



German Air Force Centre of Aerospace Medicine

Pulmonary function in NATO aircrew applicants

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BUNDESWEHR



- ❖ One goal of our RTG is to recommend pulmonary function standards
- ❖ These would be based upon medical screening of aircrew data
- ❖ What does baseline/normal spirometry look like in our aircrew?



Looked at screening spirometry data from 2008-2018.

Total of 3,885 aircrew applicants from:

- Belgium
- Canada
- Denmark
- Germany
- Finland
- Netherlands
- UK
- US*

*US only screens those with history of respiratory illness such as childhood asthma, premature birth etc.

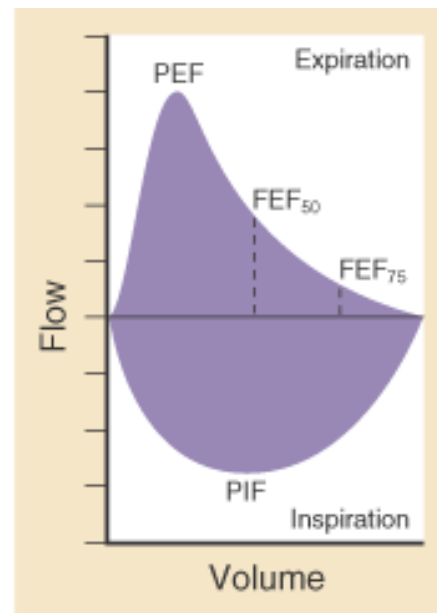


- Institutional Review Boards (IRB) approved study to examine de-identified data on pilot applicants
- Anthropometrics
- Spirometry predicted and actual values:
 - FEV1/ FVC
 - FEV1
 - FVC



Objective Pulmonary Assessment: Basic Spirometry^{1,2}

- Maximal inhalation is followed by a rapid and forceful complete exhalation into a spirometer,
- Includes measurement of:
 - FVC–Forced vital capacity; the total volume of air that can be exhaled during a maximal forced expiration effort.
 - FEV1–Forced expiratory volume in 1 second; the volume of air exhaled in the first second under force after a maximal inhalation.
 - FEV1/FVC ratio–The percentage of the FVC expired in 1 second (Tiffeneau Ratio).

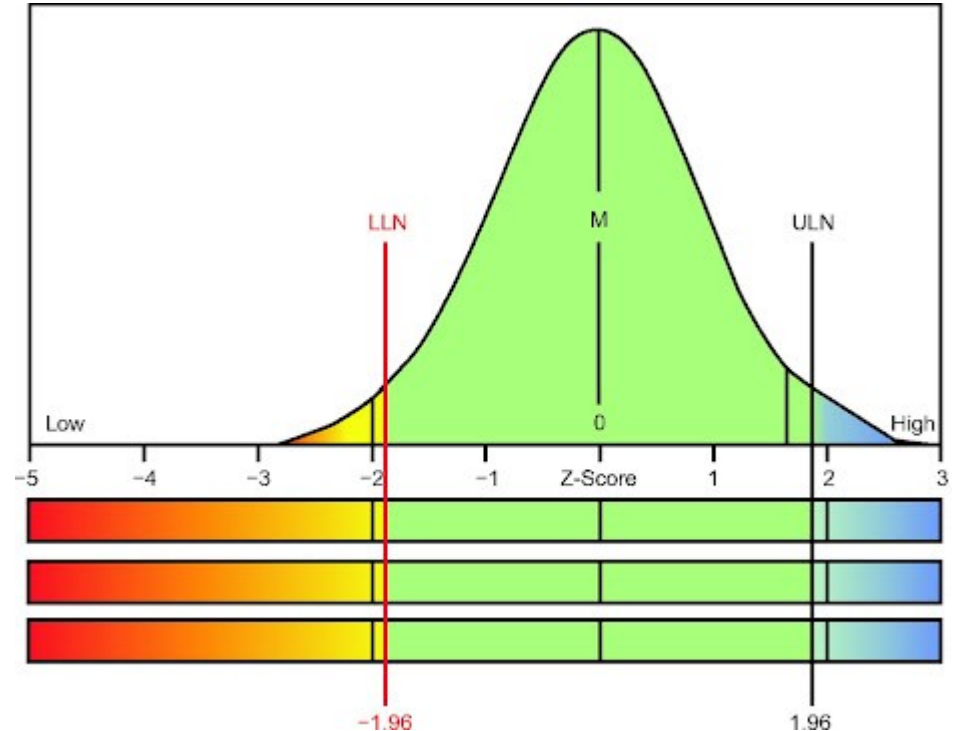


1. National Asthma Education and Prevention Program. Expert panel report 3: guidelines for the diagnosis and management of asthma. Bethesda (MD): National Heart, Lung, and Blood Institute; 2007. NIH Publication No. 08-4051.
2. Miller MR, Hankinson J, Brusasco V, et al. Standardisation of spirometry. Eur Respir J. 2005; 26(2):319-338.



WHERE ARE OUR CURRENT STANDARDS?

