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PHYSICAL AND MOTOR PERFORMANCE PREDICTORS OF LOWER BODY EXPLOSIVE POWER (LBEP) AMONG ADOLESCENTS IN THE NORTH-WEST PROVINCE: PAHL STUDY

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ABSTRACT

The aim of this study was to develop a lower body explosive power (LBEP) prediction model from various physical and motor performance components among a cohort of male and female adolescents living in the Tlokwe local municipality of the North-West Province. A cross-sectional experimental research design was employed with 214 15-year-old adolescents (88 males; 126 females; mean age: 15.8±0.68 years), from six schools, two from the Potchefstroom city area and four from the Ikageng area. They were measured over a 7-day period. Informed consent and demographic questionnaires were completed followed by seven physical and 14 motor performance tests. Regression analyses indicated that gender and 10m-speed formed a significant component-derived prediction model for LBEP values in 15-year-old adolescents, with gender contributing 39% (R^2=0.39) and 10m-speed contributing 7% (R^2=0.07). Results show that 46% (R^2=0.46) of the LBEP can be predicted by speed and gender components of adolescents. Variables other than physical and motor performance components contributed 54% to LBEP prediction in adolescents. The results could be used to identify adolescents who show potential to excel in LBEP performance driven sport.

Key words: Explosive power; Motor and physical performance; Prediction model; Adolescents; Gender.

INTRODUCTION

Lower body explosive power **(**LBEP) is dependent on the velocity of a movement and can be defined as the greatest rate of work achieved during a single, ballistic, resisted contraction (Saunders *et al*., 2008). Explosive power produced will, therefore, influence performance in activities that require high velocity at release or impact (Newton & Kraemer, 1994). Successful performance in sport such as basketball, volleyball and handball are all dependent on LBEP activities, such as jumping, sprinting, striking and agility (Karahan & Cecilia, 2011).

Several researchers (Witvrouw *et al*., 2004; Kinser *et al*., 2008; Nevill *et al*., 2009; Milanese, 2010; Milojević & Stanković, 2010), have identified various components as possible contributors to LBEP jumping in children and adolescents. The possible physical and motor performance variables include, arm hang time (Lennox *et al*., 2008; Milojević & Stanković, 2010), grip strength (Girard & Millet, 2009), leg stiffness (Korff *et al*., 2009), agility T-test

(Jovanović *et al*., 2010; Hermassi *et al*., 2011), VO_2 (Dumke *et al*., 2010), arrowhead agility test and predicted VO_{2max} (Boyle, 2011). Contribution to higher LBEP production, as demonstrated by a higher counter movement jumping height is due to the result of greater elasticity of the muscle-tendon units of the lower limbs (higher flexibility) (Witvrouw *et al*., 2004). A decreased stiffness of the muscle component is described occasionally in conjunction with increased flexibility (Morse *et al*., 2008). Contradictory to some of the previously mentioned findings is that a decreased stiffness of the series elastic component (SEC), had led to a 7.4% decrease ($p<0.05$) in LBEP output in adults (Cornwell *et al*., 2002). Furthermore, Korff *et al*. (2009) found a significantly positive correlation ($r=0.70$, $p<0.001$) between leg stiffness and peak LBEP production jumping activities among adolescents. Similarly, Kinser *et al*. (2008) stated that flexibility-induced changes due to stretching might have no effect on the LBEP output production of children and adolescents. Additionally, low flexibility scores in adults have been associated with poor speed performances (Nicholas, 1997).

Various researchers found that LBEP for children and adolescents negatively correlates with speed over short distances between 5m and 40m (Nevill *et al*., 2009; Milanese, 2010; Milojević & Stanković, 2010). Moreover, it has been suggested that motor and physical performance components could influence LBEP performance, such as handgrip strength in 13- to 15-year-old male adolescents ($r=0.72–0.83$; $p=0.001–0.01$) (Girard & Millet, 2009); leg strength in 11- to 16-year-old male ($r=0.85$) and female adolescents ($r=0.78$) (Temfemo *et al*., 2009); and in 14- to 15-year-old adolescents ($r=0.36$; $p<0.00$) (Milojević & Stanković, 2010).

