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Relationship between the modified star excursion balance test and the 4x10 m shuttle run test in children

Relación entre el star excursion balance test modificado y el 4x10 m shuttle run test en niños

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Abstract

Agility and dynamic balance are crucial skills in prepubertal physical activity and sport participation, so the identification of efficient tests for their assessment is necessary. To evaluate the correlation between agility and dynamic balance in primary school children. Twenty-seven boys and twenty girls aged 10 years, volunteered to participate in the study. The modified Star excursion balance test and the 4x10 m shuttle run test were used in order to assess dynamic balance and agility respectively. Dynamic balance composite scores with the right stance showed a moderate significant correlation (r = -0.51, $p < 0.05$) with the agility test only among boys. However, significant correlation among girls (r = -0.45, $p < 0.05$) was showed during the posterolateral reaching distance of the Star excursion balance test. The performance of the complete test or the posteromedial and posterolateral reaching distances of the Star excursion balance test is moderately associated with agility among boys, whereas the posterolateral distance is associated with agility among girls.

Key words: Dynamic balance, agility, primary school.

Resumen

La agilidad y el equilibrio dinámico son habilidades cruciales en la actividad física prepuberal y la participación deportiva, por lo tanto es necesaria la identificación de pruebas eficientes para su evaluación. Evaluar la correlación entre la agilidad y el equilibrio dinámico en niños escolares de primaria. Veintisiete niños y veinte niñas de 10 años participaron voluntariamente en el estudio. El Star Excursion Balance Test (SEBT) modificado y el 4x10 m Shuttle Run Test se utilizaron respectivamente para evaluar el equilibrio dinámico y agilidad. Las puntuaciones compuestas del equilibrio dinámico con apoyo diestro mostraron solo entre los niños una moderada correlación significativa (r = -0.51, $p < 0.05$) con la prueba de agilidad. Sin embargo, entre las niñas se mostró una correlación significativa (r = -0.45, $p < 0.05$) durante la distancia de alcance posterolateral obtenida en el SEBT. La realización del test completo o de las distancias alcanzadas a nivel posteromedial y posterolateral del SEBT se asocia moderadamente con la agilidad entre los niños, mientras que la distancia posterolateral se asocia con la agilidad entre las niñas.

Palabras clave: Equilibrio dinámico, agilidad, escuela primaria.

Introduction

Locomotor (e.g., agility) and stability (e.g., dynamic balance) are fundamental and required skills during physical activity and sport participation at all ages (Fong & Ng, 2012; Gallahue, Ozmun, & Goodway, 2012; Jordan, Korgaokar, Farley, Coons, & Caputo, 2014; Santiago, Granados, Quintela, & Yanci, 2015). A relationship between agility and balance has been assumed for some authors who stated that balance and coordination improvements might provide faster movements and faster direction changes while maintaining control (Miller, Herniman, Ricard, Cheatham, & Michael, 2006). Indeed, balance is considered an agility subcomponent (Ruiz et al., 2009) and agility is defined as a body movement with velocity or direction changes in response to a stimulus (Sheppard & Young, 2006). Studies showed an agility/balance relationship through agility improvements after a balance training intervention (Little & Williams, 2005). Nevertheless, scientific literature that provides direct agility/balance relationship is scarce, especially in children. To the best of our knowledge, only two studies with college-aged and pubescent participants established a direct correlation between agility and static balance measures, reporting a significant correlation between the aforementioned variables (Sekulic, Spasic, & Esco, 2014; Sekulic, Spasic, Mirkov, Cavar, & Sattler, 2013). However, test providing dynamic conditions are required in to identify balance deficits, fall risk and sport-related injury risk in prepubertal children (Granacher & Gollhofer, 2012). The importance of maintaining balance while performing tasks has been highlighted due to the stabilization requirements before a motor movement can be efficiently elicited decreasing centre of gravity perturbations (Anderson & Behm, 2005; Davlin, 2004; Fong & Ng, 2012). Thus, it is reasonable to hypothesize that dynamic balance provides a greater transference to physical activity demands (likewise agility performances) than static balance (Gribble, Hertel, & Plisky, 2012).

Despite the lack of investigation between balance and agility has been attributed to the difficulty to perform a balance test (Sekulic et al., 2013), some cost-effective dynamic balance measures such as the Star excursion balance test (SEBT) have been widely used in several studies.