Reference values according to
Global Lung Initiative (GLI).



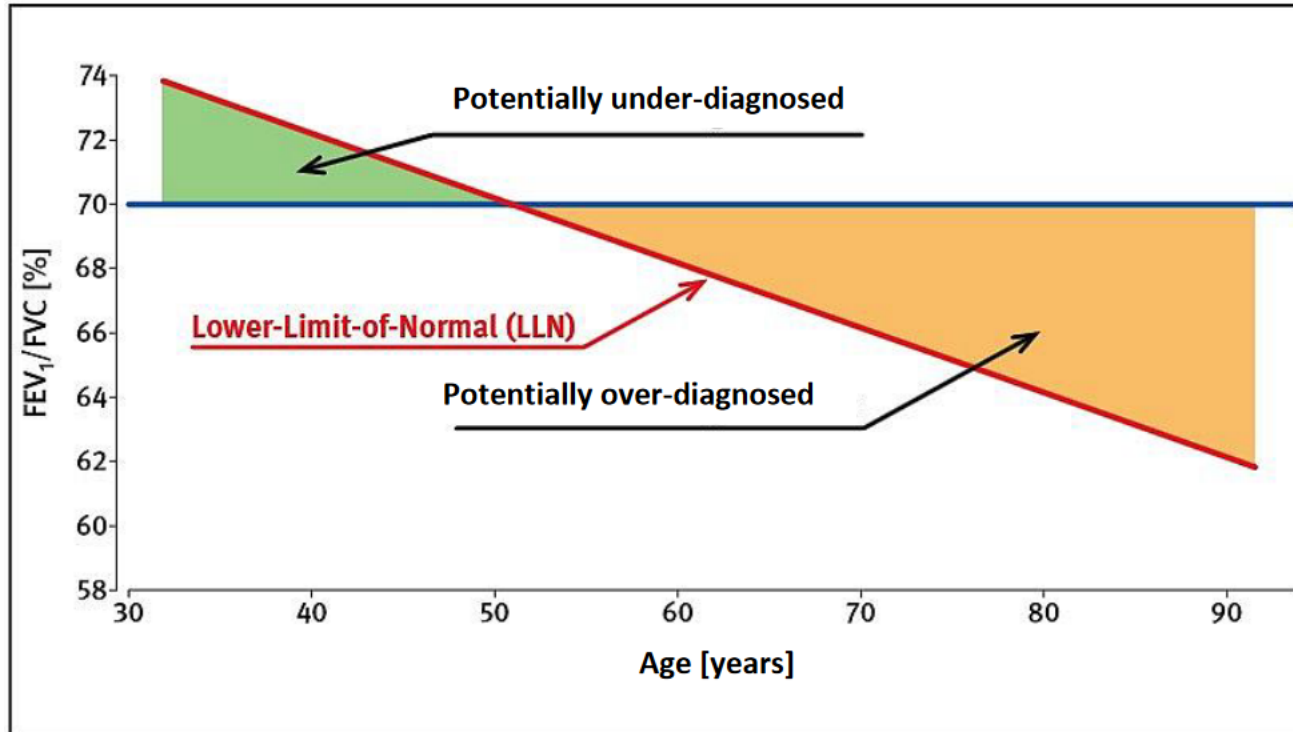


BASIC SPIROMETRY: WHAT IS NORMAL?

- United Kingdom: FEV1 between 80-120%, FEV1/FVC 75-80%, and PEFr \geq 80% of the calculated normal for age, sex, and height
- Canada: Exact number not specified in aeromedical guidelines
- Denmark: FEV1/FVC ratio greater than 70%
- Netherlands: FEV1/FVC ratio greater than 70%
- United States: Exact number not specified in aeromedical guidelines
- Germany: FEV1/FVC ratio greater than 70%
- Italy: Exact number not specified in aeromedical guidelines
- Belgium: Exact number not specified in aeromedical guidelines
- France: Exact number not specified in aeromedical guidelines



BASIC SPIROMETRY: WHAT IS NORMAL?





BELGIUM

	Belgium
NUMBER OF APPLICANTS	115
AVERAGE AGE	20.33 (SD=3.61)
AGE RANGE (YRS)	16-33
HEIGHT (CM)	179 (SD=6.86)
WEIGHT (KG)	69.96 (SD=7.9)
BMI	21.76 (SD=2.11)
BODY FAT (%)	13.45 (SD=4.66)

Belgian PFT Descriptive Statistics				
Entire Population				
Variable	N	Range	M (SD)	95% CI
Age	115	16 - 33	20.33 (3.61)	[19.66, 21]
Length (cm)	115	164 - 202.5	179 (6.86)	[177.73, 180.27]
Weight (kg)	114	52.6 - 93.6	69.96 (7.9)	[68.49, 71.42]
Fat%	115	3.8 - 33	13.45 (4.66)	[12.59, 14.31]
BMI	115	17.6 - 27.7	21.76 (2.11)	[21.37, 22.15]
FVC	115	3.29 - 8.68	5.54 (0.85)	[5.38, 5.7]
FVC%	115	80.95 - 148.85	105.66 (10.82)	[103.66, 107.66]
FEV1	115	1.07 - 6.62	4.52 (0.71)	[4.39, 4.65]
FEV1%	115	80.43 - 135.67	101.37 (9.22)	[99.66, 103.07]
FEV1/FVC (%)	115	65.17 - 115.84	89.05 (10.54)	[87.11, 91]
PEF	115	5.44 - 14.17	9.01 (1.54)	[8.73, 9.3]
PEF%	114	66.59 - 135.23	96.57 (14.89)	[93.8, 99.33]

