**Supplemental Table 1.** Clinical Characteristics of Elite Male and Female Strength Athletes and Non-Elite Controls in the 2-Minute Sit-Up Exercise

|  |  |  |  |
| --- | --- | --- | --- |
|  | Male Athletes(N =580) |  | Female Athletes(N =79) |
| Clinical characteristics | Elite(≥51 numbers)(N =93) | Non-elite controls(<51 numbers)(N =487) | p-value |  | Elite(≥50 numbers)(N =14) | Non-elite controls (<50 numbers)(N =65) | p-value |
| Age (years) |  25.13 ± 3.69 |  25.21 ± 3.73 | 0.85 |  |  23.79 ± 2.94 |  24.05 ± 2.90 | 0.76 |
| (Range: min – max, median) | (19 – 33, 25) | (19 – 34, 25) |  |  | (21 – 30, 23) | (20 – 30, 24) |  |
| 2-min sit-ups (numbers) |  59.34 ± 6.85 |  43.26 ± 5.59 | <0.001 |  |  53.57 ± 4.92 |  36.29 ± 6.06 | <0.001 |
|  (Range: min – max, median) | (51 – 80, 60) | (20 – 50, 44) |  |  | (50 – 62, 50) | (20 – 45, 36) |  |
| Height (cm) | 171.57 ± 5.53 | 172.16 ± 5.62 | 0.35 |  | 160.52 ± 7.78 | 160.17 ± 4.82 | 0.82 |
| (Range: min – max, median) | (158.7 – 186.1, 171.1) | (156.3 – 187.6, 172.3) |  |  | (151.0 – 176.0, 158.8) | (149.7 – 174.1, 159.5) |  |
| Weight (kg) |  71.09 ± 10.02 |  72.59 ± 11.59 | 0.24 |  |  60.67 ± 11.09 |  59.39 ± 7.87 | 0.61 |
| (Range: min – max, median) | (48.9 – 96.0, 70.1) | (48.8 – 118, 71.9) |  |  | (42.6 – 77.6, 62.5) | (44.4 – 80.0, 58.2) |  |
| Body surface area (m2) |  1.83 ± 0.14 |  1.85 ± 0.16 | 0.24 |  |  1.64 ± 0.18 |  1.62 ± 0.11 | 0.65 |
| (Range: min – max, median) | (1.48 – 2.18, 1.83) | (1.47 – 2.44, 1.85) |  |  | (1.37 – 1.94, 1.68) | (1.38 – 1.93, 1.61) |  |
| Waist circumference (cm) |  80.59 ± 8.01 |  82.21 ± 8.93 | 0.24 |  |  74.92 ± 10.27 |  75.65 ± 7.19 | 0.75 |
| (Range: min – max, median) | (65 – 100, 80) | (60 – 109, 81) |  |  | (58 – 93, 75) | (64 – 92, 74) |  |
| Systolic blood pressure (mmHg) |  116.14 ± 11.35 |  117.29 ± 11.91 | 0.38 |  |  110.57 ± 13.11 |  104.88 ± 10.11 | 0.07 |
| (Range: min – max, median) | (85 – 150, 116) | (84 – 166, 117) |  |  | (99 – 147, 106) | (86 – 133, 102) |  |
| Diastolic blood pressure (mmHg) |  65.98 ± 8.70 |  68.35 ± 8.69 | 0.01 |  |  64.64 ± 10.73 |  63.11 ± 6.32 | 0.47 |
| (Range: min – max, median) | (40 – 88, 66) | (42 – 106, 68) |  |  | (42 – 86, 63) | (50 – 87, 62) |  |
| Blood test |  |  |  |  |  |  |  |
| Serum creatinine (mg/dL) |  0.97 ± 0.11 |  0.94 ± 0.10 | 0.04 |  |  0.68 ± 0.08 |  0.69 ± 0.07 | 0.92 |
| (Range: min – max, median) | (0.73 – 1.43, 0.97) | (0.64 – 1.47, 0.94) |  |  | (0.57 – 0.83, 0.70) | (0.48 – 0.88, 0.68) |  |
| Total cholesterol (mg/dL) |  170.67 ± 34.37 |  168.07 ± 33.10 | 0.49 |  |  173.29 ± 23.99 |  167.28 ± 25.30 | 0.41 |
| (Range: min – max, median) | (94 – 303, 167) | (85 – 346, 165) |  |  | (128 – 206, 172) | (116 – 232, 164) |  |
| HDL-C (mmol/L) |  51.41 ± 11.21 |  48.98 ± 9.22 | 0.02 |  |  57.43 ± 8.74 |  63.23 ± 11.70 | 0.08 |
| (Range: min – max, median) | (27 – 79, 50) | (26 – 82, 49) |  |  | (43 – 73, 58) | (30 – 98, 63) |  |
| LDL-C (mmol/L) |  104.56 ± 30.45 |  104.08 ± 30.32 | 0.88 |  |  95.79 ± 21.23 |  91.57 ± 20.62 | 0.49 |
| (Range: min – max, median) | (35 – 199, 101) | (30 – 254, 100) |  |  | (60 – 145, 96) | (45 – 165, 90) |  |
| Serum triglyceride (mg/dL) |  94.40 ± 68.46 |  97.50 ± 67.44 | 0.68 |  |  91.00 ± 60.68 |  59.58 ± 20.91 | <0.001 |
| (Range: min – max, median) | (34 – 547, 77) | (31 – 566, 77) |  |  | (32 – 213, 62) | (25 – 157, 59) |  |
| Fasting plasma glucose (mg/dL) |  93.66 ± 9.64 |  93.05 ± 8.87 | 0.55 |  |  95.07 ± 9.77 |  91.35 ± 7.42 | 0.11 |
| (Range: min – max, median) | (66 – 143, 94) | (65 – 155, 93) |  |  | (88 – 126, 91) | (64 – 105, 91) |  |
| Hemoglobin (g/dL) |  15.22 ± 0.96 |  15.29 ± 0.90 | 0.55 |  |  12.65 ± 1.38 |  12.97 ± 0.96 | 0.31 |
| (Range: min – max, median) | (12.6 – 17.6, 15.2) | (12.1 – 17.6, 15.3) |  |  | (9.7 – 14.5, 12.9) | (10.1 – 14.7, 13.0) |  |

