

# Effects of invasion games on physical fitness in primary school children

Irena Valantine<sup>1</sup>✉ · Dejan Madic<sup>2</sup> · Goran Sporis<sup>3</sup>

© The Author(s) 2017. This article is published with open access.

## Abstract

Studies concerning the effects of different invasion games on physical fitness in school children are scarce. Consequently, the purpose of this study was to examine the effects of the application of invasion games on physical fitness in primary school children. A total of 62 primary school children aged 10-12 years voluntarily participated in this study. They were divided into experimental (32) and control (30) group. Physical fitness of children was estimated by the following tests: Standing broad jump, Vertical jump, Bent-arm hang, Sit-ups, Push-ups, Medicine ball test and Andersen test. The experimental group had twice per week invasion games on non-consecutive days for 12 weeks. Participants in control group did not perform specific program but attended their regular PE class twice per week. Compared with initial measurement, there was a significant ( $p < 0.05$ ) improvement in vertical jump test for both groups. Furthermore, the group that participated in the invasion games program made significantly greater gains compared to the control group ( $p < 0.05$ ) in Standing broad jump (8.2%; ES=0.56 vs. 3%; ES=0.2) and Medicine ball test (8.2%; ES=0.6 vs. 3%; ES=0.3). There was a significant improvement

in bent arm hang, sit ups and push-ups in experimental group. Compared with initial measurement, there was a significant ( $p < 0.05$ ) improvement in Andersen test in invasion games group, which was not the case with control group ( $p > 0.05$ ). To conclude, invasion games were an effective way of improving physical fitness in primary school children, because the results of this study indicate that this method was more effective for physical fitness than traditional school program.

**Keywords** invasion games · teaching · effects · children

## Introduction

Physical fitness during childhood has been identified as a strong predictor of current and future health status (Smith et al. 2014). However, the usual school day lasts more than five hours in most cases, and a great amount of this time is composed of sedentary activities. In addition to the hours spent in school, children in numerous countries spend almost half of each calendar year in school. Therefore, schools are responsible for a large amount of children's time and have the potential to provide children an opportunity to fulfil their daily physical activity needs (Janssen & Leblanc, 2010).

Invasion games are team games with purpose to invade the opponent's territory while scoring points and keeping the opposing team's points to a minimum, and all within a certain time period (Pearson & Webb, 2008). The teaching of invasion

---

✉ dekimadic@gmail.com

<sup>1</sup> Lithuanian Sports University, Department of Sport Management, Economics and Sociology, Kaunas, Lithuania

<sup>2</sup> University of Novi Sad, Faculty of Sport and Physical Education, Serbia

<sup>3</sup> University of Zagreb, Faculty of Kinesiology, Croatia

games has been the focus of discussion in recent teaching methods, such as Teaching Games for Understanding. This method suggests that students should discover the solution to tactical problems through inquiry learning because it provides the children with the opportunity to discover, explore, and build knowledge for deeper understanding. To create inquiry-learning opportunities, the modification of game play is vital. There are four ways that teachers can use to modify invasion games: court size, offense-defense ratio, rules and restrictions, and equipment (Griffin & Butler, 2005). It is broadly recognized that Sport Education model and Teaching Games for Understanding (TGfU) are one of crucial models in conceptual and methodological support for more effective and appealing learning environments in physical education classes (Kirk, 2005; Metzler, 2000). Although the TGfU approach share quite a few concepts in terms of objectives and pedagogy (Hastie & Curtner-Smith, 2006), it has paid more attention towards developing learners' abilities to play games, emphasizing the need to extend students' game appreciation and tactical awareness in order to play the games successfully (Metzler, 2000). Therefore, research on TGfU has centered almost exclusively on psychomotor and cognitive learning. Indeed, studies have shown that TGfU can improve both children's decision making and skill execution (Allison & Thorpe, 1997; Harrison et al., 2004; Turner & Martinek, 1999).

