Proceeding
Supplementary Issue: Spring Conferences of Sports Science. Costa Blanca Sports Science Events, 19-20 June 2020. Alicante, Spain.

Neuromuscular adaptations to a motor skills training program for adults with intellectual disabilities

VINCENZO LATORELLA ✉, FELICE DI DOMENICO, GAETANO ALTAVILLA

Department of Human, Philosophical and Educational Sciences, University of Salerno, Italy

ABSTRACT

The purpose of this study is to demonstrate the relationship between an injury reduction program and the improvement of stability and muscle strength in adults with intellectual disabilities because, so far, the impact of strength training has been little studied in people with intellectual disabilities. Specifically, a sample of 16 people (aged between 20 and 40) divided randomly into 2 groups: A experimental with specific protocol and control B with traditional program. The training period lasted 3 months with 3 sessions per week. Tests were administered before the start of the program and after 3 months to assess stability and physical fitness. Physical fitness tests assessed the functional aspects of muscle strength and endurance, as well as flexibility. In order to identify the factors associated with the participation of physical activity among active subjects, staff and assisted placement organizations were asked to identify the people they believed to be physically active. The results indicated differences in performance between the two groups. Group A presented better strength in the lower limbs and increased mobility with the use of Pearson's correlation statistical tool and Student's t test. Therefore, the null hypothesis is confirmed.
Keywords: Performance; Stability training; Intellectual disability; Injury prevention.

Cite this article as:
Latorella, V., Di Domenico, F., & Altavilla, G. (2020). Neuromuscular adaptations to a motor skills training program for adults with intellectual disabilities. *Journal of Human Sport and Exercise, 15*(3proc), S676-S687. doi:https://doi.org/10.14198/jhse.2020.15.Proc3.20

✉ **Corresponding author.** Department of Human, Philosophical and Educational Sciences, University of Salerno, Italy.
E-mail: v.latorella@studenti.unisa.it
Supplementary Issue: Spring Conferences of Sports Science. Costa Blanca Sports Science Events, 19-20 June 2020. Alicante, Spain.
JOURNAL OF HUMAN SPORT & EXERCISE ISSN 1988-5202

doi:10.14198/jhse.2020.15.Proc3.20

INTRODUCTION

The present study relates the effect of an injury reduction program to improve body stability, as well as in soccer training (Izzo et al, 2020ab, Izzo et al, 2019ab) and physical fitness for adults with intellectual disabilities in order to training teacher on physical activity (D'Elia, 2020). Adults with intellectual disabilities suffer a higher incidence of injury than the general population (Gaetano, 2012). In fact, recent research evidence shows that people with intellectual disabilities (ID) have double risk of involuntary injury of the general population and the risk is further increased in presence of psychopathology and epilepsy. The type of injury and the circumstances surrounding an injury event in people with intellectual disabilities have some resemblance to that of young children in the general population. Adults with intellectual disabilities often have greater postural influence and delay in motor development. Muscle weakness and hypotonia, especially in the lower limbs, are theoretically compromised by their general physical health and ability to perform daily activities (Sannicandro et al, 2017, 2016, 2015ab, 2014, 2012ab). Postural dysfunctions are the most common problems found in people with intellectual disabilities and associated with impaired proprioception, motor impairment and coordination, sensory-motor integration problems, and reduced reaction time for early postural adjustments (Sgrò et al, 2018, 2017ab, 2016, 2015). Although teenagers have postural control strategies similar to teenagers without ID, they can demonstrate precarious balance and show quantitative differences in the integration of sensory input to control position (Invernizzi et al, 2020, 2014ab, 2008). People with intellectual disabilities have a reduction in the muscle strength of the hip abductors and knee extenders compared to people without intellectual disabilities. Scientific evidence has verified the presence of a reduced quadriceps force whit respect to the comparison and generally the body image (D'Isanto, 2020, 2019, D'Isanto et al., 2019, D'Isanto, 2016), also stability have the incidence. They also said that teenagers with ID did not demonstrate the physiological increase in muscle strength that typically occurs with development within 14 years. Scientific evidence has verified the presence of a reduced quadriceps force whit respect to the comparison. They also said that teenagers with ID did not demonstrate the physiological increase in muscle strength that typically occurs with development within 14 years.

