The Relationship of Handgrip to Body Composition and Cardiopulmonary Fitness in Children and Adults with Congenital Heart Disease

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Introduction

- Handgrip Strength (HGS) is a quantitative measure of muscle function. It is non-invasive, inexpensive, and fast to obtain.
- HGS is a risk factor for unfavorable health outcomes and is associated with all-cause mortality and cardiovascular diseases (CVD) in both adults and adolescents.
- Functional exercise capacity and physical reserves are often reduced and place children and adults with congenital heart disease (CHD) at risk for hospitalization or death.
- Normal values for HGS by CHD lesion do not exist.
- HGS has been incompletely compared to body composition, functional status, and cardiopulmonary fitness in patients with CHD.

Objectives

- Describe HGS values by lesion in a cohort of youth and adults with known CHD
- Assess the relationship of HGS with markers of fitness on Cardiopulmonary Exercise Testing (CPET) and body composition assessed by Bioelectric Impedance Analysis (BIA) and NYHA functional status in youth and adults with CHD.

Methods

- Single-site
- Retrospective chart review of all patients from January 2020 to June 2023 who completed HGS, BIA, and CPET
- 2871 participants
- Each participant underwent HGS testing, bioelectrical impedance body composition analysis (BIA), and CPET.
- Handgrip for each participant was compared to age and sex matched normative values.
- Complexity by diagnostic subtype was determined AHA criteria
- Comparisons by lesion and complexity were analyzed with linear regression, Pearson's Chi Squared, Kruskal-Wallis rank sum, Fisher Exact and Wilcoxon rank sum test.

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Diagnosis	Male (%)	Age (yrs)	BMI (kg/m^2)	Dom HGS (kg)	Dom HGS (Z-Score)	pVO$_2$ (% Predicted)	SMM (kg)
Aortic Coarctation (n=94)	53%	22.5 (16.6-32.1)	25.8 (21.8-28.9)	36.0 (29.0-47.0)	0.1 (-0.5, 0.7)	80 (71-92)	30.3 (23.5-33.7)
Arterial Switch (n-49)	69%	17.6 (3.6-22.0)	22.9 (19.0-27.1)	32.0 (22.0-41.0)	-0.3 (-1.0, 0.3)	83.0 (68.0-92.0)	27.6 (22.4-32.0)
ASD (n=5)	20%	40.9 (26.3-43.5)	24.3 (22.4, 27.5)	31.0 (30.0, 32.0)	0.2 (-0.2, 0.8)	82.0 (75.0, 82.0)	24.8 (20.5, 25.6)
AVSD (n=23)	30%	27.9 (20.1, 36.4)	28.4 (24.6, 31.4)	33.0 (24.0, 40.0)	0.0 (-0.8, 0.6)	73.0 (64.0, 95.0)	27.2 (21.2, 30.1)
ccTGA (n=21)	81%	25.2 (22.4, 43.3)	24.2 (23.2, 27.5)	45.0 (34.0, 50.0)	0.1 (-0.4, 0.3)	73.9 (62.2, 81.1)	32.7 (27.5, 35.9)
Coronary Artery Anomaly (n=51)	61%	16.8 (13.6, 21.6)	26.1 (17.3, 32.7)	34.0 (22.0, 51.0)	0.0 (-0.8, 0.7)	89.0 (80.6, 94.0)	29.9 (21.6, 36.5)
DORV (n=23)	74%	15.4 (12.2, 32.5)	25.2 (17.9, 27.3)	26.0 (20.0, 36.0)	-0.6 (-1.3, 0.1)	85.0 (68.6, 87.0)	21.1 (17.6, 31.2)
Ebstein (n=23)	59%	23.8 (17.2, 36.0)	25.9 (21.5, 28.5)	32.0 (28.0, 51.0)	0.1 (-0.2, 0.7)	88.4 (74.9, 95.5)	26.1 (22.0, 35.0)
Fontan (n=213)	51%	20.5 (16.0, 26.9)	24.1 (20.7, 28.0)	30.0 (24.0, 38.0)	-0.4 (-1.0, 0.1)	81.0 (69.0, 86.9)	25.0 (20.8, 29.7)
Mustard (n=28)	61%	37.1 (34.4, 43.8)	26.2 (23.8, 30.0)	41.5 (30.0, 51.5)	0.1 (-0.3, 0.7)	89.0 (78.9, 93.0)	32.1 (25.4, 36.5)
PAPVR (n=16)	50%	36.6 (24.8, 46.7)	28.6 (26.2, 31.3)	34.0 (32.0, 41.0)	0.1 (-0.6, 0.9)	87.5 (79.6, 90.6)	26.7 (23.8, 36.7)

Table 1: Results of handgrip, bioelectrical impedance analysis, and cardiopulmonary exercise testing by CHD diagnostic subtype. Data presented as mean ± standard deviation [range].

