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Original Research Article

The Talk Test as a Method to Detect the Transition from Moderate to Vigorous Exercise Intensity in Children

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ABSTRACT

Introduction: Childhood obesity rates have increased over the last 40 years, in part because of increased sedentary behavior. Professional society recommendations call for approximately 60 minutes of moderate/vigorous exercise daily. However, physical education teachers do not have a reliable or simple way to evaluate exercise intensity or differentiate between moderate and vigorous exercise. The Talk Test (TT) has been shown to be a simple, valid and reliable measure of exercise intensity in adults for estimating the ventilatory threshold (VT), which is an accepted measure of the transition between moderate and vigorous exercise. It has not been established if the TT would produce the same results in children. The purpose of this study was to determine if the TT is a valid measurement of exercise intensity during incremental exercise, particularly of VT, in children. **Methods:** Participants attended two laboratory sessions. During the first session the participants (prepubertal children) were familiarized with the laboratory, protocols and then completed a maximal exercise test that included the use of the TT at the end of each stage. During the second session, a maximal exercise test was performed with the measurement of respiratory gas exchange in order to define VT and maximal oxygen uptake (VO_2max). The TT results were compared to the VT. Participants VT, RPE, HR, and VO_2 at each stage of the TT was analyzed using a one-way ANOVA with repeated measures to determine if there were significant differences between stages of the TT. **Results:** The data indicated that the equivocal stage of the TT was equal to the intensity at VT. The responses at the negative stage of the TT were significantly greater than VT and the last positive stage of the TT was significantly less than VT. **Conclusion:** When children are at the equivocal stage of the TT, the intensity approximates VT, just as it does in adults. This suggests that the equivocal stage of the TT is the transition between moderate and vigorous exercise in children.

Key Words: Children MVPA, Exercise Intensity, Talk Test.

Introduction

Public health recommendations have evolved as a consequence of the development of new health issues, therapies and health care improvements[1]. One of today's public health issues is the increasing prevalence in childhood obesity and physical inactivity. According to the

Centers for Disease Control and Prevention, the prevalence of childhood obesity in 2019 in the United States was 18.5%, affecting approximately 13.7 million children and adolescents from ages 2 to 19 years old[2] and has been increasing steadily since 1980. As a result of reductions in school physical education programs[3] and increases in screen time[4], children have become progressively more sedentary over at least the last 40 years. Less than one-quarter (24%) of children 6 to 17 years of age are meeting the recommended 60 minutes of daily physical activity[4].

The ACSM's guidelines for children and adolescents identify that regular physical activity at a moderate to vigorous level is essential for healthy growth and development of children[5]. Physiological benefits for children include improved body composition, lower cholesterol levels, blood pressure, blood sugar, and increased aerobic fitness, muscular strength, movement skills, and bone health[6]. In addition to the physical benefits resulting from regular exercise, evidence suggests improved academic performance[7].

The ACSM recommends that children and adolescents accumulate a minimum of 60 minutes of moderate to vigorous physical activity daily[5]. The types of exercises are not critical and can be acquired through transportation, physical education classes, organized sports, free play, or planned exercise. What is critical, is the level of intensity. In order to prescribe exercise for children, we must be able to define their VO_2 in reference to VO_2max. VO_2max is essentially their maximal exercise capacity that allows their body to transport oxygen to their muscles to continue physical activity. Defining children's maximal exercise capacity allows us to prescribe a percentage of that maximal capacity in order to promote increases in exercise capacity. In this case, moderate to vigorous intensity represents 50% to 85% of VO_2max[8]. However, this is impractical outside of a specialized research setting. Evaluation of exercise intensity level is often accomplished using heart rate (HR). But, to effectively use HR depends on having an individually anchored value for HRmax. This requires a maximal exercise test, which is rarely available for children.

An alternative and reliable way to measure exercise intensity for adults has been established using the Talk Test. In 1998, Goode et al. found that when a subject could "hear their breathing" while exercising, they were at or near their ventilatory threshold (VT) and their HR was within conventionally accepted training zones[8,9] .The intensity at the VT has come to be recognized as the transition between moderate and vigorous exercise[10]. Moderate intensity is defined as "activity that increases breathing, sweating and heart rate" while "vigorous intensity substantially increases breathing, sweating, and heart rate"[8]. This approach, based on the work of Goode et al. [9], would come to be called the Talk Test[11-24] These studies

have shown the Talk Test to be valid and reproducible approximations of VT in a number of populations of adults, during both incremental and stochastic exercise.