The SEBT is able to differentiate deficits and improvements in dynamic postural-control related to lower extremity injury and induced fatigue, and it has the potential to predict injury to the lower extremity (Gribble, Hertel, & Plisky, 2012). It is well established that children are less stable than adults (Schärli, Keller, Lorenzetti, Murer, & van de Langenberg, 2013; Shumway-Cook & Woollacott, 1985), due to a sensory system immaturity (i.e., visual, vestibular, somatosensory) (Cumberworth, Patel, Rogers, & Kenyon, 2007), undeveloped integration between sensory systems (Peterson, Christou, & Rosengren, 2006) or a lower degree of intersegmental coordination (Schärli et al., 2013). In fact, children injury rates related with falls and sport participation are higher compared with adolescents (Gallagher, Finison, Guyer, & Goodenough, 1984).

Hence, a better understanding of the association between dynamic balance measured by SEBT and agility measured by the 4x10 shuttle run test in children is warranted. Our purpose was to evaluate the correlation between the SEBT and the 4x10 m shuttle run test in children aged 10 years. In addition, since previous research reported gender-specific influences in different agility predictors (Sekulic et al., 2013) we also aimed to analyze between-gender differences. We hypothesized that the SEBT and the 4x10 m shuttle run test will show a significant correlation in both genders.

Methods

Participants

Information about the study and the experimental risks and informed consent forms were distributed in one school. All the measurement procedures and potential risks were verbally explained. Participant consent forms were sent home with students and those who returned signed consent forms (from their parents/guardians) were permitted to participate in the study. A total of 47 participants (20 female and 27 male; age 10 ± 0.7 years, height 145.07 ± 6.24 cm, weight 41.38 ± 6.97 kg) volunteered to take part in this study.

All participants were physically active and involved in regular training at least 3 times/week in swimming, basketball or in football. Participants were required to be free from lower extremity injury for at least 6 months prior to testing, have no history of hip, knee or ankle surgery (Munro & Herrington, 2010). The study was approved by the institutions' review boards and it was obtained an informed consent/assent from parents/child subjects. All procedures described in this section comply with the requirements listed in the 1975 Declaration of Helsinki and its 2008 amendment.

Protocol

Height (IP0955, Invicta Plastics Limited, Leicester, England) and body mass (Tanita model BF- 350) were obtained before starting with the familiarization. During the course of the testing, the participants were asked to maintain their normal diet and to stop exercising. A familiarization session was performed during the previous week to the data collection in order to standardize and harmonize the measurements. Data collection was performed during school hours, in a random order at the same time of the day (i.e., during the morning) by the same researchers. The researchers had previous experience with the tests assessed. All measurements were carried out during May, under standardized conditions and were always conducted in the same indoor sportive facility (with temperature between 15 and 20ºC).

The SEBT and the 4x10 m shuttle run test were used in order to assess dynamic balance and motor agility respectively and were performed the same day in a counterbalanced way. Participants performed 2 min mobility drills without ballistic movements to warm up.

The SEBT consists in maintaining a single leg stance on one leg while reaching as far as possible with the contralateral leg and was performed following the previous recommendations (Gribble, Hertel, & Plisky, 2012) and was performed in three directions (anterior, posteromedial and posterolateral). This modification reduces the time necessary to perform the SEBT and thus is more practical in the school setting. Four practice trials were performed in each direction before recording three additional reaching distances in order to minimize practice effects. The best value of the three measured trials was selected (Munro & Herrington, 2010). Participants undertook the testing barefoot with the stance foot aligned at the most distal aspect of the toes for anterior direction and the most posterior aspect of the heel for the backward directions. During trials, hands were placed on hips and minimal stance foot movement was allowed (Gribble et al., 2012). Leg length was measured quantifying the distance (in cm) from the anterior superior iliac spine to the center of the ipsilateral medial malleolus while participants lying supine. This measure was used to normalize excursion distances dividing the distance reached by leg length then multiplying by 100. A trial was discarded and repeated if participants used the reaching leg for a substantial amount of support at any time, removed the foot from the center of the grid, or were unable to maintain balance (Gribble & Hertel, 2003). The SEBT have been reported moderate and good test-retest reliability scores among children (Calatayud, Borreani, Colado, Martín, & Flández, 2014).