Note. M = Mean, SD = Standard Deviation, CI = Confidence Interval



CANADA

	Canada
NUMBER OF APPLICANTS	1207
AVERAGE AGE	23.82 (SD=5.53)
AGE RANGE (YRS)	16-54
HEIGHT (CM)	177.71 (SD=6.81)
WEIGHT (KG)	78.74 (SD=12.38)
BMI	24.91 (SD=3.56)
BODY FAT (%)	Unknown

Canada PFT Fit Descriptive Statistics

Entire Fit Population				
Variable	N	Range	M (SD)	95% CI
Age (Years)	1,207	16 - 54	23.82 (5.53)	[23.51, 24.14]
Height (cm)	1,207	153 - 199	177.71 (6.81)	[177.33, 178.1]
Weight(Kg)	1,207	48 - 128.5	78.74 (12.38)	[78.04, 79.44]
BMI	1,207	17.26 - 41.18	24.91 (3.56)	[24.71, 25.11]
VCSOLL	1,207	3.23 - 9.24	5.75 (0.89)	[5.7, 5.8]
VCIST	1,207	3.34 - 6.79	5.4 (0.56)	[5.37, 5.43]
VCPROZ	1,207	75.9 - 154.5	106.07 (11.69)	[105.41, 106.73]
FVCSOLL	1,207	3.19 - 9.16	5.73 (0.86)	[5.69, 5.78]
FVCIST	1,207	3.34 - 7.26	5.4 (0.57)	[5.36, 5.43]
FVCPROZ	1,207	77 - 148.4	105.82 (11.03)	[105.19, 106.44]
FEV1SOLL	1,207	2.71 - 6.91	4.69 (0.64)	[4.66, 4.73]
FEV1IST	1,207	2.88 - 5.94	4.49 (0.44)	[4.46, 4.51]
FEV1PROZ	1,207	76.2 - 146.9	104.23 (10.17)	[103.65, 104.8]
FEV1/FVCSOLL	1,207	57 - 98	82.23 (5.71)	[81.91, 82.56]
FEV1/FVCIST	1,207	77 - 99	83.57 (1.6)	[83.48, 83.66]
FEV1/FVCPROZ	1,207	67.1 - 115	98.01 (6.72)	[97.63, 98.39]
MEF 25	1,207	4.4 - 15	9.01 (1.57)	[8.92, 9.09]
MEF50	1,207	2.53 - 11.27	5.53 (1.28)	[5.46, 5.6]
MEF75	1,207	0.77 - 5.35	2.33 (0.68)	[2.29, 2.37]

Note. M = Mean, SD = Standard Deviation, CI = Confidence Interval



GERMANY

	Germany
NUMBER OF APPLICANTS	1,273
AVERAGE AGE	20.26 (SD=3.65)
AGE RANGE (YRS)	15-45
HEIGHT (CM)	180.27 (SD=6.71)
WEIGHT (KG)	75.42 (SD=9.8)
BMI	23.18 (SD=2.51)
BODY FAT (%)	Unknown

German PFT Fit Descriptive Statistics				
Entire Population				
Variable	N	Range	M (SD)	95% CI
AGE (years)	1,273	15 - 45	20.26 (3.65)	[20.06, 20.46]
HEIGHT (cm)	1,270	160.8 - 199.4	180.27 (6.71)	[179.9, 180.64]
WEIGHT (kg)	1,270	50.9 - 115.4	75.42 (9.8)	[74.88, 75.96]
BMI	1,270	17.95 - 32.3	23.18 (2.51)	[23.04, 23.32]
VCSOLL	1,273	3.31 - 6.88	5.5 (0.57)	[5.46, 5.53]
VCIST	1,273	2.91 - 7.37	5.37 (0.73)	[5.33, 5.41]
VCPROZ	1,273	11.6 - 135.5	97.79 (11.77)	[97.15, 98.44]
FVCSOLL	1,273	3.27 - 7.1	5.42 (0.56)	[5.39, 5.46]
FVCIST	1,273	3.02 - 7.74	5.44 (0.74)	[5.4, 5.48]
FVCPROZ	1,273	65 - 134.8	100.44 (11.44)	[99.81, 101.07]
FEV1SOLL	1,273	2.78 - 5.86	4.55 (0.45)	[4.53, 4.58]
FEV1IST	1,273	2.52 - 6.81	4.62 (0.61)	[4.59, 4.66]
FEV1PROZ	1,273	68.9 - 144.9	101.93 (12.15)	[101.27, 102.6]
FEV1/FVC SOLL	1,273	0.8 - 0.88	0.84 (0.01)	[0.84, 0.84]
FEV1/FVC IST	1,273	0.62 - 1	0.85 (0.07)	[0.85, 0.86]
FEV1/FVC PROZ	1,273	0.73 - 1.21	1.02 (0.08)	[1.01, 1.02]
EV1ZUEV	1,273	0 - 99.99	83.88 (13.02)	[83.16, 84.59]
MEF25	1,273	3 - 250.8	100.11 (30.95)	[98.41, 101.81]

