Journal of Physical Education and Sport ® (JPES), 17(3), Art 192, pp. 1954 - 1959, 2017
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Assessment of gross motor developmental level in Italian primary school children

FRANCESCO SGRÒ[1,2], ANTONELLA QUINTO[2], LUIGI MESSANA[2], SALVATORE PIGNATO[1,2], MARIO LIPOMA[1,2]
[1]Human and Society Sciences Faculty, University of Enna "Kore", ITALY
[2]Laboratory of Human Movement and Sport Performance Analysis

Published online: September 30, 2017
*(*Accepted for publication September 09, 2017
DOI:10.7752/jpes.2017.03192

Abstract
The development of Fundamental Movement Skills (FMSs) has been associated to several factors, such as weight status, gender differences and school years. In this study, we examined the level of development of several Italian primary school children taking into account school year and gender differences. The participants were 120 children (mean age: 8.70±1.53 years) and were recruited from three Italian primary schools. Each child performed all items provided in the Test of Gross-Motor Development and its level of proficiency in gross-motor skills was ranked according to its Gross-Motor Development Quotient obtained through the analysis performed by five skilled operators. Results highlighted that the children in the first school year had the highest level of proficiency in gross-motor skills in comparison with all their peers of other year groups (these differences were large for all comparisons). Moreover, boys resulted in higher level of proficiency than the girls and this difference was statistically significant in Year 2, Year 3, and Year 5 (effect size of these differences was from moderate to large). These results confirmed that the mastery in FMSs is not age-dependent and is affected by year groups and gender differences, so it is necessary to plan efficient and, if possible, subject- or group-specific educational programs in primary school setting to support the development of gross-motor skills in all children.
Keywords: Test of Gross Motor Development, Italian primary school children, locomotor skills, object-control skills

Introduction

Fundamental movement skills (FMSs) are considered the basic elements of movement capability and represent the prerequisites for practicing advanced physical activities and sport. Indeed, an adequate development of FMSs is essential for performing motor-gross skills often requires in several daily activities and sport motions. In this respect, an adequate level of proficiency in gross-motor skills supports children's participation in daily physical activity (Sgrò, Quinto, Pignato, & Lipoma, 2016), children's involvement in sport-based activities (Gabbard, 2011), children's prevention of diseases related to weight status, and children's attitude to an active lifestyle. According to Gallahue, Ozmun, and Goodway (2011), the development of these skills has to be achieved from 3- to 8-years through practice and experience, even if it depends also from several anthropometric factors, such as physical growth, weight status, and gender. However, the development of the FMSs is not naturally correlated with the growth (Gallahue, et al., 2011), but it needs to be supported from the early childhood by an adequate training/educational protocol and reinforced by specific skill-related feedback (Gabbard, 2011; Payne & Isacs, 2017). Therefore, according to several statements provided by national and international institutions (i.e, World Health Organization, National Association for Sport and Physical Education), the school has a special role because it must support the development of gross-motor skills with adequate and adapted physical education curriculum.

Assessment of fundamental movement skills developmental levels could be carried out with process- and product-oriented approaches (Sgrò, et al., 2016). Although the product-oriented approaches are easier to administer and requires few time for interpreting the results (i.e., product or outcome of the performance), the process-oriented approaches, which try to assess the pattern and the technique of the movement, are used the most in school setting. In this context, the assessment results are essential to plan efficient and effective educational programs with the aim to focus specifically the delay in FMSs development of each child. In this respect, Ulrich (1985) proposed the Test of Gross Motor Development (TGDM) for providing a valid instrument for assessing the level of proficiency in motor-gross skills in 3- to 10-years old children and for identifying potential development's delay. TGMD is a process-oriented and standardized assessment method used by teachers of pre-school and school children for evaluate motor-gross development in locomotor and object control skills. By combining with the scores of the tests related to these skills (a detailed explanation will be provided in the next paragraph), the administer can estimate a Gross-Motor Development Quotient (GMDQ), which can be used to verify the level of development in the gross-motor skills of participants according to normative data provided by Ulrich for 3- to 10-years children.

