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Physical Fitness of Physical Therapy Students

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Physical fitness norms do not exist for physical therapists or physical therapy students. This lack, in part, reflects the complexity of physical fitness and the scarcity of data reported on physical fitness norms of other populations. This report describes the methods used and the results obtained for 16 physical fitness factors of 98 female and 13 male physical therapy upperclassmen and discusses the implications of physical fitness in the practice of physical therapy. Means, standard deviations, ranges, and percentile rankings are given by sex for each of the 16 fitness factors. The purpose of this study was to begin to establish physical fitness norms. As physical fitness norms are established, it will be possible to determine how norms of physical therapists and physical therapy students compare with established values.

Key Words: *Physical fitness, Physical therapists.*

There is more to good health than just not being sick. Proper nutrition, stress management, and physical fitness are essential requirements for maintaining and improving health. People are becoming increasingly aware of their responsibility not only for preventing disease but also for improving their health status by modifying their life styles and changing their environments.

Physical fitness, one of the key requirements for good health, is a complex area. Speculation continues as to what factors contribute to physical fitness. The literature supports three vital factors: cardiorespiratory endurance, muscular endurance, and muscular strength.¹

The first factor, cardiorespiratory endurance, is frequently represented by maximum oxygen uptake ($\dot{V}O_{2max}$).² For arriving at good estimates of $\dot{V}O_{2max}$, practical "field-type" tests have been designed for groups of healthy young men and women. Safe and widely used field tests include the 12-minute run and the 1.5-mile run for time.³

The second factor, muscular endurance, can be measured with a device such as the Cybex® II* isokinetic dynamometer, which records the force of muscle contraction as a function of time.⁴ The elapsed time, in seconds, for a muscle group to regress from

maximum torque to one-half its maximal torque value is an index of muscle fatigue or endurance. This sophisticated testing device is familiar to physical therapists and commonly used by them.

The third factor, muscle strength, has been quantified for isometric, isotonic, and isokinetic contractions for the trunk and extremities. For example, an isometric dominant handgrip test is commonly used to measure upper extremity strength.⁵ By using the Cybex® II dynamometer, isokinetic peak torque outputs can be determined easily for the muscle groups that extend and flex the knee.⁶

Other important physical fitness factors have also been documented in the literature. For flexibility fitness, the sit-and-reach test provides a measure of length for the gastrocnemius-soleus, hamstring, and posterior trunk musculature and is more practical to administer to a large number of subjects than is a complete goniometric assessment.⁷ For estimating body density (percentage fat), many methods are currently available. Hydrostatic underwater weighing provides reliable data for calculating the proportion of fat in the total body, but anthropometric measures (skinfold, circumference, diameter) are more practical for clinical use.² Lung volume (vital capacity) and air flow (forced expiratory volume in one second) are generally accepted measures of respiratory function and are easily determined in the clinic.⁸ An accurate determination of blood pressure can be obtained with repeated measures that take into account the emotional state of the person and environmental conditions. Pulse rates taken immediately after a person has completed a maximal physical effort (eg, the 1.5-mile run) can be compared with published values of

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*Cybex Division of Lumex, Inc, 2100 Smithtown Ave, Ronkonkoma, NY 11779.

predicted maximal heart rates according to age and sex.⁹ Finally, resting pulse rates have been reported but must be loosely interpreted¹⁰; pulse rates fluctuate because of existing internal and external factors affecting the person.

After reviewing the literature on physical fitness testing, we developed a test battery of 16 physical fitness factors. This test battery resembles, in part, the one used by Zuti and Corbin on college freshmen¹¹ and can be replicated with resources common to most physical therapy programs.

To date, no norms for the physical fitness of physical therapists or physical therapy students have been reported. Few published reports exist that contain sufficient information about the methods to permit adequate replication, and, therefore, comparison of physical fitness studies is difficult. Established norms and standard testing procedures would allow physical therapists and students to be assessed as physically fit or unfit. The purpose of this study was to begin establishing physical fitness norms for physical therapy students. It is hoped that this study will serve as a model for further physical fitness testing of defined samples of this population.