Model of Invasion Games is conceptually structured closely to TGfU, but it also resembles a goal of Sport Education, namely, to create authentic sport contexts (Musch et al., 2002). The invasion games are considered an innovative approach, since the specific nature and the importance of specialized teaching is considered (Belka, 2004). At the same time, the invasion games fill the gaps of the TGfU's standard procedures that do not differ according to the individual strategic features of each game, whether they are invasion games, net/wall games, target games or striking and fielding games. Therefore, the invasion games take into consideration the fact that learning tasks should be aligned with the situational demands related to the play of basic forms of invasion games.

Having in mind that team games have unique skills, novice players find it difficult to master it due to small amount of transfer from other sports, except for footwork. Therefore, children require a great deal of repetition before they are able to consistently execute the fundamental skills. Nevertheless, team

games are often taught to children with little opportunity for skill practice, no lead-up games, and with full-sided teams. The most important is that children may benefit from this fun and dynamic approach to learning the game of different sports. In addition to physical characteristics and technical skills in team sports, the tactics and decision making abilities are crucial in order to become a successful player (Broek, Boen, Claessens, Feys, & Ceux, 2011). However, the remaining challenge regarding the long term athlete development is the amount of time devoted to various skills (Chevrier, Roy, Turcotte, Culver, & Cybulski, 2016). Some studies have shown the effects of invasion games on improving students' game performance (skill execution efficiency and efficacy and decision making) in invasion games (Tallir, Lenoir, Valcke, & Musch, 2007), in particular for girls and low skill-level students (Ricardo & Graca, 2008). However, to the authors' knowledge there are no studies concerning the effects of different invasion games on physical fitness in school children. Consequently, the purpose of this study was to examine the impact of the invasion games on physical fitness in primary school children.

## Method

A total of 62 (28 girls) primary school children aged 10-12 years voluntarily participated in this study. They were divided into experimental (32) and control (30) group. Children's characteristics are presented in the Table 1. Prior to the enrolment in the study, parents reported their child's health history and current activity status through a questionnaire and only healthy children from 10 to 12 years old were chosen. All the children had two classes per week and were not involved in additional strenuous training during this study. Participants were excluded if they had a chronic pediatric disease or had an orthopedic condition that would limit their ability to perform exercise. Participants were excluded if they have missed two consecutive classes during study. The study was approved by the Research Ethics Committee of the Faculty of sport and physical education in Novi Sad, and written informed consent was gained from both parents and children.

Children's anthropometric characteristics and components of fitness were measured early in the morning, at least 12 h fasted and 24 h from the last high-intensity exercise effort. Measurements were taken in Early-October (a month after the beginning of the school year) and in late December.

**Table 1.** Basic anthropometric characteristics of the study participants; values are mean±SD

	Experimental group (N=32)	Control group (N=30)
Age (y)	11.2±1.01	11.4±1.2
Body height (cm)	152.75±7.78	151.99±7.18
Body weight (kg)	46.16±11.50	48.06±12.78
BMI(kg/m <sup>2</sup> )	16.39±3.46	16.87±4.84

All study procedures took place at a school athletic facility. The same instructors tested and trained the same participants and the fitness tests were performed in the same order with identical equipment, positioning, and technique. All participants took part in one introductory session during which time proper form and technique on each fitness test were reviewed and practiced. During this session, assistants demonstrated proper testing procedures and participants practiced each test. After the training program, the subjects were instructed to perform the tests in the same order as they did before the training program.

Participants were asked not to perform any vigorous physical activity the day before or the day of any study procedure. Basic anthropometric characteristics (Body weight and Body height) were measured, in accordance with the IBP program, on the day of the testing. Before each testing, the participants performed a standard 20-minute warm-up. Standard warm up protocol consisted of 10 min of warm up running and 10 min of dynamic stretching and 5 x 30m of running exercises.