Corresponding Author: FRANCESCO SGRÒ, E-mail: francesco.sgro@unikore.it

Recently, data about the number of European children experiencing physical activity sufficiently in duration, frequency and intensity, as recommended by expert committees, suggested that it decreases with age (Armstrong & Welsman, 2006). Nowadays, the National Institute for Statistics (ISTAT, Italy) verify that: a) only 25,1% of Italian people with 3 years or more practice sport or physical activity regularly; b) boys are more involved than girls; and c) the south of Italy accounts for the regions with the highest levels of sedentary people (52.7% of south regions' people). Anyway, even if the role of an adequate development of FMSs is well-noted for fighting behaviours oriented to sedentary lifestyle, few studies have addressed the level of proficiency in motor-gross skills among Italian children. With these elements in mind, this study was to examine the level of gross-motor development in a sample of Italian primary school children taking into account year groups and gender differences.

Methods

Participants and procedures

Originally, 120 participants from year groups 1-5 (aged 5-10 years) were recruited from three primary schools of south Italy, but 8 children did not participate to all the assessment sessions, therefore they were removed from the research. The characteristics of the final sample are: 60 males and 52 females; mean age: 8.70±1.53 years. The rationale because we assessed children of these years is that mastery level in the FMSs seems to be clear from the five years and onwards (Vandaele, Cools, Decker & Martelaer, 2011). The parents of each participant provided a signed informed consent and school ethics boards and ethical committee of the University of Enna "Kore" approved the current research methodology.

The assessment procedures were performed in the gym of each school, where almost four skilled operators met the participants. Overall, the assessment period was along six days. For each school, in order to guarantee valid and reliable assessment procedures, the participants were divided in smallest group (i.e., five children per group). Anthropometric measures were carried out from the same operator for all participants by means of a wall-mounted meter for the height and an electronic weighing scales for the weight; these measures were used to estimate the Body Mass Index (BMI) as Kg/m^2 with children being classified according to the international criteria (Cole, Bellizzi, Flegal, & Dietz, 2000).

FMSs assessment

Gross-motor developmental level was measured by means of the Test of Gross-Motor Development (TGMD) (Ulrich, 1985). TGMD is composed by 12-item test divided into locomotor (run, gallop, hop, leap, standing horizontal jump, slide) and object control (strike, stationary ball bounce, catch, kick, overhand throw) subtests. Three to four skill criteria characterized each item and the operators have to identify if a child mastery or not each item's criteria. For each item, the participants performed three trials; before the assessment began, participants were involved in a low-intensity warm-up program for ten minutes.

For each trial, the raw score for locomotor subtest ranges from 0 to 26, while the raw score for object control subtest ranges from 0 to 19. The raw scores of each participant are converted to the standard score for each subtest, separately, according to the age of each child. Next, the standard scores have been used to estimate the Gross Motor Development Quotient (GMDQ). The GMDQ is used to interpret the level of motor proficiency of the child according to the normative data provided within TGMD (i.e., very low, low, under the mean, mean, over the mean, high, very high). In the current research, five operators were involved in the assessment of gross-motor development by means of TGMD. The operators followed the execution of each item in the gym and they video-recorded the performance of each child. Then, the evaluation of each trial was performed by each operator, separately, by means of the software Longomtach (LongoMatch, Ver. 0.20.8, http://longomatch.org) that accounts for several procedures (i.e., slow-motion, move the video forward and backwards frame-per-frame) useful for providing valid and reliable evaluation of the participants' performance. The inter-raters reliability ranged from 0.86 for locomotor subtest to 0.88 for object control subtest.

