sciendo

DOI 10.2478/afepuc-2021-0001
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(1): 1-13

GOAL ORIENTATIONS PREDICT EXERCISERS' EFFORT AND ENJOYMENT WHILE ENGAGED IN EXERCISE AND REASONS FOR USING A FITNESS TRACKER

Lauren Easton[1], Mary D. Fry[2], Candace M. Hogue[3], Susumu Iwasaki[4]

[1]Simple Wellness
[2]Department of Health, Sport & Exercise Sciences, University of Kansas, Lawrence, KS USA
[3] Pennsylvania State University, Harrisburg, PA USA
[4] Fort Lewis College, Durango, CO USA

Summary: Fitness trackers (FTs) can help increase activity levels and decrease sedentary behavior. However, researchers have yet to examine whether individuals' goal orientations influence physical activity behavior in response to FT use. This study examined whether goal orientations predicted participants' effort and enjoyment while exercising and their reasons for using a FT. Participants (203 females, 57 males; M_{age} = 42.35 years) reported goal orientations, enjoyment and effort while exercising, and reasons for using an FT. Four stepwise linear regression analyses were calculated to assess the extent that goal orientations predicted effort and enjoyment while exercising and task- and ego-related reasons for using FTs. Both task and ego orientation scores positively predicted effort and enjoyment. Task orientation had a much greater influence than ego orientation over these motivational outcomes. Moreover, task orientation positively predicted task-related reasons for using a FT (e.g., "helps me strive to be my physical best"), while ego orientation positively predicted ego-related reasons for using a FT (e.g., "notifies me that I outperformed others"). Results suggest practitioners and FT manufacturers should consider promoting a task orientation (e.g., define success based on personal effort & improvement) to foster clients' sustained motivation to engage in PA.

Keywords: fitness tracker, physical activity tracker, sedentary behavior, achievement goal perspective theory, exercise motivation

Introduction

Most people fail to reap the many physical and psychological benefits of engaging in regular exercise, and people also become less active across the lifespan. Physical inactivity trends are concerning because they are linked to prevalent chronic diseases and conditions associated with inactivity (e.g., heart disease, stroke, cancer, type 2 diabetes, obesity, and arthritis). Even small improvements in physical activity among adults could have significant effects on exerciser well-being and health care costs. For instance, according to the Centers for Disease Control, the U.S. could save approximately $5.6 billion in heart disease costs alone if just 10 percent of adults participated in a walking program. Much can be gained from the field of exercise psychology, if we are to understand how to use fitness trackers (FTs) to optimize exercise motivation. FTs were developed to help individuals heighten their awareness of, monitor, and increase their daily activity levels. These devices also deliver personalized feedback and progress on their physical activity (Polzien, Jakicic, Tate & Otto 2007). Activity tracker technology is extremely accessible, affordable, and has quickly become part of the many cultures, including the United States, Western Europe, and China. CCS Insight has estimated 200 million wearable devices were sold in 2020 and that 400 million will be sold yearly by 2024. FTs have potential to help individuals decrease sedentary behavior, increase PA, and reduce their health care costs. Though the ubiquity of FTs and their capabilities suggest they have tremendous potential to help individuals adopt healthier lifestyles, the FT research is limited and results are mixed in terms of beneficial outcomes for users. Moreover, the FT research employing leading theories of motivation to understand the impact and interaction between user and FT capabilities is scarce. A number of systematic reviews and meta-analyses have helped provide a more detailed understanding of FT use and benefits. This research has highlighted a need for a more nuanced understanding of the motivational and dispositional factors that influence FT use and the subsequent motivation to engage in physical activity over the long term.

Achievement Goal Perspective Theory (AGPT). One theory that has been utilized in the exercise psychology literature, and that could be helpful to employ in the development of effective physical activity tracker technology is AGPT. Nicholls (1984; 1989) wanted to address the question of how to optimize motivation among all individuals, and he suggested that a key factor is their personal definitions of success (i.e., goal orientations). Nicholls argued there are two types of goal orientations: task and ego. Individuals who adopt a high task orientation define success

based on their personal effort, skill mastery, and improvement, whereas individuals who adopt a high ego orientation define success based on their normative standing in comparison to others. That is, they feel most successful when they outperform others, win, and/or are ranked high among their peers (Nicholls 1989). Goal orientations are orthogonal so that individuals can be any combination of task and ego orientation (i.e., high and/or low in one or both).

