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Feasibility of the Target Aerobic Movement Test in Children and Adolescents With Spina Bifida

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The purpose of this study was to determine the feasibility of the Target Aerobic Movement Test (TAMT)[1] in a group of children and adolescents with spina bifida ($n = 32$). Thirty-two children (11 subjects-thoracic lesion, 21 subjects-lumbar lesion) volunteered for the study. Results indicated there were no significant differences in the proportion of subjects who passed Test 1 or Test 2 ($p > .05$). Twenty-seven out of 28 eligible subjects (96%) on Test 1 and 25 of 27 eligible subjects (93%) on Test 2 met the criteria for successful completion of the TAMT. The TAMT appears to be a reliable and feasible test for measuring aerobic behavior in children and adolescents with spina bifida. Future research should focus on studying the feasibility of the TAMT with other populations with disabilities and to also determine if the test can become a more refined discriminator of aerobic behavior and aerobic capacity.

There is a growing body of evidence that developing good cardiorespiratory fitness early in life and maintaining it throughout adulthood can reduce the incidence of morbidity and mortality from all causes of disease, particularly heart disease (Consensus Development Conference, 1995; Pate et al., 1995). In a population-based study of children and adolescents ages 10 to 14 years, investigators found that a higher level of cardiorespiratory fitness was significantly related to

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lower body weight, body fat, and systolic and diastolic blood pressure, and a higher high-density lipoprotein cholesterol (HDL-C) to total cholesterol ratio (Tell & Vellar, 1988). Much of the available data on the important benefits of cardiovascular fitness for children and adolescents led experts in the field to create physical fitness objectives for the United States, which are cited in the *Healthy People 2000* report (Public Health Service, 1991).

The promotion of cardiorespiratory fitness in children and adults with disabilities is also very important. An improvement in fitness can lead to a higher level of independence by reducing the need for assistance to perform activities of daily living (Santiago, Coyle, & Kinney, 1993). Janssen, Van Oers, Van Der Woude, and Hollander (1994) found that poor physical fitness levels resulted in much greater difficulty in persons with spinal cord injuries performing activities of daily living, particularly in performing transfers, entering or leaving a car, and negotiating environmental barriers. Noreau and Shephard (1992) noted that low levels of physical fitness among persons with a spinal cord injury made physical barriers very difficult to negotiate, and that persons who are wheelchair users needed to strengthen their shoulder muscles in order to facilitate ambulation.

Despite the overwhelming importance of maintaining good cardiorespiratory fitness in terms of overall health, there are relatively few field-based tests that can reliably and accurately measure cardiorespiratory fitness in children and adolescents with physical disabilities (Rimmer, 1994). In a recent paper by Rimmer, Braddock, and Pitetti (1996), it was recommended that researchers become more focused on developing accurate field-based measuring instruments for assessing cardiovascular fitness in persons with disabilities.

It is generally agreed that aerobic capacity is a preferred indicator of cardiorespiratory fitness because it reflects the ability to carry out prolonged strenuous exercise (American College of Sports Medicine, 1995). However, it is a measure that is very difficult and sometimes impossible to attain in certain individuals with disabilities (Rimmer, 1994). Part of this difficulty can be attributed to poor physiological compliance, low motivational levels, and a low threshold for fatigue, which prevent the individual from attaining a "true" measure of maximal aerobic capacity (Rimmer, 1994).

Recently, Winnick and Short (1995) have addressed this issue by developing a health-related cardiovascular fitness test for children and adolescents with disabilities. The investigators recommended that in children and adolescents with disabilities, a viable option would be to measure *aerobic behavior*. Aerobic behavior reflects the ability to perform an aerobic activity at a selected duration and intensity, but ordinarily does not require the individual to perform an all-out effort.

Using the guidelines established by the American College of Sports Medicine (1991, 1995)—which recommends that physical activity should elevate heart rate to between 60 and 90% of maximum heart rate for a period of 15 to 60 minutes, and should be performed 3 to 5 days a week in order to confer health benefits and improve or maintain cardiorespiratory fitness—Winnick and Short (1995) applied these guidelines to the development of a test for children and adolescents with disabilities.[2] The test is called the Target Aerobic Movement Test (TAMT) and is used to measure the *aerobic behavior* of children and adolescents with disabilities.