Scientific evidence also showed that the improvement in performance is also due to training based on injury reduction programs, however no study has evaluated the effect of this program on adults with intellectual disabilities. Many environmental injury prevention strategies for children in the general population are applicable to the population with intellectual disabilities, some may require design changes to ensure effectiveness. Other promising approaches include improved information for parents / guardians, primary medical advice and home visits from well-informed and motivated professionists. There may be benefits in preventing injuries from better management of psychopathology and epilepsy.

The objective of this study is to investigate the relationship between an injury reduction program and the improvement of muscle stability and strength in adults with intellectual disabilities (ID), bearing in mind that the study is carried out depending on factors associated with the degree of participation in physical activity among subjects detected by the staff of the structure. To verify the degree of activity, data were collected through in-depth interviews to explore the environmental and social supports and in addition the participants had to meet the inclusion criterion which included reaching 10,000 steps per day, taken on the pedometer for 7 days.

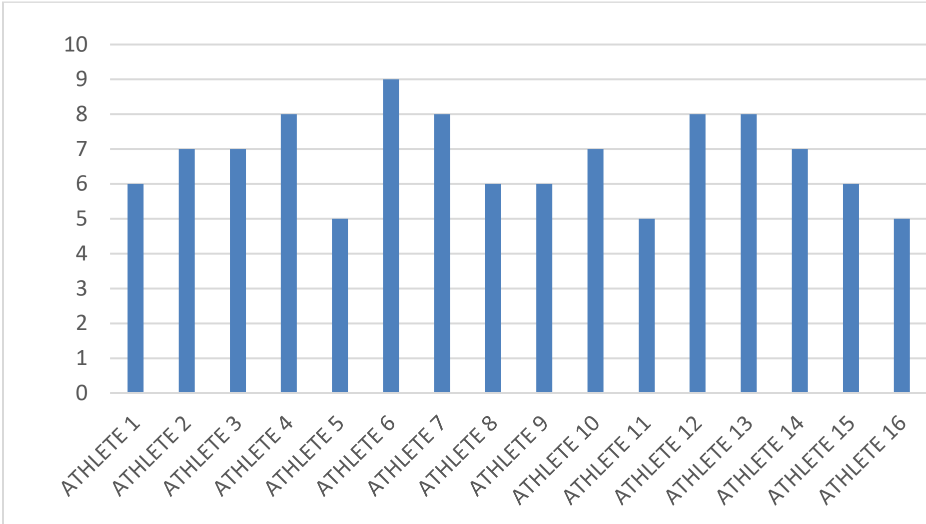

Figure 1. In this tab there are values about the degree of participation. The obtained value is 6.75, which is very significant for participation. (*Own source*).

METHODOLOGY

Sixteen people (aged 20 to 40) were randomly assigned to a group A experimental or group B control. During the training period, which lasted 3 months with 3 sessions per week, the experimental group. A carried out a series of structured exercises on the management of their body weight on all levels of movement(Mackenzie, B. (2005). The focus therefore turned mainly to the stability and mobility of the joints, starting from postures from the kneeling position to even extended up to move toward the reference position as the final goal. The control group B, on the other hand, always carried out postural gymnastics exercises, which however did not include the part of breathing and the myofascial release with the foam roller, performed with different volume and intensity. It must be remembered that muscle in its genetic memory has the only ability to contract, not that of self-stretching, except by an antagonist muscle. For this reason, muscle has a natural tendency to become "Retracted". An altered posture is the victim and the cause of persistent muscle tension. Persistent tensions will result in "Retractions". A muscle is structured in a "short" position because the connective tissue tends to "fix" and "cement" the sarcomeres in a progressively more closed position. "Whenever we stretch a muscle or a single muscle district without taking into account the interaction of the muscle chains, we will inevitably cause a shortening in other districts, creating compensation or one of the expressions of body intelligence with the aim of escaping tensions, discomforts and pain. " (Myers, 2012).