The Talk Test has been utilized with various populations, such as healthy and active adults[15,16], untrained or sedentary adults[17], athletes[18,19], and patients in cardiac rehabilitation and maintenance programs[20-24]. Published studies to date have demonstrated with adults that the point where the response to the question "can you speak comfortably?" is "yes, but" (e.g., the Equivocal stage of the Talk Test) is equal to the ventilatory threshold. However, to date, the Talk Test has been performed exclusively on adult populations.

This leads to the question, why has the Talk Test not been used with pediatric populations? It has been shown that maximal exercise capacity testing with children in laboratory setting is reliable and reproducible[25]. The Talk Test is a subjective test and one of the only exercise tests that allows participants to be evaluated outside of a clinical or research setting and does not require an anchoring maximal exercise test. Another subjective measure of exercise intensity in children is the Omni RPE scale[26]. This has been shown to be effective, but for children younger than 11, it is difficult for them to quantify their intensity levels with numbers[27]. When comparing perceived versus objective measures of intensity with RPE, there is considerable individual variability[28].

Research has shown that children typically perform moderate to vigorously activity for less than 10 seconds at a time, but it makes up for over a third of their total activity minutes[29]. Therefore, they seldom perform sustained physical activity[30] due to the stochastic nature of their pattern of play and exercising intensely only in short periods of time[31]. Baquet et al. [29] measured the duration of children's exercise bouts as light, moderate, vigorous, and very high intensity levels. These ranged anywhere from 2 seconds to 1200 seconds at each intensity level. It was found that the mean duration for light intensity was 70.8 ± 13.2 seconds, moderate was 9.0 ± 2.8 seconds, 4.7 ± 1.2 seconds for vigorous intensity, and 3.9 ± 1.6 seconds for very high intensity. However, vigorous and very high intensity accounted for 36.1 ± 5.8% of the children's total amount of physical activity[29]. This is a great representation of how children's play is sporadic in nature compared to that of adults.

Foster et al.[17] showed that adults respond to the Talk Test during interval exercise in a predictable manner, being able to speak comfortably when they were below the intensity of their VT and losing the ability to speak when they were above the intensity of their VT. However, because adults responded in this manner does not mean that children will as well. Therefore, the purpose of this study is to test the hypothesis that the equivocal state of the Talk Test will mark the intensity at the VT in children as it does in adults. As such, it

would provide a tool to demarcate moderate from vigorous activity in children.

Methods

Participants

The project was approved by the Institutional Review Board for the Protection of Human Subjects at the University of Wisconsin-La Crosse. All participants provided written informed consent that was signed by parents/guardians, along with a written assent signed by the participating child. All children completed a Physical Activity Readiness Questionnaire (PAR-Q) and an Exercise History Questionnaire to determine if there were limitations or health issues that would not allow them to participate. Twenty-three children participated in the study and consisted of 12 boys and 11 girls between the ages of 8 and 12 (Table 1). The children's parents indicated that they were prepubertal, although puberty status was not verified by Tanner staging.

Table 1. Descriptive characteristic of the children in the study.

Variable	Boys (n=12)	Girls (n=11)	Total (N=23)
Age (years)	9.9 ± 1.11	9.7 ± 1.07	9.8 ± 1.09
Height (cm)	144.9 ± 8.95	139.7 ± 8.47	142.4 ± 8.72
Weight (kg)	41.8 ± 11.26	33.7 ± 7.46	37.9 ± 9.44
VO_2max ($L \cdot min^{-1}$)	1.87 ± 0.591	1.31 ± 0.393	1.60 ± 0.496
VO_2max ($mL \cdot kg^{-1} \cdot min^{-1}$)	44.9 ± 7.41	38.6 ± 8.50	41.9 ± 7.93
VO_2 at VT ($L \cdot min^{-1}$)	1.27 ± 0.413	0.71 ± 0.249	1.0 ± 0.335
HRmax ($b \cdot min^{-1}$)	181.8 ± 10.84	179.7 ± 13.77	180.8 ± 12.24
HR at VT ($b \cdot min^{-1}$)	146.8 ± 12.08	124.6 ± 18.79	136.2 ± 15.29
RERmax	0.99 ± 0.19	0.99 ± 0.237	0.99 ± 0.212

Data are reported as mean ± SD. VO_2 = Oxygen Consumption; VO_2max = Maximal Rate of Oxygen Consumption; VT = Ventilatory Threshold; HR = Heart Rate; HRmax = Maximum Heart Rate; RERmax = Respiratory Exchange Ratio.