Note. M = Mean, SD = Standard Deviation, CI = Confidence Interval



NETHERLANDS

	Netherlands
NUMBER OF APPLICANTS	143
AVERAGE AGE	27.09 (SD=6.69)
AGE RANGE (YRS)	17-49
HEIGHT (CM)	180.55 (SD=7.58)
WEIGHT (KG)	Unknown
BMI	Unknown
BODY FAT (%)	Unknown

Dutch PFT Fit Descriptive Statistics				
Entire Population				
Variable	N	Range	M (SD)	95% CI
Age (Years)	143	17.4 - 49	27.09 (6.69)	[25.99, 28.2]
Length (cm)	143	159 - 205	180.55 (7.58)	[179.29, 181.8]
FVC	143	2.81 - 8.02	5.39 (0.99)	[5.22, 5.55]
FVC%	143	72 - 139	105.36 (11.74)	[103.42, 107.3]
FEV1	143	2.54 - 6.54	4.33 (0.79)	[4.2, 4.46]
FEV1%	143	66.8 - 130.7	100.85 (11.67)	[98.92, 102.78]
FEV1/FVC (%)	143	62.5 - 97.7	79.71 (6.7)	[78.6, 80.82]
PEF	143	5.56 - 14.44	9.74 (1.77)	[9.45, 10.04]
PEF%	143	73.3 - 133.8	101.73 (13.09)	[99.57, 103.9]

Note. M = Mean, SD = Standard Deviation, CI = Confidence Interval



UNITED STATES

- Major caveat, pilot applicants in US only undergo screening spirometry if they have history of childhood asthma or inhaler use or were born premature

	United States
NUMBER OF APPLICANTS	342
AVERAGE AGE	23.02 (SD=3.54)
AGE RANGE (YRS)	20-55
HEIGHT (CM)	176.94 (SD=7.37)
WEIGHT (KG)	76.34 (SD=10.22)
BMI	24.33 (SD=2.49)
BODY FAT (%)	Unknown

US PFT Descriptive Statistics				
Entire Fit Population				
Variable	N	Range	M (SD)	95% CI
AGE	342	20 - 55	23.02 (3.54)	[22.64, 23.39]
Ht (cm)	342	157 - 193	176.94 (7.37)	[176.16, 177.73]
WT (kg)	342	45 - 115	76.34 (10.22)	[75.25, 77.43]
BMI	342	17.91 - 32.89	24.33 (2.49)	[24.07, 24.59]
FEV1	342	2.93 - 6.37	4.52 (0.67)	[4.45, 4.59]
FVC	342	3.18 - 7.9	5.61 (0.9)	[5.51, 5.71]
PRE_FVC_P	342	3.51 - 6.65	5.42 (0.67)	[5.35, 5.49]
PRE_FVC_%PT	342	73 - 145	103.15 (11.28)	[101.95, 104.35]
FEF2575	342	1.73 - 7.17	4.31 (0.94)	[4.21, 4.41]
FEF75	342	0.81 - 4.88	2.2 (0.65)	[2.13, 2.27]



DENMARK

	Denmark
NUMBER OF APPLICANTS	94
AVERAGE AGE	22.98 (SD=2.41)
AGE RANGE (YRS)	19-31
HEIGHT (CM)	181.11 (SD=5.52)
WEIGHT (KG)	75.19 (SD=6.73)
BMI	22.94 (SD=2.03)
BODY FAT (%)	Unknown

Danish PFT Medically Cleared to Fly Descriptive Statistics

Variable	Entire Population			
	N	Range	M (SD)	95% CI
Age (Years)	94	19 - 31	22.98 (2.41)	[22.49, 23.47]
Height (cm)	94	168 - 192	181.11 (5.52)	[179.98, 182.24]
Weight(Kg)	94	59 - 89	75.19 (6.73)	[73.82, 76.57]
BMI	94	19.11 - 27.59	22.94 (2.03)	[22.53, 23.36]
Peakflow	94	423 - 901	638.69 (93.09)	[619.62, 657.76]
FEV1	94	3.68 - 6.58	4.86 (0.64)	[4.72, 4.99]
FVC	94	4.32 - 8.25	5.98 (0.76)	[5.83, 6.14]
Ratio FEV1 FVC	94	0.65 - 0.94	0.81 (0.06)	[0.8, 0.82]