Training program

1. Breathing exercises.
(diaphragmatic and paradoxical breathing, thus also mechanically activating the pelvic diaphragm). The focus of my action turned to the concentric action of the expiratory and eccentric of the inspiratory.

As Souchard states "sectoral and combined self-postures can be practiced by everyone without any restrictions, at any age, even advanced".

2. Foam rolling to mobilize soft tissues.
Release:
Of the arch.
Of the long peroneal (in all its course).

Of gastrocnemes.
Of the adductor compartment.
Buttocks and hip rotators.
TFL and middle gluteus.
Coracoid process.
Rotator cuff.
Large breastplate.

3. Stretching and mobility exercises and stability and muscle strengthening exercises:
Opening of the superficial front line.
Openings of the posterior superficial line.
Lateral line opening.
Differentiation of the frontal, superficial and deep lines.
Differentiation of all arm lines.

Tests were administered, validated in literature, before the start of the program and after 3 months to assess stability and physical fitness. Physical fitness tests assessed the functional aspects of muscle strength and endurance, as well as flexibility. The tests used are:

Chair rising test

The purpose of the chair lift test is to examine the muscle strength and endurance of the lower limbs. In this test, the participant is asked to sit on a chair, feet flat on the floor and place his hands on the opposite shoulder with his arms crossed at his wrists (arms against his chest). After listening to the command, the participant gets up in an upright position and then sits down again. The number of times it increases in 60 s (Centers for Disease Control, 2013) is recorded.

Standing long jump test

The objective of this test is to monitor the power and explosive strength of the participant's lower limbs. In this test, participants are asked to place their feet on the edge of a sandbox. The participant crouches, leans forward, swings his arms backwards and then jumps horizontally as much as possible, landing in the sandbox with both feet. The distance from the edge of the sandbox to the closest contact point is recorded. The jump start must be from a static position. This test has previously been used among people with intellectual disabilities (Yanardag, et al 2013).

Sit-up test

The purpose of the sit-up test is to monitor the participant's development of abdominal muscle strength and endurance. In this test, participants are asked to lie down on a mat, with their knees bent and their feet flat on the floor and their arms crossed on their chests. Each sit-up starts with your back on the floor. The participant then rises until the elbows touch the knees, then returns to the lying position and continues to perform as many sit-ups as possible in 30 seconds. The feet can be held by a partner. The number of sit-ups completed in 30 seconds is recorded.

Mobility

Mobility was assessed using Timed Up and Go (TUG). This is a simple and widely used measure of clinical outcome of lower limb function, fall risk and mobility (Podsiadlo & Richardson, 1991). In this test, participants are asked to get up from a standard chair, walk at a distance of three meters at a comfortable pace, turn, go back to the chair and sit down. Participants are asked not to use their arms to help them get up. The time to complete the test is measured with a stopwatch (Vereeck et al 2008). The activity is performed twice and the average value is used. The test was reliable for people with intellectual disabilities (Carmeli et al 2004). The administration of the tests took place before the start of the program and after 3 months to assess the stability and physical fitness. All subjects were informed of the study procedures and consent was given. To determine the changes due to training and to check if the difference between the two groups was significant, I used Pearson's correlation index and Student's t test.

DISCUSSION

The tables show the results obtained by comparing the data collected by both groups:

Chairing test

Table 1. Significant difference between group A and B ($p < .05$) and average growth during the training period in the chairing test. (*Own source*).