Physical fitness of children was estimated by the following tests: Sit-ups, Bent-arm hang, Push-ups, Standing broad jump, Vertical jump, Medicine ball test and Andersen test. Most of the tests are briefly described in Bala, Krneta and Katic (2010).

*Sit-ups with crossed arms* - The subject lies on the back, knees bent, arms crossed on the chest, and performs sit-ups, feet being held fast by an assistant. The number of correctly executed sit-ups in 60 s is recorded.

*Bent-arm hang* - The subject grips the bar, fingers on top and thumb underneath, pulls up (chin above the bar) and holds the position as long as possible without resting the chin on the bar. Time is measured in 0.1-s units.

*Push-Ups* - The participant assumes a prone position on the floor with hands placed under or slightly wider than the shoulders, fingers stretched

out, legs straight and slightly apart, and toes tucked under. The subject pushes up off the floor with the arms until the elbows are straight while keeping the legs and back straight. The back should be kept in a straight line from head to toes throughout the test. Then, the participant lowers the body using the arms until the elbows bend at a 90 and the upper arms are parallel to the floor. This movement is repeated as many times as possible, finishing when the subject stops, when the subject does not perform the push up completely or when subject does not keep the right position. This test assesses upper-body muscular endurance (Castro-Piñero et al., 2009).

*Standing broad jump* - The subject jumps with both feet from the reversed side of Reuter's bounce board onto a carpet with scale. The jumping distance (in cm) is recorded from take-off line to the nearest point of contact on the landing (back of the heels). Result is the longest distance jumped, the best of three attempts.

*Vertical jump test* - corresponding to Sargent vertical jump test. The measurement of the standing reach height allowed for a calculation of the relative jump heights on each of the jumping tasks (absolute jump height (cm) – standing reach height (cm) = relative jump height) (Sheppard, Gabbett, & Reeberg-Stanganelli, 2009).

*Medicine Ball Test* - Upper-body explosive strength was estimated using backward overhead medicine ball throw. Medicine ball throws were performed using the 2-kg rubber medicine balls (Tigar, Pirot, Serbia). All subjects were introduced to the testing on familiarization session. The skin of the medicine ball was lightly dampened (magnesium carbonate) to leave an imprint on the floor where first contact was made and to ensure precise measurement of the throwing distance. The athlete holds a medicine ball with arms straight in front of the body and, following a countermovement, flexes at the hips and knees before extending forcefully backward to throw the ball over the head. Distance was measured from

the base of the bench to the closest edge of the medicine ball imprint.

*The Andersen test* - developed as proxy for maximal oxygen uptake. For this research only the covered distance was taken (L. B. Andersen, T. E. Andersen, E. Andersen, & Anderssen, 2008).

**Table 2.** PE class and Invasion games

PE class	Experimental program
- warm up	- warm up
- PE unit	- invasion games
- drills	- PE unit
- cool down	- cool down

The experimental group had twice per week invasion games on non-consecutive days for 12 weeks under monitored conditions. Coach specialist discussed and demonstrated proper invasion games procedures during one week, and children had an opportunity to ask questions. The duration of invasion games was recorded, with drills typically lasting 15-20 minutes. Besides these drills, usual physical education classes were performed. Each class consisted of a warm-up period (5 to 8 minutes), invasion games (10 to 15 min) and PE unit phase (15 to 20 minutes), following 5 minutes of cool down. During the warm-up period subjects performed a series of six to ten mobility exercises. During the invasion games phase, subjects performed a variety of games that progressed from simple to complex as their competence and confidence improved. The various exercises included invasion games from different team sport games (e.g. soccer, handball, basketball, rugby). Most exercises involved throwing and intensive running without the ball. Within each category, the exercises progress from the least challenging (e.g. Maintain Possession 1-Low Level) to the most challenging (e.g. Attack goal 4-High Level).

Participants in control group did not perform specific program but attended their regular PE class twice per week during the study period and participated in the same traditional PE activities under the guidance of a PE teacher.