Anaerobic sprinting speed (40m-sprint) and LBEP (vertical jump performance), have also shown a strong correlation in adolescent populations (Foran, 2001; Du Plessis, 2007; Nevill *et al*., 2009). LBEP as measured by performance in the horizontal jump test, have demonstrated a higher correlation with sprinting speed than vertical jump test performances (Maulder & Cronin, 2005). With regard to maturation, it seems that in early mature adolescent populations an increase in LBEP (vertical jump performance), is also accompanied by a decrease in agility shuttle run times and sprint values when compared with late mature adolescent populations (Figueiredo *et al*., 2010). Maturity of male adolescents generally correlates positively with strength and motor performance abilities (Malina *et al*., 2004a), whereas, static strength and motor performance generally are not significantly related to the maturity status of female adolescents, since most correlations are low and negative (Malina *et al*., 2004a; Lennox *et al*., 2008). Maturation refers to the timing (specific maturation events occur, like appearance of pubic hair in girls and boys), and tempo (the rate at which maturation progresses, early or late), of progress toward the mature biological stage (Malina *et al*., 2004a). The above-mentioned could be underlined by the fact that male adolescents experience an increase in maximal power delivery of 375% with muscle mass doubling, while an increase in maximal power delivery of 295% and a fat mass multiplication of 1.5 with the onset of maturation occur in female adolescents (Ronan *et al*., 2003; Malina *et al*., 2004b).

Currently, the available literature on LBEP prediction models for adolescents are limited and mostly applied on adult populations. Regarding adolescents, only Travill (2011) investigated the extent various anthropometric characteristics influence LBEP production of 7- to 18-year-old male adolescents in South Africa. A LBEP prediction model will be of great value to various sporting codes, such as soccer, tennis, basketball, handball and volleyball, which are all dependent on the ability to produce great LBEP (Karahan, 2011; Cherif *et al*., 2012). Prediction models have been successfully used in the prediction of aerobic performance in both adult and adolescent populations (Akalan *et al*., 2008; Roberts *et al*., 2009; Jacks *et al*., 2012; Pienaar *et al*., 2015). To the best of the authors' knowledge, no attempt has been made to develop a LBEP prediction model by making use of physical and motor performance variables in adolescents from South Africa. The only study that could be found is that of Carvalho *et al*. (2011) from Portugal in which an attempt at quantifying maximal short-term power production (a contribution model) in male adolescents was made. As such, findings from Carvalho *et al.* (2011) reported the percentage contribution of various indicators to maximal short-term power production, which in turn might indirectly influence the LBEP performances of adolescents. In addition, anaerobic peak power production contributed 52% to maximal short-term power production. The limited available literature, as well as the fact that no physical and motor performance LBEP model currently exists for 15-year-old South African adolescents has prompted this study. Results from this study will equip South African coaches and sport scientists who are interested in adolescents' performance with a tool to predict LBEP accurately in adolescents.

PURPOSE OF THE STUDY

The purpose of this study was to develop a valid LBEP prediction model from various physical and motor performance components among a cohort of male and female adolescents living in the Tlokwe local municipality of Dr the Kenneth Kaunda district in the North-West Province of South Africa.

RESEARCH METHOD

Research design

The research data for this study forms part of the Physical Activity and Health Longitudinal Study (PAHLS), which is an observational multidisciplinary study (2010–2014) (Monyeki *et al*., 2012). For the purpose of the current study, a cross-sectional experimental research design was employed in which the data of 2012 was used. The Ethics Committee of the North-West University (NWU-0058-01-A1), as well as the District Director of the Department of Basic Education in the Tlokwe Local Municipality approved the study.