The TAMT purports to be appropriate for adolescents with a variety of disabilities, including those with spina bifida. No previous research, however, has been conducted to determine the soundness of established procedures, the appropriateness of intensity and duration requirements, or the consistency of results for children and adolescents with spina bifida. The purpose of this study, therefore, was to determine the feasibility of the TAMT in a group of children and adolescents with spina bifida.

Method

Subjects

Thirty-two subjects with spina bifida myelomeningocele (17 females, 15 males; ages 10 to 18 years old) were recruited from a residential summer camp that was specifically designed for children and adolescents with this condition. The focus of the camp was on arts and crafts, sports and recreational and educational activities. Subjects attended the camp from the following Midwestern states: Illinois, Wisconsin, Indiana, and Michigan. Eleven subjects had a thoracic lesion and 21 subjects had a lumbar lesion. Twenty-eight subjects used a wheelchair routinely, and four subjects used a wheelchair for long distances and sports only. All the subjects were recruited on a volunteer basis. Parental consent was obtained during registration for the camp. Demographic data including birth date, weight, level of cognitive and motor function, and medication usage, were obtained from camp enrollment forms. Height and resting heart rate were measured with subjects lying supine during a 20- to 30-minute rest period. Descriptive characteristics of subjects appear in Table 1.

Target Aerobic Movement Test (TAMT)

Test Description. This test, originally described by Winnick and Short (1995), is designed to assess the ability of children and adolescents to exercise within a recommended target heart rate zone for a sustained period of time. Participants can engage in virtually any physical activity they choose as long as the activity is of sufficient intensity to raise the heart rate into the target heart rate zone for a period of 15 minutes.

Table 1 Descriptive Characteristics (*N* = 32)

Variable	*M*	*SD*	Min	Max
Age (yr)	13.5	2.5	10	18
Ht (cm)	141.8	15.1	106.7	177.8
Wt (kg)	45.8	13.9	21.4	86.4
RHR (bpm)	98.1	12.9	72.0	120.0
WOC (kg)	17.7	3.6	11.8	25.0

Note. RHR = Resting heart rate; WOC = weight of wheelchair.

In the present study, all of the subjects propelled wheelchairs while performing the TAMT. The aim of the test was to get the subjects to sustain moderate physical activity for a period of 15 continuous minutes in a target heart rate zone between 130 and 160 bpm for children and adolescents between the ages of 10 and 18 years. This represented approximately 70 to 85% of the subjects' maximum predicted heart rate with a downward adjustment of 15 bpm for exercise primarily using the arms only (Rimmer, 1994, p. 221).

Heart rates and cumulative distance traveled were recorded at 1-minute intervals during testing. If the heart rate was within the designated target heart rate zone at a recording interval (130 to 160 bpm), subjects were encouraged to keep going and were told that they were doing a great job. If the heart rate was below the target heart rate zone (<130 bpm), subjects were encouraged to go a little faster in order to achieve a higher heart rate. If the value was higher than the top of the target heart rate zone (>160 bpm), subjects were encouraged to slow down. However, subjects were permitted to exceed the upper limit and given a "pass" if they were able to complete 15 continuous minutes at a threshold above 160 bpm. Scores of pass/fail were administered to each subject on the TAMT. Subjects who exceeded the minimal threshold of 130 bpm received a "pass" on the test. A detailed description of the TAMT can be found in Appendix 1.

Test Procedures. A schedule was arranged to perform the TAMT in groups of six subjects or less, a minimum of two times with a 1-day rest between tests. Due to schedule conflicts, two subjects were able to be tested only one time. The remaining 30 subjects were tested two times.

Three different testing sites were used depending on their availability. A non-air conditioned indoor arena with a smooth surface provided a 144 yd (132 m) oval track. Half of three parallel tennis courts with an all-weather surface provided a 133 yd (122 m) track, and the third testing site was a small blacktop parking area with a 97 yd (89 m) track marked off. In order to measure the cumulative distance traveled at 1-minute intervals, eight cones were placed around the track at equal distances from each other.

Subjects wore Polar Accruex II heart rate monitors while performing the TAMT. On the first test, however, three subjects who wore body-contoured back braces did not wear a monitor and instead had their heart rate recorded manually at intervals of 2, 4, 6, 9, 12, and 15 minutes. On the second test, permission was granted to loosen the back braces and place the transmitter, without the strap, on the chest and then fasten the brace over the transmitter to keep it in place. This modification was an effective alternative to regular heart rate monitoring procedures. On Test 2, the heart rate monitor malfunctioned on three other subjects, who then had their heart rate recorded manually at the carotid or radial pulse for 10 seconds by one of the principal investigators at 2, 4, 6, 9, 12, and 15 minutes.