Nicholls (1989) predicted that a high task orientation was key to optimizing motivation over time and that individuals high in task orientation would give high effort, seek challenges, and persist in the face of obstacles, regardless of their perceived ability. The predictions are more complex for ego-orientation and dependent on perceived ability. High ego orientation for individuals with high perceived ability would lead to similar adaptive responses (high effort, seek challenge, persist). However, a high ego orientation combined with low perceptions of ability would lead individuals to exert low effort, avoid challenge, and demonstrate low persistence, unless paired with a high task orientation. When individuals gauge success by controllable factors such as effort and improvement (i.e., a task orientation), this seems to protect against the adverse effects of a unilaterally high ego orientation for those with low perceived ability (i.e., who base success on less controllable factors such as outperforming others).

Research has supported Nicholls' tenets in the physical activity domain (Lochbaum et al. 2016), illustrating that a high task orientation is often associated with adaptive achievement strategies, positive emotions, desirable behaviors, a mastery/task climate, intrinsic motivation, perceived competence, and trait self-esteem, while ego orientation has been linked to less adaptive thoughts, emotions, and behaviors. Most notably, task orientation has been consistently associated with effort and enjoyment in the physical domain (Lochbaum et al. 2016). Nicholls' AGPT is relevant when considered with respect to the reasons that individuals use physical activity trackers. Individuals high in task orientation would more likely use FT to help them monitor their personal effort and improvement, whereas individuals with high ego orientation would be more inclined to employ FT to gauge their performance in comparison to other users. Though research has not currently addressed this specific question, Brown (2016) recently examined adults' pedometer steps across a walking intervention where they were encouraged to be either more task or ego-oriented. These university employees took significantly more steps when they received messages encouraging their focus to be on their personal effort and improvement (i.e., promote a task-orientation) versus emphasizing the importance of outperforming others in their group (i.e.,

promote an ego-orientation). Likewise, Bort-Roig et al.'s (2014) systematic review of smartphone technology use and physical activity found that the FT's no longer had a beneficial impact when interventions utilized competition-based strategies in an effort to promote physical activity engagement.

It follows that the reasons exercisers identify for using an FT might be directly impacted by their goal orientations. For example, if individuals define success in exercise based on their personal effort and improvement, they would be more likely to indicate they use FT for task-oriented reasons, such as monitoring their effort and improvement, and fostering social connections where they can support others in their pursuit of positive health behaviors. In contrast, it seems logical that individuals who define success based on their comparison to others (i.e., have a high ego orientation) would be more likely to wear FT to receive information about their performance comparison to others, and these reasons would impact their physical activity behavior. Thus, the first purpose of this study was to develop a measure to assess the task- and ego-related reasons university employees use FT. The second purpose of the study was to examine how goal orientations predict FT (i.e., task and ego) reasons, effort, and enjoyment. Task orientation was hypothesized to be positively linked to task-related reasons for using FT, exercise effort, exercise enjoyment. It was also hypothesized that ego orientation would be positively linked to ego-related reasons for using FT and would negatively predict effort and enjoyment.

Methods

Analyses. Analyses were conducted using Mplus 7 and SPSS 22. Two Exploratory Factor Analyses were conducted to determine the factor validity of items on the task and ego reasons for using FTs scale for both the total sample and females (Tables 1 and 2, respectively). Descriptive statistics and Pearson correlations for each scale for the total sample and both males and females separately are posted in Tables 3 and 4, respectively. Four separate stepwise regressions were conducted to examine the extent that goal orientations (TO, EO) predicted a) task-related reasons for using FTs; b) ego-related reasons for using FTs; c) exerciser effort; and d) exerciser enjoyment (Table 5).

Table 1

EFA Factor Loadings for Total Sample and Female Participants: Task-related Reasons for Using Fitness Tracker Items

	Total Sample		Females Only	
Item	**Factor 1 (Ego)**	**Factor 2 (Task)**	**Factor 1 (Ego)**	**Factor 2 (Task)**
Stem: A reason I wear my physical activity tracker is because I like to receive information that. . .				
1. . . . encourages me to try hard.	.04	.64*	.01	.63*
2. . . . shows I have tried hard.	.06	.58*	.06	.56*
3. . . . leads me to give greater effort to reach a new milestone/personal best.	-.02	.69*	-.11	.73*
4. . . . helps me monitor my personal improvement over time.	-.09	.54*	-.10	.50*
5. . . . shows a chart of my daily improvement in steps or activity level (light, moderate, vigorous).	.00	.50*	.03	.49*
6. . . . challenges me to be physically active.	.02	.68*	.04	.61*
7. . . . helps me maintain my physical activity level.	-.07	.53*	-.02*	.40*
8. . . . helps me to see my personal improvement.	-.18*	.63*	-.17*	.62*
9. . . . notifies me of my patterns of physical inactivity.	-.18*	.48*	-.19*	.48*
10. . . . helps me strive to be my physical best.	.06	.69*	.06	.68*
11. . . . spurs me to strive to reach my personal best.	.03	.79*	.02	.77*
12. . . . updates me on how I am progressing toward my physical activity goals.	-.10	.62*	-.12	.60*