Continuous variables are expressed as mean ± standard deviation, and categorical variables as n [%]

Abbreviations: HDL-C, high-density lipoprotein cholesterol; LDL-C, low-density lipoprotein cholesterol.

**Supplemental Table 2.** Electrocardiographic Characteristics of Elite Male and Female Strength Athletes and Non-Elite Controls in the 2-Minute Sit-Up Exercise

|  |  |  |  |
| --- | --- | --- | --- |
|  | Male Athletes(N =580) |  | Female Athletes(N =79) |
| ECG characteristics | Elite(≥51 numbers)(N =93) | Control(<51 numbers)(N =487) | p-value |  | Elite(≥50 numbers)(N =14) | Control(<50 numbers)(N =65) | p-value |
| Heart rate (beats/min) |  65.82 ± 11.67 |  65.97 ± 10.62 | 0.89 |  |  67.50 ± 11.07 |  68.74 ± 9.46 | 0.66 |
|  (Range: min – max, median) | (42 – 105, 65) | (38 – 105, 65) |  |  | (52 – 95, 67) | (50 – 90, 70) |  |
| P duration (ms) |  107.88 ± 13.15 |  105.56 ± 14.39 | 0.14 |  |  99.74 ± 11.50 |  99.12 ± 13.72 | 0.87 |
|  (Range: min – max, median) | (68 – 148, 106) | (56 – 184, 106) |  |  | (78 – 118, 106) | (54 – 122, 104) |  |
| PR interval (ms) |  157.38 ± 26.14 |  154.45 ± 17.94 | 0.18 |  |  147.75 ± 21.17 |  151.86 ± 20.10 | 0.49 |
|  (Range: min – max, median) | (96 – 342, 157) | (74 – 248, 157) |  |  | (98 – 148, 157) | (110 – 208, 156) |  |
| QRS duration (ms) |  98.19 ± 10.18 |  97.30 ± 10.00 | 0.43 |  |  84.29 ± 5.42 |  85.88 ± 7.80 | 0.47 |
|  (Range: min – max, median) | (84 – 140, 96) | (70 – 140, 96) |  |  | (78 – 94, 84) | (64 – 102, 86) |  |
| QTc interval (ms) |  393.10 ± 27.15 |  387.43 ± 21.36 | 0.02 |  |  408.14 ± 17.33 |  411.89 ± 30.62 | 0.66 |
|  (Range: min – max, median) | (346 – 503, 391) | (338 – 494, 386) |  |  | (384 – 438, 405) | (354 – 526, 411) |  |
| QRS axis (degree) |  64.76 ± 23.86 |  65.29 ± 28.42 | 0.86 |  |  72.43 ± 13.60 |  64.11 ± 34.79 | 0.38 |
|  (Range: min – max, median) | (-38 – 109, 68) | (-76 – 244, 70) |  |  | (58 – 107, 69) | (-66 – 119, 71) |  |

Categorical variables are expressed as N [%].

