RELIABILITY AND VALIDITY OF A MODIFIED FIELD TEST FOR THE EVALUATION OF AEROBIC PERFORMANCE

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Abstract:

The purpose of this study was to assess the reliability and the validity of a modified version of the Multistage Shuttle-Run Aerobic Test 20m. The proposed version is a hexagon with 10m side distances each named Hexagon Multi-Level Running Aerobic Test 10m. The same parameters (ending level, maximum speed and heart rate at the finish) were measured and the VO_{2max} was estimated in both tests using the Multistage Shuttle-Run Aerobic Test 20m protocol and tables. For the proposed test the reliability evaluation was applied on a sample of 18 students (age 20.8±0.9yrs) twice with a 48h time interval, giving high correlations in maximum speed and VO_{2max} (r=0.99) and ending level (r=0.98). For the Hexagon Multi-Level Running Aerobic Test 10m the validity assessment of the measured variables of this test were compared with the same variables of the Multistage Shuttle-Run Aerobic Test 20m in 62 trained adolescents (age 13.7±0.7yrs). The validity coefficients for all the variables between the two tests were r=0.86 ($p<0.01$). Furthermore, the participants' performance profile was significantly higher in the proposed version, ($p<0.05$) while the mean VO_{2max} of adolescents was significantly higher in this test than in the prototype Multistage Shuttle-Run Aerobic Test 20m (46±6.2 vs 40.8±4.9ml/kg · min), ($p<0.05$). Conclusively, it can be inferred that the Hexagon Multi-Level Running Aerobic Test 10m is not only a reliable and easy to use test but also, compared to the valid Multistage Shuttle-Run Aerobic Test 20m, it can be an objective test for the evaluation of aerobic performance in adolescents.

Key words: *VO_{2max}, running, shuttles, hexagon*

Introduction

Physiological monitoring can provide the sport scientist with an objective means of assessing the performance capability of an individual. The evaluation of aerobic performance defines the indicators of health and superiority to many daily activities. Undoubtedly, the most accurate measurement of aerobic performance in the form of maximum oxygen uptake (VO_{2max}) takes place in research laboratories. The determination of VO_{2max} by indirect calorimetry is one of the most commonly performed measurements for aerobic capacity (Morrow, Jackson, Disch, & Mood, 2000). However, this form of assessment has disadvantages in terms of availability, cost and time (Armstrong, Williams, & Ringham, 1998). A valid field test measuring aerobic performance could eliminate many of the laboratory restrictions (Noonan & Dean, 2000). The Multistage Shuttle-Run Aerobic Test 20m (Leger & Boucher, 1980; Leger & Lambert, 1982; Tokmakidis, Leger, Mercier, Peronnet, & Tibault, 1988; Leger, Mercier, Gadoury, & Lambert, 1988; Brewer, Ramsbottom, & Williams, 1988) and the 12-minute run test (Cooper, 1968) are two widely reported and commonly used field test of aerobic capacity. The low validation of the 12-minute run tests (Leger & Lambert, 1982; Jackson, DerWeduwe, Schick, & Sanchez, 1990) and the significant correlation (r=0.89) between the estimation of VO_{2max} from the Multistage Shuttle-Run Aerobic Test 20m ($MSRAT_{20m}$) and VO_{2max} laboratory measurements (Leger & Gadoury, 1989) leads to the fact that the $MSRAT_{20m}$ is one of the most valid and well accepted tests for the estimation of aerobic performance in a variety of setting rankings (i.e., physical education, adult fitness programmes and specific sports performance testing). The above test is based on a series of shuttle runs between two lines exactly 20m apart, keeping the participant at running pace with a series of audio signals. The participant stops when he or she can no longer maintain the priory determined running speed while the aerobic performance is estimated according to the final level and number of shuttles completed (Ramsbottom, Brewer, & Williams, 1988).