METHOD

Subjects

The subjects in this report were 111 volunteers (13 men and 98 women; mean age, 20.92 years) enrolled as upperclassmen in a sectarian midwestern university's program in physical therapy. All subjects signed an informed consent form and were screened by medical history questionnaire for coronary heart disease risk.

Instrumentation

Physical fitness data for all subjects in this study were obtained by using the following equipment:

1. The Vitalograph† spirometer for measuring volumetric capacity and ventilatory function.
2. A standard physician's office scale with weight balance for height and weight measurements.
3. A bend-and-reach frame, constructed according to specifications described by Wells and Dillon, for flexibility determinations.⁷
4. A Lange Skinfold Caliper‡ for skinfold measurements.
5. A Jamar Adjustable Hand Dynamometer** for grip strength measurements.

†Vitalograph Ltd, 8347 Quivira Rd, Lenexa, KS 66215.

‡Cambridge Scientific Industries, PO Box 265, Cambridge, MD 21613.

**Asimow Engineering Co, 1414 S Beverly Glen Blvd, Los Angeles, CA 90024.

6. The Cybex® Isokinetic #7104 Dual Channel System†† to determine peak torque values of the knee extensor and flexor muscles and endurance time of knee extensor muscles.
7. A standard anaeroid inflatable blood pressure cuff and a stethoscope for determining blood pressure readings from the left arm.
8. A banked indoor track for the 1.5-mile run for time (21.75 laps).

Procedure

Physical fitness testing was performed at two locations. The 1.5-mile run for time was conducted on the indoor track at the gymnasium of the subjects' university. All other tests were conducted at the physical therapy department of the local Veterans Administration medical center.

Equal-sized groups were tested on two consecutive mornings (8 AM to 12:30 PM) during the first two weeks of a semester. Students received one week advance notice that fitness testing would be performed. They were advised on how to run on the banked indoor track and of the precautions to take to avoid undue trauma when a maximum effort would be required. Students practiced self-monitoring of resting and exercise pulse rates from both the carotid and the radial arteries. Instructions were given to count their pulse rate for 10 seconds, beginning with 0, and to multiply this value by six to determine a minute pulse rate.

Immediately before fitness testing, all students determined and recorded their minute pulse rate after sitting quietly for five minutes. Resting blood pressures (sitting) were then taken from the left arm by one of two physical therapists. A physical therapist demonstrated the fitness tests to be performed at specific stations according to a written handout given each student.

Five physical therapists conducted the physical fitness testing. For each testing station, the same physical therapist(s) supervised the data collection on all subjects tested. The 1.5-mile run for time was supervised by two physical therapists.

Height was measured to the nearest half-inch (shoes removed) and weight to the nearest quarter-pound. (Lab attire was worn: shorts for men, shorts and halter tops or T-shirts for women.) Percentage body fat determinations were made by skinfold caliper. Sites selected were chest, abdomen, and anterior thigh for men, and triceps brachii muscle, suprailiac, and anterior thigh for women. Skinfold readings were taken on the right side according to the technique described by Pollock and Schmidt.² Averages for

††Cybex Division of Lumex, Inc, 2100 Smithtown Ave, Ronkonkoma, NY 11779.