The 4x10 m shuttle run test was performed according to a previous description (Ortega, Ruiz, Castillo, & Sjöström, 2008). Two parallel lines were drawn on the floor 10 m apart. The participants ran as fast as possible from the starting line to the other line and returned to the starting line, crossing each line with both feet every time. Every time the participant crosses any of the lines, he/she should pick up (the first time) or exchange (second and third time) a sponge that has earlier been placed behind the lines. The rater was situated at the starting line and stopped the stopwatch when the participants crossed the line with one foot. The time taken to complete the test was recorded to the nearest tenth of a second. Participants wore sport shoes and performed the test with twice with one minute rest and the best time was selected. The 4x10 m shuttle run test measured with the stopwatch is valid and reliable to assess motor fitness and has been recently included in health-related fitness test battery for children and adolescents (Ruiz et al., 2011).

Statistical analyses

Statistical analysis was carried out using SPSS version 22 (SPSS inc., Chicago, IL, USA). The level of significance was set at $p < 0.05$ for all statistical tests.

Means and standard deviations were calculated for the tests and the anthropometric measures. Differences between right/left reach distances during the SEBT were evaluated by paired t-tests in each direction. In addition, composite reach distance was calculated as the sum of the 3 normalized reach distances (anterior, posteromedial, and posterolateral), divided by three times limb length, multiplied by 100.

The differences between men and women in all the applied tests were calculated using independent t-test. The relations between agility and dynamic balance for total sample, and separately for boys and girls were evaluated by Pearson correlation.

Results

There were no gender differences for the anthropometrics measurements (Table 1).

Boys had greater 4x10 m shuttle run test performance than girls as well as greater posterolateral reaching distance when the test was performed with the leg stance (Table 2). SEBT composite scores showed significant correlation with the 4x10 m Shuttle Run Test when

Table 1. Descriptive statistics of anthropometric measures

	Total sample (*n* = 47) Mean ± SD	Boys (*n* = 27) Mean ± SD	Girls (*n* = 20) Mean ± SD
Age	10 ± 0.7	10 ± 0.8	10 ± 0.6
Height (cm)	145.07 ± 6.24	144.98 ± 5.94	145.2 ± 6.78
Weight (kg)	41.38 ± 6.97	41.67 ± 6.49	40.95 ± 7.66
Right leg length	78.37 ± 4.54	77.96 ± 4.08	78.92 ± 5.15
Left leg length	78.74 ± 4.47	78.2 ± 4.04	78.82 ± 5.08

Table 2. 4x10 m Shuttle Run Test results and normalized dynamic balance SEBT scores

		Total sample (*n* = 47) Mean ± SD	Boys (*n* = 27) Mean ± SD	Girls (*n* = 20) Mean ± SD
4x10 m Shuttle Run Test (s)		13.5 ± 0.83	13.29 ± 0.85	13.78 ± 0.72*
SEBT Right Stance	Anterior	74.42 ± 7.24	75.27 ± 7.59	73.28 ± 6.76
	Posteromedial	92.42 ± 9.85	93.8 ± 9.49	90.57 ± 10.27
	Posterolateral	83.19 ± 11.59	84.52 ± 11.33	81.39 ± 11.99
SEBT Left Stance	Anterior	75.39 ± 7.79	74.91 ± 9.14	76.04 ± 5.65
	Posteromedial	92.23 ± 11.71	92.58 ± 11.54	91.77 ± 12.23
	Posterolateral	84.38 ± 14.3	88.45 ± 12.8	78.9 ± 14.67*
SEBT Composite	Right Stance	83.34 ± 7.66	84.53 ± 7.5	81.74 ± 7.77
	Left Stance	84 ± 9.1	85.31 ± 9.02	82.23 ± 9.13
SEBT total composite		83.67 ± 7.7	84.92 ± 7.23	81.98 ± 8.16

*Denotes significant differences between genders ($p < 0.05$).
Composite = sum of the 3 normalized reach distances, divided by 3 times limb length, multiplied by 100. SEBT results are presented as a % of the leg length distance.

the right stance was examined in the whole sample but only in boys when sample was separated. Regarding the specific reaching distances of the SEBT, boys presented significant correlation during the posteromedial and posterolateral reaching distance with the right stance whereas girls only showed a significant agility/dynamic balance correlation during the posterolateral reaching distance with the right stance. Complete correlation coefficients between the 4x10 m Shuttle Run Test and the SEBT are showed in the Table 3.