**Supplemental Table 3.** Echocardiographic Characteristics of Elite Male and Female Strength Athletes and Non-Elite Controls in the 2-Minute Sit-Up Exercise

|  |  |  |  |
| --- | --- | --- | --- |
|  | Male Athletes(N =580) |  | Female Athletes(N =79) |
| Echocardiographic characteristics | Elite(≥51 numbers)(N =93) | Control(<51 numbers)(N =487) | p-value |  | Elite(≥50 numbers)(N =14) | Control(<50 numbers)(N =65) | p-value |
| Aortic valve open (mm), PLAX |  20.53 ± 1.72 |  20.35 ± 1.85 | 0.38 |  |  19.93 ± 2.05 |  18.66 ± 1.81 | 0.02 |
|  (Range: min – max, median) | (17 – 25, 20) | (15 – 25, 20) |  |  | (15 – 23, 20) | (15 – 24, 18) |  |
| Aortic root dimension (mm), PALX |  30.09 ± 2.45 |  29.83 ± 2.74 | 0.39 |  |  30.21 ± 3.70 |  26.92 ± 2.52 | <0.001 |
|  (Range: min – max, median) | (23 – 36, 30) | (18 – 38, 30) |  |  | (25 – 38, 30) | (23 – 34, 27) |  |
| LV posterior wall (mm), PLAX |  8.41 ± 0.82 |  8.29 ± 0.83 | 0.20 |  |  7.07 ± 0.82 |  7.11 ± 0.75 | 0.83 |
|  (Range: min – max, median) | (7 – 11, 8) | (6 – 11, 8) |  |  | (5 – 8, 7) | (6 – 9, 7) |  |
| LV internal dimension in diastole (mm), PLAX |  49.60 ± 3.37 |  49.07 ± 3.48 | 0.17 |  |  44.64 ± 3.02 |  44.52 ± 2.88 | 0.88 |
|  (Range: min – max, median) | (41 – 57, 50) | (40 – 60, 49) |  |  | (41 – 51, 44) | (38 – 51, 45) |  |
| LV internal dimension in systole (mm), PLAX |  31.38 ± 3.08 |  30.37 ± 3.22 |  0.006 |  |  30.86 ± 3.67 |  28.12 ± 2.84 |  0.003 |
|  (Range: min – max, median) | (25 – 39, 31) | (19 – 41, 30) |  |  | (23 – 36, 32) | (20 – 34, 28) |  |
| Interventricular septum, (mm), PLAX |  8.55 ± 0.80 |  8.48 ± 0.89 | 0.52 |  |  7.29 ± 0.99 |  7.28 ± 0.78 | 0.97 |
|  (Range: min – max, median) | (7 – 11, 8) | (6 – 11, 8) |  |  | (5 – 9, 7) | (6 – 9, 7) |  |
| RV wall thickness (mm), PLAX |  4.65 ± 0.63 |  4.69 ± 0.59 | 0.54 |  |  4.49 ± 0.73 |  4.33 ± 0.45 | 0.30 |
|  (Range: min – max, median) | (0.54 – 5.89, 4.71) | (0.54 – 5.95, 4.76) |  |  | (3.39 – 5.73, 4.61) | (3.19 – 5.45, 4.36) |  |
| RV outflow tract dimension in diastole (mm), PLAX  |  26.47 ± 3.72 |  26.30 ± 3.99 | 0.70 |  |  28.50 ± 4.04 |  25.72 ± 3.46 | 0.01 |
|  (Range: min – max, median) | (15 – 35, 26) | (16 – 36, 26) |  |  | (19 – 33, 29) | (19 – 33, 26) |  |
| Left atrial dimension (mm), PLAX |  32.97 ± 3.34 |  32.83 ± 4.00 | 0.74 |  |  33.21 ± 3.74 |  30.98 ± 4.94 | 0.11 |
|  (Range: min – max, median) | (24 – 41, 33) | (20 – 52, 33) |  |  | (25 – 38, 33) | (22 – 58, 31) |  |
| LV mass (gm) |  148.64 ± 24.01 |  144.35 ± 27.16 | 0.15 |  |  100.87 ± 21.93 |  100.40 ± 18.84 | 0.93 |