From its initial design until today a number of modifications have been applied to the $MSRAT_{20m}$ (Tokmakidis et al., 1988; Nicholas, Nuttall, & Williams, 2000; Flouris, Tsiotras, & Koutentakis, 2003). The scientific hypothesis was that by changing the shuttle and intermittent way of running during the $MSRAT_{20m}$ to a curvilinear continuous running motion of the Hexagon Multi-Level Running Aerobic Test 10m ($HMRAT_{10m}$) the participants will have a positive effect in maximum aerobic capacity as a result of the running economy yielded from the modified version. For this reason the aim of this study was to evaluate the reliability and the validity of a modified version of the multistage running field test for the prediction of maximal aerobic performance in young adults and adolescents.

Methods

Participants

In the preliminary study the participants in the $HMRAT_{10m}$ reliability test-retest trials consisted of eighteen (n=18) healthy PE students (10 males & 8 females), aged 20.8±0.9yrs. In addition, sixty-two adolescents (n=62), 39 males and 23 females, aged 13.7±0.7yrs, with experience in athletics, participated in the main study. Both PE students who participated in the $HMRAT_{10m}$ reliability study as well as the adolescents who took part in the main study were volunteers and gave their written consent. Prior to the beginning of the testing procedures oral instructions were given about the nature of the research as well as what the participants should avoid doing before and after the measurements. The adolescents' physical and anthropometric data of the main study were obtained as part of the initial screening (Table 1).

Experimental design

The modified version is based on a hexagon and is named Hexagon Multi-Level Run Aerobic Test 10m ($HMRAT_{10m}$). A hexagon was drawn with white lines on the running surface with each angle distance of 10m, the vertex of the hexagon 45° while the other four vertexes were 150° (Figure 1). In practice the $HMRAT_{10m}$ is a continuous incremental speed clockwise running task consisting of six straight lines, with the distance from angle to angle 10m. This version of the design was based on the assumption that the hexagon with these two types of angles (45° & 150°) could be the link between a) the forward and backward directions intermittent $MSRAT_{20m}$ and, b) the fully forward in running direction and continuous aerobic capacity test which takes place on a track. The participants during the $HMRAT_{10m}$ were instructed to run clockwise from the start angle at a running speed based on the sound bleeps of the series of audio signals of the $MSRAT_{20m}$ protocol (Ramsbottom et al., 1988). The participants, in groups of three, should aim to be in every 20m or in two angles distance (10+10m) at any sound signal. For any individual who fails twice to reach the 20m angle's mark at the end of each shuttle, at a given pace of $MSRAT_{20m}$ protocol, the test is terminated. The participants' maximal oxygen uptake (VO_{2max}) was calculated by using the tables for predictive VO_{2max} values (Ramsbottom et al., 1988).

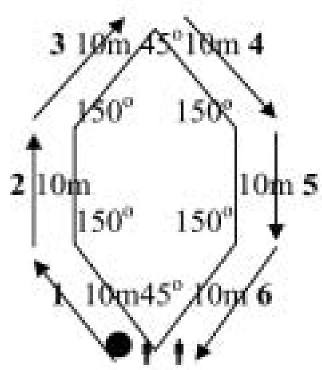

Figure 1. Schematic representation of the $HMRAT_{10m}$.

Experimental protocol

All the tests were conducted in a school sports ground with the subjects being instructed to refrain from heavy exercise at least 24 hours before each testing session. The participants of the preliminary measurements for the reliability and repeatability of the modified version completed the $HMRAT_{10m}$ twice, with a standard of 48 hours interval between each session. The two research sessions were carried out for all the participants for the same time and on the same running surface and in similar environmental conditions.

For the validity evaluation, participants were randomly assigned to a test order of $HMRAT_{10m}$ and $MSRAT_{20m}$. The reason for choosing the $MSRAT_{20m}$ and not a laboratory treadmill VO_{2max} test was that

Table 1. Main participants' physical and anthropometric characteristics (mean±SD)

	Age (yrs)	Body mass (kg)	Stature (cm)	Body Mass Index (kg/m^2)
Total (n=62)	13.7(0.7)	56.4 (11.3)	163 (0.8)	21.22 (10.8)
Males (n=39)	13.6(0.7)	56.3 (10.9)	162 (0.1)	21.48 (11.3)
Females (n=23)	13.7(0.8)	56.5 (12.2)	165 (0.5)	20.75 (8.8)

the investigator wanted to find out how the kinetic and kinematic characteristics of each test could affect the VO_{2max} by using the same aerobic performance measurements protocol in both tests. The trials were held in two sessions with a difference of at least two days in similar testing protocol and ambient temperature (~20°C) and with a random counterbalanced turn. Testing procedures in both tests were based on the protocol and instructions of $MSRAT_{20m}$ (Ramsbottom et al., 1988).