Data analysis

First, participants GMQD values were checked for verifying whether they were normally distributed and accounted for the presence of univariate outlier. In order to examine whether existed significant differences for GMQD (dependent variable) among gender and school years (independent variables), separately, student's t test for independent sample and one-way analyses of variance (ANOVA) were conducted, respectively. If significant differences were found for school years, student's t tests for independent samples, with Bonferroni-Holm correction for multiple comparisons, were computed to identify the parameters that differed among two school years. The effect size of such parameters was estimated by means of Cohen's d_Z value, and it was interpreted with the following criteria: small= 0.20 to 0.49, moderate= 0.50 to 0.79, and large ≥0.80 (Cohen, 1988). The statistical procedures were performed using SPSS Version 20.0 for Mac OS X (SPSS Inc., Chicago, Illinois) and their significance level was set to .05.

Results

Data screening revealed three subjects were univariate outlier, so their data were discarded from further analysis. Because no other violations of assumption were noted, parametric analyses were carried out. Table 1 described the anthropometric characteristics of the children in relevant school year.

Table 1. Anthropometric characteristics of the participants in each school year.

	Year 1 (n=22)		Year 2 (n=21)		Year 3 (n=19)		Year 4 (n=26)		Year 5 (n=21)	
	Boys (n=13)	Girls (n=9)	Boys (n=8)	Girls (n=13)	Boys (n=9)	Girls (n=10)	Boys (n=17)	Girls (n=9)	Boys (n=10)	Girls (n=11)
	M (SD)	M(SD)	M (SD)	M(SD)	M (SD)	M(SD)	M (SD)	M(SD)	M (SD)	M(SD)
Age (y)	6.78 (0.4)	6.31 (0.4)	7.88 (0.3)	7.52 (0.3)	8.8 (0.4)	8.6 (0.3)	9.1 (0.8)	9.5 (0.7)	10.9 (0.3)	10.9 (0.3)
Height (m)	1.23 (0.04)	1.21 (0.04)	1.26 (0.04)	1.26 (0.07)	1.32 (0.06)	1.27 (0.04)	1.40 (0.06)	1.37 (0.04)	1.43 (0.07)	1.42 (0.07)
Weight (kg)	26.29 (6.0)	28.2 (6.6)	32.9 (8.5)	27.7 (5.6)	34.9 (12.8)	29.0 (3.9)	38.7 (10.9)	36.6 (7.3)	40.5 (11.0)	40.5 (9.5)
BMI (kg/m^2)	17.7 (3.7)	18.3 (3.5)	20.3 (4.2)	17.2 (2.3)	19.6 (5.1)	17.8 (2.9)	19.5 (4.2)	19.4 (3.7)	19.6 (3.8)	19.7 (3.1)

Note: M=mean; SD= Standard Deviation; y= year; m=meter; kg=kilograms; BMI= Body Mass Index

The classification of children according to BMI taxonomy (Cole, et al., 2000) was as follow: underweight (2.7%), normal (56.3%), overweight (15.2%), and obese (25.9%). One-way ANOVA revealed not statistically significant differences for BMI data among school years, between gender, and between gender in each school year.

For what concern the overall level of proficiency in the gross-motor skills, the majority of children was classed at 'very low" and 'low' levels (56.2%), 19.6% of children were classed as 'under the mean', 18.8% of children were classed as 'in the mean', and only 5.6% of children were classified at 'over the mean' and 'high' levels. Table 2 describes the level of proficiency in FMSs across school years.

Table 2. The number of children (%) for each school year across the level of proficiency defined according to the cut-offs provided by Ulrich for the interpretation of GMDQ.

