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EXERCISE SCIENCE

Perceived Exertion of the PACER in High School Students

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Abstract

The purpose of this study was to explore high school students' perceived exertion after participating in the Progressive Aerobic Cardiovascular Endurance Run (PACER). Immediately after completing the PACER, students (N = 792) indicated their perceived exertion on the OMNI rating of perceived exertion (RPE) for children (1–10 scale). All students, whether passing or failing, rated their exertion after the PACER test significantly lower than a hypothetical mean of 6 (p < .05), which corresponds to tired *on the OMNI scale. Students who did not meet the criteria rated their exertion less than* tired *and may not have provided a full effort on the test, which resulted in less than acceptable passing rates for cardiovascular fitness among this population.*

Being physically active is a means by which risk factors for diseases can be reduced. Evidence suggests that physical activity can lower the risk factors or reduce the symptoms of cardiovascular disease (Nocon et al., 2008; Paffenbarger et al., 1993; Sherman, D'Agostino, Cobb, & Kannel, 1994), obesity (Hill & Wyatt, 2005; Rippe & Hess, 1998), type 2 diabetes (Sigal, Kenny, Wasserman, Castaneda-Sceppa, & White, 2006; Wei, Schwertner, & Blair, 2000),

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and some cancers (Hardman, 2001; Lee, 2003). It is recommended that adults accumulate a minimum of 30 min of moderate-intensity aerobic activity at least 5 days a week or a minimum of 20 min of vigorous-intensity aerobic activity at least 3 days a week (Haskell et al., 2007) and that children and adolescents accumulate at least 60 min of moderate-to-vigorous activity each day (U.S. Department of Health and Human Services, 2008). The increasing rates and prevalence of obesity (Ogden et al., 2006; Wang & Beydoun, 2007), type 2 diabetes (Centers for Disease Control and Prevention, 2008; Deshpande, Harris-Hayes, & Schootman, 2010), and cardiovascular disease (Lloyd-Jones et al., 2010) in adults is alarming, but in children the rates and prevalence of obesity (Han, Lawlor, & Kimm, 2010; Ogden, Flegal, Carroll, & Johnson, 2002; Wang, Monteiro, & Popkin, 2002), type 2 diabetes (Mohamadi & Cooke, 2010; Pinhas-Hamiel & Zeitler, 2007), and cardiovascular risk factors (McCrindle et al., 2010; Prentice, Kitly, Stearne, & Dobbin, 2008) are even more so.

It has been suggested that fitness levels of U.S. children decline as they age (Allison, Adlaf, Dwyer, Lysy, & Irving, 2007; Caspersen, Pereira, & Curran, 2000; McMurray, Harrell, Bradley, Deng, & Bangdiwala, 2002), and this is evidenced through declines in aerobic power and physical activity levels from childhood through adolescence (McMurray, Harrell, Bangdiwala, & Hu, 2003). This may be due to low physical activity levels (Barnett, O'Loughlin, & Paradis, 2002; Eaton et al., 2010) and increased sedentary behavior (Adams, 2006; Eaton et al., 2010). One avenue of children obtaining physical activity is through physical education classes (PE), but unfortunately many U.S. children do not participate in daily PE (Lee, Burgeson, Fulton, & Spain, 2007). Many U.S. states, however, require that students' fitness levels be assessed and reported. For example, fitness testing is required for grade levels 3–12, which is stated in the Texas Education Code (TEC) Chapter 38 Sub Chapter C (§ 38.101–106). All grade levels must be assessed, but only grades 9–12 are reported to the Texas Education Agency (TEA). Because many students do not participate in daily PE and the rates and prevalence of disease in children is increasing, children in the United States who participate in these fitness tests will plausibly have low passing rates.