Descriptive characteristics were calculated for all variables. Group differences before experiment were evaluated using independent sample t-tests. Normality assumptions for all data before and after treatments were checked respectively with Kolmogorov–Smirnov tests. A two-way repeated measure ANOVA (2×2) was used to test for interactions and main effects for time (initial vs. final) and group (experimental vs. control) on the dependent physical fitness variables. Post hoc follow-up tests consisted of t-tests (Otto, Coburn, Brown, & Spiering, 2012). Effect size (ES) was calculated for multiple comparisons to determine the magnitude of the pre–post changes. ES were classified as follows: <0.2 was defined as trivial, 0.2–0.6 was defined as small, 0.6–1.2 was defined as moderate, 1.2–2.0 was defined as large, and >2.0 was defined as very large (Hopkins, Marshall, Batterham, & Hanin, 2009). Statistical analyses were conducted in SPSS (SPSS, Version 18.0, Chicago; IL). Statistical significance of differences was established a priori at  $p < 0.05$  to test the hypothesis that experimental group would be more effective than control in improving physical fitness measures in children.

## Results

The Kolmogorov-Smirnov test has shown that data were normally distributed. Independent sample t test revealed no statistically significant differences between the groups for all variables prior to the program. The results for the vertical jump indicated no significant differences between groups following 12 weeks (Table 3). Furthermore, the group that participated in the invasion games program made significantly greater gains compared to the control group ( $p < 0.05$ ) in Standing broad jump (8.2%; ES=0.56 vs. 3%; ES=0.2) and Medicine ball test (8.2%; ES=0.6 vs. 3%; ES=0.3).

**Table 3.** Mean±SD results of different parameters: strength, jumping, throwing and running performance before the experimental period (initial) and after the 12-week experimental period (final)

Variable	Experimental group				Control group			
	Initial	Final	%	ES	Initial	Final	%	ES
Vertical jump (cm)	31.26± 4.25	37.14± 6.19*	18.8	1.1	32.88± 3.09	35.57± 4.08*	8.2	0.7
Standing broad jump (cm)	132.65± 19.68	143.56± 19.56*†	8.2	0.56	133.66± 18.44	137.70± 16.56	3	0.2
Medicine ball test (cm)	6.24± 0.79	6.75±0.89*†	8.2	0.6	6.34± 0.61	6.53±0.62	3	0.3
Bent arm hang (s)	35.03± 16.67	42.53±17.14*†	21.4	0.44	32.75±15.47	34.23±14.37	4.5	0.1
Push-ups (freq.)	12.90±2.40	17.03±3.17*	32	1.5	10.53±3.17	12.80±3.32*	21.6	0.7
Sit ups (n/60s)	27.00±5.26	31.13±6.05*	15.3	0.73	30.10±6.31	32.86±5.05	9.2	0.5
Andersen test (m)	860±90.8	927±105.3*†	7.8	0.68	865±69.5	904±105.0	4.5	0.43

The results for the Push-ups indicated no significant group by time interaction, but there was a significant main effect for time. The results for the Sit ups indicated no significant group by time interaction, but there was a significant main effect for time in experimental group. There was a significant 2-way interaction for bent arm hang. The results indicated that there were significant increases in Bent arm hang in experimental group (21.4%; ES=0.4) compared to control group (4.5%; ES=0.1). Compared with initial measurement, there was a significant improvement in Andersen test in invasion games group, which was not the case with control group ( $p>0.05$ ).

## Discussion

The present study investigated the effect of invasion games on physical fitness in primary school children. The primary finding of this study was that regular participation in a progressive invasion games program produced greater improvement in physical fitness than traditional physical education lessons in primary school children after 12 weeks of training. To measure explosive power, we used Vertical jump, Standing broad jump and Medicine ball test. Significant improvement was observed for invasion games group in both jumping tests. These results demonstrate that specific invasion games, as part of the overall physical education process, can be considered a useful tool for the improvement of jumping ability. Rotstein, Dotan, Bar-Or and Tenenbaum (1986) also stated that a 9-week interval training might improve anaerobic capacity in

preadolescent boys. Adeniran and Toriola (1988) showed the positive impact of interval running training on anaerobic power in girls (Vertical jump performances, +13.4% and +14.6%,  $p<0.05$ ). On contrary, Kristicevic, Sporis, Trajkovic, Pencic and Ignjatovic (2016) found no significant improvements in jumping performance following skill based conditioning games in young female volleyball players.