	Very Low	Low	Under the mean	Mean	Over the mean	High
Year 1	-	18.2	13.6	45.5	18.2	4.5
Year 2	23.8	42.9	28.6	4.8	-	-
Year 3	5.3	36.8	36.8	21.1	-	-
Year 4	38.5	38.5	7.7	15.4	-	-
Year 5	28.6	47.6	19.0	4.8	-	-

One-way ANOVA revealed significant differences for GMDQ among school years: $F(4,104) = 14.55$, $p<.0001$. According to our aims, student's t tests for independent samples were performed for assessing pairwise differences among years, by considering the correction of the significant level according to Bonferroni-Holm procedure for multiple comparison. Significant differences were found between: Year 1 to Year 2 (t= 5.09, $p<.0001$, d_z=1.59); Year 1 to Year 3 (t= 3.58, $p<.0001$, d_z=1.15); Year 1 to Year 4 (t= 5.49, $p<.0001$, d_z=1.62); Year 1 to Year 5 (t= 6.28, $p<.0001$, d_z=1.96); Year 3 to Year 4 (t= 2.39, $p<.05$, d_z=0.74); Year 3 to Year 5 (t= 3.28, $p<.0001$, d_z=1.07).

For what concern the differences of GMQD between girls and boys, student's t test revealed the following data: t= -4.08, $p<.001$, d_z= 0.8. Figure 1 provides GMQD scores distinctly for males and female in each year group.

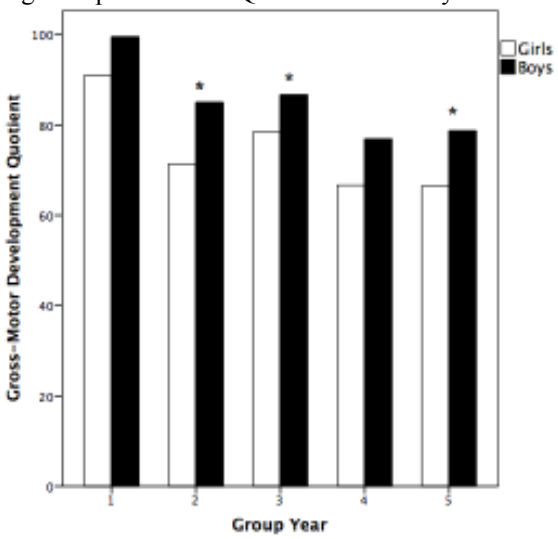

Figure 1 – Mean values of GMDQ according to year group. *Significant difference for gender.

Statistically significant differences of GMQD scores between girls and boys for each school year were found for: Year 2 (t= -3,81, p=.001, *dz*=-1.81), Year 3 (t= -2,12, p=.04, *dz*=-1.03), and Year 5 (t= -3,51, p=.002, *dz*=-1.61).

Discussion and conclusion

The aim of this study was to examine the level of proficiency in motor-gross skills in a sample of Italian primary school children taking into account year group and gender differences. The level of motor proficiency was assessed by means of a processes-oriented approach, the TGMD. The anthropometric characteristics (i.e., height, weight, and BMI) of current participants were not statistically different across school years, while year group and gender provided an effect on the aforementioned level of proficiency. These results suggested that the level of gross-motor development in our sample was not directly related to the physical characteristics of the children but it seems to depend from their level of overall development; accordingly, the significant role of the physical education through primary school years to support the mastery of FMSs is reinforced. This point is essential because adequate development of FMSs increases habitual physical activity, improves overall level of well-being, and prevents diseases related to overweight and obese status. Furthermore, this result could be considered somewhat an upgrade of the current literature because it represents novel evidences about the level of FMSs proficiency in Italian primary school children.

The analysis about the development of gross-motor skills in the current participants outlined that the majority of them was significantly under the level of mean provided by Ulrich's normative data. This result is in agreement with several previous evidences provided by studies which have addressed the level of proficiency in gross-motor skills worldwide (Niemeijer, et al., 2006; Niemeijer & Smits-Engelsman, 2007; Rosenberg, et al., 2008; Hardy, et al., 2012; Bryant, et al., 2014). This is a worrying evidence because it confirms the presence of a worldwide problem about the high level of sedentary among children and adolescence. Furthermore, this statement is opposed to the well-noted significant role of the FMSs development as a basic element for a right lifestyle.