One of the tests used to assess fitness of school children is the FITNESSGRAM. This battery consists of six items that assess cardiovascular fitness (Progressive Aerobic Cardiovascular

Endurance Run [PACER], 1-mile run/walk, or walk test), abdominal strength and endurance (curl-up), trunk extensor strength and endurance (trunk lift), upper body strength and endurance (push-up, modified pull-up, or flexed arm hang), body composition (BMI or percent body fat calculated from triceps and calf skinfolds), and flexibility (backsaver, sit and reach, or shoulder stretch). Results from fitness tests such as this, however, must be interpreted cautiously. For example, when data from school children in Texas who completed this battery were examined, less than 13% of high school students during 2008, 2009, and 2010 achieved the minimal criteria on all six items to be considered in the healthy fitness zone (Texas Education Agency, 2010). Whether this is a true representation of students' fitness has yet to be determined, and one factor that has yet to be examined is exertion.

Literature on the effort of children who participate in fitness testing is sparse. Some studies have explored children's perceptions of physical education (Birtwistle & Brodie, 1991; Carlson, 1995; Luke & Sinclair, 1991; Stelzer, Ernest, Fenster, & Langford, 2004), and although children's perceptions of fitness testing have been explored (Lamb & Eston, 1997), studies such as this are also sparse. Sampson (2008) indicated students feel a degree of success and accomplishment and understand the importance and role of fitness testing, and it has been suggested that running and fitness activities are frequently disliked and that fitness testing is misunderstood by students (Flohr & Williams, 1997) or that they do not understand why they have to perform fitness testing and view it as a negative experience that is little fun (Hopple & Graham, 1995). If children's attitudes and perceptions of physical fitness testing are viewed negatively, plausibly these children may not provide a true effort during testing and ultimately may be misclassified as unhealthy. Also, children may terminate a test prematurely for other reasons, such as not wearing appropriate clothing, not wanting to sweat, and even being apathetic. Many of these children may be classified as *false negative*, in other words, as unhealthy when they truly are healthy. These children, who may otherwise pass with a true physical effort, may be causing the failing rates to increase and therefore cause a misrepresentation of fitness levels.

Thus the purpose of this paper is to examine students' exertion during the PACER test, which is a test item of the FITNESSGRAM® that assesses aerobic fitness. This test consists of running between a series of beeps that get progressively faster, and students finish

when they can no longer continue or until they meet the criteria of the healthy fitness zone. Only the PACER was used for this study because of time constraints and feasibility. The OMNI rating of perceived exertion (RPE) for children (1–10 scale) was used to assess exertion, and it was expected that ratings would be high, suggesting students performed the test with high effort.

The hypothesis for this study was that no significant difference would be found between RPE of students and the mean rating of 6 on the OMNI scale. This number corresponds to *tired* on the scale, and this word is also written below the number 6 with a picture of a tired child who is running. It was also hypothesized that no significant difference would be found in RPE between males and females who did and did not meet the criteria of the healthy fitness zone.

Methods

Participants

This study was approved by the University's Institutional Review Board. A written informed consent form was made available and signed by each student and parent, in addition to the superintendent consenting to the study. The participants for this study were male and female high school students attending public schools in south-central Texas. Participants agreed to answer a question about how they felt immediately after the PACER test, to give their birth date, and to have their height and weight measured.

Instruments and Procedures

The PACER was conducted by the school's physical education teachers during normal school hours. The physical education teachers were in charge of the assessment, and the investigators had no part of instructing or conducting this test. Other than including the scale and instruction for interpretation with consent forms for parents and children to see, the investigators provided no verbal directions prior to testing on how to use the scale. This was done to reduce the influence the investigators may have had on students' effort, as well as because of the tight schedule to which the physical education teachers were assigned.