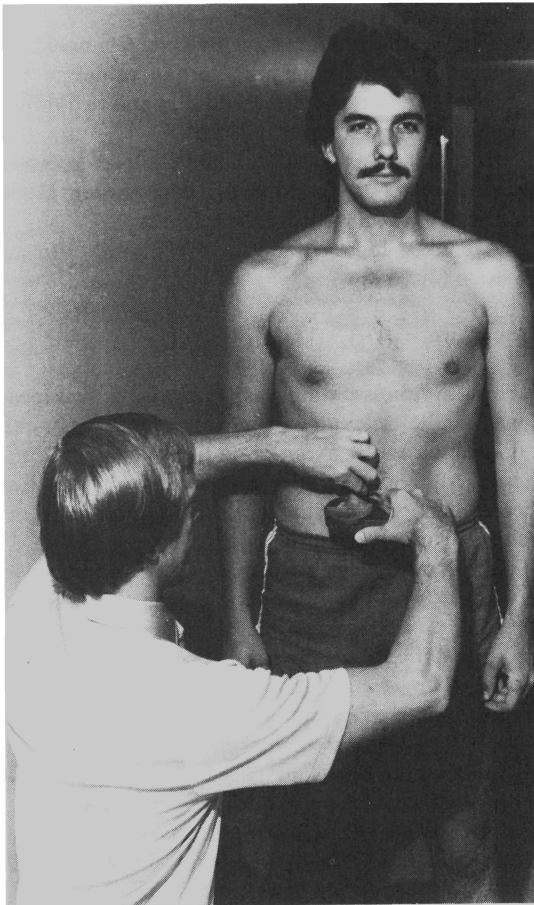


Fig. 1. Abdominal skinfold assessment for percentage body fat determination.

three trials were determined, and a sum for the three averages was calculated. Predictions for percentage body fat were made according to data by Pollock and Schmidt (Fig. 1).²

Subjects were assigned a random order of completing the four specific testing stations. The following instructions were given to the subjects at the stations.

Station 1 (spirometry). "Standing, with nostrils pinched, fill your lungs with as much air as possible, seal your lips tightly around mouthpiece, slowly exhale as long as you can to squeeze all the air out of your lungs. Repeat three trials for vital capacity (VC)." As above, "Exhale as hard and as fast as you can; don't stop until you are told to stop." (Test terminated when flow curve reached a plateau.) Repeat three trials for forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) (Fig. 2).

Station 2 (flexibility). "Perform three squats. Place your feet on the footprints on the frame end, keeping your knees fully extended, slowly slide your fingertips to push the block away from you without jerking. When you can't move the block any more, hold this

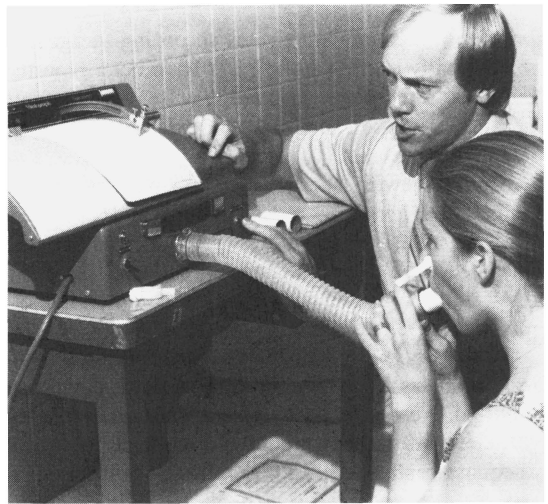


Fig. 2. Respiratory function testing (VC, FEV_1 , and FEV_1/FVC) using the Vitalograph.

position for three seconds. You will be checked for cervical, thoracic, and lumbar spinal restriction. Record results on test form in scores to the nearest half-inch. Repeat three trials for flexibility" (Fig. 3).

Station 3 (grip strength). "Standing, arm alongside the body with elbow extended and metacarpal-phalangeal joints in neutral position, perform three trials of grip strength with the right (right grip) and then the left hand (left grip). Record results of each trial and calculate the average scores for both the right and left sides" (Fig. 4).

Station 4 (lower extremity strength and endurance). The instructions given to each subject during learning and testing trials on the Cybex® II isokinetic apparatus were to "extend and flex your knee as fast as you can three times, pushing on the way up and pulling on the way down. You will then rest for 30 seconds, and when I say 'Go,' extend and flex your knee as fast as you can until told to stop (right knee extension peak torque and right knee flexion peak torque)."