The current study revealed that the level of proficiency in gross-motor skills was different across year groups and it was consistent with previous study (Bryant, et al., 2014). The participants of Year 1 (mean age 6.54 years) provided the highest level of gross-motor development and their scores were statistically different with the ones of other year groups. The effect size of these differences was high for all comparisons, but the highest differences were between Year 1-Year 4 and Year 1-Year 5. At the same way, the participants of Year 3 had a level of proficiency statistically different from their peers of Year 4 and Year 5 (effect size of these differences was medium and large, respectively). Several relevant notes derived from these results. First, this result confirms the "paradox of universality vs variability" provided by Thelen and Ulrich (1991) about the relation between FMSs development and age; moreover, the lack of age-dependent relation with the gross-motor development supports the results provided in previous studies about the developmental level of jumps skills (Sgrò, et al., 2015; Sgrò, et al., 2017). Second, the lowest levels of proficiency in the children of Year 4 and Year 5 were in agreement with the evidence provided by Spessato and colleagues (2013) about the presence of a plateau in the development of FMSs from 8- to 10-years children. This trend was also verified considering a big sample (n=2377) of Brazilians children (Valentini, et al., 2016). However, these results are partially in contrast with the previsions provided by Hands (2008) about a graded response between FMSs and age. According to Bryant and colleagues (2014), we hypothesize that this result can be explained by considering that there was less consistency in the programs of physical education across the year groups of the primary schools involved in this study. Indeed, the relevance of an adequate support by physical education courses for guiding and improving, step-by-step, the aforementioned development has been verified by several evidences (Valentini & Rudisill, 2004; Hardy, King, Farrell, Macniven, & Howlett, 2010; Logan, Robinson, Wilson, & Lucas, 2011; Morgan et al., 2013). This is a key element in the mission of all the stakeholder directly or indirectly involved in the promotion of physical activity and well-being oriented lifestyle, and in the prevention of weight related diseases. For what concern the school, this result need to be much addressed by the governance of the teaching-learning processes in order to identify all the shortcomings in the curriculum which limited the impact of physical education in gross-motor development.

The level of proficiency in gross-motor skills was significantly affected by gender, with a large difference between boys and girls (see figure 1). The current result signified that the boys' level of gross-motor development was higher than the ones of girls. The same result was verified by Jiménez-Diaz and colleagues (2015) for locomotor and object control subtest, respectively, and, in general, several previous researches support the current differences between boys and girls (Barnett van Beurden, Morgan, Brooks, and Beard, 2010; Hardy et al., 2012; Spessato et al., 2012; Lorson, Stodden, Langendorfer, and Goodway, 2013; Mathisen, 2016). For example, a study on the effect of gender on the level of FMSs proficiency suggested that the boys seem to be more skilled in object control while girls outperformed boys in such locomotor or balance skills (Okely and Both, 2004). According to Malina and colleagues (2004), during the primary school age children should be biologically (somatically) similar, so the gender differences in FMSs developmental level need to be searched in psico-social factors. In this respect, although the process-oriented assessment approach has been suggested for evaluating the pattern of motion required in FMSs (Sgrò, et al., 2016), this approach seems to affect negatively the outcomes of girls (Hardy, et al., 2012). In this respect, it is well-noted as any approach for assessing FMSs developmental level needs to be "ecological", by reinforcing the relation between participants, task, and environment (Gallahue, et al., 2011). Moreover, boys 'highest level of FMSs proficiency can be also explained

by considering that they are more likely to engage free and structured physical and sport activity compared to the girls during their free time (Reichert, Barros, Domingues, and Hallal, 2007), while the girls seem to be not supported by their same family on such activities (Silva, Gomes, and Goellner, 2008).

Despite identifying important information about the level of proficiency in gross-motor skills of Italian primary school children, this study is limited by several factors. There is the lack of a detailed analysis about the level of proficiency in object control and locomotor skills, separately. The impact of socio-economic factors in the development of gross-motor skills is not provided, while this information seems to be related with the overall development process of each child (Venetsanou, 2010). Finally, the level of involvement of the current participants in physical activity or sport structured programs during post-school time is not considered. Therefore, further studies need to support the assessment of level of proficiency in gross-motor skills by integrating the aforementioned contextual information.