To conduct the PACER, the physical education teachers marked two lines 20 m apart using cones or tape at each end of a hardwood floor indoor gymnasium. Students were then lined up behind the

start line, and a CD player projected over loud speakers was started. Students listened to the automated instructions on the CD, and on the first beep, they jogged to the opposite line, turned around, and waited for the next beep. Each progression from one line to the other was considered a lap. As the test continued, the time between the beeps was progressively shorter, causing students to run faster, and if not able to complete a lap before the beep, they immediately reversed direction and were allowed to catch up. Once students were not able to complete a lap two times, their test was over. Students then recorded the number of laps completed on an index card, and the investigator showed them the OMNI rating of perceived exertion for children, which has been validated in children and adolescents while they walk and jog (Pfeiffer, Pivarnik, Womack, Reeves, & Malina, 2002; Robertson et al., 2006; Roemmich et al., 2006; Utter, Robertson, Nieman, & Kang, 2002).

This scale produced an intraclass and single-trail reliability coefficient of 0.95 and 0.91, respectively, with validity coefficients for percentage heart rate maximum and percentage VO_2 maximum of 0.86 and 0.89, respectively, in children aged 13–18 (Pfeiffer et al., 2002). The OMNI scale indicates intensity on a numerical scale from 0 to 10, with illustrations showing a child getting progressively tired as the numbers increase from 0 (*not tired at all*), to 2 (*a little tired*), to 4 (*getting more tired*), to 6 (*tired*), to 8 (*really tired*), to 10 (*very, very tired*). Odd numbers were included but did not have descriptors. The students were specifically asked to "place your finger on a number to describe how tired the test made you feel." Some students, depending on time constraints, were asked the open-ended question "Why did you decide to stop?" The answers were recorded along with the laps completed on a data sheet, and students were brought to a Dectecto DR400C digital scale (Webb City, MO) and a Seca S-214 portable height rod (Hanover, MD), where body weight and height were recorded, respectively, without shoes. Birth date and gender were also recorded at this time.

Not every student at every testing session was assessed with the OMNI scale. During any given PACER test, at least 50 students participated at the same time due to the testing schedule implemented by the schools, and because only three to five investigators were present, not all student data were captured. While there was no systematic procedure to randomize collecting data from students, the investigators made every effort to gather information from students who finished early, in the middle, and later in the test.

Design and Analysis

This study aimed to describe effort in the PACER test using the OMNI rating of perceived exertion for children. It was expected that after students completed the PACER test, they would indicate a high effort on the OMNI RPE scale. First, a one sample *t* test was conducted to compare students' RPE to the hypothetical mean of 6, which is the number on the scale that indicates *tired*. This number was chosen by the authors because they expected students to feel tired after the PACER, especially when they provided a full effort to achieve the minimum criteria. Cohen's *d* with the sample standard deviation was used to compute the effect size between the sample mean and the hypothetical mean, with $d \geq 0.8$ considered a large effect, .05 considered a medium effect, and ≤ 0.2 considered a small effect.

A MANOVA was then used to determine if there were significant differences in RPE and laps completed between gender as well as those who met the criteria and those who did not (pass/fail). Cohen's *d* with the pooled standard deviation was used to compute the effect sizes when examining pairwise comparisons. The criteria used for pass/fail on the PACER was the lower end of the healthy fitness zone for each age group, which is the criteria the schools use when the results are reported to the TEA. Type I error was controlled in pairwise comparisons with the Bonferroni technique.

Additionally, Pearson's product–moment correlations were used to examine the relationship between laps completed and RPE. Alpha was set at $p < .05$ for all inferential tests.

Results

Data from 792 students who participated in the PACER test can be seen in Table 1, with over 75% of the sample population not meeting the minimum criterion of laps completed to be in the healthy fitness zone. A one sample *t* test indicated that students rated their exertion significantly lower than the mean of 6, which corresponds to *tired* on the OMNI scale, $t(791) = -17.1$, $p = .001$, $d = 0.60$. Ratings of exertion in only those who met the criteria were also significantly lower than 6, $t(177) = -7.7$, $p = .001$, $d = 0.57$, as well as in those who did not meet the criteria, $t(614) = -15.3$, $p = .001$, $d = 0.61$ (Figure 1).