Table 3. Correlation coefficients between 4x10 m Shuttle Run Test and the SEBT

		Total sample	Boys	Girls
Right Stance	Anterior	-0.27	-0.02	-0.01
	Posteromedial	-0.35*	-0.51*	-0.14
	Posterolateral	-0.52*	-0.56*	-0.45*
Left Stance	Anterior	-0.15	-0.25	0.03
	Posteromedial	0.01	-0.02	0.06
	Posterolateral	-0.13	-0.07	-0.16
Composite	Right Stance	-0.42*	-0.51*	-0.29
	Left Stance	-0.10	-0.13	-0.05

* Denotes significant Pearson's correlation coefficients ($p < 0.05$).
Composite= sum of the 3 normalized reach distances, divided by 3 times limb length, multiplied by 100.
SEBT results are presented as a % of the leg length distance.

Discussion

The purpose of the study was to evaluate the relationship between the SEBT and the 4x10 m shuttle run test in primary school students. Partly in accordance with the hypothesis, our principal result showed a moderate correlation between the 4x10 m shuttle run test and the composite SEBT only in boys when the right stance was examined. Other interesting findings in our study are: a) posteromedial and posterolateral reaching distances provided the greatest association; b) correlation was only showed during the SEBT with right stance. Each of these findings is discussed with further details in the following texts.

Supporting our principal result, two previous studies reported moderate (Sekulic et al., 2013) and low (Sekulic et al., 2014) significant correlation between static balance and agility measures among college-aged boys and girls and pubescent boys respectively. Despite the general correlation that we found (i.e., composite scores), the association was only showed among boys. However, it is worthy to mention that significant correlation among girls was showed during posterolateral reaching distance. Neuromuscular improvements due to balance training such as reflex adaptations or an increase in rate of force development may benefit explosive muscular actions and thus, improve motor skill performance (Gruber & Gollhofer, 2004). In fact, a systematic review concluded that balance training increase static and dynamic balance in athletes and non-athletes and may also have a positive effect on strength performance, jumping and agility (Zech et al., 2010).

Some authors have speculated about the relationship between dynamic balance and agility. For instance, balance training induced a positive transference to agility performance (Little & Williams, 2005). Additionally, sports requiring agility skills have demonstrated superior static unipedal and dynamic balance ability compared with control participants (Bressel, Yonker, Kras, & Heath, 2007). Since balance has special influence in the efficacy of directional changes (Sekulic et al., 2013), our findings regarding the correlation of the different reaching distances in the SEBT with the agility test seem logical. The results of the present study corroborate recently reported findings where lateral and semilateral movements showed the highest correlation with balance (Sekulic et al., 2013). In our case, posteromedial and especially the posterolateral reaching distances showed higher correlation with the agility test than anterior direction, probably due to the lower balance disruptions during this position.

Regarding sex differences in test performance, we found that boys were faster than girls in the agility test, which is already reported in participants aged 20 years (Sekulic et al., 2013). Similarly, previous studies reported that boys had a greater sprint performance (Karppanen, Ahonen, Tammelin, Vanhala, & Korpelainen, 2012; Nassif et al., 2012). Different results were found regarding dynamic balance between boys and girls. Concretely, girls and boys obtained similar scores during the SEBT. Previous studies reported that women showed greater static balance results among adults and greater static balance among prepubescent participants (Karppanen et al., 2012; Marta, Marinho, Barbosa, Izquierdo, & Marques, 2012) and participants aged 20 years (Sekulic et al., 2013). It is probable that the non-significant differences in anthropometric measures (i.e. in our study boys and girls do not differ significantly in height and weight) defined the non-significant differences in dynamic balance between genders. Despite greater flexibility in the ankle joint has been identified as one of the key factors in maintaining balance (Sekulic et al., 2013), their influence remain limited to the anterior distance of the SEBT (Hoch, Staton, & McKeon, 2011). In addition, other variables such as knee flexion degree, hip flexion degree, height and leg length may influence the SEBT results (Gribble et al., 2012). It has been stated that a lower center of mass may allow greater stability (Allard, Nault, Hinse, LeBlanc, & Labelle, 2001). Nevertheless, prepubertal stage results in a reduction of the height differences between boys and girls, since girls have a faster grown during this stage, reaching the height peak earlier than boys (Malina, Bouchard, & Bar-Or, 2004). However, the gender differences in the correlation between dynamic balance and agility (i.e. correlations between these qualities are more evident among boys), are most probably related to the power and speed as has been observed in a previous study (Sekulic et al., 2013).