Procedures

The Participants came into the laboratory on two separate days. The first visit was for familiarization to the laboratory, the treadmill, and the collecting of subject characteristics information. They also completed a maximal exercise test while using the Talk Test.

A modified Balke type exercise protocol (e.g., constant walking speed with progressive increments in treadmill grade) was used. A warm-up stage was included to allow the subjects to adapt to treadmill walking, and the test concluded with a cool down stage at one and a half miles per hour at a zero percent grade. During the main test, speed remained constant at three mph ($1.34\ m*s^{-1}$) and grade started at zero and increased by two percent at the end of each two-minute stage. Heart rate and RPE were recorded at the end of each stage as well as their TT response when asked "can you speak comfortably?".

The Talk Test was administered during the last 30 seconds of each two-minute stage.

The children were asked to recite a short passage that was approximately 100 words in length, which was chosen to be of the appropriate reading level[33]. After each recitation, they were asked "Can you speak comfortably?". When participants responded with "yes" it was recorded as a positive stage (+), "yes, but" was recorded as equivocal stage (±), and "no" was recorded as a negative stage (-). Heart rate was recorded at the end of each stage as well as RPE.

There were at least 24 hours between the first and second laboratory visits. The second visit included a second maximal exercise test on the treadmill using the same protocol, while measuring respiratory gas exchange. During the test maximal oxygen uptake and ventilatory threshold were measured. Gas exchange was measured by open-circuit spirometry (Moxus Metabolic Cart System, AEI Technologies, Pittsburgh, Pennsylvania). The metabolic cart was calibrated using a 3.0 L syringe and known gas concentrations (16% O_2, 4% CO_2 and room air). The "V-slope" method as well as the ventilatory equivalent method were used to identify the ventilatory threshold[32].Heart rate (HR) was assessed during both tests using radiotelemetry (Polar Vantage XL, Polar USA, Lake Success, New York). The original OMNI scale[26] created specifically for children was used to subjectively assess the RPE during exercise tests.

Statistical analyses

For the purpose of this study, a one-way ANOVA with repeated measures was used. Tukey's post hoc test was used to compare VT to the TT stages of LP, EQ, and NEG. A Bonferroni post-hoc test was performed to test for pairwise differences between the stages.

Results

Plots of VO_2 at each stage of the TT compared to VT are presented in Figures 1-3, respectively. Mean values are presented in Figure 4. It was found that VO_2 at the LP stage was significantly lower than VT. All but four of the data points were under the line of identity, which means that most children were below their VT at this stage. There was no significant difference between VO_2 at VT and the EQ stage of the TT. As can be seen in Figure 2, the data points fall evenly along the line of identity, with 43.4% of participants being below VT and 56.6% of subject being above VT. At the NEG stage of the TT, VO_2 was significantly greater than VT. All but four of the data points were above the line of identity, which means that 82.6% of participants had a VO_2 that was greater than VT at this stage. Similarly, for HR (Figure 5) and RPE (Figure 6), mean values at the LP stage were significantly lower than VT, values at the EQ stage were equal to VT, and values at the NEG stage were significantly greater than VT.