Subjects

The 126 female and 88 male adolescents from Grade 10 (N=214; 15.8±0.68 years) were purposefully selected from pre-required class lists from 6 high schools in the Tlokwe Local Municipality (Potchefstroom area) of the Dr Kennith Kaunda District in the North West Province of South Africa. Four (4) of the selected schools were in the Ikageng Township area, which primarily consisted of subjects living in an semi-urban area (areas which are not part of a legally proclaimed urban area, but adjoin it; Statistics South Africa, 2007) and 2 of the schools were from the Potchefstroom urban area. At the time of measurement in 2012 only subjects in Grade 10 were eligible for participation. Prior to commencement, all subjects were informed concerning the nature of the study, including all potential risks and benefits. Informed consent for the research was requested from the school authorities, the parents and subjects of the participating schools in the weeks leading up to the research period. Only subjects who obtained full consent from all parties concerned took part in the study. Subjects were free to withdraw from the study at any time if they needed to do so.

Testing procedure

To determine the reliability of the tests used, a pilot study was conducted before commencement of the main study, during which one school's learners were subjected to the anthropometric protocol, as well as all the physical and motor performance tests. The average test-retest reliability coefficient for the physical and motor performance component tests of the pilot study was between 0.89 and 0.99. For the main part of the study, the subjects underwent 1 day of testing at the testing centre of the research institution. On arrival, the subjects completed the Demographic, General Information, Sport and Training Habits, Physical Activity and Maturity Determination Questionnaires after which the anthropometric measurements, physical, LBEP and motor performance tests were administered. Before the start of the physical, LBEP and motor performance tests, the subjects were subjected to a thorough warm-up of approximately 15 minutes consisting of aerobic running exercises for an estimated 8 minutes. Thereafter, a shorter warm-up period of specifically high-intensity movements and dynamic stretches followed.

Measurements and data were obtained with regard to stature, sitting height and body mass according to methods of the International Society for the Advancement of Kinanthropometry (ISAK) (Stewart *et al*., 2011), together with age, maturity age, and Peak Height Velocity (PHV) age. This was followed by the measurement of the physical and motor performance variables. *Physical performance* tests, each in accordance with their own method, included: sit-and-reach test (Maud & Kerr, 2006), shoulder external rotation (Harvey & Mansfield, 2000; Maud & Kerr, 2006), shoulder internal rotation (Harvey & Mansfield, 2000; Maud & Kerr, 2006), passive straight-leg raise (Maud & Kerr, 2006), active straight-leg raise (Harvey & Mansfield, 2000), Modified Thomas Iliopsoas test (MTIT) (Harvey & Mansfield, 2000; Maud & Kerr, 2006), and the Modified Thomas Quadriceps test (MTQT) (Harvey & Mansfield, 2000). The *motor performance* tests included, basketball throw (Ball, 1991), handgrip strength (Hoffman *et al*., 2009), abdominal strength (Eurofit, 1988), bent arm hang (Eurofit, 1988), sit-ups (Ellis *et al*., 2000), 40-metre acceleration and speed test (Ellis *et al*., 2000), and the 505-agility test (Ellis *et al*., 2000).

PHV age was calculated by using the birth date, measurement date and gender. For estimating maturity age, the anthropometric measurements of sitting height, body stature and body mass were used. For the final maturity age, chronological age was used from which PHV age at the date of measurement was subtracted (Thompson *et al*., 2002). If the PHV age was identical to chronological age, maturity age was categorised as zero (Thompson *et al*., 2002). Noting at which age male adolescents' voice broke and at which age menarche onset occurred for female adolescents was a verification of maturation age for each gender. The determination of maturation age for individual adolescents could not be done utilising the Tanner stages (Faulkner, 1996) as cultural beliefs and practices prohibited the researchers from doing so.

For the LBEP measurements, the following test or measurements were taken: the Horizontal Jump Test (HJT), or as referred to as the standing broad jump (SBJ), the Vertical Jump Test (VJT), as well as peak velocity and peak power.

The VJT is regarded as a valid (r=0.93) and objective test (r=0.90) for determining the peak anaerobic power output of subjects (Safrit, 1990; Maud *et al*., 2006). The method of Harman *et al*. (2000) was used to execute the VJT. The subjects performed a minimum of 2 trials with a 10-second rest period between each trial with the better of the 2 trials being used in the final analysis. Power output during the VJT was measured for each jump with a Tendo Power Output Unit (Tendo Sports Machines, Trensin, Slovak Republic, 2009). The Tendo unit consisted of a transducer that was attached to the waist of each subject, which measured linear displacement and time. Subsequently, jump velocity was calculated and power would be determined. Both peak and mean power output were recorded for each jump and used for the subsequent analyses. According to Hoffman *et al*. (2009), the test-retest reliability of the Tendo unit is r≤0.90.