Each subject wheeled to the testing area without assistance. This took approximately 5 minutes and was used as a warm-up. After pushing one lap around the track, a button was pushed on each subject's heart rate monitor to begin testing. The heart rate monitors recorded time and cumulative heart rates for the entire 15-minute testing period. During the test, the lead investigator called off 1-minute intervals, at which time each subject read off their heart rate from the watch. A camp counselor familiar with the test procedures, and one of two lead investigators, recorded the heart rate along with the distance traveled. Distance was measured in cumulative laps plus completed cone increments. There was a separate score sheet for each subject on each testing day.

Results

Several analyses were conducted to evaluate the intensity, duration, and consistency of the TAMT. The first analysis dealt with attainability. Subjects who had their heart rates recorded manually were excluded from this part of the analysis to ensure maximum accuracy. In Test 1, the three subjects who wore back braces, as well as one subject whose monitor yielded inaccurate readings, were eliminated from this analysis. In Test 2, two subjects were unavailable for testing and three subjects had their heart rate monitors malfunction. Twenty-seven out of 28 eligible subjects (96%) on Test 1, and 25 out of 27 eligible subjects (93%) on Test 2, met the criterion for successful completion of the TAMT. One subject in Test 1 and two subjects in Test 2 were unable to maintain a heart rate greater or equal to 130 bpm and, therefore, failed on these trials of the test. The subject who failed Test 1 passed the TAMT in Test 2, and one subject who failed Test 2 passed the TAMT in Test 1. There was only one subject who did not pass the TAMT at least once and this subject completed only one test. Results are not presented by gender because of the high success rates (96% and 93%).

The second analysis evaluated the consistency of the results between Tests 1 and 2. Twenty-four subjects who had functional heart rate monitors on both tests, or who performed both tests, were evaluated in terms of their passing or failing the TAMT according to the previously stated criteria. Out of the 24 subjects, 22 subjects passed both tests (proportion of agreement = .92). A z test for significance of differences between two proportions (Bruning & Kuntz, 1987) revealed no significant difference ($p > .05$) in the proportion of subjects who passed Test 1 or Test 2. All 24 subjects passed one of the two tests.

The average heart rate of subjects over the 15-minute test also was analyzed in an attempt to study consistency of results. Some subjects stayed strictly within the 130 to 160 target heart rate zone, while others exercised above 160 bpm for at least some portion of the test. For subjects exercising between 130 and 160 bpm on both tests ($n = 10$), mean heart rate for Trial 1 was 146.6 bpm (±7.6) and for Trial 2, 147.0 bpm (±7.6). For the 22 subjects exercising within the target heart rate zone of 130 to 160 bpm and/or above 160 bpm, the mean heart rate for Trial 1 was 156.0 bpm (±12.1) and for Trial 2, 157.1 bpm (±13.6). A correlated t-test revealed no significant difference in mean heart rate between trials ($p > .05$) for subjects ($n = 22$) exercising within and/or above the target heart rate zone, and a significant correlation was obtained on mean heart rate between trials ($r = .71, p < .05$).

Relative to cumulative distance, subjects were able to push further on Trial 1 (1716 yd [1569 m]) compared to Trial 2 (1607 yd [1469 m]), $p < .05$. Although there was a statistically significant difference on cumulative distance traveled between Tests 1 and 2, the intraclass reliability was very high ($R = .94, p < .000$). The lower cumulative distance covered during Test 2 was probably the result of the shorter course, which was used for all the subjects in Test 2 and required more turns and, therefore, a greater amount of deceleration around the turns.

Discussion

The present study sought to determine if the Target Aerobic Movement Test (TAMT) could be considered a feasible test for measuring moderate levels of *aerobic be-*

havior in children and adolescents with spina bifida. Feasibility was determined by studying the suitability of the testing procedures for children and adolescents wheeling around a designated area, the attainability of test intensity and duration, and consistency (reliability) of test results. The results of our study suggest that the TAMT is a feasible test for measuring moderate levels of aerobic behavior in children and adolescents with spina bifida.