	Variable 1	***Variable 2***
Average	16.875	14.375
Variance	4.125	4.267857143
Observation	8	8
Pearson correlation	0.693717522	
Difference hypothesized for averages	0	
DoF	7	
Stat t	4.409585518	
p(T<=t) one line	0.001560192	
t critic one line	1.894578605	
p(T<=t) two line	0.003120383	
t critic two line	2.364624252	

Sit up test

Table 2. Significant difference between group A and B ($p <0.05$), and average growth during the training period in the sit up test. (*Own source*).

	Variable 1	***Variable 2***
Average	8.875	7.25
Variance	6.125	2.785714286
Observation	8	8
Pearson correlation	0.97701016	
Difference hypothesized for averages	0	
DoF	7	
Stat t	5.016992402	
P(T<=t) one line	0.000767817	
t critic one line	1.894578605	
P(T<=t) two line	0.001535635	

Standing long jump test

Table 3. Significant difference between group A and B (p <0.05), and average growth during the training period in the standing long jump test. (*Own source*).

	Variable 1	***Variable 2***
Average	0.682125	0.590125
Variance	0.009955268	0.013519839
Observation	8	8
Pearson correlation	0.921361194	
Difference hypothesized for averages	0	
DoF	7	
Stat t	5.682617169	
p(T<=t) one line	0.000374349	
t critic one line	1.894578605	
p(T<=t) two line	0.000748698	
t critic two line	2.364624252	

Time up and go test (TUG)

Table 4. Significant difference between group A and B (p <0.05), and average growth during the training period in the time up and go test. (*Own source*).

	Variable 1	***Variable 2***
Average	0.00014265	0.000152199
Variance	9.44412E-11	1.30515E-10
Observation	8	8
Pearson correlation	0.984238485	
Difference hypothesized for averages	0	
DoF	7	
Stat t	-10.66658893	
p(T<=t) one line	6.97985E-06	
t critic one line	1.894578605	
p(T<=t) two line	1.39597E-05	
t critic two line	2.364624252	

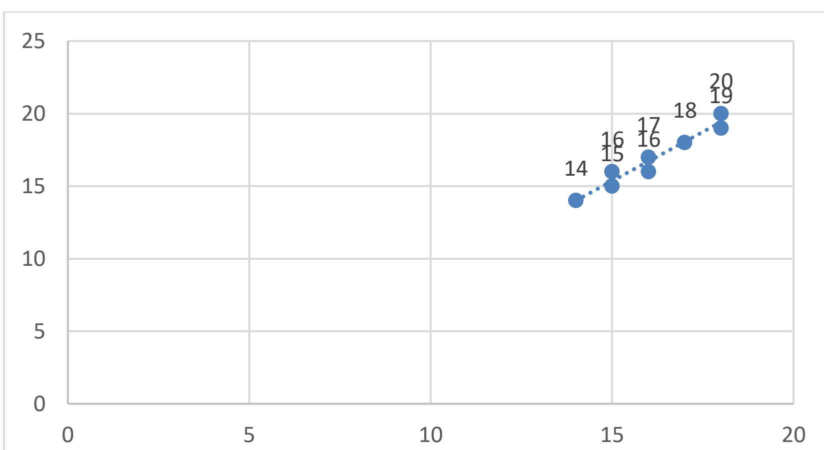

Figure 2. Results of the chair ascent test. (*Own source*).

The purpose of this test is to examine muscle strength and endurance of the lower limbs. This graph shows the improvement in the average of the repetitions. Group A has passed from an average of 16.125 detected by the data before the administration of the program to an average of 16.875 detected by the administration of the test after three months.