***Indicates significant loading $p < .05$*

Table 2

EFA Factor Loadings for Total Sample and Female Participants: Ego-related Reasons for Using Fitness Tracker Items

	Total Sample		Females Only	
Item	**Factor 1 (Ego)**	**Factor 2 (Task)**	**Factor 1 (Ego)**	**Factor 2 (Task)**
Stem: A reason I wear my physical activity tracker is because I like to receive information that. . .				
1. . . . notifies me that I outperformed others.	.81*	-.05	.81*	-.07
2. . . . informs me that I engaged in more physical activity than others I know.	.78*	-.14*	.79*	-.12*
3. . . . I am outperforming (more active than) others in my physical activity group.	.86*	.01	.86*	.01
4. . . . alerts me about where I rank on a leaderboard (or compared with others).	.78*	.06	.78*	.08
5. . . . updates me that I have received more digital badges/awards/trophies than others.	.61*	.02	.65*	.01
6. . . . I am competing well against others in my physical activity group who use the same device.	.82*	.02	.84*	.04
7. . . . encourages me to be more active than others.	.73*	.07	*	.06

8. . . . updates me on how I am progressing toward my goal of outperforming others.	.91*	-.07	.93*	-.07
9. . . . indicates to me that my physical activity level is greater and/or higher than others.	.86*	-.02	.86*	-.01
10. . . . I can share with friends/family members so we can call people out for not reaching our goals.	.56*	-.01	.59*	-.06
11. . . . updates me that I am successfully competing against others (e.g., complete more steps, perform with higher intensity).	.82*	.07	.80*	.10

*****Indicates significant loading $p < .05$*

Table 3

Scale Correlations and Descriptive Statistics for the Total Sample

	1	2	3	4	5	6
1. Task Orientation	1.00					
2. Ego Orientation	.19**	1.00				
3. Task-Related Reasons	.32**	-.01	1.00			
4. Ego-Related Reasons	.11	.53**	.21**	1.00		
5. Effort	.44**	.25**	.25**	.17**	1.00	
6. Enjoyment	.38**	.21**	.15*	.19**	.69**	1.00
Mean	4.23	1.95	4.06	1.91	3.75	3.46
SD	.63	.87	.55	.81	.79	.95
Alpha	.84	.89	.88	.94	.84	.91

*$p < .05$, **$p <. 001$

Table 4

Scale Correlations and Descriptive Statistics by Gender

	1	2	3	4	5	6
1. Task Orientation	1.00					
2. Ego Orientation	**.13** .29*	1.00				
3. Task-Related Reasons	**.36**** .29*	**.12** -.19	1.00			
4. Ego-Related Reasons	**.11** .08	**.60**** .38**	**.20**** .23	1.00		
5. Effort	**.43**** .51**	**.22**** .25	**.32**** .19	**.17*** .23	1.00	
6. Enjoyment	**.42**** .27*	**.17*** .31*	**.17*** .16	**.19**** .20	**.69**** .66**	1.00
Mean	**4.25** 4.26	**1.83** 2.12	**4.11** 3.88	**1.93** 1.83	**3.70** 3.92	**3.42** 3.61
SD	**.58** .66	**.82** .98	**.50** .68	**.85** .64	**.82** .68	**.97** .85
Alpha	**.81** .87	**.89** .88	**.86** .91	**.94** .90	**.86** .73	**.91** .86

*Note. Female responses are bolded. Male responses are not bolded. *$p < .05$, **$p <. 001$*

Table 5

Stepwise Multiple Regression For Variables Predicting Reasons for Using PATT, Exercise Effort, and Enjoyment

