The future of activity-promoting video games in clinical practice: Is it the ultimate exercise test in pre-pubertal children?

Aktivite üreten video oyunlarının gelecekte klinik uygulamadaki yeri: Ergenlik öncesi çocuklar için güvenli bir efor testi olabilir mi?

Bülent Oran[1], Alper Akkurt[2], Derya Arslan[1] , Derya Çimen[1]

[1]Department of Pediatric Cardiology, Selcuk University, Medical Faculty, Konya, Turkey
[2]Department of Pediatrics, Selcuk University, Medical Faculty, Konya, Turkey

Abstract
Paediatric exercise testing laboratories should accommodate subjects of various sizes and ages. To this day, games and conventional treadmill exercise tests have not been carried out in pre-pubertal children. Children cannot easily adapt to the treadmill or cycle ergometer. We therefore aim to the use of video games as a form of exercise tests in pre-pubertal children. Twenty healthy children (10 girls and 10 boys, aged 5-11 years old) were enrolled in the study. The physical examination, 12-lead electrocardiography and echocardiography were performed. The heart rate and respiratory rate were measured with systolic blood pressures. Treadmill exercise testing was performed, and electrocardiographic changes were studied during both the treadmill exercise test with Bruce protocol and an activity-promoting video game (Nintendo Wii Boxing), in different time periods. Exercises were stopped at the target heart rate.The mean duration of exercise was 15 minutes in both the Bruce protocol and the activity-promoting video game. Although the data of healthy children (including heart rate and blood pressure responses to exercise) were consistent with the results from several countries using the Bruce protocol, the mean maximal heart rates for all groups were slightly lower than those obtained with the video game. The data obtained from this new exercise test may be used to determine the diagnosis and activation of cardiovascular disease in pre-pubertal children. It can be used as an exercise test especially in young children who are unable to use the treadmill or cycle ergometer
Keywords: Exercise test, games, experimental, child

Özet
Çocukların efor testileri çeşitli kilo ve yaş aralıklarını içermelidir. Oyunlar ve geleneksel koşu bandı efor testleri ergenlik öncesi çocuklarda bugüne kadar uygulanmamıştır. Çocuklar koşu bandına veya bisiklet ergometresine kolay adapte olamazlar. Bu nedenle ergenlik öncesi çocuklarda efor testlerinin çeşidi olarak video oyunlarını kullanmayı hedefliyoruz. 20 sağlıklı çocuk (yaşları 5-11 arasında, 10 kız ve 10 erkek) çalışmaya alındı. Fizik muayene, elektrokardiyografi ve ekokardiyografi yapıldı. Kalp hızı ve solunum hızı sistolik kan basıncı ile ölçüldü. Yapılan koşu bandı efor testinde; farklı zaman dilimlerinde yapılan Bruce Protokolünü içeren koşu bandı testi ile aktive edici video oyununun (Nintendo Wii Boxing) her ikisinde de elektrokardiyografik değişiklikler incelenmiştir. Eforlar testleri hedeflenen kalp hızına ulaşılınca durduruldu. Bruce Protokolü ve Aktive Edici Video Oyununları ortalama 15 dakika sürdü. Sağlıklı çocukların verileri (kalp hızı ve kan basıncının efor testine yanıtı), Bruce Protokolü kulllanan çeşitli ülkelerin sonuçları ile uyumlu olmasına rağmen; tüm gruplar için ortalama kalp hızı video oyunu ile elde edilenden biraz daha düşüktü. Bu yeni efor testinden elde edilen veriler ergenlik öncesi çocuklardaki kardiyovasküler hastalıkların tanısı ve aktivasyonunu belirlemek için kullanılabilir. Özellikle koşu bandı veya bisiklet ergometresi kullanamayan küçük çocuklarda efor testi olarak kullanılabilir
Anahtar kelimeler: Efor testi, oyunlar, deneysel, çocuk

Introduction

Treadmill tests help to maintain vital sign status in a healthy physiologic range. The tests have become important diagnostic markers of cardiovascular diseases in both adults and prepubertal children. The Bruce Treadmill Test, first published in 1963, is the most commonly used exercise test protocol in the world. This test is also used in paediatric cardiology to measure the heart's ability to respond to external stress in a controlled clinical environment (1,2).

Although many studies suggest that treadmill tests are reliable tests for diagnosing significant cardiovascular diseases in adults, children cannot be easily adapted to the test, as these are designed for adults and children are reluctant to take the test. For this reason, benefits of the test are limited for prepubertal age groups, especially during the pre-school period (3). In this study, we are looking for the

Correspondence: Derya Arslan, Department of Pediatric Cardiology, Selcuk University Medical Faculty 42075 Konya-TURKEY
Tel:+90 332 2415000 *deryaamine78@hotmail.com*

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answer to the question: The future of activity-promoting video games in clinical practice: Is it the ultimate exercise test in prepubertal children? Because these video games are more attractive, more fun, more desirable, and more spectacular for children and their parents, children may more easily adapt to these games.