Interestingly, agility-balance correlation was only showed during the right stance of the SEBT. However, no significant difference was found between reaching distances of both limbs. An anterior right/left reach distance difference greater than 4 cm has been related to a greater lower extremity injury risk (Plisky, Rauh, Kaminski, & Underwood, 2006). In addition, a decreased reach distance in 1 limb may be a potential risk factor for injury to either limb (Plisky et al., 2006). Considering the absence of significant differences between right/left reach distances during the SEBT in our study, is possible that a right stance which was related with a greater number of participant´s limb dominance has a greater implication in direction changes during the agility test.

The use of photoelectric cells could have provided greater accuracy in our results and may be a limitation. However, the use of a manual stopwatch has been validated and is a reliable measure to assess the 4x10 m shuttle run test even when the raters are not trained for it (Vicente-Rodríguez et al., 2011). In addition, a stopwatch is much cheaper and feasible in the school setting.

Conclusions

Our results demonstrate that the composite score of the modified SEBT and the posteromedial and posterolateral reaching distances with the right stance are moderately associated with the 4x10 m shuttle run test performance in male children aged 10 years. A relationship between these tests among girls may be showed only during the SEBT posterolateral reaching distance with right stance.

REFERENCES

Allard, P., Nault, M. L., Hinse, S., LeBlanc, R., & Labelle, H. (2001). Relationship between morphologic somatotypes and standing posture equilibrium. *Annals of Human Biology*, *28*(6), 624-633. doi:10.1080/03014460110047946

Anderson, K., & Behm, D. G. (2005). The impact of instability resistance training on balance and stability. *Sports medicine*, *35*(1), 43-53. doi:10.2165/00007256-200535010-00004

Bressel, E, Yonker, J. C., Kras, J., & Heath, E. M. (2007). Comparison of static and dynamic balance in female collegiate soccer, basketball, and gymnastics athletes. *Journal of Athletic Training, 42*, 42-6.

Calatayud, J., Borreani, S., Colado, J. C., Martin, F., & Flandez, J. (2014). Test-retest reliability of the star excursion balance test in primary school children. *The Physician and Sportsmedicine*, *42*(4), 120-124. doi:10.3810/psm.2014.11.2098

Cumberworth, V. L., Patel, N. N., Rogers, W., & Kenyon, G. S. (2007). The maturation of balance in children. *The Journal of Laryngology and Otology*, *121*(5), 449-454. doi:10.1017/S0022215106004051

Davlin, C. D. (2004). Dynamic balance in high level athletes. *Perceptual and Motor Skills*, *98*(3-2), 1171-1176. doi:10.2466/pms.98.3c.1171-1176

Fong, S. M., & Ng, G. Y. F. (2012). Sensory integration and standing balance in adolescent taekwondo practitioners. *Pediatric exercise science*, *24*(1), 142-151. doi:10.1123/pes.24.1.142

Gallagher, S. S, Finison, K., Guyer, B., & Goodenough, S. (1984). The incidence of injuries among 87,000 Massachusetts children and adolescents: Results of the 1980-81 statewide childhood injury prevention program surveillance system. *American Journal of Public Health*, *74*(12), 1340-1347. doi:10.1097/00004630-198607000-00013

Gallahue, D. L., Ozmun, J. C., & Goodway, J. (2012). *Understanding motor development: Infants, children, adolescents, adults*. New York: McGraw-Hill.

Granacher, U., & Gollhofer, A. (2012). Is there an association between variables of postural control and strength in prepubertal children? *Journal of Strength and Conditioning Research*, *26*(1), 210-216. doi:10.1519/JSC.0b013e31821b7c30

Gribble, P. A., & Hertel, J. (2003). Considerations for normalizing measures of the star excursion balance test. *Measurement in Physical Education and Exercise Science*, *7*(2), 89-100. doi:10.1207/S15327841MPEE0702_3

Gribble, P. A., Hertel, J., & Plisky, P. (2012). Using the star excursion balance test to assess dynamic postural-control deficits and outcomes in lower extremity injury: A literature and systematic review. *Journal of athletic training*, *47*(3), 339-357. doi:10.4085/1062-6050-47.3.08