Variable		*B*	*SE B*	*β*
Task-Related Reasons for Using PATT				
	Step 1			
	Task Orientation	.30	.06	0.32**
	R^2 = .10 for Step 1 (p <.001).			
Ego-Related Reasons for Using PATT				
	Step 1			
	Ego Orientation	.48	.05	0.53**
	R^2 = .28 for Step 1 (p <.001).			
Effort				
	Step 1			
	Task Orientation	.55	.08	0.41**
	Step 2			
	Ego Orientation	.15	.05	0.16**
	R^2 = .21 for Step 1: ΔR^2 = .03 for Step 2 (p <.05).			
Enjoyment				
	Step 1			
	Task Orientation	.57	.10	0.35**
	Step 2			
	Ego Orientation	.18	.07	0.16*

*p < .05, **p <. 001

Participants

Participants (N = 261; M = 42.14 years, sd = 11.83; 57 males: M = 41.59 yrs, sd = 13.50; 203 females: M = 42.35 yrs, sd = 11.35; 1 “other”) between 23 – 74 years old included faculty, staff, and administrative employees in the U.S. (from 73 different institutions). The sample identified as Caucasian/White (75 %); Asian, Black/African American (3.9 %), and Hispanic (2.6 %). Participation inclusion criteria included monitoring PA with a FT during waking hours and bouts of PA.

Procedure

Permission to administer both a digital and hard copy version of the survey was obtained by the Human Subjects Committee of the Institutional Review Board. A measure was developed for the purposes of this study to assess exerciser’s reasons for wearing FTs, conceptualized as task and ego-involving.

Measures

Goal Orientations. The Goal Orientation in Exercise Measure (Petherick & Markland, 2008) was used to assess participants' goal orientations with regard to exercise. Participants rated five task and five ego items on a 5-point scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The stem "I feel most successful when…" was used. Sample items include, ". . . I can prove to others that I'm the best" (ego) and, "… I exercise at a level that reflects personal improvement" (task). Petherick and Markland (2008) reported acceptable internal consistency for the task (α = .78) and ego scales (α = .88).

Reasons for Using a Physical Activity Tracker Survey. *Task- and ego-related reasons.* This measure was developed for the purposes of this study to assess participants' task and ego reasons for wearing FTs and included 28-items. The scale included 16 task-related reasons for using FT items and 12 ego-related reasons. A 5-point Likert scale ranging from 1 (*strongly agree*) to 5 (*strongly disagree*) was used. The stem read, "A reason I wear my physical activity tracker is because…". Sample items include, "… I like to receive information that leads me to give greater effort" (task) and "…that notifies me that I outperformed others in my social network" (ego).

Exercise Effort and Enjoyment. Exercise effort and enjoyment was measured using the effort and enjoyment subscales of the Intrinsic Motivation Inventory (IMI; McAuley et al., 1989). Participants rated their responses on 5-items using a five-point scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). A sample item is "I try hard while I exercise". A sample enjoyment item is "I enjoy exercise very much". McAuley et al. (1989) determined the internal consistency of the effort and enjoyment subscales (α = .84; α = .78), respectively, to be satisfactory.

Results

Two separate EFAs were conducted with the total sample and the sample of female participants to examine the task and ego-related reasons for using FT. There were not enough male participants in the study to conduct a separate EFA for males. The results of the total sample EFA revealed each of the 28 items had significant factor loadings. Loadings below .4 and/or items that loaded on both factors were considered weak items. Five items met the cutoff criteria and were arranged by the size of the difference between their loadings on factor one and factor two of the model. Beginning with the item with the largest factor loading difference, these items were removed one at a time. The model was run until each of the five items was removed, at which time the model demonstrated acceptable fit. The final model contained a total of 23 items, with 12 task-

related reason items and 11 ego-related reason items for using FT. The two-factor model fit indices indicated acceptable model fit with a comparative fit index (CFI) of .90, Tucker-Lewis Index (TLI) of .88, root mean square error of approximation (RMSEA) of .08, and standardized root mean square residual (SRMR) of .05. Using the initial 28-item model, a second EFA was conducted with female participants. The same process noted above was followed to determine if all items should remain in the model. The two-factor model fit indices indicated acceptable model fit with a CFI of .93, Tucker-Lewis Index TFI of .91, RMSEA of .07, and SRMR of .04.

