# Percentile Ranking of Aerobic Capacity ($VO_2$) for Children 6-11 Years of Age

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The purpose was the development of percentile ranks for the aerobic fitness levels of children (<11 years of age) using statistical calculations from published data. All of the available published data presents children's aerobic capacities as mean data. Although a number of the published papers have relatively large numbers of subjects, a mean value does not provide the clinician with a comparative value to discuss with the parent of a child. Additionally, most reports use age ranges, such as 8-11 years, and do not report data for each year of age. However, Leger et al. published values for children in each age group from 6-11 years of age, with age groups having between 112 and 404 subjects in groups for both male and females. From this report, we calculated percentiles for aerobic capacity from the 5th to the 95th percentile for each age/sex group.

Calculations were derived from the data reported by Leger et al., using a modification of the standard equation for the z-score, the computed area under the normal curve, and the concepts within the Central Limit Theorem. The Central limit Theorem simply states that as the sample size increase, the sampling distribution take the shape of the normal curve or distribution, even if the distribution is initially skewed. From this definition, it is possible to calculate reference values.

The calculated chart developed can be used by clinicians to discuss aerobic fitness levels of children, either predicted or measured, with their parents. Additionally, the incorporation of data from a recent article by Adegboye et al., provides for discussion related to minimal aerobic capacity levels related to health and decreased disease risk in children. Because of the devastating effects that inactivity and childhood obesity are having on children, this tool provides clinicians with another avenue to address disease prevention and wellness in the physical therapy setting.

Equation 1 is the simple calculation of z-score.

**Equation 1:** **z = (X – mean) / (sd)**
**Where:** **z is the z-score**
**sd is the standard deviation for the sample**
**X is the subject's score**

Equation 2 is a rearrangement of Equation 1, isolating "X" and redefining "X" as the percentile rank.

**Equation 2:** **X = (z· sd) + mean**
**Where:** **z is the z-score**
**sd is the standard deviation for the sample**
**X is the percentile rank**

**Percentile rank and associated z-score, obtained from a table of the normal distribution**

| Percentile Rank | Associated z-score |
|---|---|
| 95 | 1.64505 |
| 90 | 1.28155 |
| 85 | 1.03645 |
| 80 | 0.84165 |
| 75 | 0.67445 |
| 70 | 0.52445 |
| 65 | 0.38535 |
| 60 | 0.25345 |
| 55 | 0.12565 |
| 50 | 0 |
| 45 | -0.12565 |
| 40 | -0.25345 |
| 35 | -0.38535 |
| 30 | -0.52445 |
| 25 | -0.67445 |
| 20 | -0.84165 |
| 15 | -1.03645 |
| 10 | -1.28155 |
| 5 | -1.64505 |

**References**

Leger LA, Mercier D, Gadoury C, Lambert J. The multistage 20 metre shuttle run test for aerobic fitness. Journal of Sport Science. 1988 Summer; 6(2):93-101.

Adegboye AR, Anderssen SA, Froberg K, Sardinha LB, Heitmann BL,Steene-Johannessen J, Kolle E, Andersen LB. Recommended aerobic fitness level formetabolic health in children and adolescents: a study of diagnostic accuracy. Br J Sports Med. 2010 Jun 17. [Epub ahead of print]

Hinkle DE, Wiersma W, Jurs S. Applied Statistics for the Behavior Sciences, 5ed. Boston: Houghton Mifflin Co. 2003.