Each learning trial consisted of three cycles of extension-flexion at $30^\circ/\text{sec}$, a 30-second rest period, and four extension-flexion cycles at $180^\circ/\text{sec}$. Verbal encouragement was given to all groups during the testing trials. The waiting time between trial and testing sessions was uniform (approximately 53 minutes). Endurance tests were terminated when the torque values for knee extension were half the peak values attained during the first several contractions at $180^\circ/\text{sec}$ (right knee extension endurance to half peak torque). Subjects were secured to the Cybex® II apparatus according to standard procedures described for knee extension and knee flexion testing (Fig. 5).⁴

The test battery was completed with the 1.5-mile run for time at maximum effort, in a counterclockwise direction (Fig. 6). No more than 15 subjects ran at a



Fig. 3. Sit-and-reach test for flexibility of the gastrocnemius-soleus, hamstring, and posterior trunk muscles.

time. Each subject was paired with a nonrunning partner who was responsible for keeping count of the number of laps run, assisting the partner at the finish line, recording the finishing time, and monitoring the 1-, 3-, and 5-minute recovery pulse rates. The runs were preceded by a 5-minute warm-up period for stretching and calisthenics. During each run, subjects were instructed to pace themselves. If they needed to stop running, they were instructed to walk briskly along the outside perimeter of the track until they could begin running again. At the finish, subjects were held upright by their partners and escorted to a physical therapist who determined their maximum pulse rate at the carotid artery within the first 15 seconds immediately after the run (Fig. 7).

RESULTS

Table 1 describes the subjects in terms of 16 physical fitness factors. The data are organized according to percentile scores. Lowest and highest scores for each of the 16 factors are reported in place of the 0 and 100 percentiles, respectively. In addition, means, standard deviations, and ranges were calculated and are presented in Table 2.

DISCUSSION

This study generated normative physical fitness data for upperclass students in the physical therapy program at a sectarian midwestern university. It is based on the premise that, to define an abnormality, one must first define what is considered to be "normal" for a given population. No information had been previously reported for junior and senior college students. The fitness factors in Table 1 were compared

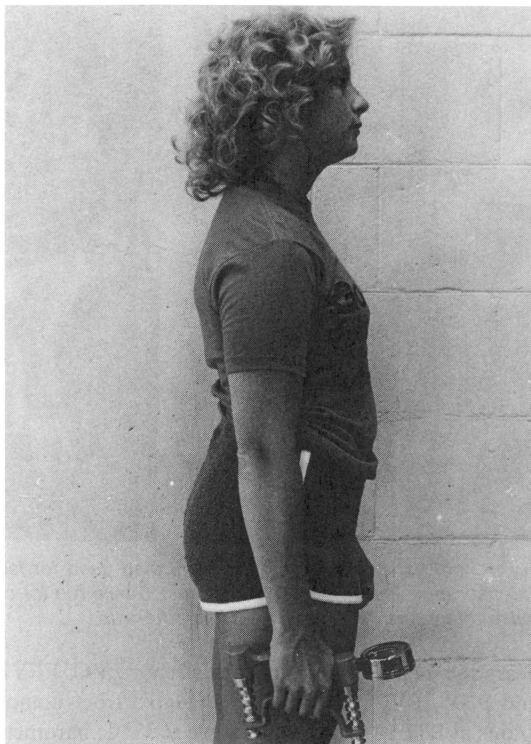


Fig. 4. Right hand grip strength testing.

with those previously reported by other investigators for other populations using similar methods.

According to Pollock and associates,¹⁰ the 50th percentile values of resting heart rate and systolic and diastolic blood pressure for college-age women were 65 beats per minute (bpm), 112 mm Hg, 75 mm Hg and for college-age men were 63 bpm, 121 mm Hg, and 80 mm Hg. The 50th percentile values for women and men of this study were 76 bpm, 106 mm Hg, 66 mm Hg and 72 bpm, 122 mm Hg, and 70 mm Hg, respectively.

Zuti and Corbin reported height and weight values for the 50th percentile on 1,533 college freshman women.¹¹ Their 164.6 cm and 58.0 kg values were close to the 164.4 cm and 59.2 kg values for women subjects of this report. For 1,717 male freshmen, 50th percentile scores of 177.5 cm and 71.7 kg are, likewise, similar to the 177.2 cm and 69.6 kg values found for the men in this report. Zuti and Corbin also reported percentage body weight, that is, fat estimates, for men and women.¹¹ Their 23.2 percent fat estimate for the 50th percentile is 3.6 percent less than the 26.8 percent value at the 50th percentile for women of this report. A 3 percent standard error has been reported, however, when using skinfold measurements for percentage fat estimates.² Zuti and Corbin¹¹ reported a 10.8 percent fat estimate at the 50th percentile that compares well with the 11.7 percent for men in this report.