Gruber, M., & Gollhofer, A. (2004). Impact of sensorimotor training on the rate of force development and neural activation. *European Journal of Applied Physiology*, *92*(1-2), 98-105. doi:10.1007/s00421-004-1080-y

Hoch, M. C., Staton, G. S., & McKeon, P. O. (2011). Dorsiflexion range of motion significantly influences dynamic balance. *Journal of Science and Medicine in Sport*, *14*(1), 90-92. doi:10.1016/j.jsams.2010.08.001

Jordan, J. B., Korgaokar, A., Farley, R. S., Coons, J. M., & Caputo, J. L. (2014). Caffeine supplementation and reactive agility in elite youth soccer players. *Pediatric Exercise Science*, *26*(2), 168-176. doi:10.1123/pes.2013-0134

Karppanen, A. K., Ahonen S. M., Tammelin, T., Vanhala, M., & Korpelainen, R. (2012). Physical activity and fitness in 8-year-old overweight and normal weight children and their parents. *International Journal of Circumpolar Health*, *71*(1), 17621. doi:10.3402/ijch.v71i0.17621

Little, T., & Williams, A. G. (2005). Specificity of acceleration, maximum speed, and agility in professional soccer players. *Journal of Strength and Conditioning Research*, *19*(1), 76-78. doi:10.1519/14253.1

Malina, R. M., Bouchard, C., Bar-Or, O. (2004). *Growth, maturation, and physical activity.* Champaign, Ill: Human Kinetics.

Marta, C. C., Marinho, D. A, Barbosa, T. M., Izquierdo, M., & Marques, M. C. (2012). Physical fitness differences between prepubescent boys and girls. *Journal of Strength and Conditioning Research*, *26*(7), 1756-1766. doi:10.1519/JSC.0b013e31825bb4aa

Miller, M. G., Herniman, J. J., Ricard, M. D., Cheatham, C. C., & Michael, T. J. (2006). The effects of a 6-week plyometric training program on agility. *Journal of Sports Science and Medicine*, *5*(3), 459-465.

Munro, A. G., & Herrington, L. C. (2010). Between-session reliability of the star excursion balance test. *Physical Therapy in Sport*, *11*(4), 128-132. doi: 10.1016/j.ptsp.2010.07.002

Nassif, H., Sedeaud, A., Abidh, E., Schipman, J., Tafflet, M., Deschamps, T., …Toussaint, J. F. (2012). Monitoring fitness levels and detecting implications for health in a French population: An observational study. *BMJ Open*, *2*(5), e001022. doi:10.1136/bmjopen-2012-001022

Ortega, F. B., Ruiz, J. R., Castillo, M. J., & Sjöström, M. (2008). Physical fitness in childhood and adolescence: A powerful marker of health. *International Journal of Obesity*, *32*(1), 1-11. doi: 10.1038/sj.ijo.0803774

Peterson, M. L., Christou, E., & Rosengren, K. S. (2006). Children achieve adult-like sensory integration during stance at 12-years-old. *Gait & Posture*, *23*(4), 455-463. doi: 10.1016/j.gaitpost.2005.05.003

Plisky, P. J., Rauh, M. J., Kaminski, T. W., & Underwood, F. B. (2006). Star excursion balance test as a predictor of lower extremity injury in high school basketball players. *Journal of Orthopaedic and Sports Physical Therapy*, *36*(12), 911-919. doi: 10.2519/jospt.2006.2244

Ruiz, J. R., Castro-Piñero, J., Artero, E. G., Ortega, F. B., Sjöström, M., Suni, J., Castillo, M. J. (2009). Predictive validity of health-related fitness in youth: A systematic review. *British Journal of Sports Medicine*, *43*(12), 909-923. doi: 10.1136/bjsm.2008.056499

Ruiz, J. R., Castro-Piñero, J., España-Romero, V., Artero, E. G., Ortega, F. B., Cuenca, M. M. …Castillo, M. J. (2011). Field-based fitness assessment in young people: The ALPHA health-related fitness test battery for children and adolescents. *British Journal of Sports Medicine*, *45*(6), 518-524. doi: 10.1136/bjsm.2010.075341

Santiago, A., Granados, C., Quintela, K., & Yanci, J. (2015). Differences in the acceleration, change of direction and jumping capacity between different ages soccer players. *Cultura_Ciencia_Deporte, 10*(29), 135-143. doi:10.12800/ccd.v10i29.551.