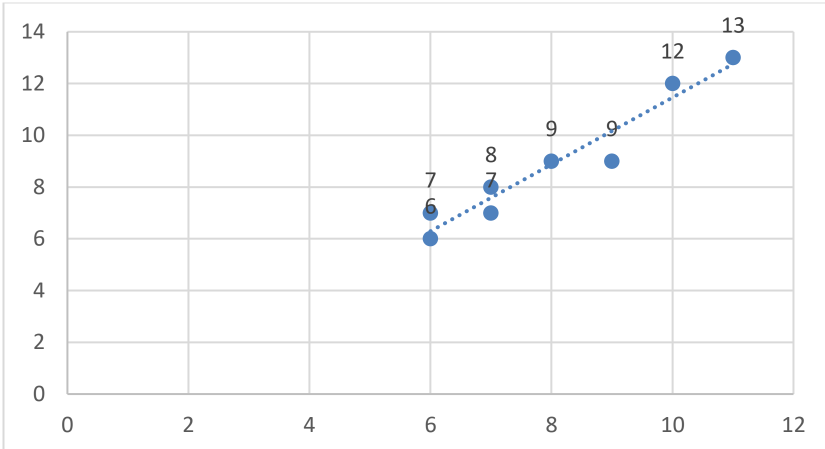

Figure 3. Results of the sit up test. (*Own source*).

This further graph I analysed shows the positive results that I detected through the sit up test in order to measure mobility. Here too we can see that five out of eight people have increased their parameters. We went from an average of 8 repetitions to an average of 8.875 detected by the administration of the test after three months.

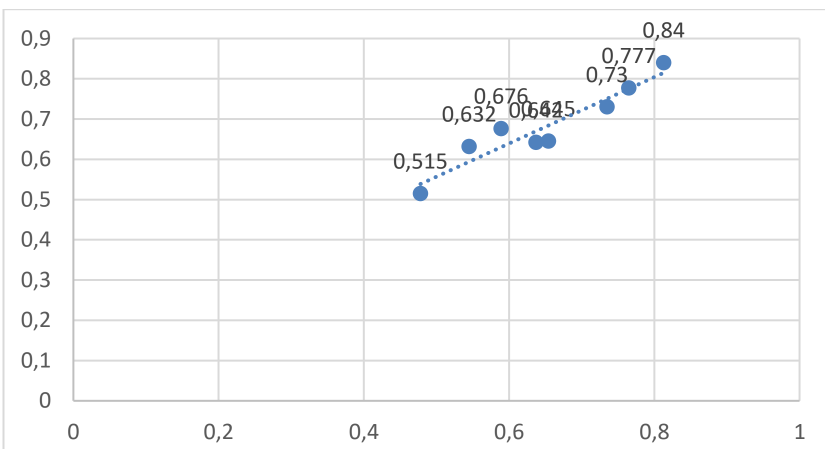

Figure 4. Standing Long Jump test results. (*Own source*).

Through monitoring of the power and explosive strength of the participants' lower limbs, improvements were noted which indicated significant differences.

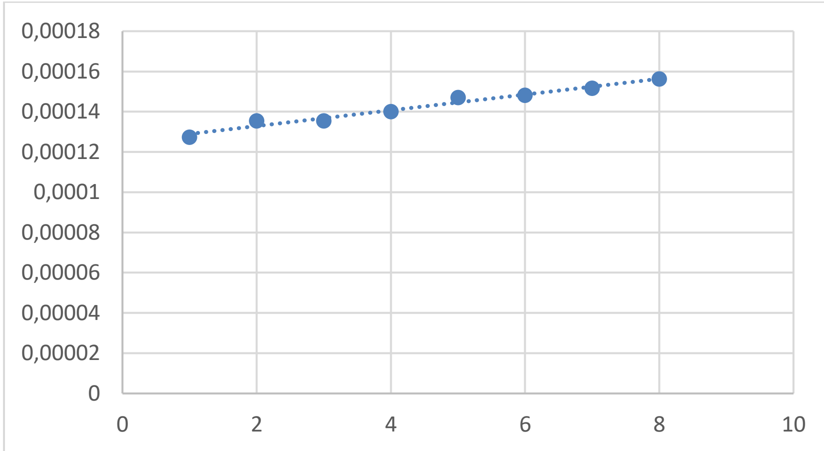

Figure 5. Tug test results. (*Own source*).