	Medium Complexity (n=540)	High Complexity (n=357)	P Value
Age (yr)	21.8 (16.6, 32.5)	21.0 (15.6, 29.7)	0.062
Weight (kg)	72.9 (58.5, 87.8)	67.4 (55.1, 80.0)	<0.001
BMI (kg/m^2)	25.5 (21.6, 30.1)	24.1 (20.7, 27.7)	0.002
SMM (kg)	28.1 (22.4, 34.4)	26.2 (21.4, 31.3)	<0.001
Dom HGS (kg)	34.0 (26.0, 45.0)	31.0 (24.0, 40.0)	<0.001
Dom HGS (Z-Score)	0.02	-0.42	<0.001
pVO$_2$ (per kg)	27.0 (21.0, 34.0)	25.0 (21.0, 30.0)	<0.001
pVO$_2$ (% Predicted)	80.0 (68.0, 94.0)	70.0 (60.0, 83.0)	<0.001
Moderate / Severe Dysfunction (%)	1.1%	8.7%	<0.001

Table 2: Results of handgrip, bioelectrical impedance analysis, and cardiopulmonary exercise testing by moderate vs great complexity CHD diagnostic subtype. Data presented as mean ± standard deviation [range].

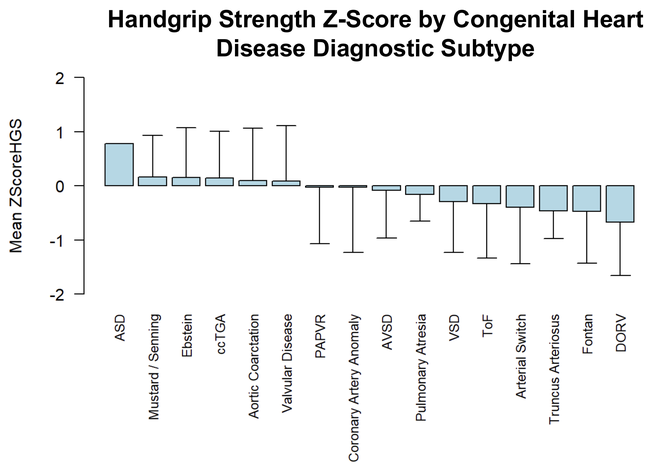

Figure 1: Peak dominant handgrip strength Z score by CHD diagnostic subtype.

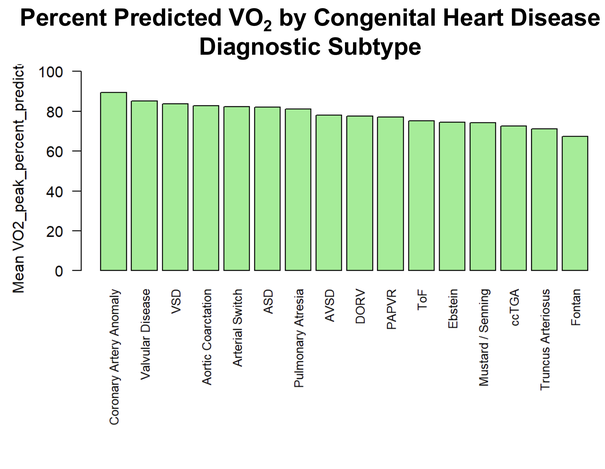

Figure 2: Average percent predicted VO$_2$ CHD diagnostic subtype

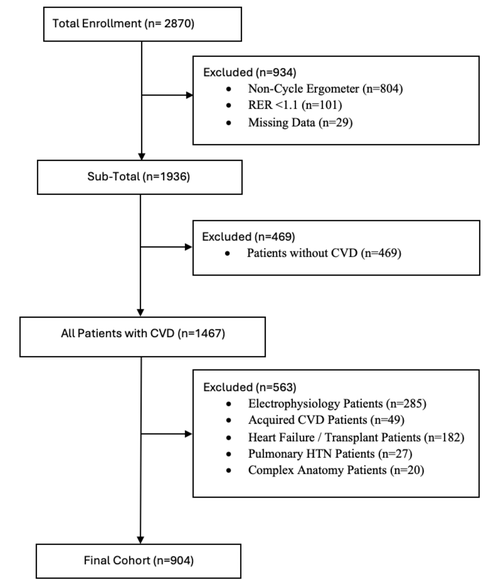

Figure 3: Flowsheet of total enrollment with application of the exclusion criteria to demonstrate cohort selection.

Results

- Following application of our inclusion/exclusion criteria there were 918 participants (average age 24.5 yrs; 34% <18 years, 56% male) included in the analysis.
- Normative values for HGS, BIA, CPET were determined by diagnostic subtype (Table 1)
- HGS, BIA, and CPET between medium and high complexity diagnostic subtypes were compared (Table 2).
- Greater CHD complexity was associated with a decreased HGS Z Score (simple: n = 7, HGS Z Score =0.49; moderate: n = 540, HGS Z Score = 0.03; great: n=371, HGS Z Score = -0.42).
- Compared to those with great CHD complexity, participants with moderate complexity CHD had higher peak dominant HGS, HGS Z Score, skeletal muscle mass, peak VO2 (oxygen consumption), peak predicted VO2, and peak VO2/kg, (p<0.001).

Conclusion

- This study provides normal values for HGS by lesion for youth and adults with CHD. Participants with CHD have lower HGS than their age and sex matched non-CHD peers. Predictably, participants with greater complexity CHD have lower muscular strength, muscular mass, and exercise capacity compared to those with moderate complexity CHD.