The HJT measured the explosive power in the legs and the ability to jump in a horizontal direction. To measure horizontal power output, the method of Maulder and Cronin (2005) was used. Each of the subjects was allowed 2 trials and the better of the 2 trials was used in the final analysis. The HJT is regarded as a reliable (r=0.89–0.90) (Maulder & Cronin, 2005:79) and valid test for determining peak anaerobic power output.

Data analysis

The Statistical Consultation Services of the North-West University (Potchefstroom Campus) determined the statistical methods and procedures for the analysis of the research data. SPSS for Windows (version 20) was applied for the analyses of the data. Firstly, descriptive statistics (minimum, maximum, mean and standard deviations), for each test predictor was analysed. T-tests (independent groups) were used to indicate statistically significant differences between the mean value of the male and female adolescents. Secondly, an exploratory principal component factor analysis with varimax rotation was performed for all the prediction variables. This was followed by a forward, stepwise multiple regression analysis in which the independent predictors identified from the factor analysis was included. The LBEP values, as measured by the vertical jump and the horizontal jump test were set as the dependant variables. The level of significance was set at p≤0.05.

The 4 measurements representing LBEP were the VJT, tendo peak power, tendo speed and the SBJ. Due to the high correlation between these 4 measurements, a Principal Component Factor Analysis (PCFA) was performed. The results of the PCFA indicated that the measurement of the adolescents' VJT had the highest loading as predictor of LBEP with a value of 0.86, while tendo peak power (0.73), tendo speed (0.83) and the SBJ (0.70) each yielded a lower loading as predictors. The prediction model for LBEP was, therefore, based on the VJT performance of the adolescents.

RESULTS

The descriptive statistics of the male and female adolescents are represented in Tables 1 to 3.

TABLE 1. **DESCRIPTIVE STATISTICS AND INDEPENDENT T-TEST FOR VARIABLES**

	Total group (N=214)			Females (n=126)			Males (n=88)		
Variables	Mean±SD	Min	Max	Mean±SD	Min	Max	Mean±SD	Min	Max
Age (yrs)	15.8±0.7	13.6	17.1	15.8±0.7	13.6	17.0	15.8±0.6	14.4	17.1
Stature (cm)	163.7±8.7	146.7	196.2	159.9±6.1	147.4	173.7	169.1±8.9**	146.7	196.2
Maturity age (yrs)	1.8±0.4	1.0	2.0	1.8±0.4	1.0	2.0	1.8±0.4	1.0	2.0
Sitting height (cm)	119.8±14.5	13.8	141.2	118.5±13.5	13.8	141.2	121.6±15.8	18.8	137.9
Body mass (kg)	57.2±14.2	32.9	120.8	55.4±12.9	32.9	118.5	59.3±15.0	34.8	120.8
PHV age (yrs)	14.2±0.7	12.4	16.0	14.2±0.7	12.4	16.0	14.2±0.7	12.5	16.0

* p<0.05 ** p<0.001 yrs= years cm= centimetre kg= kilogramme PHV= Peak Height Velocity

The results of Table 1 indicate significant differences only in the stature of the male and female adolescents.