Regarding the suitability of the testing procedures, testing went smoothly with all of the subjects with the exception of two minor problems. During Test 1, three subjects were not able to wear the heart rate monitor because of interference with body-contoured back braces. During Test 2, however, this problem was alleviated by loosening the back braces and placing the transmitter against the chest and then fastening the brace over the transmitter to keep it in place. The second minor problem involved the heart rate monitor malfunctioning (gave erratic readings or shut down) for one subject on Test 1 and three subjects on Test 2. This may have resulted from the transmitter slipping below the breast level dux+ing testing or from poor contact.

Reliability was primarily determined by examining the passing rate of subjects on successive administrations of the test, as well as analyzing the relationship and significance of differences in mean heart rates for the 15-minute exercise period between Tests 1 and 2. Based on these analyses, it appears that the TAMT is reliable for use in field-based settings. The percentage of subjects passing Test 1 and Test 2 was 96% and 93%, respectively. All 24 subjects who were evaluated on both tests with an intact heart rate monitor passed one of the two tests.

Clearly, one of the disadvantages of the TAMT is that it does not discriminate fitness levels among those who successfully pass it. It is plausible, however, that such distinctions may be enhanced if distance (work) along with heart rate were evaluated. As a matter of interest, pilot data were collected in this regard. These preliminary data suggested that the detection of differences in health-related physical fitness on the TAMT may be enhanced by evaluating distance covered, as an index of workload, in addition to monitoring heart rate. This contention is only suggestive, however, because no attempt was made to control for wheelchair type or to account for differences in course layout or surface texture.

In this study, mean heart rates between trials were virtually identical and the correlation between heart rates on Test 1 and Test 2 was strong. Interestingly, the ability to work at heart rates ≥160 bpm, which equates to a training intensity greater than 80% of maximum heart rate for children and adolescents between the ages of 10 to 18 years old performing arms-only exercise was demonstrated in several subjects. Much to our surprise, 10 subjects (31%) on Test 1 and 11 subjects (37%)

Table 2 Passing Rates on the TAMT

Test	Number	Number passing	% passing
1	28	27	96%
2	27	25	93%

on Test 2 ignored our requests to slow down after they were told that their heart rate was above the upper limit of their training zone and finished the test with a mean heart rate ≥ 160 bpm. It was evident that these subjects were performing at a high enough intensity level to reflect a more vigorous level of aerobic behavior. However, more research needs to be conducted to determine if the TAMT, using a target heart rate zone of greater intensity, would be a good indicator of vigorous physical activity.

In conclusion, the TAMT appears to be a reliable and feasible test for measuring moderate levels of aerobic behavior in children and adolescents with spina bifida. Future research should focus on studying the feasibility of the TAMT with other populations with disabilities and, if the test is revised appropriately, use of the test as a reflection of the ability to perform vigorous physical activity and as a more refined discriminator of aerobic behavior and aerobic capacity.

References

American College of Sports Medicine. (1991). *Guidelines for exercise testing and prescription* (4th ed.) Philadelphia: Lea & Febiger.

American College of Sports Medicine. (1995). *ACSM's guidelines for exercise testing and prescription* (5th ed.) Baltimore: Williams & Wilkins.

Bruning, J.L., & Kuntz, B.L. (1987). *Computational handbook of statistics*. Glenview, IL: Scott, Foresman, and Co.

Consensus Development Conference. (1995, December 18-20). *NIH consensus development conference on physical activity and cardiovascular health*. Bethesda, MD.

Janssen, T.W.J., Van Oers, C.A.J.M., Van Der Woude, L.H., & Hollander, A.P. (1994). physical strain in daily life of wheelchair users with spinal cord injuries. *Medicine and Science in Sports and Exercise*, **26**, 661-670.

Noreau, L., & Shephard, R.J. (1992). Physical fitness and productive activity of paraplegics. *Sports Medicine, Training, and Rehabilitation*, **3**, 165-181.

Pate, R.R., Pratt, M., Blair, S.N., Haskell, W.L., Macera, C.A., Bouchard, C. (1995). Physical activity and public health: A recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Journal of the American Medical Association*, **273**, 402-407.

Public Health Service. (1991). *Healthy people 2000. National health promotion and disease prevention objectives* (DHHS Publication No. 91-50212). Washington, DC: U.S. Department of Health and Human Services.

Rimmer, J.H. (1994). *Fitness and rehabilitation programs for special populations*. Dubuque, IA: Brown & Benchmark.

Rimmer, J.H., Braddock, D., & Pitetti, K.H. (1996). Research in physical activity and disability: An emerging national priority. *Medicine and Science in Sports and Exercise*, **28**, 1366-1372.