Using the mean heights and an average age of 20

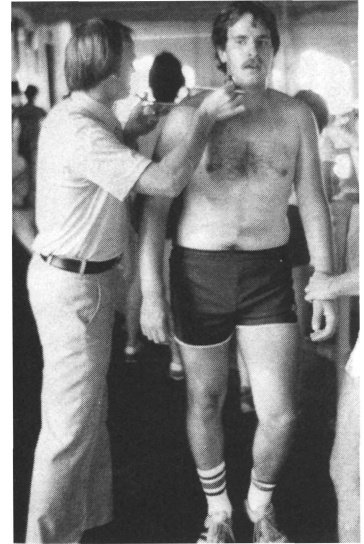
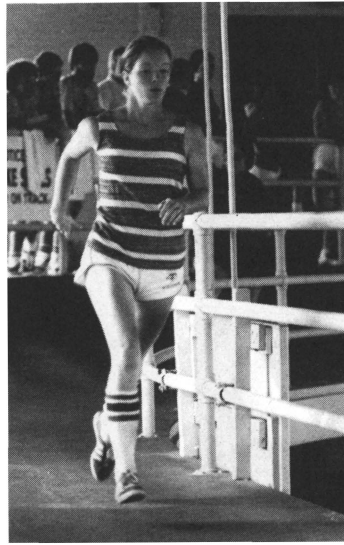


Fig. 5. (left) Cybex® II dynamometer being used for isokinetic strength and endurance testing for knee flexor and extensor muscles. Fig. 6. (center) A 1.5-mile run for cardiorespiratory endurance testing. Fig. 7. (right) Carotid pulse rate determination immediately after run.

years for men and women in this report, VC, FEV₁, and FEV₁/FVC values were calculated from nomograms at BTPS (body temperature at 37°C, barometric pressure saturated with water vapor) on normal college subjects.⁸ For women in this report, mean VC was 3.90 L and mean FEV₁ and FEV₁/FVC were 3.65 L and 90.9 percent, respectively. For men in this report, mean VC was 5.68 L, mean FEV₁ was 4.97 L, and mean FEV₁/FVC was 87.5 percent. These respiratory function values are essentially normal for both sexes. This assessment information is useful before performing cardiorespiratory endurance testing (eg, 1.5-mile run for time) because abnormal respiratory function would limit subject performance on this fitness test.¹²

Zuti and Corbin reported 50th percentile values for trunk flexibility as 46.5 cm and 45.2 cm for women and men, respectively.¹¹ In comparison, women and men of this report revealed greater flexibility, measuring 47.5 cm and 47.0 cm, respectively.

Upper extremity grip strength measures reported for this study are considerably less than those reported by Zuti and Corbin for each sex in both the dominant and nondominant hands, using a rectangular-type manometer.¹¹ Strength comparisons for women were 26.5 kg versus 22.8 kg for the right grip and 24.0 versus 21.3 kg for the left grip. Comparisons for men were 49.6 kg versus 40.0 kg for the right grip and 45.6 kg versus 35.8 kg for the left grip. A study that used the Jamar dynamometer for grip strength testing reported 31.7 kg (dominant hand) and 29.0 kg (nondominant hand) in 80 "normal" women (age range, 18–52 years), and 51.4 kg (dominant hand) and 49.3 kg (nondominant hand) in 1,128 "normal" men (age range, 18–62 years).⁵

The literature is scarce in reporting normative isokinetic values for peak knee flexion, peak knee extension, and endurance times to one-half peak torque for subjects comparable with those in this report (ie, similar body type, height, weight, and overall physical condition). A literature review by Nosse of strength relationships of the knee musculature revealed isokinetic studies in which the knee flexor muscle strength was between 43 and 90 percent of the knee extensor muscles.⁶ In those isokinetic studies that have been reported, variations in speed of contraction, test positions, joint angles, degree of stabilization of subjects, and isokinetic resistance devices used have made strength and endurance comparisons impractical.⁶