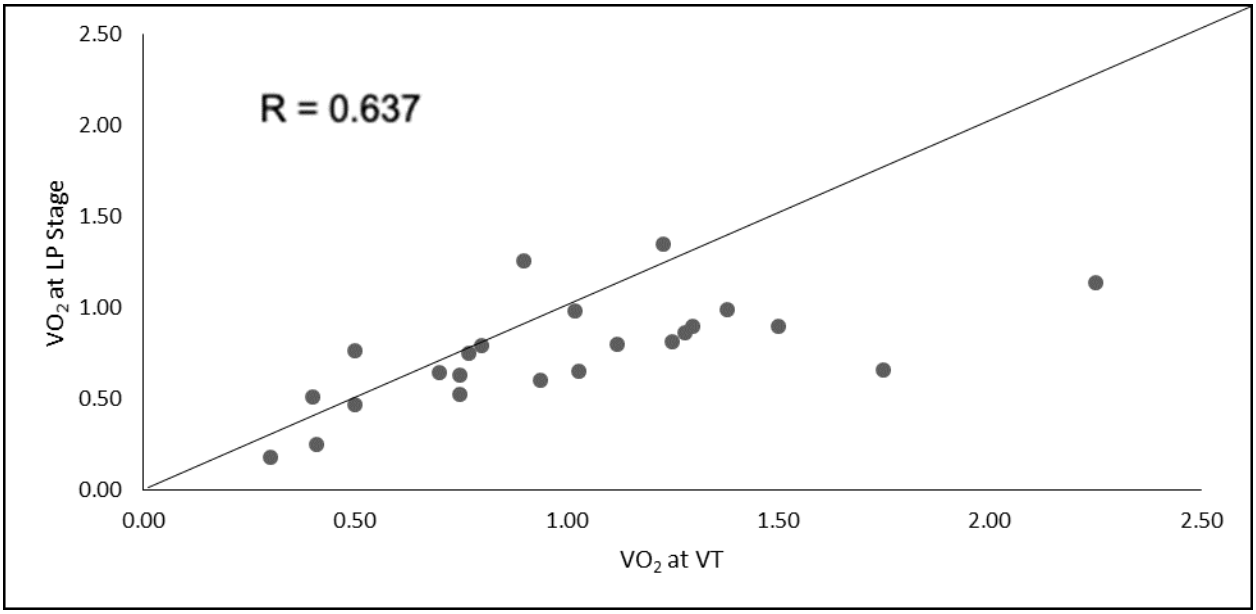

Figure 1. Individual oxygen consumption at VT versus oxygen consumption at LP stage of the TT.

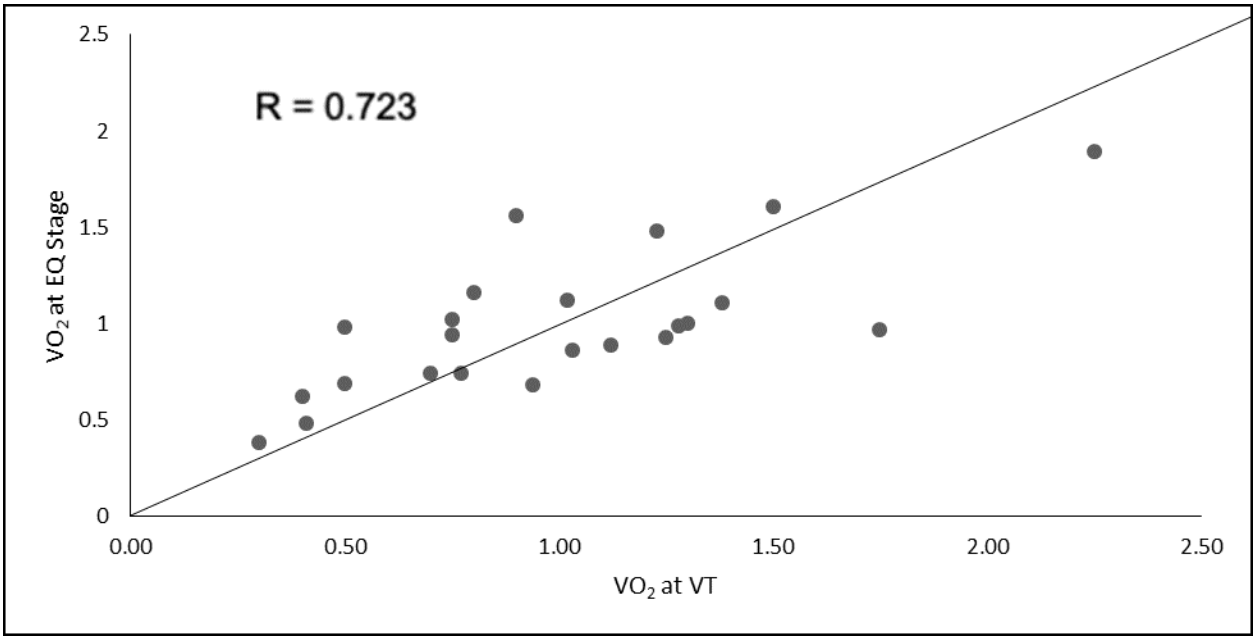

Figure 2. Individual oxygen consumption at VT versus oxygen consumption at EQ stage of the TT.