In conclusion, the findings of this study seem to identify almost two factors which affected the development of motor-gross skill in the sampled participants. Identifying the fall in FMSs level across school years and the differences between boys and girls are relevant information for developing adequate and valid strategies for targeting separately group of children (i.e., according to year group or gender) to increase mastery in FMSs. In this respect, the role of school and family and their collaboration are essential for increasing the children's possibility of practicing physical activity and sport. Indeed, if the children will be supported and encouraged to practice physical education courses and sport activities, they will improve their level of proficiency in gross-motor skills and will be oriented toward a right lifestyle.

Acknowledgments

The authors would like to thank the following colleagues for their support during the assessment sessions: Salvatore Brunelli, Corinne Calvagna, Roberto Coppola, Giovannni Occhipinti, Giorgia Parisi, Vittoria Patania, Marco Tuttolomondo.

References

Armstrong, N., & Welsman, J. R. (2006). The physical activity patterns of European youth with reference to methods of assessment. *Sports Medicine*, *36*(12), 1067-1086.

Barnett, L. M., van Beurden, E., Morgan, P. J., Brooks, L. O., & Beard, J. R. (2010). Gender differences in motor skill proficiency from childhood to adolescence: A longitudinal study. *Research Quarterly for Exercise and Sport*, *81*(2), 162–170.

Bryant, E. S., Duncan, M. J., & Birch, S. L. (2014). Fundamental movement skills and weight status in British primary school children. *European journal of sport science*, *14*(7), 730-736.

Cohen, J. (1988). Statistical power analysis for the behavioral sciences . Hilsdale. *NJ: Lawrence Earlbaum Associates*, *2*.

Cole, T. J., Bellizzi, M. C., Flegal, K. M., & Dietz, W. H. (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. *Bmj*, *320*(7244), 1240.

Gabbard, C. P. (2011). *Lifelong motor development (6th ed.)*. San Francisco, CA: Benjamin Cummings.

Gallahue, D., Ozmun, J.C., & Goodway, J. (2011). Understanding motor development: Infants, children, adults. New York, NY: McGraw-Hill.

Hardy, L.L., King, L., Farrell, L., Macniven, R., & Howlett, S. (2010). Fundamental movement skills among Australian preschool children. *Journal of Science and Medicine in Sport*, *13*, 503–508.

Hardy, L. L., Reinten-Reynolds, T., Espinel, P., Zask, A., & Okely, A. D. (2012). Prevalence and correlates of low fundamental movement skill competency in children. *Pediatrics*, *130*(2), e390–e398.

Jiménez-Díaz, J., Salazar-Rojas, W., & Morera, M. (2015). Age and gender differences in fundamental motor skills. *PENSAR EN MOVIMIENTO: Revista de Ciencias del Ejercicio y la Salud*, *13*(2).

Logan, S.W., Robinson, L.E., Wilson, A.E., & Lucas, W.A. (2011). Getting the fundamentals of movement: A meta-analysis of the effectiveness of motor skill interventions in children. *Child: Care, Health and Development*, *38*, 305–315.

Lorson, K. M., Stodden, D. F., Langendorfer, S. J., & Goodway, J. D. (2013). Age and gender differences in adolescent and adult overarm throwing. Research Quarterly for Exercise and Sport, *84*(2), 239–244.

Malina, R. M., Bouchard, C., & Bar-Or, O. (2004). *Growth, maturation and physical activity* (2nd ed.). Champaign, IL: Human Kinetics.

Mathisen, G. E. (2016). Motor competence and implications in primary school. *Journal of Physical Education and Sport*, *16*(1), 206.