TABLE 2. **DESCRIPTIVE STATISTICS AND INDEPENDENT T-TEST FOR FLEXIBILITY-RELATED PREDICTORS**

Measurements	**Total group (N=214)**			**Females (F) (n=126)**			**Males (M) (n=88)**		
	Mean±SD	**Min**	**Max**	**Mean±SD**	**Min**	**Max**	**Mean±SD**	**Min**	**Max**
Sit-and-reach end (cm)	30.6±9.2	0.0	53.5	32.3±7.4	10.7	49.0	28.3±11.0*	0.0	53.5
Shoulder external rotation best (º)	98.5±13.2	23.0	119.0	100.8±8.7	73.0	118.0	95.0±17.3*	23.0	119.0
Shoulder internal rotation best (º)	42.5±16.2	17.0	101.0	42.2±15.1	17.0	83.0	43.2±17.9	21.0	101.0
Passive straight-leg raise best (º)	99.4±16.5	57.0	153.0	101.4±14.9	61.0	135.0	96.7±18.1*	57.0	153.0
Active straight-leg raise best (º)	80.4±21.3	-1.0	230.0	84.2±20.0	50.0	230.0	75.2±22.1*	-1.0	121.0
MTIT best (º)	4.9±11.9	-30.0	83.0	3.0±9.4	-30.0	22.0	7.6±14.4*	-13.0	83.0
MTQT best (º)	66.1±11.5	40.0	97.0	67.8±11.4	40.0	97.0	63.5±11.2*	40.0	94.0

* p<0.05 ** p<0.001 cm= centimetre º= degrees
MTIT= Modified Thomas Iliopsoas Test MTQT= Modified Thomas Quadriceps Test

From Table 2 it is clear that the female adolescents showed statistically significantly better flexibility measurements (p<0.05) in the sit-and-reach test, shoulder external rotation, passive straight-leg raise, active straight-leg raise, MTIT and the MTQT, than their male adolescent counterparts.

TABLE 3. **DESCRIPTIVE STATISTICS AND INDEPENDENT T-TEST FOR PHYSICAL- AND MOTOR PERFORMANCE-RELATED PREDICTORS**

	Total group (N=214)			**Females (F) (n=126)**			**Males (M) (n=88)**		
Measurement	**Mean±SD**	**Min**	**Max**	**Mean±SD**	**Min**	**Max**	**Mean±SD**	**Min**	**Max**
VJ (cm)	32.6±12.4	4.5	55.0	26.1±10.2	4.5	50.0	41.8±9.1 **	15.5	55.0
Tendo peak power (W)	1347.2±373.9	696.0	2870.0	1207.5±258.7	696.0	2264.0	1535.5±408.8 **	847.0	2870.0
Tendo speed (cm)	2.4±0.3	1.7	3.3	2.3±0.3	1.7	2.8	2.6±0.2 **	2.2	3.3
SBJ (cm)	165.5±34.5	98.0	325.0	150.8±30.9	108.0	325.0	186.7±28.1 **	98.0	280.0
Basketball throw (m)	4.6±2.8	1.2	7.4	4.1±0.56	1.2	5.4	5.0±0.9	3.6	7.4
Handgrip strength (kg)	30.8±8.4	9.3	58.2	26.2±4.7	9.3	40.6	37.4±8.0 **	18.4	58.2
Abd. strength (level)	2.3±1.9	0.0	7.0	1.9±1.7	0.0	6.0	2.9±1.9 **	0.0	7.0
Bent arm hang (sec)	10.1±12.5	0.0	55.4	3.2±4.2	0.0	21.4	20.2±13.6 **	0.0	55.4
Sit ups (reps)	27.0±10.4	2.0	52.0	22.5±9.8	2.0	46.0	33.2±7.6 **	13.0	52.0
5m-speed (sec)	1.3±0.2	0.9	1.8	1.3±0.1	0.9	1.8	1.1±0.1 **	0.9	1.5
10m-speed (sec)	2.2±0.2	1.6	2.9	2.3±0.2	1.7	2.9	2.0±0.1 **	1.6	2.3
40m-speed (sec)	7.2±3.4	5.3	54.3	7.5±0.8	5.9	10.4	6.7±5.2	5.3	54.3
505 left (sec)	3.0±0.3	2.3	3.8	3.1±0.2	2.3	3.8	2.8±0.2 **	2.4	3.3
505 right (sec)	3.0±0.3	2.4	4.0	3.1±0.2	2.7	4.0	2.8±0.2 **	2.4	3.4

* $p<0.05$ ** $p<0.001$ cm= centimetre sec= seconds VJ= Vertical Jump SBJ= Standing Broad Jump

Table 3 indicates significant differences ($p<0.001$) in the following tests: VJT, tendo peak power, tendo speed, SBJ, basketball throw, handgrip strength, abdominal strength, bent arm hang, sit ups, 5m-, 10m- and 40m-speed, 505 left and 505 right, with the results of the male adolescents being better than those of female adolescents.