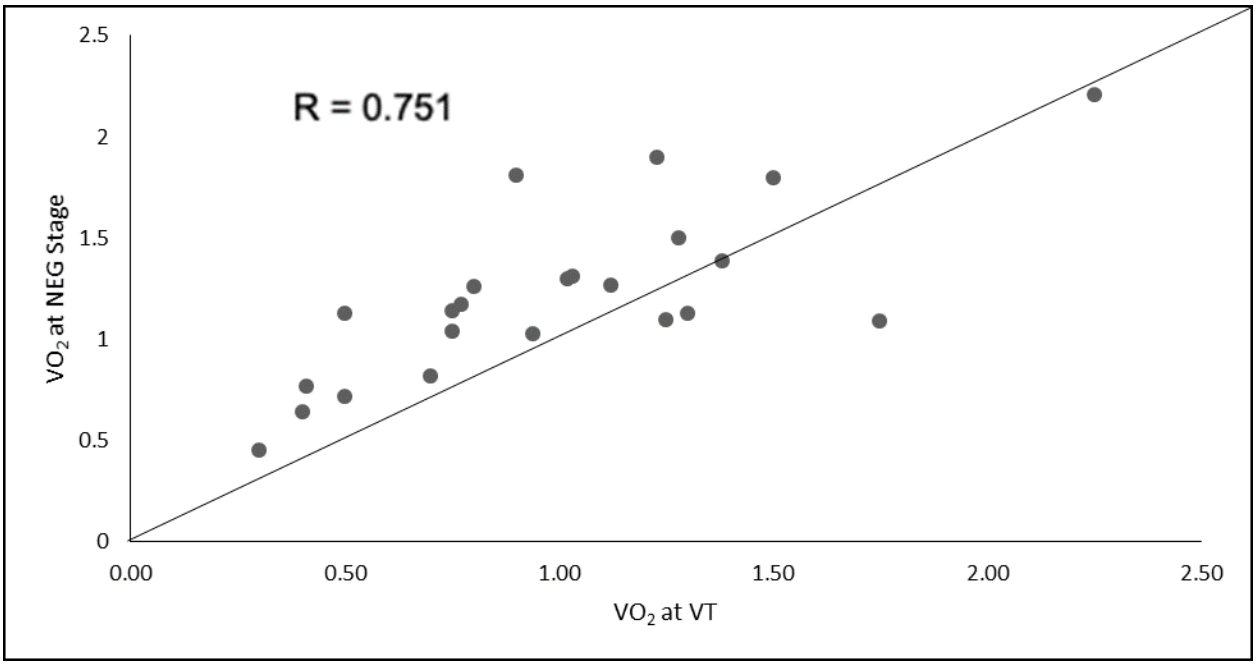

Figure 3. Individual oxygen consumption at VT versus oxygen consumption at NEG stage of the TT.

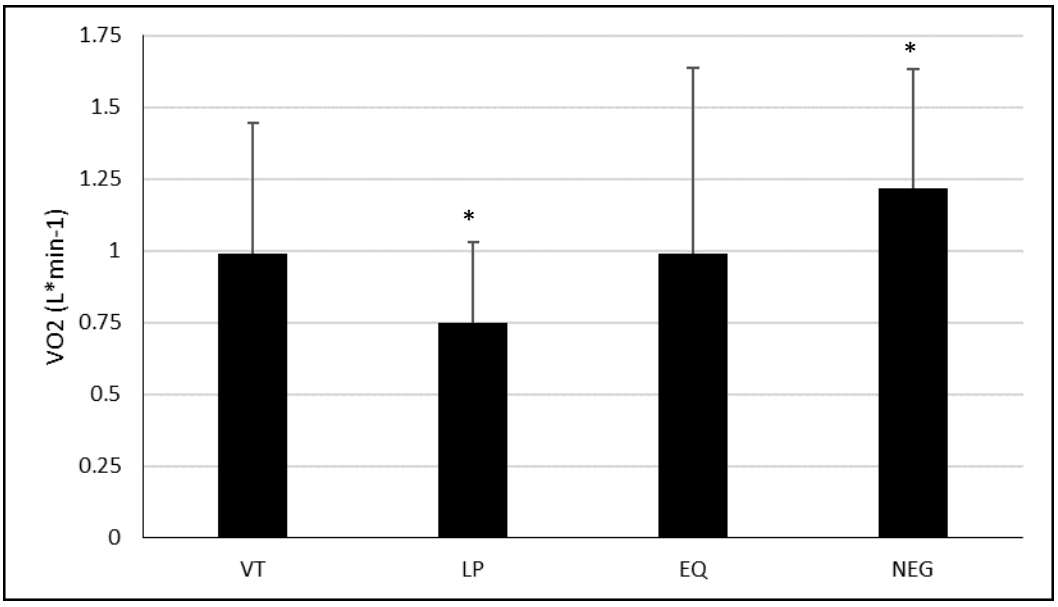

Figure 4. Mean VO_2 compared between VT, and LP, EQ, and NEG stages of the TT.