Equating Cooper's "fair" category for the 1.5-mile run for time to be approximately the 50th percentile, women under 30 years of age can be expected to run 1.5 miles in 15 minutes 55 seconds to 18 minutes 30 seconds.¹³ Men of the same age are expected to run 1.5 miles in 12 minutes 1 second to 14 minutes.¹³ The 50th percentile run times in this report were 14 minutes 22 seconds for women and 10 minutes 20 seconds for men. Both sexes demonstrated a better than "fair" level of cardiorespiratory endurance.

Sheffield and colleagues, as reported by the American Heart Association,¹⁴ gave a predicted maximal heart rate at age 20 to be 197 bpm for untrained subjects. This value compared with the 202 bpm and 199 bpm mean values recorded for women and men in this study. Maximal pulse rates as high as 258 for women and 222 for men were noted. According to Astrand and Rodahl, the maximal heart rate may be below 175 bpm or above 215 bpm for 25-year-old women or men.¹⁵

TABLE 1
Physical Fitness Results for FEMALE (n = 98) and MALE (n = 13) Physical Therapy Upperclassmen

Factors	Percentiles									
	Lowest		25		50		75		Highest	
	F	M	F	M	F	M	F	M	F	M
Height (cm)	151.1	165.1	160.5	169.5	164.4	177.2	169.5	180.8	181.6	184.2
Weight (kg)	42.6	61.5	54.3	65.7	59.2	69.6	70.0	81.1	100.3	98.0
Percent fat	13.8	8.3	23.4	10.5	26.8	11.7	30.2	14.6	40.0	22.5
Flexibility (cm)	25.4	39.4	16.9	16.4	48.0	45.2	20.9	19.7	67.8	57.9
Right grip (kg)	14.0	30.0	19.6	32.2	22.8	40.0	26.2	44.0	34.7	50.6
Left grip (kg)	10.3	24.5	17.5	31.5	21.3	35.8	24.2	40.6	32.0	46.3
Right knee extension peak torque (ft-lbs)	49.0	126.0	82.6	134.5	90.5	147.3	105.2	172.1	156.7	190.0
Right knee flexion peak torque (ft-lbs)	34.0	56.3	47.8	69.1	52.9	83.3	61.1	104.4	78.8	127.3
Knee flexor/extensor strength ratio (%)	43.3	38.7	51.9	46.0	58.5	55.1	64.9	63.4	81.7	75.2
Knee extensor endurance time to half peak torque (sec)	19.2	28.8	30.8	29.8	36.2	34.0	40.1	39.3	68.2	42.8
Resting pulse rate (BPM)	54	60	68	62	76	72	81	84	108	90
Heart rate maximum (BPM)	150	186	193	194	202	199	211	208	258	222
5-minute recovery heart rate (BPM)	60	60	94	105	115	116	123	122	156	138
1.5-mile run (min:sec)	10:42	9:34	12:58	9:59	14:22	10:29	15:51	11:00	19:50	14:17
Resting diastolic blood pressure (mm Hg)	50	58	59	64	66	70	72	77	100	80
Resting systolic blood pressure (mm Hg)	88	102	98	119	106	122	112	128	156	136

TABLE 2
Physical Fitness Results for Female (Male) Physical Therapy Upperclassmen

