Nor Loegeforen nr. 31, 105:2240-2, 1985.
	Berglund	BE	E. Berglund, G. Birath, J. Bjure, G. Grimby, I. Kjellmer, L. Sandqvist, B. Söderholm. Spirometric Studies in Normal Subjects. Acta Medica Scandinavica, Vol. 173, fasc. 2, p. 185-206, 1963.
	Finnish	FI	Adult: The Scandinavian Journal of Clinical & Laboratory Investigation, Vol. 42 - Suppl 159, 1982. Pediatric: Suomen Lääkärilethi, Vol. 53, 395-402, 1998.
Australia Asia	Hibbert	HI	Marienne E. Hibbert, M App SCI, Anna Lannigan, RN, Louis I. Landau, MD, Peter D. Phelan, MD. Lung Function Values From a Longitudinal Study of Healthy Children Adolescents, Pediatric Pulmonology 7:101-109 (1989).
	Gore, Crockett	GO	C.J. Gore, A.J. Crockett, D.G. Pederson, M.L. Booth, A. Bauman, N. Owen. Spirometric standards for healthy adult lifetime nonsmokers in Australia. Eur Respir J., 1995, 8, 773-782.
	Asia 1,2,3,4	A1-4	n/a
	JRS2001	JR	日本人のスパイログラムと動脈血液ガス分圧基準値　　日本呼吸器学会肺生理専門委員会２００１年４月
	Fukuda Standard	FU	Mixed references from: Ishida, Kanagami, Baldwin, Bjure, Berglund, Dickman, Schmidt, Cherrniak, Needham.

	Predicted Normals for Diffusion Capacity							Ethnicity					Parameter							LLN of Parameter						
	Reference	Publ. Year	Abbrev.	Age Range [yr]	Height Range [cm]	Weight Range [kg]	Build In	Caucasian	African	Mexican	Asian	Other	DLCO	DL adj.	DLCO/VA	VA	TLC sb	RV sb	RV/TLC sb	DLCO	DL adj.	DLCO/VA	VA	TLC sb	RV sb	RV/TLC sb
North America	**Ayers** (see 1)	1975	Ay			unused		o					o							o						
	Burrows (see 1)	1961	Bu					o					o	o	o					o	o	o				
	Cotes	1979	Co			unused		o																		
	Crapo	1981	Cr			unused		o					o							o						
	Goldman & Becklake		GB			unused		o									o	o	o					o	o	o
	Knudson		Kn			unused		o					o							o						
	McGrath & Thompson	1959	MT			unused		o																		
	Miller	1980	Mi			unused		o					o							o						
	NHANES	1996	NH			unused		o	o				o							o						
	Polgar	1971	Po			unused		o					o				o	o	o	o				o		
Latin America																										
Europe Scandinavia	**ERS**	1993	ER			unused		o					o			o				o			o			
	Zapletal		Za			unused		o					o							o						
	Roca	1990	Ro					o					o							o						
	Gulsvik	1992	Gu	18-73 (18.90)		unused		o					o		o	o				o		o	o			

Remarks regarding predicted normals for Diffusion Capacity:

1. The article of B. Make et al. compares different predicted normals sources and come to the conclusion that *"the same subject may be classified as 'normal', 'abnormal' or 'very abnormal' depending on which equation is used"*. This specifically applies to the predicted sources of Burrows (very low predicted values) and Ayers (no age dependency).

	Reference	Abbrev.	Publication
North America	Ayers	Ay	Ayers LN, Ginsberg ML, Fein J, Wasserman K. Diffusing capacity and interpretation of diffusing defects. West J Med 1975; 123:255-264.
	Burrows	Bu	Burrows BJ, Kasik JE, Niden AH, Barclay WR. Clinical usefulness of the single-breth pulmonary diffusing capacity test. Am Rev Respir Dis 1961; 84:798-806.
	Cotes	Co	Cotes JE. Lung function, 4th ed. Oxford: Blackwell Scientific, 1979.
	Crapo	Cr	Crapo RO, Morris AH. Standardized single breath normal values for carbon monoxide diffusing capacity. Am Rev Respir Dis 1981; 123:185-189.
	Goldman & Becklake	GB	
	Knudson	Kn	
	McGrath & Thompson	MT	McGrath MW, Thompson ML. The effect of age, body size and lung volume change on alveolar-capillary permeability and diffusing capacity in man. J Physiol 1959; 146:572-582.
	Miller	Mi	Miller A, Thornton JC, Warshaw R, Anderson H, Teirstein AS, Selikoff IJ. Single breath diffusing capacity in a representative sample of the population of Michigan, a large industrial state. Am Rev Respir Dis 1983; 127:270-277.
	NHANES	NH	
	Polgar	Po	Polgar, Promadhat, Pulmonary Function Testing in Children: Techniques and Standards. W.B. Saunders Co., Philadelphia, 1971.
Europe Scandinavia	ERS	ER	P.H. Quanjer. Lung Volumes and Forced Ventilatory Flows. Eur Respir J, Vol 6, Suppl 16, p. 5-40, 1993.
	Zapletal	Za	
	Roca	Ro	Roca J, Rodriguez-Roisin R, Cobo E, Burgos F, Perez J, Clausen JL. Single breath carbon monoxide diffusing capacity prediction equations from a Mediterranean population. Am Rev Respir Dis 1990; 141:1026-1032.
	Gulsvik	Gu	Gulsvik A, Bakke P, Humerfelt S, Omenaas E, Tosteson T, Weiss ST, Speizer FE. Single breath transfer factor for carbon monoxide in an asymptomatic population of never smokers. Thorax 1992; 47:167-173.