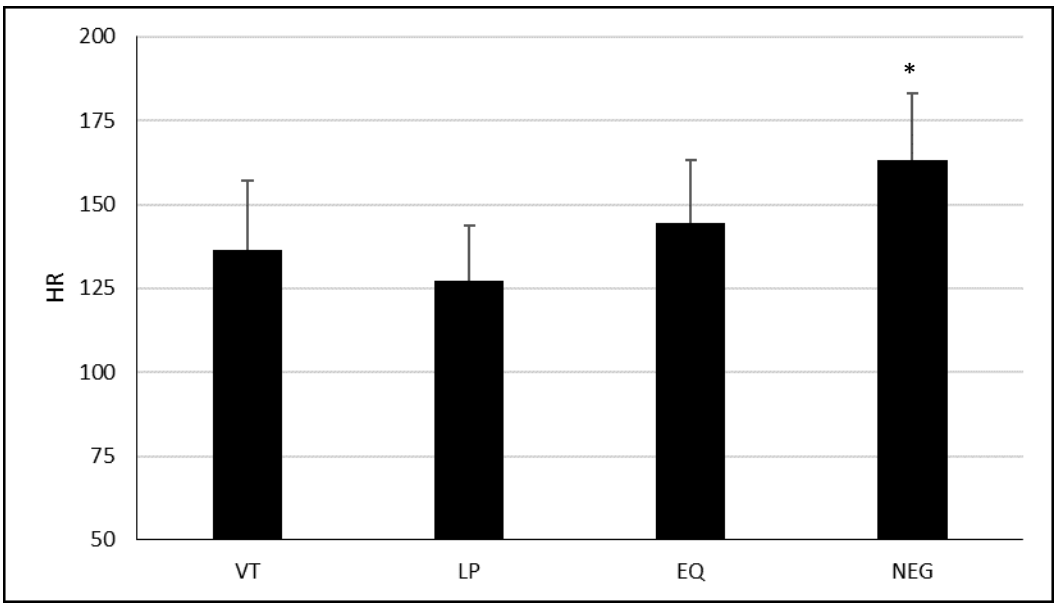

Figure 5. Mean HR compared between VT, and LP, EQ, and NEG stages of the TT.

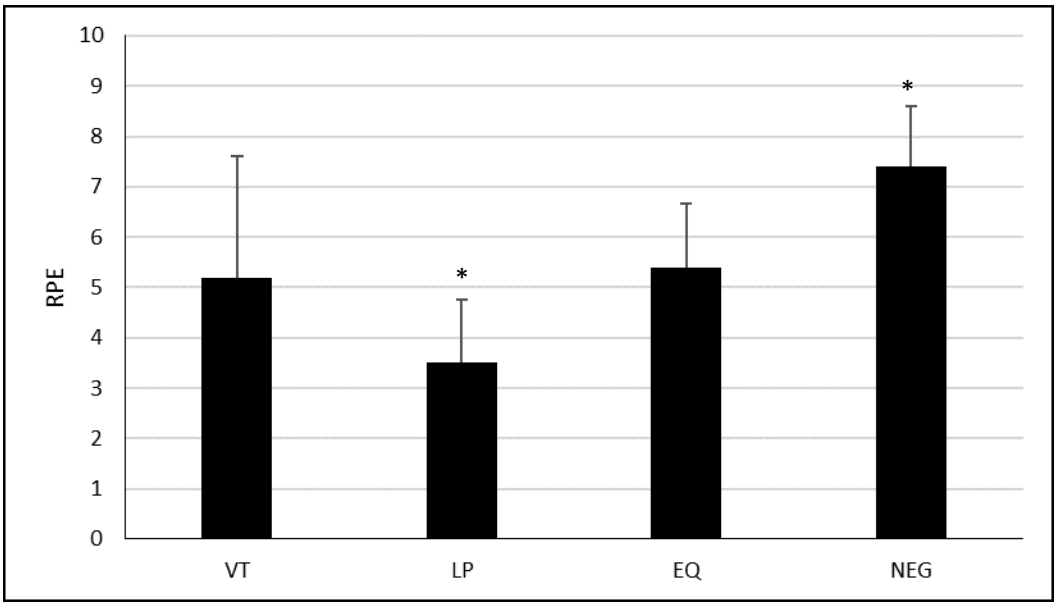

Figure 6. Mean RPE compared between VT, and LP, EQ, and NEG stages of the TT.