**Reference Values for Aerobic Capacity ($VO_2$) according to sex and age**

**Males**

| Percentile Rank | Age | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|
| | Mean | 52.35 | 51.23 | 51.67 | 51.54 | 51.64 | 51.13 |
| | SD | 2.83 | 3.34 | 3.91 | 4.39 | 4.23 | 4.53 |
| | N | 121 | 297 | 303 | 322 | 404 | 386 |
| | 95 | 57.01 | 56.72 | 58.10 | 58.76 | 58.60 | 58.58 |
| | 90 | 55.98 | 55.51 | 56.68 | 57.17 | 57.06 | 56.94 |
| | 85 | 55.28 | 54.69 | 55.72 | 56.09 | 56.02 | 55.83 |
| | 80 | 54.73 | 54.04 | 54.96 | 55.23 | 55.20 | 54.94 |
| | 75 | 54.26 | 53.48 | 54.31 | 54.50 | 54.49 | 54.19 |
| | 70 | 53.83 | 52.98 | 53.72 | 53.84 | 53.86 | 53.51 |
| | 65 | 53.44 | 52.52 | 53.18 | 53.23 | 53.27 | 52.88 |
| | 60 | 53.07 | 52.08 | 52.66 | 52.65 | 52.71 | 52.28 |
| | 55 | 52.71 | 51.65 | 52.16 | 52.09 | 52.17 | 51.70 |
| | 50 | 52.35 | 51.23 | 51.67 | 51.54 | 51.64 | 51.13 |
| | 45 | 51.99 | 50.81 | 51.18 | 50.99 | 51.11 | 50.56 |
| | 40 | 51.63 | 50.38 | 50.68 | 50.43 | 50.57 | 49.98 |
| | 35 | 51.26 | 49.94 | 50.16 | 49.85 | 50.01 | 49.38 |
| | 30 | 50.87 | 49.48 | 49.62 | 49.24 | 49.42 | 48.75 |
| | 25 | 50.44 | 48.98 | 49.03 | 48.58 | 48.79 | 48.07 |
| | 20 | 49.97 | 48.42 | 48.38 | 47.85 | 48.08 | 47.32 |
| | 15 | 49.42 | 47.77 | 47.62 | 46.99 | 47.26 | 46.43 |
| | 10 | 48.72 | 46.95 | 46.66 | 45.91 | 46.22 | 45.32 |
| | 5 | 47.69 | 45.74 | 45.24 | 44.32 | 44.68 | 43.68 |

**Females**

| Percentile Rank | Age | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|
| | Mean | 51.83 | 50.26 | 49.82 | 49.2 | 46.84 | 47.51 |
| | SD | 2.25 | 2.63 | 3.44 | 3.24 | 2.76 | 4.04 |
| | N | 112 | 299 | 308 | 322 | 335 | 382 |
| | 95 | 55.53 | 54.59 | 55.48 | 54.53 | 51.38 | 54.16 |
| | 90 | 54.71 | 53.63 | 54.23 | 53.35 | 50.38 | 52.69 |
| | 85 | 54.16 | 52.99 | 53.39 | 52.56 | 49.70 | 51.70 |
| | 80 | 53.72 | 52.47 | 52.72 | 51.93 | 49.16 | 50.91 |
| | 75 | 53.35 | 52.03 | 52.14 | 51.39 | 48.70 | 50.23 |
| | 70 | 53.01 | 51.64 | 51.62 | 50.90 | 48.29 | 49.63 |
| | 65 | 52.70 | 51.27 | 51.15 | 50.45 | 47.90 | 49.07 |
| | 60 | 52.40 | 50.93 | 50.69 | 50.02 | 47.54 | 48.53 |
| | 55 | 52.11 | 50.59 | 50.25 | 49.61 | 47.19 | 48.02 |
| | 50 | 51.83 | 50.26 | 49.82 | 49.20 | 46.84 | 47.51 |
| | 45 | 51.55 | 49.93 | 49.39 | 48.79 | 46.49 | 47.00 |
| | 40 | 51.26 | 49.59 | 48.95 | 48.38 | 46.14 | 46.49 |
| | 35 | 50.96 | 49.25 | 48.49 | 47.95 | 45.78 | 45.95 |
| | 30 | 50.65 | 48.88 | 48.02 | 47.50 | 45.39 | 45.39 |
| | 25 | 50.31 | 48.49 | 47.50 | 47.01 | 44.98 | 44.79 |
| | 20 | 49.94 | 48.03 | 46.92 | 46.46 | 44.52 | 44.11 |
| | 15 | 49.50 | 47.53 | 46.25 | 45.84 | 43.98 | 43.32 |
| | 10 | 48.95 | 46.89 | 45.41 | 45.05 | 43.30 | 42.33 |
| | 5 | 48.13 | 45.93 | 44.16 | 43.87 | 42.30 | 40.86 |

Hard copy of reference values is available upon request.