The TUG was used as a tool to predict falls. People with intellectual disabilities constitute a population with special needs at high risk of falling (Van Hanegem, Enkelaar, Smulders and Weerdesteyn, 2014) and from my analysis the program did not lead to a significant reduction in the time needed to complete the TUG.

The main results of this study showed that group A presented better capacity in most results. The results indicated significant differences in the chair rising test, the sit up test and the standing long jump test. The level of significance (p <5) of three tests out of four confirmed my initial hypotheses, while the increase recorded in the last test was not significant.

From the data in Table 4 we can see that five out of eight people have increased their strength in the lower limbs. We have gone from an average of 16.125 detected by the data before the administration of the program to an average of 1675 detected by the administration of the test after three months

Figure 2 shows the positive results detected through the sit up test in order to measure mobility. Here too we can see that five out of eight people have increased their parameters. We went from an average of 8 repetitions to an average of 8.875 detected by the administration of the test after three months. In this study, the level of mobility was established using the TUG. The TUG can also be used as a tool to predict falls. People with intellectual disabilities constitute a population with special needs at high risk of falling and the program did not lead to a significant reduction in the time needed to complete the TUG. The ineffectiveness of a program in improving mobility may be due to the following: (a) training intensity - the program consists of a training session / week, which may not provide adequate stimulus for physiological changes to occur; (b) training objectives - the program did not specifically focus on improving mobility and balance of the lower limbs. Despite compared to the typical developing population, people with intellectual disabilities have been reported to exhibit low levels of physical fitness, our program has shown significant improvements in body stability and lower limb power.

CONCLUSIONS

Some limitations of the study must be recognized. The limitations observed by the measurements are associated with the test protocols used in the study analysis:

a) the sample size could be considered small. Nevertheless, the homogeneity of the sample was checked by checking physical activity outside the study program. In fact, the subjects live in the same social environment, with the same possibilities and interests. No routine changes were recorded during the study period.
b) Lack of a longitudinal approach, as no replicative measurements were performed at different times and by not making a division based on the degree of participation.
c) Lack of tests performed under conditions of physical effort. The tests used in the study were performed in a resting state, for example the participants performed when they felt ready according to the test protocols. It has in fact been shown that fatigue can affect certain mechanisms since they operate from the entry to the exit of information.

So far, the impact of strength training has not been thoroughly studied in people with intellectual disabilities. It had been speculated that, despite the low training volume, positive effects would be revealed in the first group of disabilities. However, different trends were observed regarding each group's progress in skills and mobility. The improvement of motor skills requires a combination of various components of physical fitness, such as strength of the lower limbs, cardiovascular resistance, balance, coordination and motor control. Since in the present study the second group of intellectual disabilities did not present significant changes in the strength or balance of the lower limbs it is reasonable to assume that the improvement in motor skills may have been mediated by other changes related to training that were not measured in this study, such as cardiovascular endurance or neuromuscular coordination.

These activities also allowed the participants to keep their mind trained, especially memory (remembering what is allowed to be done and when it can be done) and reasoning.

In addition to improving motor skills and abilities, the activities carried out have improved these contents:
1. expressiveness and centrality of the body and movement in the training process.
2. development and enhancement of the various dimensions of the individual's personality.
3. development of a motor and expressive heritage that will lead to the goals for the development of skills.
4. development of security and self-esteem.
5. building a greater awareness of one's own body's potential and limitations.

The laboratory activities favoured the development of balance in the regulation of the tonic function and of connection with the cognitive and emotional dimension.

The results indicated differences in baseline performance and impact on training between the two groups. This should be taken into consideration when developing training programs for people with intellectual disabilities. Based on these results, together with the fact that these activities require only simple equipment and that it is a pleasant group activity - potentially with additional psychosocial effects, it can be suggested that an injury reduction program may be recommended for people. with intellectual disability. However, it is important to work separately with each group of disabilities, as they have different motor skills and fitness levels and may require the use of different motor and motor learning strategies.