Discussion

The purpose of this study was to determine if the Talk Test is a valid measurement of exercise intensity during incremental exercise, particularly of VT, in children. This was tested using direct measurements of VT compared to responses during the Talk Test. The data demonstrated that the EQ stage of the Talk Test consistently approximated the intensity of the VT. The LP stage of the Talk Test generally occurred at a lower intensity than the VT, while the

NEG stage of the Talk test generally occurred at a greater intensity than the VT. Therefore, the data supports the hypothesis that the EQ stage of the Talk Test represents the demarcation of moderate and vigorous exercise intensities in children.

The present findings are important because of how difficult it is to quantify exercise intensity in children. After analyzing subject RPE responses, a cutoff can be identified to represent a given stage of the TT. It was determined that an RPE of five on the OMNI scale was equivalent to the EQ stage of the Talk Test, and also equivalent to their VT. Therefore, any RPE below a five is likely in the moderate intensity range and any RPE above a five is likely above their VT and therefore considered vigorous activity. This baseline provides an easy and inexpensive method of analyzing exercise intensity in children without having to measure direct physiological responses. Physical educators can use the OMNI scale and ask students to rate their RPE during or after activities to determine if they are exercising at a moderate to vigorous intensity level. This comparison of the TT stages to VT also demonstrates that quantifying exercise intensity for children is possible. The use of the OMNI scale makes it more comprehendible for children to quantify their intensity as well versus the Borg 6 to 20 scale[28].

The implications of this study relative to guiding physical activity in children are considerable. Childhood obesity rates are at 18.5% and show no sign of retreating. Approximately 13.7 million children and adolescents are affected by this issue and providing an easy and reliable way to quantify their exercise intensity is important for guiding exercise programs[2]. Obesity at a young age leads to a predictable health problem as children develop into adults including cardiovascular disease, insulin resistance, diabetes, musculoskeletal disorders such as osteoarthritis, and even some cancers[2]. To combat these issues, the ACSM recommends 60 minutes of daily physical activity at a moderate to vigorous level of intensity. This means that children should spend much of their time exercising at their highest exercise intensity that is just compatible with speech, the LP stage of the Talk Test. However, there should be at least some portion of their exercise time above an intensity where comfortable speech is possible. This is the EQ or NEG stages of the Talk Test which is at and above VT, respectively. Heart rate cannot be used as a primary measure of intensity because it requires anchoring maximal exercise tests to establish maximal heart rate. Further, children's exercise patterns do not reflect traditional, steady-state exercise, where heart rate is a very good measure of intensity[34]. However, a strategy of anchoring heart rate responses in relation to the Talk Test may provide a vehicle whereby heart rate can be effectively, and individually, used to guide exercise training[35].

This study provides great practical application to physical education teaching. One application is the ability for teachers to observe the speech and breathing patterns of their students. Similar to adults, children have the natural inclination to increase breathing frequency with increased exercise intensity. Because children work in a more interval fashion, it is important that those short bursts of activity reach the level of moderate to vigorous intensity. Physical education instructors can observe the sounds of the gymnasium to determine if students breathing becomes louder or if speaking fades, they would be at or above their VT. This would contribute to meeting the goal of having some of their daily exercise in the vigorous category.

Limitations of this study included constraining exercise intensity. This was done to demonstrate that the ability to speak was gained and lost in relation to intensity, defined by VT. The subjects were also cued at a particular time to recite a passage. Constraining the level of intensity as well as indicating when to speak, reduces the spontaneous nature of children's activity patterns.

Conclusion

Although the sample size was limited the results demonstrate a clear trend. The EQ stage of the Talk Test is representative of the intensity at VT in prepubertal children. These results are consistent with Talk Test responses observed in adults during steady state or stochastic exercise[16]. This is essential for understanding moderate to vigorous exercise intensity for children to ensure they are exercising at an intensity to meet the daily requirements of physical activity recommended by ACSM[8].

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