Note. M = Mean, SD = Standard Deviation, CI = Confidence Interval



FINLAND

	Finland
NUMBER OF APPLICANTS	305
AVERAGE AGE	33.79 (SD=6.92)
AGE RANGE (YRS)	23-53
HEIGHT (CM)	179.21 (SD=5.19)
WEIGHT (KG)	80.26 (SD=8.54)
BMI	24.97 (SD=2.26)
BODY FAT (%)	Unknown

Finland PFT Descriptive Statistics

Entire Fit Population

Variable	N	Range	M (SD)	95% CI
AGE (years)	305	23 - 53	33.79 (6.92)	[33.01, 34.57]
HT (cm)	305	166 - 193	179.21 (5.19)	[178.63, 179.79]
WT (kg)	305	58 - 113	80.26 (8.54)	[79.3, 81.22]
FVC	305	3.89 - 8.69	5.76 (0.73)	[5.68, 5.85]
FEV1	305	2.87 - 6.09	4.46 (0.59)	[4.4, 4.53]
FEV%	305	56.45 - 95.09	77.69 (6.43)	[76.96, 78.41]
PEF	305	6.68 - 14.76	10.43 (1.46)	[10.27, 10.6]
MEF50	305	1.39 - 9.62	4.82 (1.38)	[4.67, 4.98]
FVC - ABT	305	4.05 - 8.58	5.73 (0.72)	[5.65, 5.81]
FEV1 - ABT	305	3.1 - 6.33	4.64 (0.6)	[4.57, 4.7]
FEV% - ABT	305	62.09 - 95.44	80.98 (5.84)	[80.33, 81.64]
PEF - ABT	305	6.6 - 15.34	10.6 (1.47)	[10.43, 10.76]
MEF50 - ABT	305	2.3 - 10.63	5.55 (1.49)	[5.38, 5.72]

Note. M = Mean, SD = Standard Deviation, CI = Confidence Interval



UNITED KINGDOM

- Major caveat, RTG 299 was only able to obtain limited release of data

	United Kingdom
NUMBER OF APPLICANTS	406
AVERAGE AGE	Unknown
AGE RANGE (YRS)	15-49
HEIGHT (CM)	179.41 (SD=5.92)
WEIGHT (KG)	Unknown
BMI	Unknown
BODY FAT (%)	Unknown

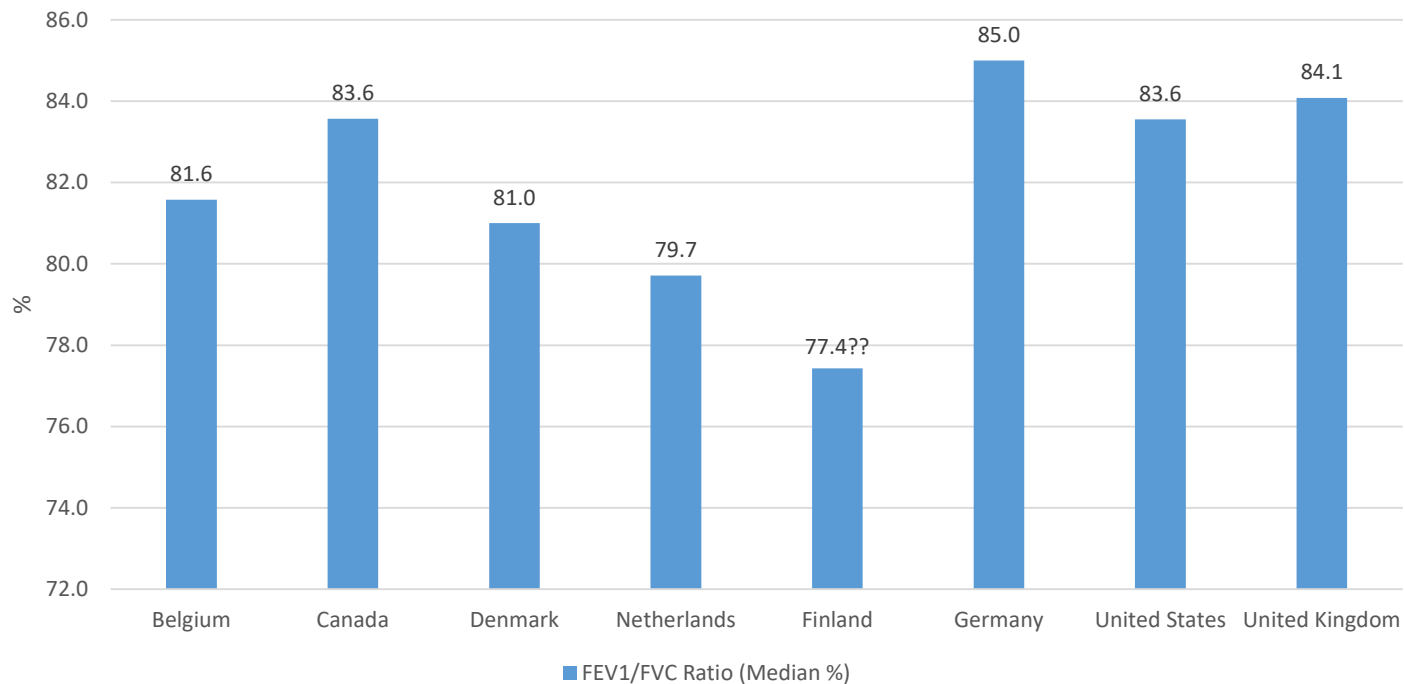
UK PFT Gender Descriptive Statistics Entire Fit Population				
Variable	N	Range	M (SD)	95% CI
Height (cm)	406	158 - 196	179.41 (5.92)	[178.83, 179.98]
Peak Flow lmin	406	97 - 938	606.38 (130.06)	[593.7, 619.07]
Forced Expiratory Volumn	406	63 - 100	84.08 (6.52)	[83.44, 84.71]