We have recommendations for coaches of athletes with intellectual disabilities:
a) Programs should be planned for the athlete according to his condition, physical and physiological characteristics. Although important information may have been found on training programs for

athletes with intellectual disabilities, it is suggested that more emphasis be placed on different motor and learning strategies.

b) A careful selection of the tests and tests administered should be made. As already reported, there is a wide range of tests that are able to confirm physical and physiological abilities in adults with intellectual disabilities. For this reason, it is recommended to select the most suitable test.

We propose that future research focus on time-movement analyses, physiological needs during performance and the effects of performance fatigue over a longer period.

REFERENCES

Carmeli, E., Kessel, S., Bar-Chad, S., & Merrick, J. (2004). A comparison between older persons with down syndrome and a control group: clinical characteristics, functional status and sensorimotor function. Down's syndrome, research and practice : the journal of the Sarah Duffen Centre, 9(1), 17–24.

Centers for Disease Control and Prevention (2013). The chair stand test. Retrieved from http://www.cdc.gov/steadi/pdf/30_second_chair_stand_test-a.pdf

D'Elia, F. Teachers' perspectives about contents and learning aim of physical education in Italian primary school (2020) Journal of Human Sport and Exercise, 15 (Proc2), pp. S279-S288. https://doi.org/10.14198/jhse.2020.15.proc2.19

D'isanto, T. (2020) Sports skills in sitting volleyball between disabled and non-disabled people Journal of Physical Education and Sport, 20 (3), art. no. 194, pp. 1408-1414.

D'Isanto, T. (2016). Pedagogical value of the body and physical activity in childhood, Sport Science, 9, 13-18.

D'Isanto, T., D'Elia, F., Raiola, G., Altavilla, G. (2019) Assessment of sport performance: Theoretical aspects and practical indications, Sport Mont, 17 (1), pp. 79-82.

Gaetano, R. (2012) Motor learning and didactics into physical education and sport documents in middle school-first cycle of education in Italy, Journal of Physical Education and Sport, 12 (2), pp. 157-163.

Invernizzi, P.L., Signorini, G., Bosio, A., Raiola, G., Scurati, R. (2020) Validity and reliability of self-perception-based submaximal fitness tests in young adult females: An educational perspective Sustainability, 12 (6). https://doi.org/10.3390/su12062265

Invernizzi, P.L., Limonta, E., Bosio, A., Scurati, R., Veicsteinas, A., Esposito, F. (2014a) Effects of a 25-km trial on psychological, physiological and stroke characteristics of short- And mid-distance swimmers Journal of Sports Medicine and Physical Fitness, 54 (1), pp. 53-62.

Invernizzi, P.L., Longo, S., Scurati, R., Maggioni, M.A., Michielon, G., Bosio, A. (2014b) Interpretation and perception of slow, moderate, and fast swimming paces in distance and sprint swimmers Perceptual and Motor Skills, 118 (3), pp. 833-849. https://doi.org/10.2466/27.29.pms.118k23w0

Invernizzi, P.L., Longo, S., Scurati, R. (2008) Analysis of heart rate and lactate concentrations during coordinative tasks: Pilot study in karate kata world champions Sport Sciences for Health, 3 (1-2), pp. 41-46. https://doi.org/10.1007/s11332-008-0053-7

Izzo, R., Raiola, G., D'isanto, T., Cejudo, A., Giovanelli, G.M. (2020a) Modelling an adequate profile for a more targeted work methodology, with dedicated technologies, for elite-level footballers: Comparison between sub 17 vs sub 19, highlights and shadows, Sport Science, 13 (1), pp. 36-42.

Izzo, R., D'isanto, T., Raiola, G., Cejudo, A., Ponsano, N., Varde'i, C.H. (2020b) The role of fatigue in football matches, performance model analysis and evaluation during quarters using live global positioning system technology at 50hz, Sport Science, 13 (1), pp. 30-35.

