ÅSTRAND-RYHMING STEP TEST NORMS FOR COLLEGE STUDENTS

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INTRODUCTION

The Åstrand-Ryhming (A-R) Step Test was developed as a submaximal variation of the Harvard test (Åstrand, 1960). It has been shown to be valid (Ryhming, 1954; Sharkey, 1974) and reliable (Day, 1967; Ryhming, 1954). In its original form (Ryhming, 1954), the Å-R test requires measurement of the exercise heart rate and, through the use of a nomogram (Åstrand & Ryhming, 1954), permits estimation of aerobic capacity. Sharkey (1966, 1968a, 1968b, 1974) adapted the test for assessing cardiorespiratory (CR) fitness of employees in the U.S. Forest Service. In so doing, he found it necessary to eliminate the measuring of exercise heart rate to increase its practicality as a field instrument. Sharkey assumed that the recovery pulse would be more variable following this submaximal test than after a maximal test and thus calculated several correlations between the exercise heart rate and various post-exercise intervals in an attempt to find an acceptable counting period. This resulted in adoption of the 15 to 30 second postexercise interval as a standard. Physical fitness slide rule calculators were then developed for men and women. These calculators are based on pulse responses of subjects aged 18 to 59 and require the assessment of bodyweight in addition to heart rate. Examination of calculator *Male* and *Female Index* scales reveals minimal differences between scale scores of heavy and light-weight individuals with identical heart rates. For this reason, the writers consider weight measurements unnecessary. The present study, then, was concerned with developing Å-R test norms for entering first-year college students which require no bodyweight measurement. The data were collected at North Carolina State University during the 1971-72, 1972-73 and 1973-74 academic school years.

Procedure

The A-R test for men requires subjects to step up and down on a 40 centimeter (16 inch) bench for 5 minutes at the rate of 90 steps per minute. Women perform the test on a 33 centimeter (13 inch) bench at the same pace and for the same length of time. Heart rate is measured from exactly 15 to 30 seconds following completion of the test.

The temperature and humidity of the testing room were controlled for every testing session. The step benches, each 10 feet long, were placed around the perimeter of the room, seven were for men and three for women, thus it was possible to test as many as 80 students in one class period. Men and women were segregated in different parts of the room for testing. A 5-minute vocal cadence of the step test was recorded on tape with the assistance of a professional broadcaster. Norelco C-30 low noise tape was utilized and the recording was played on a Kodak ASP-201 tape machine. Those readers wishing to undertake a more extensive review of procedure should refer to a previous report (Marley and Linnerud, in press) where it is covered in greater detail. Statistical calculations were made at the NCSU Computing Center with the following techniques being completed for each pulse count interval: maximal oxygen uptake (ml O_2 kg/min), sigma scale score, percentile score, T-score, standard score, and Z-percentile.

Results and Summary

Table I presents the age distribution for the sample. Table II portrays the norms for men. The mean for this distribution is 34.9 ± 4.9 beats per 15 seconds (bps_{15}) and the pulse responses ranged from 17.5 to 54 bps_{15}. Table III lists the norm analysis for women. The mean is 35.8 ± 4.7 bps_{15} and the distribution ranges from 18 to 48.5 pulse counts.

Previous work by the writers (Marley and Linnerud – in press) has shown the A-R test to be feasible as a cardiorespiratory fitness testing instrument for screening and classifying large numbers of students, both men and women. The postexercise pulse counting method which employs two counters rather than one in addition to the testee, is the most reliable method. It is hoped that the publication of these findings, with the norms presented here, will increase the application and practicality of the A-R test as a field instrument.

TABLE I

Age Analysis

Men (N = 1487)			Women (N = 484)		
Age	N	Mean ± S.D.	Age	N	Mean ± S.D.
17	134	18.00	16	2	17.92
18	1278	± .65	17	51	± .53
19	53		18	423	
20	7		19	5	
21	4		20	1	
22	3		21	1	
23	4		26	1	
25	2				
26	2				

FOOTNOTE:

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TABLE II – Men

Pulse Count (bps_{15})	N	Max VO_2 * ml O_2/kg/min (Estimated)	T-Score	Sigma Scale	Standard Score	Percentile	Z Percentile
17.5	1		85	109	3.54	99.98	99.98
19.0	2		82	104	3.24	99.94	99.94
19.5	1		81	102	3.14	99.92	99.91
20.0	4		80	101	3.03	99.85	99.88
20.5	2		79	99	2.93	99.81	99.83
21.0	10		78	97	2.83	99.62	99.77
21.5	1		77	95	2.73	99.60	99.68
22.0	22	70.3	76	94	2.63	99.19	99.57
22.5	4	68.8	75	92	2.52	99.11	99.42
23.0	22	67.3	74	90	2.42	98.69	99.23
23.5	3	66.0	73	89	2.32	98.64	98.98
24.0	47	64.7	72	87	2.22	97.75	98.67
24.5	4	63.4	71	85	2.12	97.67	98.28
25.0	61	62.2	70	84	2.01	96.52	97.80
25.5	5	61.0	69	82	1.91	96.43	97.21
26.0	92	59.9	68	80	1.81	94.87	96.49
26.5	13	58.8	67	78	1.71	94.63	95.62
27.0	103	57.7	66	77	1.61	92.68	94.59
27.5	9	56.7	65	75	1.50	92.51	93.38
28.0	157	55.8	64	73	1.40	89.54	91.97
28.5	12	54.8	63	72	1.30	89.31	90.34
29.0	168	53.9	62	70	1.20	85.95	88.48
29.5	10	53.0	61	68	1.10	85.76	86.37
30.0	270	52.2	60	67	1.00	80.65	84.02
30.5	24	51.3	59	65	0.89	80.20	81.42
31.0	211	50.5	58	63	0.79	76.21	78.57
31.5	26	49.8	57	61	0.69	75.71	75.48
32.0	286	49.0	56	60	0.59	70.30	72.17
32.5	17	48.3	55	58	0.49	69.98	68.65
33.0	345	47.6	54	56	0.38	63.46	64.96
33.5	31	46.9	53	55	0.28	62.87	61.11
34.0	365	46.2	52	53	0.18	55.97	57.16
34.5	31	45.6	51	51	0.08	55.38	53.13
35.0	398	44.9	50	50	–0.02	47.85	49.07
35.5	43	44.3	49	48	–0.13	47.04	45.02
36.0	425	43.7	48	46	–0.23	39.00	41.02
36.5	38	43.1	47	45	–0.33	38.28	37.11
37.0	367	42.6	46	43	–0.43	31.34	33.33
37.5	32	42.0	45	41	–0.53	30.74	29.71
38.0	323	41.5	44	39	–0.63	24.63	26.28
38.5	40	41.0	43	38	–0.74	23.87	23.07
39.0	307	40.5	42	36	–0.84	18.06	20.09
39.5	44	40.0	41	34	–0.94	17.23	17.35
40.0	281	39.5	40	33	–1.04	11.92	14.87
40.5	35	39.0	39	31	–1.14	11.25	12.63
41.0	175	38.5	38	29	–1.25	7.94	10.64
41.5	16	38.1	37	28	–1.35	7.64	8.89
42.0	138	37.6	36	26	–1.45	5.03	7.36
42.5	20	37.2	34	24	–1.55	4.65	6.04
43.0	92	36.8	33	22	–1.65	2.91	4.91
43.5	11	36.4	32	21	–1.76	2.70	3.96
44.0	50	36.0	31	19	–1.86	1.76	3.26
44.5	9	35.6	30	17	–1.96	1.59	3.50
45.0	28	35.2	29	16	–2.06	1.06	2.97
45.5	11		28	14	–2.16	.85	1.53
46.0	23		27	12	–2.26	.42	1.18
46.5	2		26	11	–2.37	.38	.90
47.0	5		25	9	–2.47	.28	.68
47.5	1		24	7	–2.57	.26	.51
48.0	5		23	5	–2.67	.17	.38
48.5	1		22	4	–2.77	.15	.28
49.0	1		21	2	–2.86	.13	.20
49.5	1		20	0	–2.98	.11	.15
50.0	4		19	–1	–3.08	.04	.10
52.0	1		15	–8	–3.49	.02	.02
54.0	1		11	–15	–3.89	.00	.01

** The estimated values above 70.3 and below 35.2 ml have been deleted because they differ from the performance levels of individuals utilized by Åstrand and Sharkey in deriving their respective formulas. Also, in this context, Åstrand (2) has suggested that only maximum pulse rates between 125 and 170 bpm should be used for such calculations.*