Santiago, M.C., Coyle, C.P., & Kinney, W.B. (1993). Aerobic exercise effect on individuals with physical disabilities. *Archives of Physical Medicine and Rehabilitation*, **74**, 1192-1198.

Tell, G.S., & Vellar, O.D. (1988). Physical fitness, physical activity, and cardiovascular disease risk factors in adolescents: The Oslo youth study. *Preventive Medicine*, **17**, 12-24.

Winnick, J.P., & Short, F.X. (1995). *Project Target test manual*. Unpublished manuscript, State University of New York College at Brockport, NY.

Appendix 1

Target Aerobic Movement Test[3]

Description: This test is designed to assess the aerobic behavior of children and adolescents. Participants attempt to exercise within a target heart rate zone (THRZ) for 15 minutes. Participants can engage in virtually any physical activity they choose as long as the activity is of sufficient intensity to raise the heart rate into the THRZ. In preparation for this test, instructors are encouraged to work with participants to help them identify an appropriate physical activity. For most participants who engage in "whole-body" forms of exercise, the THRZ is defined as 70 to 85% of maximum predicted heart rate (i.e., 140-180 bpm). There are two exceptions to these THRZ values. The first is for participants who have a spinal cord injury that results in low level quadriplegia (spinal lesion between C6-C8 inclusive). For those youngsters, THRZ may be defined in one of two ways. If a youngster has a resting (sitting) heart rate of less than 65 beats per minute, the THRZ is defined as 85 to 100 beats per minute. If a youngster's resting heart rate is 65 or more beats per minute, the THRZ is defined as a range of 20 to 30 beats above the resting value. The second exception applies to those who engage strictly in arm exercise. For those who use arms-only forms of exercise, the THRZ ranges from 130 to 170 beats per minute. The tester checks the participant's heart rate at least once every 60 seconds. If participants are within their THRZ, the tester reinforces the behavior and encourages participants to continue at their present intensity of exercise. If participants are below their THRZ, the tester encourages participants to increase exercise intensity. Should participants fall below their THRZ, they have one minute to regain their minimum value. If they do, the test continues; if not, the test is terminated at that time. If the participant is above the THRZ, the tester should acknowledge the participant's effort but also encourage the participant to decrease exercise intensity. If a participant is above THRZ, the test is continued and passed if the participant exercises for 15 minutes.

Equipment: It is recommended that testers use an electronic heart rate monitor in administering this test. It also is recommended that music with a fast tempo be played during the test to provide motivation and a sense of rhythmic, steady-state exercise.

Scoring and Trials: One test trial is given. This is a pass/fail test item; participants who can stay in or above the THRZ for 15 minutes pass the test. The 15-minute count does not begin until after the participant enters the THRZ. For those unable to pass the test, it is recommended that testers note the length of time that the participant was able to exercise in the THRZ.

Test Modification: If a heart rate monitor is unavailable, the test may be administered using the following procedures: Pulse rate at the wrist (i.e., radial pulse) is counted manually for 10-second intervals at a number of predetermined checkpoints. (The participant's exercise must be briefly interrupted for each pulse check). Pulse rate is checked at the end of a 3-minute warm up period and at the end of each of the following test exercise intervals: 2 minutes, 4 minutes, 6 minutes, 9 minutes, 12 minutes, and 15 minutes. Participants able to exercise for minimum THRZ values for 15 minutes pass the test.

Suggestions for Test Administration

Provide a "cool-down" area and activities of decreasing intensity for participants at the conclusion of the test. Individuals with spinal injuries above T6 are subject to "automatic dysreflexia," a condition which can elevate the heart rate (and blood pressure) as a result of bowel or bladder distention or skin irritation. As a precaution, therefore, it is recommended that youngsters with spinal cord injuries above T6 empty their bowels and bladders and be checked for tight clothing, straps, or pressure sores which might contribute to skin irritation prior to testing.

Notes

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[2]The 1991 ACSM recommendation for minimal duration was 15 minutes. In 1995, ACSM revised its recommendation to 20 minutes. We chose to employ the 15-minute guideline because the recommendation by ACSM was for training purposes and was not a standard for testing aerobic behavior. The project advisory committee, made up of experts in exercise physiology and adapted physical education, felt that a 15-minute test would adequately represent an individual's aerobic behavior.

[3]This test is a modification of the aerobic movement test developed by Pat Good, Howe School, Dearborn, MI 48124.