Cronbach's alpha coefficients, descriptive statistics, and correlations were calculated for the total sample and separately for females and males. Pearson correlations can be found in Tables 2 and 3. Overall, participants reported higher task orientation and relatively low ego orientation, as well as moderate effort in and enjoyment of physical activity. Participants also reported more task-related reasons than ego-related reasons for using FT. On average, participants rated items involving awareness of physical activity and reminders to be physically active higher than items involving sharing information with their doctor or on social media. Four stepwise linear regression analyses were calculated to assess the extent that goal orientations (task and ego) predict a) task-related reasons for using FT; b) ego-related reasons for using FT; c) exercise effort; and d) enjoyment. In each linear regression, the predictor variables (task and ego orientation) were modeled and added (i.e., based on hypotheses) or removed one at a time in a stepwise manner in order to obtain the most robust model. These predictor variables were removed from each model based on their partial *F*-tests statistics.

The first linear regression examined the relationship between goal orientations and task-related reasons for using FT. The positive and significant relationship between task orientation and task-related reasons for using FT (based on the bivariate correlation) and theoretical support suggest task orientation should be modeled as the first predictor variable and ego orientation added as the second predictor variable. As expected, the results revealed participants' task orientation was the only significant predictor (ego orientation did not contribute) of task-related reasons for using FT [$R^2 = .10$, $F\ (1, 251) = 28.63$, $p < .001$, 95 % CI (2.34, 3.28)] and accounted for 10 % of the variance in task-related reasons for using FT scores. A second linear regression examined the role of goal orientations in predicting ego-related reasons for using FT. Due to the positive and significant relationship between ego orientation and ego-related reasons for using FT (based on the bivariate correlation) and theoretical support from AGPT, ego orientation was modeled as the

first predictor variable and task orientation was added as the second predictor variable. As hypothesized, the results of the regression indicated ego orientation was the only significant predictor of ego-related reasons for using FT [$R^2 = .28$, $F(1, 251) = 96.08$, $p < .001$, 95 % CI (.78, 1.19)] and accounted for 28 % of the variance in ego-related reasons for using FT. A third linear regression examined the role of goal orientations in predicting effort. Theoretical support and linear correlation values led researchers to enter task orientation as the first predictor variable. The regression revealed both task orientation $t(243) = 7.01$, $p < .001$ and ego orientation $t(243) = 2.80$, $p < .05$ scores significantly and positively predicted effort scores, accounting for 20.8 % of the variance in effort [($R^2 = .21$, $F(1, 243) = 33.11$, $p < .05$, 95 % CI (.50, 1.81)]. R^2 values indicated that task orientation made a greater contribution than ego orientation in predicting exercise effort scores Lastly, the fourth linear regression examined the role of goal orientation in predicting enjoyment. Theoretical support and linear correlation values led researchers to enter task orientation as the first predictor variable. The regression revealed both task orientation $t(242) = 5.94$, $p < .001$ and ego orientation $t(242) = 2.61$, $p < .05$ scores significantly and positively predicted enjoyment scores and accounted for 16.2 % of the variance in enjoyment [$R^2 = .16$, $F(1, 243) = 24.61$, $p < .001$, 95 % CI (-.12, 1.50)]. R^2 values indicated that task orientation was a stronger predictor of enjoyment than ego orientation (Table 4).

Discussion

The purpose of the study was to examine how goal orientations predict reasons for FT use (i.e., task and ego), effort, and enjoyment of exercise, and to develop a measure to assess the task- and ego-related reasons FTs are used. The EFA models for both the total sample and the female sample provided support for the two-factor structure of the FT measure. As expected, task orientation was found to predict task-related reasons for using FTs and ego orientation was found to predict ego-related reasons for using FTs. Although both task and ego orientation were found to be positive predictors of exercise effort and enjoyment, task orientation was found to be a much stronger predictor of effort and enjoyment. High ego orientation paired with low task orientation is typically associated with less adaptive outcomes including greater tension/pressure and lower enjoyment (Treasure & Roberts 1994). These findings may help inform practitioners in their intervention efforts to foster greater enjoyment of physical activity, which has proven challenging. Research suggests that the benefits of FTs are maximized when paired with personalized

interventions, and even then it has proven a formidable challenge to help sustain motivation over the long term. Utilizing AGPT to help optimize FT use may aid in overcoming potential barriers to continued FT use and motivation to engage in exercise. For instance, the results of the current investigation are conceptually aligned with the tenets of Nicholls' (1989) AGPT. If individuals use FT for reasons that place value on effort, personal improvement, and skill mastery, it is likely that they will experience more control over their progress, put forth high effort, and sustain motivation by seeking to continuously master new skills during exercise (Roberts 2012). Likewise, individuals who hold a high ego orientation and utilize their FT for ego-related reasons may feel less control over their experience due to normative comparisons. Moreover, the results of the current investigation suggest that ego orientations are linked to more extrinsic rewards, suggesting motivation to continue exercising over time may be thwarted. Anshel (2014) notes that new exercisers are more likely to sustain their motivation to exercise and to engage in healthy behaviors if goals are intrinsic. It is essential for FT companies to understand these relationships and underlying motivational processes related to exercise if they are to maximize the potential benefits of FTs.