A portable CD player, a CD supplied with a booklet, a measuring tape (to measure the 10m and 20m lines), marker cones, a digital chronometer and a heart rate monitor (Polar Electro Sports Tester, S_{810i}, Polar Electro, Kempele, Finland) were used in order to record the performance and physiological measurements. Both $MSRAT_{20m}$ and $HMRAT_{10m}$ were terminated if the subject voluntarily dropped out or did not make the 20m line in two consecutive laps. The final successfully completed level was recorded as the finish while the subjects were instructed to complete as many levels as possible. The participants' maximum speed (S_{max}) obtained in km/h was considered the speed of the final successfully completed level. The predicted VO_{2max} in both $MSRAT_{20m}$ and $HMRAT_{10m}$ was calculated relatively to body mass according to the $MSRAT_{20m}$ tables and norms for any individual. In addition, the performance peak heart rate (HR_P) was recorded and stored with digital display in order to confirm the participants' maximal effort immediately after the completion of both tests.

Statistical analysis

Descriptive statistics were applied for the subjects' physical and anthropometric variables. The nature of the data was the paired variables of one group. The Intraclass Correlation Coefficient (ICC) was applied to estimate the relative reliability (95% CI) between both $HMRAT_{10m}$ measuring variables. The $HMRAT_{10m}$ absolute reliability was reported using both the calculations of coefficients of variation (CV) and standard error of measurements (SEM). The statistical design for the $HMRAT_{10m}$ validity evaluation was based on Pearson's r correlation coefficient analysis. The correlated control t (paired samples *t*-test) was used in order to analyse the performance and physiological data between $HMRAT_{10m}$ and $MSRAT_{20m}$. One-way ANOVA was applied to evaluate the differences between the performance and physiological variables for each test in relation to the participants' gender. All statistical procedure was based on the statistical package SPSS 14 for Windows. The acceptable level of significance was set at 0.05 and all the results were reported as mean ± standard deviation.

Results

The first observation of the investigator from the reliability testing procedures was that the modified version for the estimation of aerobic performance was easy in use and a very well accepted task by the participants. The test-retest analysis confirmed that the majority of data resulting from $HMRAT_{10m}$ had a high reliability coefficients. The ending level of the $HMRAT_{10m}$ presented an excellent ICCorrelation (0.99) in both trials (8.1 vs 8.3). Similarly, high ICCorrelation in S_{max} (0.99), which corresponds to the PE students speed of the final successfully completed level (12 vs 12.1km/h), was observed between trials during both $HMRAT_{10m}$. In addition, the VO_{2max} estimated from both $HMRAT_{10m}$ (47.2 ±9.1 vs 47.6±9.3ml/kg · min) presented a reliability coefficient of 0.99 as a result of the above high correlated variables. In contrast, for the performance HR_P of both $HMRAT_{10m}$ the reliability coefficient was acceptable (0.77), while the participants mean HR_P ranged from 191±8.1b/min at the 1st $HMRAT_{10m}$ to 194±9.4b/min at the 2nd $HMRAT_{10m}$. Table 2 illustrates the preliminary study reliability results of the $HMRAT_{10m}$ measured and recorded variables in 18 PE students.

In the validity evaluation the measured parameters of a test termination or ending level, S_{max} at the finishing point and VO_{2max} in both $HMRAT_{10m}$ and $MSRAT_{20m}$ presented correlation coefficients as high as 0.86 ($p<0.01$), while the physiological variable of HR_P of both tests revealed a low validity correlation ($r=0.33$, $p<0.01$). In addition, significant higher values of the ending level, S_{max}, and VO_{2max}

Table 2. Test-retest (mean±SD), coefficient of variation (%), intraclass correlation coefficient (95%CI) and standard error of measurements of the $HMRAT_{10m}$