Morgan, P. J., Barnett, L. M., Cliff, D. P., Okely, A. D., Scott, H. A., Cohen, K. E., & Lubans, D. R. (2013). Fundamental movement skill intervention in youth: A systematic review and meta-analysis. *Pediatrics*, *132*, e1361–e1382.

Niemeijer, A.S., & Smits-Engelsman, B.C.M. (2007). Neuromotor task training for children with developmental coordination disorder: A controlled trial. *Developmental Medicine and Child Neurology*, *49*, 406–411.

Niemeijer, A.S., Schoemaker, M.M., & Smits-Engelsman, C.M. (2006). Are teaching principles associated with motor performance in children with developmental coordination disorder? A pilot study. Physical Therapy, *86*, 1221–1230

Okely, A. D., & Booth, M. L. (2004). Mastery of fundamental movement skills among children in New South Wales: prevalence and sociodemographic distribution. *Journal of science and medicine in sport*, *7*(3), 358-372.

Payne, V. G., & Isaacs, L. D. (2017). *Human motor development: A lifespan approach*. Routledge.

Reichert, F.F., Barros, A.J.D., Domingues, M.R., & Hallal, P.C. (2007). The role of perceived personal barriers to engagement in leisure-time physical activity. *American Journal of Public Health*, *97*, 515–519.

Rosenberg, S.A., Zhang, D., & Robinson, C.C. (2008). Prevalence of developmental delays and participation in early intervention services for young children. *Pediatrics*, *121*, e1503–e1509.

Sgrò, F., Nicolosi, S., Schembri, R., Pavone, M., & Lipoma, M. (2015). Assessing vertical jump developmental levels in childhood using a low-cost motion capture approach. *Perceptual and motor skills*, *120*(2), 642-658.

Sgro, F., Quinto, A., Pignato, S., & Lipoma, M. (2016). Comparison of product and process oriented model accuracy for assessing countermovement vertical jump motor proficiency in pre-adolescents. *Journal of Physical Education and Sport*, *16*(3), 921-926.

Sgrò, F., Mango, P., Pignato, S., Schembri, R., Licari, D., & Lipoma, M. (2017). Assessing Standing Long Jump Developmental Levels Using an Inertial Measurement Unit. *Perceptual and Motor Skills*, *124*(1), 21-38.

Silva, P., Gomes, P.B., & Goellner, S.V. (2008). Gender relations in physical education's classes – students' perceptions. *Revista Portuguesa Cienncias do Desporto*, *8*(3), 396 –405

Valentini, N. C., Logan, S. W., Spessato, B. C., de Souza, M. S., Pereira, K. G., & Rudisill, M. E. (2016). Fundamental Motor Skills Across Childhood: Age, Sex, and Competence Outcomes of Brazilian Children. *Journal of Motor Learning and Development*, *4*(1), 16-36.

Thelen, E., & Ulrich, B. D. (1991). Hidden Skills: A Dynamic Systems Analysis of Treadmill Stepping during the First Year. *Monographs of the Society for Research in Child Development*, *56*(1), 1-98.

Valentini, N., & Rudisill, M. E. (2004). Motivational climate, motor-skill development, and perceived competence: Two studies of developmentally delayed kindergarten children. *Journal of Teaching in Physical Education*, *23*(3), 216–234.

Valentini, N. C., Logan, S. W., Spessato, B. C., de Souza, M. S., Pereira, K. G., & Rudisill, M. E. (2016). Fundamental Motor Skills Across Childhood: Age, Sex, and Competence Outcomes of Brazilian Children. *Journal of Motor Learning and Development*, *4*(1), 16-36.

Vandaele, B., Cools, W., de Decker, S., & de Martelaer, K. (2011). Mastery of fundamental movement skills among 6-year-old Flemish pre-school children. *European Physical Education Review*, *17*(1), 3-17.

Venetsanou, F., & Kambas, A. (2010). Environmental factors affecting preschoolers' motor development. *Early Childhood Education Journal*, *37*(4), 319-327.