FT software companies may reach consumers from the moment they activate their FT. Typically, new consumers begin using their new FT by registering their device with the company's software and application platform. Upon device registration, individuals may complete an online survey that includes a measure of their goal orientation (e.g., the Goal Orientation in Exercise Measure; GOEM), specify their physical activity goals, and indicate notification preferences. These users may then receive a brief summary and description of their GOEM score, and information about how they can maximize the use of their FT to enhance their task orientation and support their goals (e.g., attaining high effort, personal improvement, and consistent physical activity levels). Lastly, FT software companies can emphasize the assistance provided by their technical support staff, who are trained in health and exercise psychological theory. One additional strategy FT companies may use to market FT to adult consumers includes emphasizing that the devices are capable of monitoring users' skill mastery, personal improvement, and effort. FT software designers can design progress messages/activity notifications to reflect these capabilities, such as praising high effort when individuals achieve a personal best. Research suggests such messages will increase the likelihood that participants will experience more positive motivational responses (Brown 2016). Also promising is that smartphone

users prefer features such as progress-tracking, goal-setting, and problem-solving in their applications (Rabin & Bock 2011). By applying this strategy, FT companies may help to optimize users' exercise experiences and meet the needs of their consumers.

It is necessary to acknowledge limitations of the study. To begin, responses from participants were collected at one time point and may not accurately represent individuals' perceptions of their FT use over weeks, months, or years. It may be more beneficial to check for FT patterns of behavior change versus behavior consistency. Further, participants self-reported their physical activity, FT patterns, and experiences using FTs. Also, data may be more precise if the study was conducted in a controlled setting or if participants were assigned to groups based on their specific types of physical activity. Additionally, self-report errors with regard to physical activity could be eliminated if data were collected by FTs and sent directly to the researcher. Finally, the researchers examined effort and enjoyment associated with physical activity. However, there are additional outcomes linked to long-term, positive experiences in physical activity settings that could be considered in future research. For example, exercise commitment was previously examined in an exercise setting (Brown & Fry 2014). These findings would expand researchers' understanding of the role of FT in users' exercise experiences. Additionally, the results would provide FT software companies with the information they need to capture the interest and investment of consumers.

Conclusion

To conclude, the present research provides an initial assessment of the predictive roles of goal orientation (task, ego) to goal orientation-related reasons for using FT and to exercise effort and enjoyment. The results reveal the benefits of adopting a high task orientation and utilizing FTs for reasons that reflect high effort, task mastery, and personal improvement for positive physical activity outcomes. Future studies may continue to explore the role of FT interventions that employ AGPT tenants in physical activity-based settings.

References

1. BORT-ROIG, J., N. D. GILSON N, A. PUIG-RIBERA, R. S. CONTRERAS & S. G. TROST, 2014. Measuring and influencing physical activity with smartphone technology: A systematic review. In: *Sports Med.* **44**(5). pp. 671-686.