	1st $HMRAT_{10m}$	CV*	2nd $HMRAT_{10m}$	CV*	ICC#	95%CI	SEM†
Level (No)	8.1±3.1	38.3	8.3±3.2	38.6	0.98	0.95-0.99	0.44
S_{max} (km/h)	12±1.6	13.3	12.1±1.6	13.2	0.99	0.96-0.99	0.16
VO_{2max} (ml/kg · min)	47.2±9.1	19.3	47.6±9.3	19.5	0.99	0.96-0.99	0.92
HR_P (b/min)	191±8.1	4.2	194±9.4	4.9	0.77	0.36-0.90	4.19

* *Coefficient of Variation*
\# *Intraclass Correlation Coefficient*
† *Standard Error of Measurements*

were reported in participants during the $HMRAT_{10m}$ in comparison to $MSRAT_{20m}$ ($p<0.01$). The ending level of the $HMRAT_{10m}$ was significantly higher with values of 6.3±2.3 than the $MSRAT_{20m}$ ending level values of 4.3±1.8 (t=12.9, df=61 2-tailed $p<0.001$). Similarly, the S_{max} at the finishing point of the $HMRAT_{10m}$ (11.1±1.1km/h) was significantly higher than the $MSRAT_{20m}$ (10.1±0.9km/h) (t=12.9, df=61 2-tailed $p<0.001$). Likewise, the VO_{2max} (46±6.2ml/kg · min) was significantly higher in the $HMRAT_{10m}$ than in VO_{2max} (40.8±4.9ml · kg^{-1} · min) during the $MSRAT_{20m}$ (t=12.8, df=61 2-tailed $p<0.001$). In contrast, slightly higher but not significant differences were found in participants HR_P at test termination or finishing time at $HMRAT_{10m}$ (196±6.2 b/min) in comparison to $MSRAT_{20m}$ (194±9.7b/min) (t=1.3, df=61 2-tailed p=0.20). The correlation of coefficients between the performance and physiological variables of both tests is presented in Table 3.

in relation to $MSRAT_{20m}$, apart from the finishing point HR_P in which both males and females had similar values (Table 4).

Discussion and conclusions

The purpose of the present study was to develop a modified field test easy in use in order to estimate aerobic performance. The confirmation and justification of the $HMRAT_{10m}$ use as a new test was based both on the assessment of test-retest coefficient of reliability as well as on the determination of the validity of this test, assessing if there existed correlation coefficients between the same performance variables of $HMRAT_{10m}$ and the already valid $MSRAT_{20m}$. The aerobic parameters (ending level, S_{max} and VO_{2max}) as measured during both $HMRAT_{10m}$ in PE students, presented high test-retest reliability. Thus, the present study supports the fact that the $HMRAT_{10m}$ is an easily taught, reliable and reproducible task for the maximal aerobic capacity estimation.

Table 3. Correlation matrix between physiological and performance variables of $HMRAT_{10m}$ and $MSRAT_{20m}$

	VO_{2max} $HMRAT_{10m}$	VO_{2max} $MSRAT_{20m}$	Level $HMRAT_{10m}$	Level $MSRAT_{20m}$	S_{max} $HMRAT_{10m}$	S_{max} $MSRAT_{20m}$	HR_p $HMRAT_{10m}$	HR_p $MSRAT_{20m}$
VO_{2max} $HMRAT_{10m}$	1	0.86†	0.98†	0.86†	0.98†	0.86†	0.51†	0.19
VO_{2max} $MSRAT_{20m}$		1	0.82†	0.97†	0.82†	0.97†	0.45†	0.26*
Level $HMRAT_{10m}$			1	0.86†	0.99†	0.87†	0.48†	0.20
Level $MSRAT_{20m}$				1	0.86†	0.99†	0.41†	0.28*
S_{max} $HMRAT_{10m}$					1	0.87†	0.48†	0.20
S_{max} $MSRAT_{20m}$						1	0.41†	0.28*
HR_p $HMRAT_{10m}$							1	0.33†
HR_p $MSRAT_{20m}$								1

† *$p< 0.01$*
* *$p<0.05$*

Table 4. Measured, recorded and calculated data (mean±SD) from $HMRAT_{10m}$ and $MSRAT_{20m}$ adjusted by the adolescents' gender