Note. M = Mean, SD = Standard Deviation, CI = Confidence Interval



FEV1/FVC

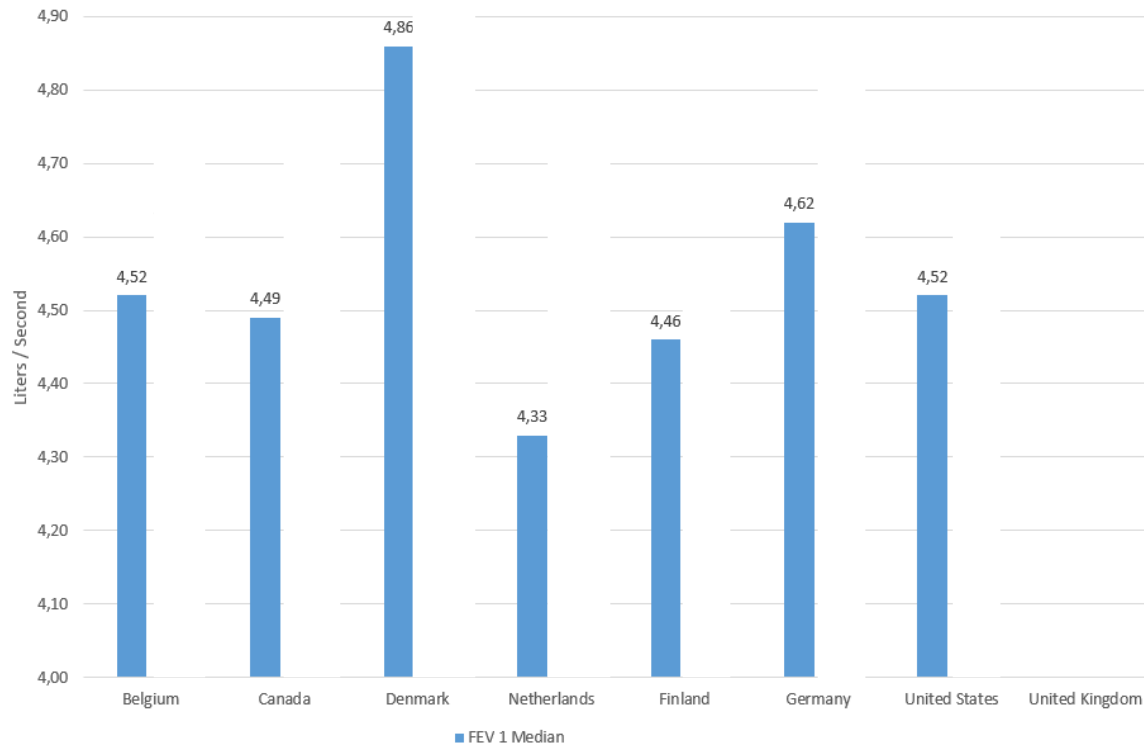
FEV1/FVC Ratio





FEV1

FEV 1

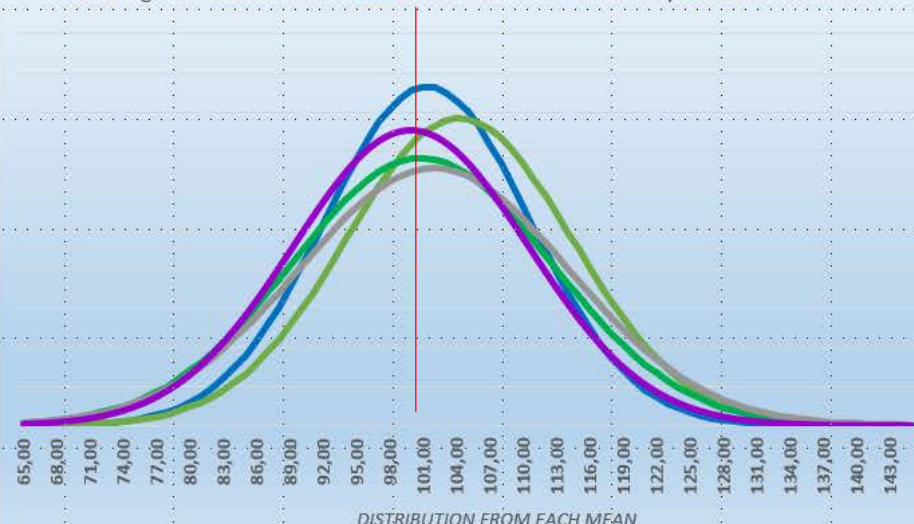




FEV1

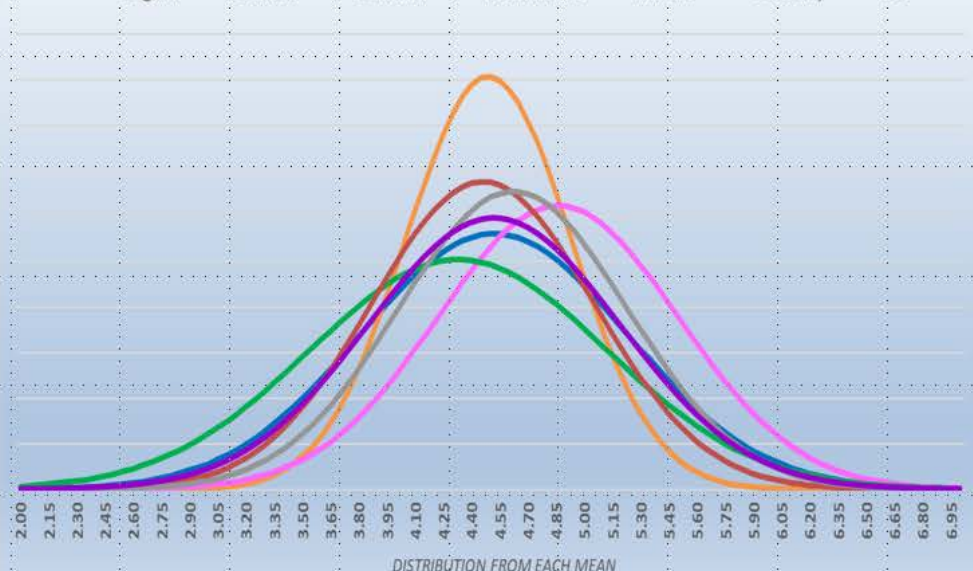