2. BROWN T., 2016. Impact of a theory-guided encouragement intervention on an employee walking pilot program. In: *J Appl Sport Psychol*. **28**(4). pp. 452-468.
3. BROWN, T. C. & M. D. FRY, 2014. Motivational climate, staff and members' behaviors, and members' psychological well-being at a national fitness franchise. In: *Res Q Exercise Sport*. **85**(2). pp. 208–217. ISBN 1041-3200.
4. LOCHBAUM, M., Z. K. ÇETINKALP, K. A. GRAHAM, T. WRIGHT & R. ZAZO, 2016. Task and ego goal orientations in competitive sport: A quantitative review of the literature from 1989 to 2016. In: *Kinesiology*. **48**(1). pp. 3-29. ISBN 1331-1441
5. MCAULEY, E., T. DUNCAN & V. TAMMEN, 1989. Psychometric properties of the Intrinsic Motivation Inventory in a competitive sport setting: A confirmatory factor analysis. In: *Res Quart*. **60**(1). pp. 48-58.
6. NICHOLLS, J. G., 1984. Achievement motivation: Conceptions of ability, subjective experience, task choice, and performance. In: *Psychol Rev*. **91**(3). pp. 328-346. ISBN 1939-1471
7. NICHOLLS, J. G., 1989. *The competitive ethos and democratic education*. Harvard U. Press.
8. PETHERICK, C. M. & D. MARKLAND, 2008. The development of a Goal Orientation in Exercise Measure. In: *Meas Phys Educ Exerc Sci*. **12**(2). pp. 55-71.
9. POLZIEN, K. M., J. M. JAKICIC, D. F. TATE & A. D. OTTO, 2007 The efficacy of a technology-based system in a short-term behavioral weight loss intervention. In: *Obes*. **15**(4). pp. 825-830.
10. RABIN, C. & B. BOCK, 2011. Desired features of smartphone applications promoting physical activity. In: *Telemed E-Health*. **17**(10). pp. 801-803.
11. ROBERTS, G. C., 2012. Motivation in sport and exercise from an achievement goal theory perspective: After 30 years, where are we? In G. ROBERTS, & D. TREASURE (Eds.), *Advances in Motivation in Sport and Exercise*. Champaign, IL: Human Kinetics. pp.5-58
12. TREASURE, D. & G. C. ROBERTS, 1994. Cognitive and affective concomitants of task and ego goal orientations during the middle school years. *J Sport Exerc Psychol*.**16**(1), pp. 15-28. ISBN 0033-6297

DOI 10.2478/afepuc-2021-0002
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(1): 14-23

PHYSIOLOGICAL RESPONSE TO DIFFERENT KATA PERFORMANCES

Dušana Augustovičová, Radovan Hadža, Rastislav Štyriak, Peter Barinec

Comenius University in Bratislava, Faculty of Physical Education and Sport, Department of Track and Field Slovakia

Summary. During a karate competition, a competitor in the kata discipline may choose one kata of 102 katas on the list. This kata must not be repeated. Katas differ in duration, complexity, number of fast and slow techniques, which also means different intensity, physiological response of the karateka body and energy coverage. **Problems and Aim.** In our study, we focused on the identification and assessment of the duration and difficulty of selected katas by monitoring the internal response of the human body (heart rate, lactate) of three top women´s Slovak national team karate competitors of kata individual categories during training and competition. **Methods.** The research sample consisted of 3 karate kata athletes (age 17.3 years, body height 161.7 cm, body weight 55.7 kg), who trained kata on average 7 years. To evaluate the indicators of the internal body load in selected katas we used mean, standard deviation, min-max. **Results.** The highest mean maximum heart rate values athletes had during performance kata Gojushi Ho (187 ± 8.2 bpm). The highest average heart rate values were observed during performance kata Chatanyara Kushanku (171 ± 9.9). Similarly, we found the highest mean values of blood lactate 4 minutes after performance kata Chatanyara Kushanku. (7.6 ± 2.5 mmol.l^{-1}). The longest duration had the kata Suparinpei (204 ± 13 s). There was a significant difference in level of blood lactate reached in different katas ($p \leq 0.05$) and the duration of katas. **Conclusions.** The duration of 5 most common katas used at the high level competition is different ($p \leq 0.05$), thus the intensity expressed by the frequency of the techniques, and heart rate and blood lactate concentration. ATP-PCr energy system seems to be the major contributor while contribution of the aerobic energy system rises with the increase in duration of kata.

Key words: karate, kata, heart rate, lactate

Introduction

According to Čierna (2014), kata is a means of aesthetic expression, considered as a measure of technical development and advancement of the karateka. Sport performance in kata is determined by a whole number of different factors. Zemková (2006) indicates, that performance in karate is certainly affected by the motor, physiological, technical, somatic,

tactical and psychological determinants. In the study of Invernizzi et al. (2008) the internal load, in the form of heart rate monitoring, was tracked during practice, where they compared the maximum performance of kata individuals and teams. Arriaza (2009) monitored the mean heart rate values of kumite and kata practitioners, where kata competitors reached average heart rate values of 142 bpm.

Heart rate values were monitored by Penov et al. (2020) during the national kata competition, in which the three katas were performed by each subject. Results showed mean heart rate values 179 ± 11.55 bpm, 180 ± 11.63 bpm and 181.5 ± 15.44 bpm during first, second and third kata respectively.

Higher heart rate values may also be affected by the pre-start condition, in which the athlete experiences the heart rate increase even without a load. The effect of higher heart rate values is mediated by the sympathetic nervous system, as evidenced by higher levels of epinephrine and norepinephrine (Hamar & Lipková 1996).