Test	$HMRAT_{10m}$	$MSRAT_{20m}$		$HMRAT_{10m}$	$MSRAT_{20m}$	
	Males		P	Females		P
Level	6.7±2.6	4.6±1.9	0.05	5.4±1.4	3.7±1.3	0.05
S_{max} (km/h)	11.3±1.3	10.3±0.9	0.001.	10.7±0.7	9.8±0.6	0.05
VO_{2max} (ml/kg · min)	47.5±6.8	42±5.1	0.05	43.5±4.1	38.8±3.8	0.05
HR_P (b/min)	197.3±6.4	193.7±10.5	ns	197.1±7.9	195.1±5.9	ns

As for gender, male adolescents had statistically significant differences than females in aerobic performance in both $HMRAT_{10m}$ and $MSRAT_{20m}$. According to the measured parameters males during the $HMRAT_{10m}$ performed better than females

In validation assessment, the $HMRAT_{10m}$ demonstrated that its measured aerobic profile presented a high correlation with the same indices measured during the already valid $MSRAT_{20m}$, confirming that the proposed version, compared to $MSRAT_{20m}$ is a valid field test for the prediction of aerobic performance. Furthermore, the mean HR_P of 196±6.2 b/min as a parameter recorded for the maximal nature evaluation of the new version is in accordance with a similar design $MSRAT_{20m}$ validation study held in adolescents (Murray et al., 1993) confirming the participants maximal effort during the $HMRAT_{10m}$. Additionally the absence of significant differences at the finishing point HR_P between $HMRAT_{10m}$ and $MSRAT_{20m}$ lead to the strong evidence that both tests were characterized by a similar fatigue profile.

The comparisons between $HMRAT_{10m}$ and $MSRAT_{20m}$ concerning the ending level, the S_{max} and the VO_{2max} showed a statistically significant difference of both tests performance parameters, while the finishing point HR_P did not show significant differences in adolescents in both tests (Table 5). The adolescents' aerobic performance of $HMRAT_{10m}$ in comparison to that of $MSRAT_{20m}$ was 31.7% better at the ending level, 9% higher at the finishing point S_{max} and 11.3% greater in VO_{2max} which could be the most important evidence of this study (Table 5). Considering that the HR_P at the finishing time was almost similar in both tests, interpreting the maximal participants' effort, we can assume that the $HMRAT_{10m}$ exhibits a better maximal aerobic performance than $MSRAT_{20m}$.

Table 5. Performance (mean±SD) and differences (%) between $HMRAT_{10m}$ and $MSRAT_{20m}$ in adolescents

	$HMRAT_{10m}$	$MSRAT_{20m}$	(%)
Level	6.3±2.3*	4.3±1.8	31.7
S_{max} (km/h)	11.1±1.1*	10.1±0.9	9
VO_{2max} (ml/kg · min)	46±6.2*	40.8±4.9	11.3
HR_P (b/min)	196±6.2	194±9.7	1

* *p<0.01*

From a practical point of view, the primary source of this variance in performance during the $HMRAT_{10m}$, in relation to the $MSRAT_{20m}$, may be interpreted as a result of the participants' better biomechanical efficiency during the $HMRAT_{10m}$ which is associated with the continuous and not intermittent characteristic of running at the modified version presented. The higher S_{max} yielded from the $HMRAT_{10m}$ adolescents' performance in relation to the $MSRAT_{20m}$ S_{max} resulted in greater VO_{2max} values possibly due to the fact that four angles of the proposed test are 150° which means that the running directions are almost circular. For this reason, the $HMRAT_{10m}$ seems to be easier in higher maximum speed acquisition which results in greater VO_{2max} values in contrast to the intermittent and changing running directions of $MSRAT_{20m}$. The deceleration periods during the turn around and run back of the $MSRAT_{20m}$ possibly affect a decrease in the stride length and running speed of the participants, resulting in a higher anaerobic contribution, earlier fatigue and earlier onset of test termination or ending the $MSRAT_{20m}$. In the same way a recent study presented a modification of $MSRAT_{20m}$ for the prediction of VO_{2max} in adults named the Squared Endurance Test 20m (Flouris et al., 2003). Similarly with the present study, the Squared Endurance Test 20m (SET_{20m}) validity analysis, based on maximal aerobic performance estimation from the $MSRAT_{20m}$ protocol, presented a high correlation of 0.89 ($p<0.001$) for the VO_{2max} in both tests. The above version gives higher S_{max} at the finishing point and greater ending level than the $MSRAT_{20m}$, but not as high as S_{max} and the ending level measured values of $HMRAT_{10m}$. Furthermore, the comparisons between the participants' gender of this study are in accordance with other studies (Murray et al., 1993; Armstrong et al., 1998) confirming that in all physiological and performance variables, males appeared to have a better aerobic profile in both tests than females and consequently male adolescents had greater aerobic performance than females in $HMRAT_{10m}$.