Fitness Variable	Descriptive Statistics							
	n		\bar{X}		s		Range	
	F	M	F	M	F	M	F	M
Height (cm)	97	13	165.33	176.52	6.42	6.49	151.1-181.6	165.1-184.2
Weight (kg)	97	13	60.20	75.19	10.22	11.18	43.0-100.2	61.5-98.0
Percent Fat	97	12	27.15	13.32	4.87	3.88	13.8-40.0	9.0-22.5
Flexibility (in)	96	13	18.70	13.46	3.19	2.34	10.0-26.7	15.5-22.8
Right grip (kg)	96	12	23.12	39.50	4.43	6.88	14.0-34.7	30.0-50.6
Left grip (kg)	96	13	21.05	36.74	4.37	6.47	10.3-32.0	24.5-46.3
Right knee extension peak torque (ft-lbs)	95	12	93.78	156.35	18.45	21.63	49.0-156.7	126.0-190.0
Right knee flexion peak torque (ft-lbs)	95	12	53.92	88.58	11.23	22.22	34.0-78.8	56.3-127.3
Knee flexor/extensor strength ratio (%)	95	12	0.59	0.57	0.914	0.108	0.433-.817	0.39-0.75
Knee extensor endurance time to half peak torque (sec)	92	12	36.26	35.92	8.11	4.91	19.2-68.2	28.8-42.8
Resting pulse rate (BPM)	88	12	77.2	74.50	11.4	11.8	54.0-108.0	60.0-90.0
Pulse rate maximum (BPM)	92	13	204.59	204.46	17.2	11.6	150.0-258.0	186.0-222.0
5-minute recovery pulse rate (BPM)	92	13	111.98	114.46	21.5	21.3	60.0-156.0	60.0-138.0
1.5-mile run (min:sec)	92	13	14:40	11:01	2:18	1:24	10:42-26:21	9:34-14:17
Resting systolic blood pressure (mm Hg)	88	12	107.39	123.17	11.8	8.67	88.0-156.0	102.0-136.0
Resting diastolic blood pressure (mm Hg)	88	12	67.11	71.33	9.91	7.79	50.0-100.0	58.0-80.0

In summary, the women in this study had greater values for resting and maximum pulse rates, percentage body fat estimates, and flexibility, but lesser values for resting diastolic and systolic blood pressure, grip strength, and 1.5-mile run for time than results previously recorded. The men demonstrated greater values for resting and maximum pulse rates, resting systolic blood pressure, percentage body fat estimates, and flexibility but lesser values for resting diastolic blood pressure, body weight, grip strength, and 1.5-mile run for time than results previously reported. Normative values for comparison on five-minute recovery pulse rates were not identified in the literature. Respiratory function (eg, VC, FEV₁, and FEV₁/FVC) was normal for both sexes.

Implications for Practice

The occupational demands of physical therapy practice have not yet been quantified. Longitudinal investigations extending into the first year(s) of professional work experience may be warranted to ascertain the degree of physical fitness compatible with a therapist's work-related responsibilities.

In view of the occupational obligation to aid patients in achieving optimal levels of function, physical

therapists should examine the efficacy of their attitudes, appearances, and actions in eliciting desirable outcomes. Physical fitness and appearance of the physical therapist may have far-reaching implications in the therapist-patient relationship. It may be wise to keep in mind the proverb "actions speak louder than words" and to guard against a "do as I say, not as I do" approach. Once physical fitness norms are established, physical therapists will have a means of determining whether they are physically fit or unfit. When combined with quantifiable information pertaining to fitness requirements for the occupation, this interpretation can specify personal qualifications for being physically fit or unfit to practice. It is in the patients' best interest that physical therapists achieve optimal levels of physical fitness to serve as good role models. This report is a first attempt to establish norms and methods to determine physical fitness in physical therapy.

CONCLUSION

The results of the physical fitness factors for a narrowly defined population of physical therapy students were presented. The results of this study serve as a first attempt to establish physical fitness norms

in physical therapy students and other select populations. The need for standardized methods for measuring physical fitness was accentuated by fitness differences between subjects of the same sex in this and previous reports.

This report describes select physical fitness testing methods to permit replication for future research. Areas of future research could include determining whether the occupational demands of physical ther-

apy match fitness levels of physical therapists, assessing curricular stress on student wellness, determining whether knowledge of one's physical fitness is an effective self-motivational strategy for fitness enhancement, and establishing physical fitness norms for physical therapists. In addition, these methods can be applied toward preventive screening for work, recreation, or sport in a safe, affordable, and reproducible manner.

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