Table 1

Means and Standard Deviations for Participant Characteristics, Laps Completed in the PACER, and Rating of Perceived Exertion

	Total (*N* = 792)		**Boys (*n* = 446)**		**Girls (*n* = 346)**	
	Pass (22.3%)	**Fail (77.7%)**	**Pass (21.7%)**	**Fail (78.1%)**	**Pass (23.1%)**	**Fail (76.9%)**
Age (years)	14.5 ± 0.6	16.6 ± 1.1	14.6 ± 0.6	16.7 ± 1.1	14.5 ± 0.6	16.6 ± 1.2
BMI (kg/m^2)	22.3 ± 3.0	26.2 ± 6.7	22.5 ± 3.1	26.7 ± 7.1	21.8 ± 3.0	24.1 ± 6.1
Laps	61.6 ± 21.8	21.2 ± 14.9	72.4 ± 19.0	26.4 ± 16.6	47.8 ± 16.0	13.7 ± 7.7
RPE	4.7 ± 2.3	4.5 ± 2.4	5.1 ± 2.2	4.7 ± 2.4	4.2 ± 2.4	4.3 ± 2.4

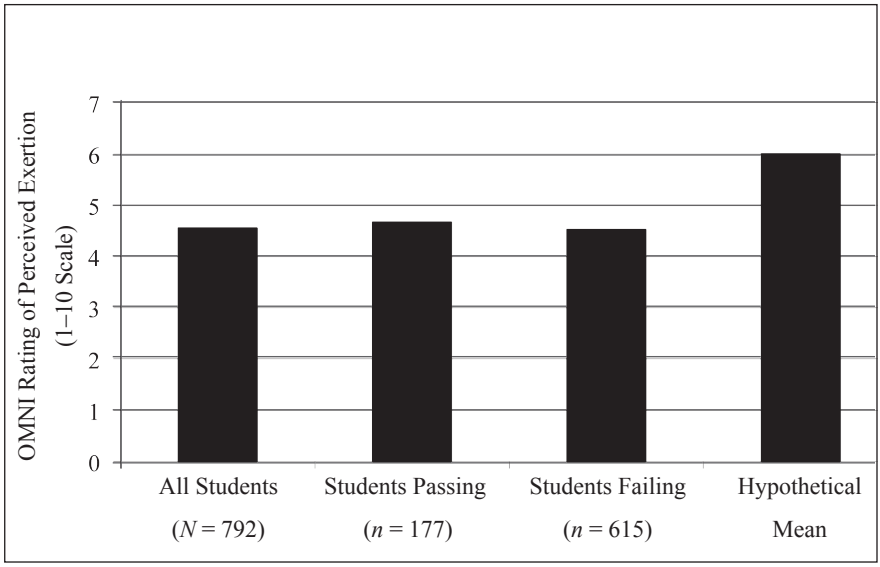

Figure 1. All students, whether passing or failing, rated their exertion after the PACER test significantly lower than a hypothetical mean of 6 ($p > .05$), which corresponds to *tired* on the OMNI scale.

The MANOVA results indicated a significant interaction among gender and pass/fail, Wilks' $\Lambda = .971$, $F(2, 787) = 11.7$, $p = .001$, $\eta^2 = .029$. Pairwise comparisons indicated boys who passed completed a significantly greater amount of laps compared to boys who failed ($p = .001$, $d = 2.68$), and this was also evident in the girls ($p = .001$, $d = 3.32$). The RPE was not significantly different between boys who passed and failed ($p = .127$, $d = 0.17$) and girls who passed and failed ($p = .591$, $d = 0.06$). Results also demonstrated that boys who passed completed significantly more laps than girls who passed ($p = .001$, $d = 1.39$) and that boys who failed also completed significantly more laps than girls who failed ($p = .001$, $d = 0.93$). Although boys who passed rated RPE significantly higher compared to girls who passed ($p = .014$, $d = 0.38$), there was no significant difference in RPE between genders that did not pass ($p = .113$, $d = 0.12$).