|  (Range: min – max, median) | (83.28 –197.78, 145.07) | (71.74 –230.52, 144.11) |  |  | (57.71 –140.01, 97.97) | (62.91 –150.23, 97.97) |  |
| LV mass index (gm/m2) |  80.93 ± 11.73 |  77.52 ± 12.00 | 0.01 |  |  61.11 ± 9.19 |  61.65 ± 9.28 | 0.84 |
|  (Range: min – max, median) | (52.23 – 107.38, 80.12) | (45.57 – 128.92, 76.91) |  |  | (42.06 – 78.71, 59.60) | (40.86 – 88.44, 60.82) |  |
| LV ejection fraction (%), PLAX | 62.52 ± 5.36 | 62.50 ± 5.32 | 0.97 |  | 63.43 ± 5.68 | 61.20 ± 4.91 | 0.13 |
|  (Range: min – max, median) | (50 – 70, 60) | (27 – 75, 60) |  |  | (55 – 70, 61) | (55 – 70, 60) |  |
| RV systolic pressure (mmHg) |  29.53 ± 4.15 |  27.80 ± 3.73 | <0.001 |  |  28.21 ± 3.19 |  27.49 ± 3.75 | 0.50 |
|  (Range: min – max, median) | (20 – 40, 29) | (9 – 45, 28) |  |  | (25 – 37, 28) | (11 – 35, 28) |  |
| Mitral inflow power Doppler E-wave (m/sec) |  89.64 ± 14.62 |  87.32 ± 14.45 | 0.15 |  |  94.35 ± 10.49 |  96.75 ± 13.75 | 0.54 |
|  (Range: min – max, median) | (49.4 – 122.0, 89.9) | (50.4 – 134.0, 86.7) |  |  | (75.0 – 144.0, 95.1) | (71.1 – 132.0, 97.2) |  |
| Mitral inflow power Doppler A-wave (m/sec) |  49.25 ± 9.10 |  49.25 ± 9.95 | 0.99 |  |  47.67 ± 8.32 |  50.85 ± 10.43 | 0.29 |
|  (Range: min – max, median) | (28.8 – 79.3, 48.0) | (26.4 – 85.0, 48.0) |  |  | (35.8 – 60.0, 45.9) | (30.9 – 78.6, 50.0) |  |
| E/A ratio |  1.88 ± 0.49 |  1.84 ± 0.47 | 0.41 |  |  2.03 ± 0.44 |  1.98 ± 0.50 | 0.68 |
|  (Range: min – max, median) | (1.06 – 3.44, 1.85) | (0.73 – 3.81, 1.76) |  |  | (1.33 – 2.93, 1.96) | (1.15 – 3.81, 1.94) |  |
| Mitral lateral annulus tissue Doppler E’ (cm/sec) |  18.89 ± 4.21 |  18.20 ± 4.04 | 0.13 |  |  19.75 ± 3.40 |  18.88 ± 3.90 | 0.44 |
|  (Range: min – max, median) | (9.6 – 31.0, 18.9) | (8.4 – 34.2, 18.0) |  |  | (15.4 – 26.4, 18.7) | (12.4 – 31.7, 18.4) |  |
| Mitral lateral annulus tissue Doppler A’ (cm/sec) |  8.50 ± 1.90 |  9.33 ± 4.99 | 0.11 |  |  9.52 ± 2.75 |  8.92 ± 2.19 | 0.37 |
|  (Range: min – max, median) | (5.3 – 14.3, 8.2) | (4.2 – 17.9, 8.7) |  |  | (6.2 – 14.7, 8.5) | (4.7 – 17.3, 8.5) |  |
| E’/A’ ratio |  2.32 ± 0.70 |  2.11 ± 0.71 | 0.01 |  |  2.23 ± 0.80 |  2.23 ± 0.68 | 0.97 |
|  (Range: min – max, median) | (1.13 – 4.60, 2.27) | (0.26 – 5.26, 2.03) |  |  | (1.27 – 4.23, 2.02) | (1.09 – 4.37, 2.09) |  |

Continuous variables are expressed as mean ± SD (standard deviation), and categorical variables as N [%].

Abbreviations: left ventricle, LV; right ventricle, RV; echocardiographic parasternal long axis view, PLAX; echocardiographic parasternal short axis view, PSAX