Materials and Methods

Twenty healthy children (10 girls and 10 boys, aged 5-11 years old) were enrolled in the study. The physical examination, 12-lead electrocardiography (ECG) (Marquette Medical Health System, GE) and transthoracic echocardiography (Toshiba Aplio XG) were performed in all patients. Echocardiographic investigation was determined according to the American Society of Echocardiography recommendations (4).

The heart rate and respiratory rate were measured with systolic blood pressures. The heart rate was continuously recorded at the rest phase and during the graded exercise and recovery period, using an event recorder with 12-lead ECG. All tests in this study were performed by the same staff, under the same conditions and in the same laboratory. Each child completed 2 visits to the laboratory within a two day period. The testing order was fixed with treadmill walking performed with Bruce protocol on visit 1 and Wii (boxing) play performed on visit 2. Participants fasted (only water was allowed) for 4 hours before arrival. The testing was performed in a well-lit room at a consistent temperature (22°-24°C) and relative humidity (45-55%). After the rest phase (20 minutes), the subjects performed the exercise test (visit 1) or played the video game (visit 2).

Exercise protocol:

Initially, participants performed a ramp-like progressive exercise test until exhaustion on the treadmill with Bruce protocol. The exercise workload (speed and/or slope) was increased every 60 seconds with completion of the incremental part of the exercise test between approximately 8 to 15 minutes (1). In visit 2, after a familiarisation session (1-2 minutes), participants performed video games for 15 minutes. The boxing games were played with handheld controllers that contain motion sensors which transmit player actions to an on-screen character (Figure 1). Each participant began his or her game session at the beginner skill level. Exercises were stopped at the estimated target heart rate [(200-age as years) x 0,85] (5).

Statistical analysis

The data are presented as mean ± SD. Unpaired Student t tests was used to examine physical characteristics for the cardiovascular variables. The chi-square (x2) test was used to assess the gender differences between Bruce protocol and activity-promoting video games. Heart rates and blood pressures during both exercise tests were analyzed using two-way analysis of variance (ANOVA) with repeated measures to test the possible differences between groups. Probability values of < 0.05 were considered statistically significant.

Results

Mean body surface area were 0.75±0.06 m2 and mean body mass index were 20±0,2 kg/m2 (3-98th percentile for age and gender), mean maximal heart rate were 180.8±10.9 beats/minute and 181.4±11.2 beats/minute with Bruce protocol and activity-promoting video games, respectively. The maximum level of systolic blood pressure were 112±14 and 113±12 mmHg with Bruce protocol andactivity-promoting video games respectively (Figure 2).None developed arrhythmia, ST and T-wave alternans, QT prolongation, and heart rate turbulence,inHolter recordings, during both the treadmill exercise tests and the video game.