TABLE III – Women

Pulse Count (bps_{15})	N	Max VO_2* ml O_2/kg/min (Estimated)	T-Score	Sigma Scale	Standard Score	Percentile	Z Percentile
18.0	3		87	112	3.75	99.71	99.99
19.0	3		85	109	3.54	99.57	99.98
19.5	1		84	107	3.43	99.50	99.97
20.0	4		83	105	3.33	99.21	99.96
20.5	4		82	104	3.22	98.93	99.94
21.0	1		81	102	3.12	98.86	99.91
21.5	3		80	100	3.01	98.64	99.87
22.0	6	72.5	79	98	2.91	98.22	99.82
22.5	1	70.5	78	97	2.80	98.14	99.75
23.0	3	68.6	77	95	2.70	97.93	99.65
23.5	1	66.8	76	93	2.59	97.86	99.52
24.0	6	65.0	75	91	2.49	97.43	99.35
24.5	5	63.4	74	90	2.38	97.07	99.13
25.0	6	61.9	73	88	2.27	96.65	98.85
25.5	4	60.4	72	86	2.17	96.36	98.50
26.0	6	59.0	71	84	2.06	95.93	98.05
26.5	6	57.6	70	83	1.96	95.50	97.49
27.0	6	56.3	69	81	1.85	95.07	96.80
27.5	7	55.1	67	79	1.75	94.58	95.97
28.0	11	53.9	66	77	1.64	93.79	94.97
28.5	9	52.8	65	76	1.54	93.15	93.78
29.0	24	51.7	64	74	1.43	91.43	92.38
29.5	10	50.7	63	72	1.33	90.72	90.75
30.0	28	49.7	62	70	1.22	88.72	88.88
30.5	29	48.7	61	69	1.11	86.65	86.75
31.0	33	47.8	60	67	1.01	84.30	84.36
31.5	15	46.9	59	65	0.90	83.23	81.70
32.0	35	46.1	58	63	0.80	80.73	78.77
32.5	26	45.3	57	62	0.69	78.87	75.59
33.0	63	44.5	56	60	0.59	74.38	72.17
33.5	33	43.7	55	58	0.48	72.02	68.52
34.0	60	42.9	54	56	0.38	67.74	64.69
34.5	35	42.2	53	55	0.27	65.24	60.70
35.0	93	41.5	52	53	0.17	58.60	56.60
35.5	42	40.9	51	51	0.06	55.60	52.42
36.0	86	40.2	50	49	–0.04	49.46	48.22
36.5	43	39.6	48	47	–0.15	46.40	44.04
37.0	93	39.0	47	46	–0.26	39.76	39.92
37.5	43	38.4	46	44	–0.36	36.69	35.91
38.0	79	37.8	45	42	–0.47	31.05	32.05
38.5	36	37.3	44	40	–0.57	28.48	28.38
39.0	82	36.7	43	39	–0.68	22.63	24.92
39.5	31	36.2	42	37	–0.78	20.41	21.70
40.0	85	35.7	41	35	–0.89	14.35	18.73
40.5	33	35.2	40	33	–0.99	11.99	16.03
41.0	39	34.7	39	32	–1.10	9.21	13.59
41.5	19	34.2	38	30	–1.20	7.85	11.43
42.0	36	33.8	37	28	–1.31	5.28	9.52
42.5	13	33.3	36	26	–1.41	4.35	7.85
43.0	17	32.9	35	25	–1.52	3.14	6.42
43.5	6	32.4	34	23	–1.63	2.71	5.20
44.0	16	32.1	33	21	–1.73	1.57	4.17
44.5	5	31.7	32	19	–1.84	1.21	3.31
45.0	4	31.3	31	18	–1.94	.93	2.61
45.5	4		30	16	–2.05	.64	2.03
46.0	6		28	14	–2.15	.21	1.57
46.5	1		27	12	–2.26	.14	1.20
47.0	1		26	11	–2.36	.07	.90
48.5	1		23	5	–2.68	.00	.37

** The estimated values above 72.5 and below 31.3 ml have been deleted because they differ from the performance levels of individuals utilized by Åstrand and Sharkey in deriving their respective formulas. Also in this context, Åstrand (Åstrand and Rhyming, 1954) has suggested that only maximum pulse rates between 125 and 170 bpm should be used for such calculations.*

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