Forced Expiratory Volume 1 Second (FEV1)
Expressed As a Percent

— Belgium — Canada — Netherlands — Germany — United States



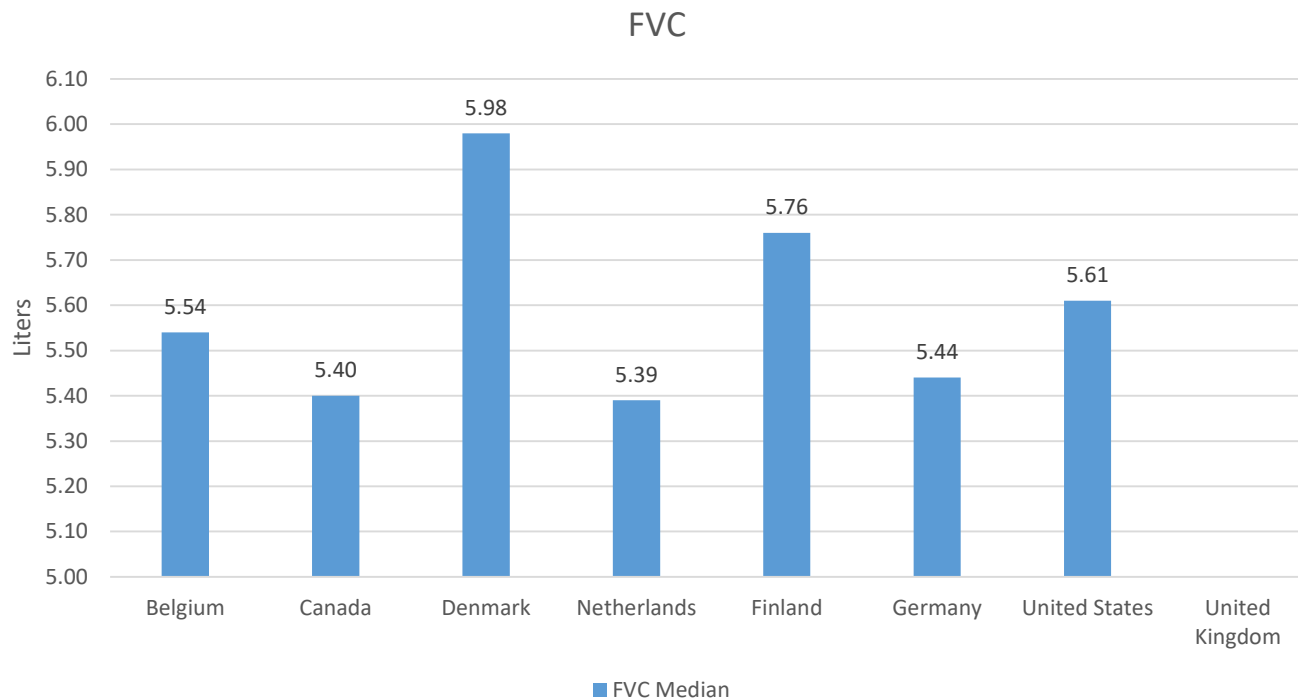
Forced Expiratory Volume 1 Second (FEV1)