Although a significant relationship was found among laps and RPE, $r(792) = .163$, $p = .001$, this coefficient is weak, and only 2% of the variance can be accounted for by the two variables. Figure 2 illustrates this association and does not indicate a curvilinear relationship. Figure 2 also illustrates the number of students who

perceive their exertion very low when completing a few or many laps, as well as those who indicate a high RPE when completing only a few or many laps.

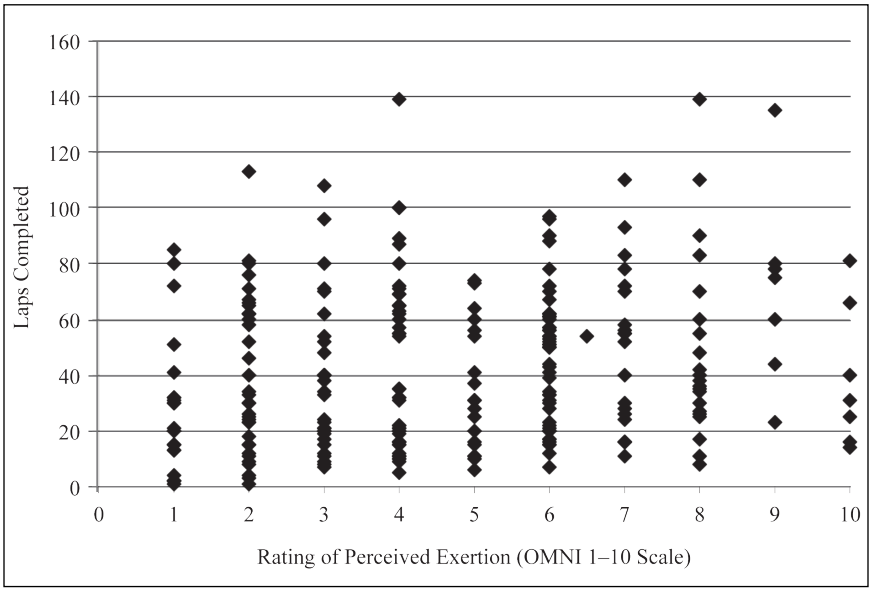

Figure 2. The association between RPE and laps is low, $r(792) = .163$, $p = .001$, in 792 high school students.

Open-ended questions were asked of 162 students, with recurrent themes of being tired (18.5%); just deciding to stop (13.5%); hurting leg, knee, ankle, or foot (8.0%); and sweating (6.1%) being the most common. Students had many other responses, including having asthma, feeling sick, not having proper shoes, having clothing issues, being bored, not being able to breath, not going as far as they could have, not wanting to be the only one running, having to go to the bathroom, being told by a friend to stop, and being too hot.

Discussion

These findings evidently show that high school boys and girls do not perceive themselves as being tired after the PACER test when rating their exertion using the children's OMNI scale. Students possibly may have sufficient fitness to reach the minimum criteria for the healthy fitness zone without becoming tired, and in this case,

their rating was expected to be below 6. This was evident in boys and girls who reached the criteria; however, even those who did not reach the criteria did not rate themselves as being tired. One would expect those who did not reach the criteria to be at a higher RPE because they would make a greater effort to achieve it, and because this was not the case, we speculated that these students were not attempting to put forth the required effort needed to reach the healthy fitness zone. Many students who stopped before meeting the criteria were observably not tired, not breathing hard, and/or not sweaty. The investigators asked 162 of these students why they decided to stop, and recurring themes were "did not want to sweat" and "did not feel like doing it." Other issues, such as not being dressed in proper shoes or clothing and having asthma also contributed to the notion that these students were not providing the effort needed to reach the criteria. In this case, the failing rates may not accurately reflect the true fitness levels of these students because a true effort was not given, resulting in many students possibly being placed into a false negative category (i.e., the test indicates a student is not fit but he or she may be).