Compared with initial testing in this study, there was a significant ( $p<0.05$ ) improvement in Medicine ball test following 12 weeks' invasion games. Related studies with children that lasted only 6 weeks, found an increase in the medicine ball throw of 19% (Faigenbaum & Mediate, 2006). Moreover, after combined resistance training program and medicine ball throws Faigenbaum et al., (2007) found an increase of 14%, and D. J. Szymanski, J. M. Szymanski, Bradford, Schade and Pascoe (2007) in a 12-week study found an increase of 10% in the medicine ball throws. The increases observed in our study were in line with abovementioned increases.

One of the findings from our study was that there was a significant improvement in Bent arm hang, Sit ups and Push-ups in experimental group. Performance gains in the Push-up test following invasion games were similar to control group concerning the fact that Push-ups are the most frequent exercise in PE programs. Furthermore, training intervention did not include exercise specifically designed to enhance core strength. However, it is possible that the performance of other movements with proper exercise technique

contributed to improvement in sit ups for experimental group.

In the present study, the invasion games produced also a significant improvement in aerobic performances. The high intensity of invasion games might explain the higher improvement in compared to usual PE class. After the training period the average distance covered following invasion games was  $860 \pm 90.8$  (initial) and  $927 \pm 105.3$  (final). Invasion games group showed significantly better results compared to group that was involved in PE classes. Moreover, it could be speculated that invasion games may enhance enjoyment and increase compliance. Similarly, Baquet, Berthoin, Gerbeaux and Van Praagh (2001) only used short intermittent exercises as an attempt to improve the adolescents cardio-respiratory fitness.

A novel finding from the present investigation was that 10 to 15 min of invasion games performed twice per week resulted in significantly greater gains in physical fitness measures than normally achieved with standard PE in children. Since both groups participated in the same traditional PE lessons during the study period, such differences in fitness performance are likely due to the specific training adaptations that resulted from invasion games training. However, some authors have noted significant gains in strength without significant improvements in motor performance skills (Faigenbaum, Zaichkowsky, Westcott, Micheli, & Fehlandt, 1993). Though invasion games usually promote relatively high levels of activity, vigorous activities values ranging from 3% to 9% were produced during soccer, basketball, and hockey (Simons-Morton, Taylor, Snider, & Huang, 1993). Therefore, it is most likely that there is a diversity of pedagogical approaches employed which could lead to the discrepancies in classroom teachers' skills, knowledge, and understanding of how to maximize physical fitness and physical activity in physical education (McKenzie, Sallis, Kolody, & Faucette, 1997).

Young children often find it hard to support the traditional fitness training, because of a lack of enjoyment and experience with this type of exercise (Wall & Côt, 2007). Therefore, the use of invasion games as drills offers the simulation of movement patterns in team sports, while maintaining a competitive environment in which children must perform under pressure and fatigue (Gabbett, 2002). Moreover, the important consideration is the

optimization of skill development in team sport while still obtaining appropriate conditioning levels.

To conclude, invasion games appear to be an effective way of improving physical fitness in primary school children. The results of this study indicate that this method was more effective for performance than traditional school program. From a practical viewpoint, these findings demonstrate that invasion games should be implemented in regular curricula to enhance the physiological characteristics of children. Teachers and coaches could use this information in the process of planning the program in schools and teams.