In conclusion, the Hexagon Multi-Level Running Test for the aerobic performance estimation was not designed and developed to replace the Multistage Shuttle-Run Aerobic test. This modified version tries to cover kinematically the gap between the shuttle intermittent nature of $MSRAT_{20m}$ with the circular running nature of endurance field tests which are carried out on a track with a steady state or progressively increasing running speed. The predominance of $HMRAT_{10m}$ reliability correlations in relation to its high validity coefficients in comparison to $MSRAT_{20m}$ could propose this test as an alternative task for the prediction of VO_{2max}. Further research evaluating the validity coefficients of aerobic performance of $HMRAT_{10m}$ in the form of maximum oxygen uptake (VO_{2max}) in research laboratories settings could define the $HMRAT_{10m}$ as a new, valid and well accepted field test with its own equations for the aerobic performance estimation in a variety of ages, population and range of sports.

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POUZDANOST I VALJANOST MODOFICIRANOGA TERENSKOG TESTA ZA PROCJENU AEROBNE SPOSOBNOSTI

Sažetak

Uvod

Tijekom posljednja tri desetljeća pojavio se povećan interes za mjerenje aerobnih sposobnosti na razini populacije. Do danas su se te fiziološke karakteristike pretežno određivale primjenom laboratorijskih mjerenja, poput submaksimalnih ili maksimalnih testova na bicikl-ergometru ili pokretnom sagu. Nasuprot tome, terensko testiranje je jedino rješenje u kojem znanstvenik može učinkovito simulirati sportske situacije. Cilj je ovog istraživanja bio ocijeniti pouzdanost i valjanost modificirane verzije višestupanjskog aerobnog testa izmjeničnog trčanja na 20 metara (Multistage Shuttle-Run Aerobic Test 20m - $MSRAT_{20m}$).

Metode

Predložena verzija je šesterokut sa svakom stranicom duljine od 10 metara. Test je nazvan šesterokutni višerazinski aerobni test trčanja na 10 metara (Hexagon Multilevel Running Aerobic Test 10m - $HMRAT_{10m}$). Da bi se opravdalo razvijanje modificiranog terenskog testa, ocijenjeni su $HMRAT_{10m}$ test-retest koeficijenti pouzdanosti i valjanosti parametara mjerenih testom $HMRAT_{10m}$ s istim parametrima $MSRAT_{20m}$ testa. U oba testa ($MSRAT_{20m}$ i $HMRAT_{10m}$) je korištenjem $MSRAT_{20m}$ protokola izmjerena završna razina, maksimalna brzina i frekvencija srca u završnoj točki, a procijenjen je i maksimalni primitak kisika (VO_{2max}) (Ramsbottom, Brewer, Williams, 1988).

U evaluaciji pouzdanosti $HMRAT_{10m}$, predložena verzija testa primijenjena je na uzorku od 18 studenata kineziologije (10 mladića i 8 djevojaka) u dobi od 20.8±0,9 godina. Test je izveden dva puta, s intervalom od 48 sati između dva izvođenja. Završna razina $HMRAT_{10m}$ dala je izvrsnu IC korelaciju (0,99) u oba izvođenja (8,1 vs 8,3). Slično tome, visoka IC korelacija opažena je između dva izvođenja tijekom oba $HMRAT_{10m}$ testa pri maksimalnoj brzini u završnoj točci (0,99), što odgovara brzini koju su studenti postigli na posljednjoj uspješno izvedenoj razini testa (12 vs 12,1km/h). Uz to, VO_{2max} (47,2±9,1 vs 47,6±9,3 ml/kg ·min), procijenjen na temelju tablica $MSRAT_{20m}$ protokola, u oba je $HMRAT_{10m}$ testa pokazao koeficijent pouzdanosti od 0,99. Za razliku od toga, za vršnu je frekvenciju srca u izvođenju oba $HMRAT_{10m}$ testa koeficijent pouzdanosti bio prihvatljiv (0,77), dok su se srednje vrijednosti vršne frekvencije srca ispitanika kretale u rasponu od 191±8.1b/min u prvom $HMRAT_{10m}$ testu, do 194±,4 b/min u drugom $HMRAT_{10m}$ testu.