— Belgium — Canada — Denmark — Netherlands — Finland — Germany — US



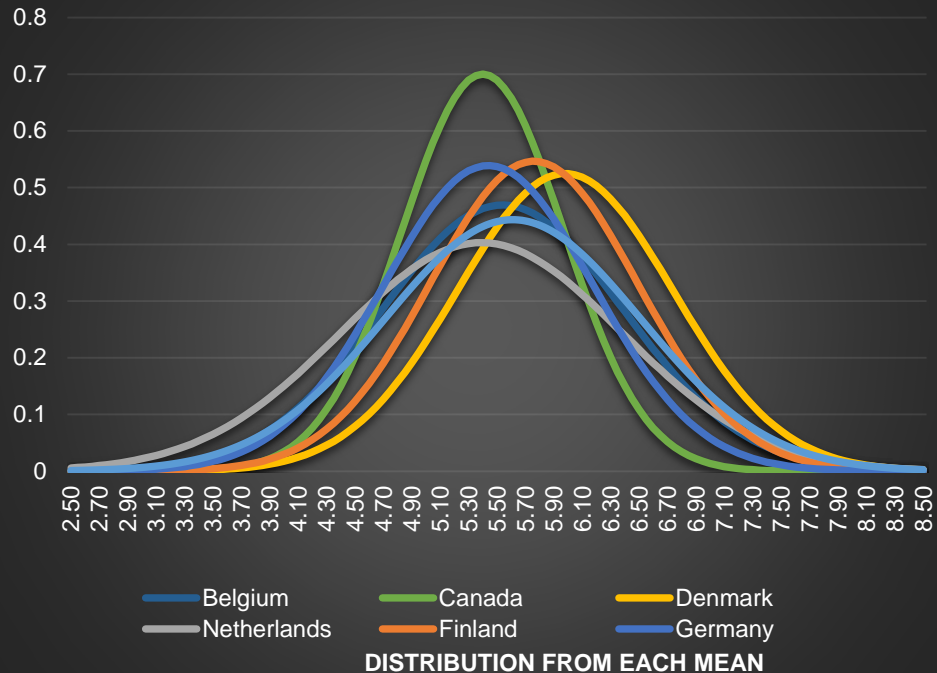


FVC

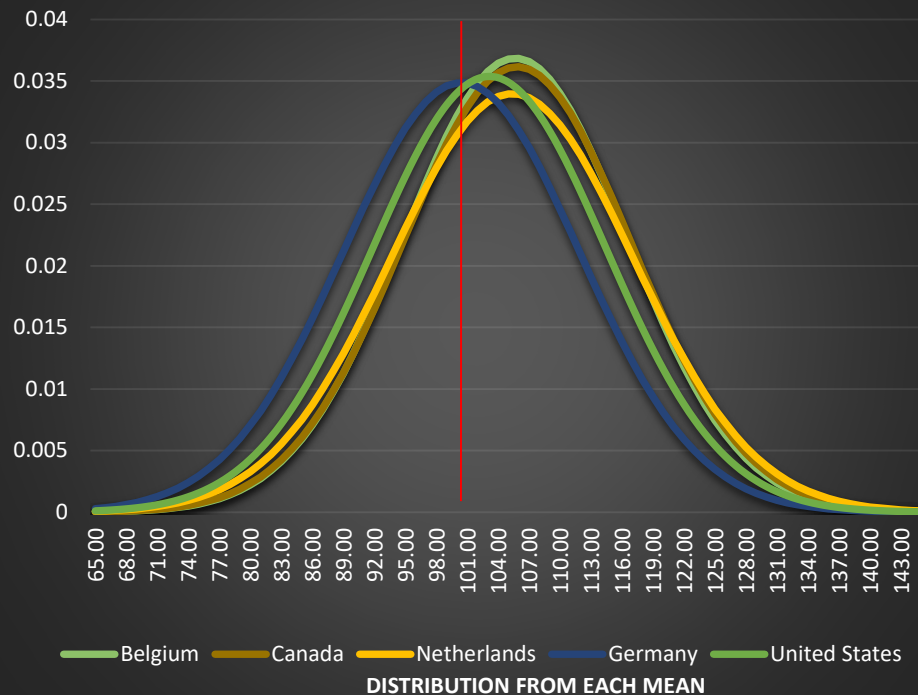




Forced Vital Capacity (FVC)



Forced Vital Capacity Expressed (FVC) As a Percent





- ❖ Medically fit aircrew applicants have a superior lung function compared to the general population.
- ❖ It is important to understand the typical anthropometrics and pulmonary function of our medically cleared pilots in order to establish pulmonary function standards, recognize deviation from norms and to mitigate aeromedical risk.

THANK YOU FOR YOUR ATTENTION!



ANY QUESTIONS?



FEV1/FVC