## References

- Adeniran, S. A., & Toriola, A. L. (1988). Effects of continuous and interval running programs on aerobic and anaerobic capacities in schoolgirls aged 13 to 17 years. *Journal of sports medicine and physical fitness*, 28(3), 260-266.
- Allison, S., & Thorpe, R. (1997). A comparison of the effectiveness of two approaches to teaching games within physical education. A skills approach versus a games for understanding approach. *British Journal of Physical Education*, 28(3), 9-13.
- Andersen, L. B., Andersen, T. E., Andersen, E., & Andersen, S. A. (2008). An intermittent running test to estimate maximal oxygen uptake: The Andersen test. *Journal of Sports Medicine and Physical Fitness*, 48(4), 434.
- Bala, G., Krneta, Ž., & Katić, R. (2010). Effects of kindergarten period on school readiness and motor abilities. *Collegium Antropologicum*, 34(1), 61-67.
- Baquet, G., Berthoin, S., Gerbeaux, M., & Van Praagh, E. (2001). High-intensity aerobic training during a 10 week one-hour physical education cycle: effects on physical fitness of adolescents aged 11 to 16. *International Journal of Sports Medicine*, 22(4), 295-300.
- Belka, D. E. (2004). Combining and sequencing games skills. *Journal of Physical Education, Recreation & Dance*, 75(4), 23-27.
- Broek, G., Boen, F., Claessens, M., Feys, J., & Ceux, T. (2011). Comparison of three instructional approaches to enhance tactical knowledge in volleyball among university students. *Journal of Teaching in Physical Education*, 30(4), 375-392.
- Castro-Piñero, J., González-Montesinos, J. L., Mora, J., Keating, X. D., Girela-Rejón, M. J., Sjöström, M., & Ruiz, J. R. (2009). Percentile values for muscular