In addition, an exploratory principal component factor analysis with varimax rotation was applied to all the physical and motor performance predictors and the predictors were reduced from 27 to 7. The remaining predictors used for further analyses were: gender, 10m-speed (sec), sit-and-reach end measurement (cm), the MTIT right (degrees), shoulder internal rotation test right (degrees), shoulder external rotation test right (degrees) and 40m-speed (sec). These 7 predictors, together with the dichotomised value of gender (male=1, female=0) were entered into the forward stepwise regression analysis. The results are presented in Table 4.

TABLE 4. **RESULTS OF FORWARD STEPWISE REGRESSION ANALYSIS**

Predictors	**ßeta**	**Regression coefficient**	**R-square change**	**p-value**
Gender	0.39	9.81	0.39	0.000**
10m-speed (sec)	-0.34	-18.33	0.07	0.000**

** p<0.001

The results in Table 4 indicate that only gender (R^2=0.39) and 10m-speed (R^2=0.07) acted as significant (p≤0.001) predictors of LBEP in the adolescents with gender contributing 39% and 10m-speed contributing a further 7% to the total LBEP of the adolescents. The results further show that males achieved greater LBEP than female adolescents. The stepwise forward regression analysis coefficient of R^2=0.458 suggests that gender and 10m-speed contributed 46% to the variance of the LBEP values of the adolescents.

The prediction formula derived for LBEP from the predictors of gender and 10m-speed, equated to:

$$\text{LBEP} = 68.21 + 9.81\ (\text{gender}) - 18.33\ (\text{10m-speed})$$

DISCUSSION

To the best of the authors' knowledge, this is the first study that attempted to develop a LBEP prediction model from various physical and motor performance components among a cohort of male and female adolescents living in the Tlokwe local municipality of the Dr Kenneth Kaunda district in the North-West Province of South Africa. The results revealed that a prediction model for the adolescents could be compiled by making use of gender and the 10m-speed results of the adolescents.

Accordingly, gender delivered a LBEP production contribution of 39% (R^2=0.39) to the total prediction model (p<0.001). Gender-specific differences during maturation resulting in increased body weight can be seen from the results (Table 1), and are in accordance with previous research by Rogol *et al*. (2000). Tomkinson (2007) demonstrated that an increase in fat mass impaired LBEP jumping values whereas an increase in muscle mass led to increased LBEP jumping values in children and adolescents form 6 to 19 years of age. For further clarification of the above-mentioned, Nevill *et al*. (2009) found 12-year-old male adolescents to have a LBEP of 9% higher compared to female adolescents due to males' marked increase in muscle mass. The increase in muscle mass and corresponding increase in LBEP is not experienced in female adolescents, mainly due to a lesser increase in testosterone production (Bratić *et al*., 2010). It is, therefore, suggested that an increase in muscle mass contributes to an increase in the absolute anaerobic power output achieved from LBEP (Malina *et al*., 2004a; Tomkinson, 2007; Lazzer *et al*., 2009). The higher LBEP production seen in males is also emphasised by the fact that female adolescents experience a 1.5 times increase in their fat mass during maturation (Malina *et al*., 2004a).

The results of the current study further indicate that 10m-speed contributed 7% (R^2=0.07; p<0.001) to the LBEP of the cohort of adolescents. In similar findings, the Counter Movement Jump test (CMJ), a variation of the VJT which is also used to evaluate LBEP, significantly correlated (r= -0.89; p<0.001), with the 10m-speed values of 12- to 15-year-old male and female tennis players (Girard & Millet; 2009). The ability to cover the longest possible distance in the shortest time span is vital for performance in some sporting events and this ability is directly related to maximum speed during the sprinting phases to propel the body horizontally (Boyle, 2011).