Figure1. Figure of activity-promoting video games

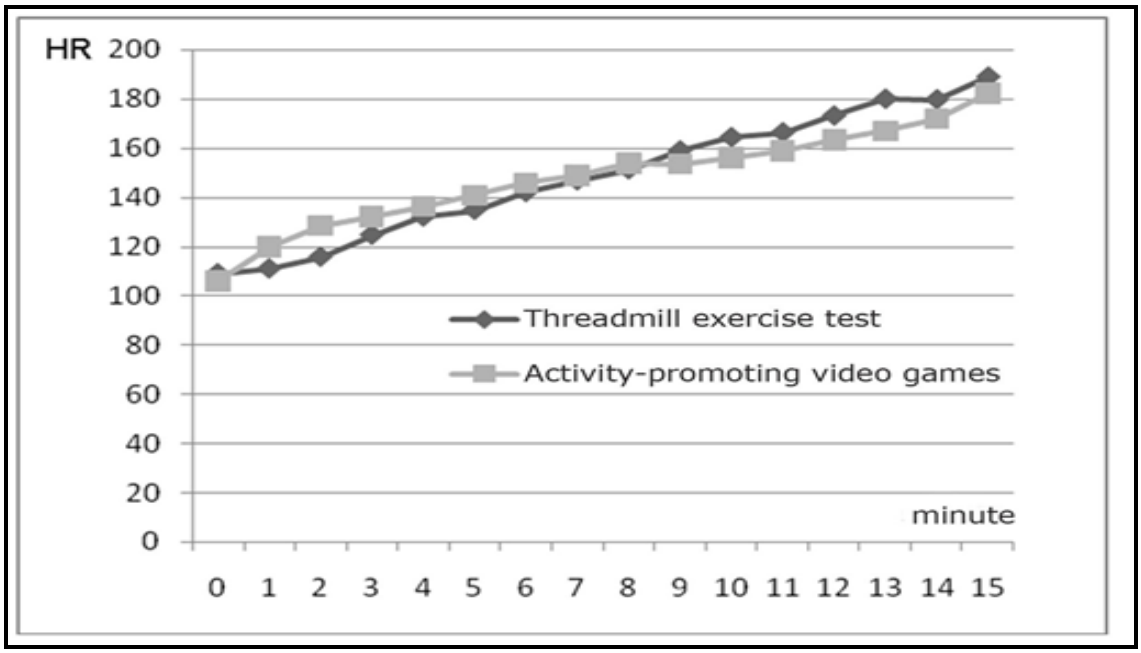

Figure2. Heart rate (HR) of children during both treadmill exercise test and activity-promoting video games.

Discussion

The best exercise testing protocol for children depends on the information required and the age, health, and fitness level of the subject. Heart rate, respiratory rate and blood pressure are the three established vital signs that serve as the foundation of a clinical assessment across all paediatric populations and in apparently healthy children (6).

Traditional vital signs (heart rate, respiratory rate and blood pressure), serve as the cornerstone of a physical examination in children. To this day, however, there has been limited consideration for exercise assessment as a vital sign (6,7).Previous research has demonstrated that the assessment of heart rate and blood pressure during exercise provides particularly valuable prognostic and diagnostic information. Values for one or more of the three classic vital signs that fall into the abnormal range are, in their ownright, potential indicatorsof underlying pathophysiology. In fact, an elevated resting heart rate and blood pressure are both strong indicators of poor health and of an increased risk for adverse events (8).

Concerning differences in cardiovascular responses, children show a higher chronotropic and lower inotropic response during maximal effort. In fact, these results are in agreement with previous reports that showed that children have higher heart rate values at the same relative workload as adults. This higher heart rate observed in the paediatric population is a compensatory mechanism for their smaller hearts and lower stroke volume (8-10). Furthermore, this response may be related to more sensitive peripheral chemoreceptors sensing the build up of metabolites in the exercising muscles (7). On the other hand, children demonstrated lower values for O2 pulse during maximal exercise compared with adults. Although O2 pulse is only an indirect value, this finding may be due to the following factors: 1) smaller heart size; 2) lower stroke volume; and 3) smaller muscle mass, which results in an attenuated venous return (preload) observed in children (8,11).The cardiovascular system of children responds to exercise differently than does that of an adult, although the mechanisms behind the differences are unclear. During dynamic exercise, it has been reported that heart rate response to the initiation of exercise is both faster and slower in children than in adults. Furthermore, heart rate recovery has been reported to be faster in children. During submaximal steady state exercise, heart rate and total peripheral resistance are higher, while stroke volume and cardiac output are lower in children at a given rate of work. At maximal exercise intensities heart rate is higher while stroke volume and cardiac output are lower in children than in adults (12-14).

In summary, despite the differences observed, prepubertal children demonstrated similar data of the treadmill exercise test as compared to the video game. Whatever the mechanism concerning differences in cardiovascular responses in prepubertal children, there have been a few clinical investigations supporting the hypothesis that activity-promoting video games may be used as a special treadmill test. Despite vital sign and electrocardiographic similarities of both types of exercise, in the real world, video games are not used as a treadmill test in prepubertal children today. It is postulated that video games may be used as

reference values same as Treadmill exercise test in the future.

Although these findings indicate that the cardiovascular and ventilatory responses during the Treadmill exercise test was not significantly different as compared to that of the video game and there are only insignificant differences. We speculate that the data obtained from this new exercise test, an activity-promoting video game, offers age and sex appropriate normal data in healthy children and may be used as reference values just as the treadmill exercise test.

Conclusions

In conclusion, children show different responses in cardiovascular parameters during treadmill exercise test when compared with adults and so it is very difficult to standardize. The data obtained from this new exercise test or "futuristic paediatric exercise test" may be used to determine the diagnosis and activation of cardiovascular disease, especially in incompatible prepubertal children. However, further studies into these games are needed before widespread clinical implementation.

Limitations

We recognize limitations in the present study. The main limitation is that our participants were selected from out-patient clinics, in a prospective cross-sectional study. Information about the relationship between sample and population is limited. Thus, we cannot extrapolate the results of this study to the population. Standardization issues must be considered

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