As mentioned earlier, this scale has been validated and used in many studies; however, there is no way to determine if students in this study read the scale when the information went home with them prior to data collection. Although many students may be classified as false negatives, those who do not meet the criteria and truly provide an honest effort without indicating a 6 on the OMNI scale must be considered. Students who dropped out before meeting the criteria because of fatigue may have indicated a rating of less than 6 in an effort to hide their embarrassment or to avoid a perception of being weak, whether through intrinsic or extrinsic factors. Those who were tired after the test may not have indicated an honest response and thus provided an inaccurate rating. Of the 117 children who did not meet the criteria and were asked why they stopped, 20% responded they were tired and also indicated *tired* on the OMNI scale ($M = 6.2$, $SD = 2.5$). This shows that students can interpret the scale correctly without having reviewed it prior to testing. Additionally, the mean RPE of all students who failed was 4.5, and on the OMNI scale a 4 corresponds with the words *getting more tired*. If students terminate the PACER at this point, one can speculate they are not fatigued, full effort was not given, and an honest response was not provided.

The test protocol, and not just the rating scale, may have also influenced the perceptual responsiveness of students in this study

(Groslambert & Mahon, 2006). During the PACER, groups ran together in unison, and some students may have dropped out early because they perceived themselves as less fit than others, and thus a full effort was not given. Additionally, once the first students stopped, other students who were not interested in the test may have also terminated early, possibly noting they would not be singled out as the first to stop, yet never having the intention to provide the effort required to reach the healthy fitness zone.

The most surprising finding when examining differences between boys and girls was the significantly lower RPE in girls who passed compared to boys who passed. Although the effect size of this comparison is considered small, the difference in RPE may be attributed to relatively easier standards for the girls compared to the boys. As of late 2010, the standards for reaching the healthy fitness zone were being adjusted so that the new criteria for boys and girls of all ages will be more challenging compared to the current criteria. The RPE in boys who failed and in girls who failed was well below 6, indicating that both genders may not have been honest in their response or did not provide an effort to reach the criteria.

Students' effort may also be dictated by their perceived importance of this test. When collecting data for this study, the teachers did not explain the test or the rationale for administering the test. Many students may not have known why they were performing the PACER, and if they felt it was not important, they may not have provided a full effort to achieve the minimum criteria. Additionally, the investigators visually noted that many students ran with their friends and once their friends stopped, they would stop as well, indicating peer pressure may have influenced the effort provided during the PACER test.

Specific trends are evident between those students who met the criteria and those who did not. Most notably is the difference of the BMI of these students, with almost a 4 kg/m^2 increase in those who failed compared to those who passed. BMI-for-age percentiles were used to measure pass or fail. The mean of boys who did not pass fell in the 92^{nd} percentile, which is considered overweight and is just 3 percentile points away from being considered obese, compared to the 80^{th} for those who passed. Girls who failed were not considered overweight (80^{th} percentile), but still were noticeably different than girls who passed (73^{rd} percentile). This same trend was also seen in age, with the younger students meeting the criteria and the older students failing. This is consistent with literature that suggests aging

is associated with declines in physical activity (Barnett et al., 2002; Sallis, Prochaska, & Taylor, 2000) and increases in BMI (Adair, 2008; Ogden et al., 2006; Vincent, Pangrazi, Raustorp, Tomson, & Cuddihy, 2003). Although the purpose of this study was not to explore physical activity levels of students, physical activity is related to physical fitness (Morrow & Freedson, 1994; Rowlands, Eston, & Ingledew, 1999), and we speculated that the students in this study who did not meet the criteria are not leading physically active lifestyles.

Conclusion

The majority of high school students in this study who participated in the PACER did not meet the criteria for the healthy fitness zone. It seems one of two scenarios is occurring: (a) the majority of high school students in this study are truly not physically fit, most likely due to a sedentary lifestyle, or (b) students are not providing a true effort during the PACER, and thus the percentage of passing/failing students is inaccurate. This second point can be supported by students who did not meet the criteria and did not rate their perceived exertion as *tired*. However, greater efforts do not necessarily indicate a greater number of laps achieved, and more studies may be needed to explore the use of the children's OMNI scale in a field testing situation.

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