Osim ocjene pouzdanosti testa $HMRAT_{10m}$, bilo je nužno dobiti koeficijente korelacije između varijabli modificirane verzije i varijabli mjerenih već valjanim testom. Za evaluaciju valjanosti $HMRAT_{10m}$ parametri ovog testa uspoređeni su s istim parametrima $MSRAT_{20m}$ testa kod 62 trenirana adolescenta (39 mladića i 23 djevojke), u dobi od 13,7±0,7 godina.

Rezultati

U ocjeni valjanosti mjerenih parametara predstavljene modificirane verzije na razini odustajanja ili na završnoj razini testa, maksimalna brzina u završnoj točki i VO_{2max} u oba $HMRAT_{10m}$ i $MSRAT_{20m}$ testa pokazali su koeficijente korelacije do razine od r=0,86, (p<0,01), dok je fiziološka varijabla frekvencije srca u završnoj točki oba testa pokazala nisku korelaciju (r=0,33, p<0,01). Parametri aerobne sposobnosti adolescenata u $HMRAT_{10m}$ testu, u odnosu na parametre u $MSRAT_{20m}$ testu, bili su 31,7% bolji na završnoj razini, 9% viši kod maksimalne brzine u završnoj točci i 11,3% veći u VO_{2max}, što je možda i najjači dokaz ovog istraživanja. Uzimajući u obzir da je vršna frekvencija srca ispitanika u završnoj točki, kao pokazatelj maksimalnog napora ispitanika, bila prilično slična u oba testa, možemo pretpostaviti da $HMRAT_{10m}$ pokazuje bolje maksimalne aerobne sposobnosti od $MSRAT_{20m}$. Normaliziranjem rezultata prema spolu, dobili smo podatke da su adolescenti muškog spola pokazali bolje rezultate tijekom $HMRAT_{10m}$ od djevojaka, u odnosu na $MSRAT_{20m}$, izuzevši vršnu frekvenciju srca u završnoj točki, u kojoj su i mladići i djevojke imali slične vrijednosti. Štoviše, usporedbe ispitanika prema spolu u ovom istraživanju potvrđuju da su u svim mjerenim varijablama mladići imali bolji aerobni profil od djevojaka u oba testa te su, posljedično, adolescenti muškog spola imali bolje aerobne rezultate od djevojaka u testu $HMRAT_{10m}$.

Zaključci

U zaključku, $HMRAT_{10m}$ test za procjenu aerobne sposobnosti dizajniran je da kinematički premosti jaz između intermitentne naizmjenične osobine $MSRAT_{20m}$ testa i kružne trkačke osobine terenskih testova izdržljivosti koji se izvode na stazi, sa stalnom ili progresivno rastućom brzinom trčanja. Prevladavanje korelacija pouzdanosti $HMRAT_{10m}$ testa u odnosu na njegove visoke koeficijente valjanosti, u usporedbi s već postojećim valjanim i dobro prihvaćenim $MSRAT_{20m}$ testom, moglo bi ovaj test ponuditi kao alternativni oblik procjene VO_{2max}. Daljnja istraživanja, koja bi u uvjetima istraživačkih laboratorija evaluirala koeficijente valjanosti aerobnih rezultata $HMRAT_{10m}$ testa u vidu VO_{2max}, mogla bi $HMRAT_{10m}$ test definirati kao novi, valjan i dobro prihvaćen terenski test, s vlastitim jednadžbama za procjenu aerobne sposobnosti za različite dobne skupine, populacije i različite sportove.