Therefore, the application of vertical jumping force and the ability to transfer the power generated into horizontal force, is key to the propulsion of the body during each stride in sprinting (Boyle, 2011; Paja, 2011). More specifically, Boyle (2011) found that LBEP, as measured by the SBJ, has a correlation of r= -0.54 to an adolescent's 10m-sprinting time. This take-off speed of a LBEP jump may influence the performance of adolescents in the vertical jump as the forward propulsion of the jump is also applied as vertical power (Boyle, 2011), and thus it will be assumed that a high take-off speed improves jumping performance (Papadopoulos *et al*., 2011). Sprinting distances, specifically of 10m, showed a weak significant correlation with the VJT (r= -0.36; p≤0.05) (Boyle, 2011).

For LBEP jumps, a stronger positive relationship is found between horizontal jumps than between vertical jumps (Maulder & Cronin, 2005). In this regard, Boyle (2011) reported that LBEP, as measured in the SBJ, explained 29% of the variance in 10m-sprinting time and 10 to 20% in 5m-sprinting time. No explanatory variable depicting VJT forces, such as the above-mentioned proposed by Boyle (2011), could be found for adolescent populations. Boyle (2011) further indicate that for elite under-15 to under-17 male soccer players, the 5m-sprinting time equation would be 20% less accurate if the LBEP (horizontal and vertical) production was not accounted for. The initiation of the sprinting action requires LBEP (Boyle, 2011), and thus, emphasises the use of LBEP during the initial phases and also the first 10m of a sprint in order to accelerate. The results of the current study concur with these above-mentioned results.

It is acknowledged that very little is currently known regarding the maturity effects on anaerobic power necessary for LBEP (Malina *et al*., 2004a). To further emphasise the complicated effects between gender, motor performance variables (LBEP and speed) and maturity (as with increased muscle mass), Figueiredo *et al*. (2010) found that early mature adolescents showed a higher vertical jump performance in conjunction with an increase in sprint and agility shuttle run values than late mature adolescents.

The significant contribution of 46% (R^2=0.458) made only by gender (39%), and 10m-speed (7%) to the LBEP prediction model of the cohort of adolescents, leads to the conclusion that LBEP is also influenced by various other factors. Anthropometrical (Malina *et al*., 2004b; Girard & Millet, 2009), psychological (Escarti & Guzman, 1999), and external factors, such as available sporting facilities and environment (Chillón *et al*., 2011), as well as technique and training experience (Vanezis & Lees, 2005; Moresi *et al*., 2011; Paja, 2011), may be some of the other factors that could account for the remaining variables in the LBEP prediction model.

CONCLUSIONS

The results from the present study led to the development of a LBEP prediction from two physical and motor performance components among a cohort of male and female adolescents living in the Tlokwe local municipality of the Dr Kenneth Kaunda district in the North West Province of South Africa. It is believed that this is the first study to investigate the possibility of predicting LBEP in adolescents. It seems conclusive that an adolescent's gender (r=0.390), as well as the power generated by an adolescent for propulsion of his/her own body weight in a 10m-sprint (r= -0.349), correlates significantly with his/her VJ height achieved during LBEP production. Limitations of this study are extended to non-demographic representation of the South African adolescent population, as female adolescents were represented by 48% more than male adolescents in the study population. Furthermore, Caucasian adolescents were also measured, but not necessarily in relation to their South African representation in general.

RECOMMENDATIONS

Recommendations for future research of this kind would be to compile LBEP prediction models for adolescents of all ages, as well as to conduct the study on a broader population representative of South Africa thereby allowing a better demographic representation of all races, as well as a more balanced gender representation. In spite of some limitations, the LBEP model developed may be valuable tool for sport scientists, coaches or teachers where no other measurement options are available or if expensive and time-consuming test batteries cannot be applied to obtain VJT measurements. Additionally, the LBEP prediction model developed may be used by making use of a gender notation entry and a 10m-sprint time result and will allow for accurate prediction of LBEP of adolescents with specific reference to the North-West Province of South Africa.

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Disclaimer

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