- strength field tests in children aged 6 to 17 years: influence of weight status. *The Journal of Strength & Conditioning Research*, 23(8), 2295-2310.
- Chevrier, J., Roy, M., Turcotte, S., Culver, D. M., & Cybulski, S. (2016). Skills trained by coaches of Canadian male volleyball teams: A comparison with long-term athlete development guidelines. *International Journal of Sports Science & Coaching*, 11(3), 410-421.
- Faigenbaum, A. D., McFarland, J. E., Keiper, F. B., Tevlin, W., Ratamess, N. A., Kang, J., & Hoffman, J. R. (2007). Effects of a short-term plyometric and resistance training program on fitness performance in boys age 12 to 15 years. *Journal of Sports and Science in Medicine*, 6(4), 519-525.
- Faigenbaum, A., & Mediate, P. (2006). Effects of Medicine ball training on physical fitness in high school physical education students. *The Physical Educator*, 63(3), 161-168.
- Faigenbaum, A.D., Zaichkowsky, L.D., Westcott, W.L., Micheli, L.J., & Fehlandt, A.F. (1993). The effects of a twice per week strength training program on children. *Pediatric Exercise Science*, 5, 339-346.
- Gabbett, T. J. (2002). Training injuries in rugby league: an evaluation of skill-based conditioning games. *Journal of Strength and Conditioning Research*, 16, 236-241.
- Griffin, L. L., & Butler, J. (2005). Teaching games for understanding: Theory, research, and practice. *Human Kinetics*.
- Harrison, J. M., Blakemore, C. L., Richards, R. P., & Oliver, J. (2004). The Effects of Two Instructional Models-Tactical and Skill Teaching-on Skill Development and Game Play, Knowledge, Self-Efficacy, and Student Perceptions in Volleyball. *Physical Educator*, 61(4), 186.
- Hastie, P. A., & Curtner-Smith, M. D. (2006). Influence of a hybrid Sport Education—Teaching Games for Understanding unit on one teacher and his students. *Physical Education & Sport Pedagogy*, 11(01), 1-27.
- Hopkins, W., Marshall, S., Batterham, A., & Hanin, J. (2009). Progressive statistics for studies in sports medicine and exercise science. *Medicine Science in Sports Exercise*, 41(1), 3.
- Janssen, I., & LeBlanc, A. G. (2010). Systematic review of the health benefits of physical activity and fitness in school-aged children and youth. *The International Journal of Behavioral Nutrition and Physical Activity*, 7, 40.
- Kirk, D. (2005) Future prospects for teaching games for understanding. In L.L. Griffin and J. Butler (Eds.), *Teaching Games for Understanding: Theory, Research and Practice* (pp. 213-226). Champaign, IL: Human Kinetics.
- Krističević, T., Sporiš, G., Trajković, N., Penčić, N., & Ignjatović, M. (2016). Skill- based conditioning training in young female volleyball players: Impact on power and change of direction speed. *Exercise and Quality of Life*, 8(1), 3-12.
- McKenzie, T.L., Sallis, J.F., Kolody, B., & Faucette, F. (1997). Long term effects of a physical education curriculum and staff development program: SPARK. *Research Quarterly for Exercise and Sport*, 68, 280-291.
- Metzler, M.W. (2000). *Instructional Models for Physical Education*. Needham Heights, MA: Allyn and Bacon.
- Musch, E., Mertens, B., Timmers, E., Mertens, T., Graça, A., Taborsky, F., & Vonderlynck, V. (2002). An innovative didactical invasion games model to teach basketball and handball, presented on cd. In *7th Annual Congress of the European College of Sport Science*.
- Otto III, W. H., Coburn, J. W., Brown, L. E., & Spiering, B. A. (2012). Effects of weightlifting vs. kettlebell training on vertical jump, strength, and body composition. *The Journal of Strength & Conditioning Research*, 26(5), 1199-1202.
- Webb, P. I., & Pearson, P. J. (2008). An integrated approach to teaching games for understanding (TGfU).
- Ricardo, V., & Graça, A. (2008). Developing secondary school students' competence in playing basketball: Analysis of an experimental teaching unit. In *the teaching games for understanding 2008 international conference, University of British Columbia, Vancouver, British Columbia, Canada*.
- Rotstein, A., Dotan, R., Bar-Or, O., & Tenenbaum, G. (1986). Effect of training on anaerobic threshold, maximal aerobic power and anaerobic performance of preadolescent boys. *International journal of sports medicine*, 7(5), 281-286.
- Sheppard, J.M., Gabbett, T.J., & ReebergStanganelli, L.C. (2009). An analysis of playing positions in elite men's volleyball: considerations for competition demands and physiologic qualities. *Journal of Strength and Conditioning Research*, 23(6), 1858-1866.
- Simons-Morton, B.G., Taylor, W., Snider, S., & Huang, I. (1993). The physical activity of fifth-grade students during physical education classes. *American Journal of Public Health*, 83, 262-264.
- Smith, J. J., Eather, N., Morgan, P. J., Plotnikoff, R. C., Faigenbaum, A. D., & Lubans, D. R. (2014). The health benefits of muscular fitness for children and adolescents: a systematic review and meta-analysis. *Sports medicine*, 44(9), 1209-1223.

- Szymanski, D. J., Szymanski, J. M., Bradford, T. J., Schade, R. L., & Pascoe, D. D. (2007). Effect of twelve weeks of medicine ball training on high school baseball players. *The Journal of Strength & Conditioning Research*, 21(3), 894-901.
- Tallir, I. B., Lenoir, M., Valcke, M., & Musch, E. (2007). Do alternative instructional approaches result in different game performance learning outcomes? Authentic assessment in varying game conditions. *International Journal of Sport Psychology*, 38(3), 263-282.
- Turner, A. P., & Martinek, T. J. (1999). An investigation into teaching games for understanding: Effects on skill, knowledge, and game play. *Research Quarterly for Exercise and Sport*, 70(3), 286-296.
- Wall, M., & Côt, J. (2007). Developmental activities that lead to dropout and investment in sport. *Physical Education & Sport Pedagogy*, 12(1), 77-87.