Izzo, R., Giovannelli, M., Raiola, G. (2019a) Training load in elite goalkeepers with k-track for monitoring performance, Journal of Physical Education and Sport, 19, art. no. 280, pp. 1890-1896.

Izzo, R., Giovannelli, M., D'isanto, T. (2019b) The injury prevention program WTA functional primitive movement in professional football players: A case study Journal of Physical Education and Sport, 19, art. no. 279, pp. 1885-1889.

Myers T. (2012) Tensegrity continuum. Massage magazine. The anatomy trains.

Sannicandro, I. (2017) Effects of strength and core stability training versus strength and aerobic training in subjects aged over 65 [Article@Effetti dell'allenamento di forza e core stability versus allenamento di forza e aerobico a intensità controllata in soggetti over 65] Medicina dello Sport, 70 (4), pp. 410-418.

Sannicandro, I., Cofano, G., Rosa, A.R. (2016) Heart rate response comparison of young soccer plyers in “cage” small-sided and 8vs8 games Journal of Physical Education and Sport, 16 (4), art. no. 180, pp. 1122-1127.

Sannicandro, I., Spedicato, M., Palaia, G., Cofano, G., Bisciotti, G.N., Eirale, C. (2015a) Strength ability, endurance and anthropometric parameters in youth football: Descriptive analysis and functional relationships [Article@Capacità di forza, endurance e parametri antropometrici nel calcio giovanile: Analisi descrittiva e rapporti funzionali] Medicina dello Sport, 68 (1), pp. 19-30.

Sannicandro (2015b) Descriptive analysis and functional relationships Medicina dello Sport, 68 (1), pp. 19-30.

Sannicandro, I., Piccinino, A., Cofano, G., Eirale, C., Biscotti, G.N. (2014) Effects of plyometric training on phases of jumping in young fencers [Article@Effetti dell'allenamento pliometrico sulle fasi del salto in giovani schermidori] Medicina dello Sport, 67 (1), pp. 27-45.

Sannicandro, I., Piccinno, A., Cofano, G., De Pascalis, S., Rosa, A.R. (2012a) Analysis of some variable performances of under 12 tennis players, Medicina dello Sport, 65 (4), pp. 473-484.

Sannicandro, I., Rosa, R.A., De Pascalis, S., Piccinno, A. (2012b) The determination of functional asymmetries in the lower limbs of young soccer players using the countermovement jump. The lower limbs asymmetry of young soccer players Science and Sports, 27 (6), pp. 375-377. https://doi.org/10.1016/j.scispo.2011.11.001

Sgrò, F., Pignato, S., Lipoma, M. (2018) Assessing the impact of gender and sport practice on students ‘performance required in team games Journal of Physical Education and Sport, 18, art. no. 71, pp. 497-502.

Sgrò, F., Quinto, A., Messana, L., Pignato, S., Lipoma, M. (2017a) Assessment of gross motor developmental level in italian primary school children Journal of Physical Education and Sport, 17 (3), art. no. 192, pp. 1954-1959.

Sgrò, F., Mango, P., Pignato, S., Schembri, R., Licari, D., Lipoma, M. (2017b) Assessing Standing Long Jump Developmental Levels Using an Inertial Measurement Unit Perceptual and Motor Skills, 124 (1), pp. 21-38. https://doi.org/10.1177/0031512516682649

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), art. no. 145, pp. 921-926.

Sgrò, F., Licari, D., Coppola, R., Lipoma, M. (2015) Assessment of balance abilities in elderly people by means of a clinical test and a low-cost force plate Kinesiology, 47 (1), pp. 33-43.

Vereeck, L., Wuyts, F., Truijen, S., & Van de Heyning, P. (2008). Clinical assessment of balance: Normative data, and gender and age effects. International Journal ofAudiology. https://doi.org/10.1080/14992020701689688

Yanardag, M., Arikan, H., Yilmaz, L., & Konukman, F. (2013). Physical fitness levels of young adults with and without intellectual disability. Kinesiology.