Schärli, A. M., Keller, M., Lorenzetti, S., Murer, K., & van de Langenberg, R. (2013). Balancing on a Slackline: 8-Year-Olds vs. Adults. *Frontiers in Psychology*, *4*, 208. doi: 10.3389/fpsyg.2013.00208

Sekulic, D., Spasic, M., & Esco, M. R. (2014). Predicting agility performance with other performance variables in pubescent boys: A multiple-regression approach. *Perceptual and Motor Skills*, *118*(2), 447-461. doi: 10.2466/25.10.PMS.118k16w4

Sekulic, D., Spasic, M., Mirkov, D., Cavar, M., & Sattler, T. (2013). Gender-specific influences of balance, speed, and power on agility performance. *Journal of Strength and Conditioning Research*, *27*(3), 802-811. doi:10.1519/JSC.0b013e31825c2cb0

Sheppard, J. M., & Young, W. B. (2006). Agility literature review: Classifications, training and testing. *Journal of Sports Sciences*, *24*(9), 919-932. doi: 10.1080/02640410500457109

Shumway-Cook, A., & Woollacott, M. H. (1985). The growth of stability: Postural control from a development perspective. *Journal of Motor Behavior*, *17*(2), 131-147. doi: 10.1080/00222895.1985.10735341

Vicente-Rodríguez, G., Rey-López, J. P., Ruíz, J. R., Jiménez-Pavón, D., Bergman, P., Ciarapica, D., Ortega, F. B. (2011). Interrater reliability and time measurement validity of speed-agility field tests in adolescents. *Journal of Strength and Conditioning Research*, *25*(7), 2059-2063. doi: 10.1519/JSC.0b013e3181e742fe

Zech, A., Hübscher, M., Vogt, L., Banzer, W., Hänsel, F., & Pfeifer, K. (2010). Balance training for neuromuscular control and performance enhancement: A systematic review. *Journal of Athletic Training*, *45*(4), 392-403. doi: 10.4085/1062-6050-45.4.392.

Relación entre locus de control, ira y rendimiento deportivo en jugadores de tenis de mesa

Link between locus of control, anger and sport performance in table tennis players

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Resumen

Los objetivos de este estudio fueron comprobar la relación entre el locus de control y el rendimiento deportivo, y conocer la relación entre el locus de control y las variables de ira. La muestra de la investigación se compuso de 58 jugadores federados de tenis de mesa de toda la geografía española. Los participantes completaron un cuestionario sociodemográfico *ad hoc*, la *Escala de Locus de Control* (ELC) y el *Inventario de Expresión de la Ira Estado-Rasgo* (STAXI-2). Los resultados revelaron que no había diferencias de medias en los niveles de locus de control externo en función de la división de juego y del tipo de práctica deportiva (profesionales *vs* amateurs). Por otro lado, se confirmó la relación entre el locus de control externo y la expresión externa de la ira, encontrándose diferencias estadísticamente significativas entre la expresión externa de la ira y los grupos de locus de control externo alto y bajo. Finalmente, se concluyó que el nivel de rendimiento deportivo no interfería en los niveles de locus de control y, por otro lado, se confirma la relación del locus de control externo en la expresión externa de la ira de los jugadores de tenis de mesa. Por lo tanto, el locus de control interno se muestra como una variable protectora importante para intervenir con jugadores y entrenadores.

Palabras clave: Deporte de raqueta, competición, creencia de control, ajuste psicológico.

Abstract

The aims of this study were to verify the relationship between locus of control and athletic performance, and understand the relationship between locus of control and anger variables. The research sample consisted of 58 federated table tennis players from all Spanish geographic areas. Participants completed a sociodemographic questionnaire *ad hoc*, the *Locus of Control Scale* (ELC) and the *State-Trait Anger Expression Inventory* (STAXI-2). The results revealed no differences in mean levels of external locus of control in terms of the division of play and type of sport (amateur versus professional). On the other hand, we found relationship between external locus of control and anger. We showed statistically significant differences in outward expression of anger and groups of high and low external locus of control. Finally, it was concluded that the level of athletic performance did not interfere with the levels of locus of control, on the other hand, the ratio of external locus of control and outward expression of anger of table tennis players was confirmed. Therefore, internal locus of control is shown as an important protective variable to intervene with for players and coaches.

Key words: Racket sport, competition, control belief, psychological adjustment.