The intensity of the body's internal load can be assessed based on the concentration of blood lactate (Bielik 2014). The ability to release the lactate from muscle cells (mainly type II muscle fibres) into the bloodstream directly depends on the amount of its production. Usually, these values are used to define the metabolic stress of a given activity or load on the body and depend on total lactate production, transport, metabolism, and elimination (Wirtz et al. 2014). In the methodology of measuring blood lactate, testing is essential. Bielik (2014) mentions two options can be used from the earlobe or the fingertip. Bielik et al. (2006) did not find a significant difference in blood lactate values using these two types of blood sampling. Chren (2011) and Štefanovský et al. (2014) state that in sports where the nature of the load is highly intense (judo, dance sports, etc.). It is appropriate to perform blood sampling in the range of 5 - 8 minutes after the performance.

Bussweiler and Hartmann (2012) examined metabolic demands and partial energy supply during the basic kata (Heian Nidan, Shotokan) performed once and twice in a row without rest, in six male kata competitors (age 29 ± 8 years; height 177 ± 5 cm, body mass 75 ± 9 kg). This basic kata consists of 26 movements, and its duration is about 30 s. The energy contribution of anaerobic alactic, anaerobic lactic and aerobic metabolism 52, 25, resp.23 %. In two consecutive executions, the energy supply ratios were 33, 25 and 42 %. Despite the relatively high concentration of blood lactate 8.1 $mmol.l^{-1}$, which could indicate the dominance of anaerobic lactic energy system supply, anaerobic lactic metabolism covered only 17 – 31 % of total energy requirements. Arriaza (2009) found an average blood lactate level of 8.79 $mmol.l^{-1}$ in his sample, with the range of values 6.8 – 10.6 $mmol.l^{-1}$. The progressive increase

in the average values of lactate during the competition was observed in work Penov et al. (2020) from resting 1.4 ± 0.32 mmol. l^{-1} up to 7.1 ± 2.35 mmol/l^{-1} after the last round of kata.

Arriaza (2009), Bussweiler and Hartmann (2012) determined the values of heart rate and blood lactate in kata individuals after performing kata, without analyzing the relationship to the specific kata, Penov et al. (2020) in turn, evaluated the response of the competitors´ organisms with an increasing number of katas executed during multiple rounds in the competition.

In our study, we focused on assessing the difficulty of selected kata based on monitoring the physiological response of the body (maximum heart rate, average heart rate, lactate) of three top women´s Slovak national team karate competitors of kata individual categories during practice and competition.

Methods

Participants

The research sample consisted of three women´s karate athletes (age 17.3 years, body height 161.7 cm, body weight 55.7 kg), who practice kata minimally seven years. The participants were members of the Slovak club Sports school karate Prievidza. Karate athletes included in this study regularly attended national or international tournaments. All athletes, or their legal representatives, voluntarily signed a consent agreement form. The study design received ethical approval from the local Ethics Committee.

Procedures

Data were collected multiple times, during the training session, at the international Grand Prix Slovakia and the Slovak National Championships. The athletes performed each kata repeatedly multiple times, once in training and twice in competition. Before the experimental protocol all participants realized an anthropometric valuation. After familiarization with the procedures and a free warm-up, each athlete underwent a total of five katas (Paiku, Suparinapei, Gojushi Ho, Chatanyara Kushanku, Nipaipo) in one session with a recovery of 8 minutes between katas, protocol similar to Invernizzi (2008). Data During the kata performance, we recorded the parameters of the physiological response of the body (the maximal and average heart rate using the chest strap POLAR H7 Bluetooth Smart Heart Rate Sensor, fig. 1). The katas were performed with the maximal effort.

Figure 1
Polar for heart rate data acquisition (cirquee 2018)

Blood samples were taken from our subjects 4 minutes after each performed kata. To analyze blood lactate levels, we used an Accutrend device from Accusport (fig. 2).

Figure 2
Device for measuring the value of blood lactate from blood samples (laberservis 2018)

Indicators of the intensity of the body's load in our work were values of heart rate and blood lactate.

Statistical analysis

We used basic mathematical-statistical characteristics (mean, minimum, maximum, standard deviation). We assessed the homogeneity of the data by the Shapiro-Wilk test. To assess the differences in physiological parameters between katas we used the nonparametric Anova method for independent samples. We set the level of significance at $p \leq 0.05$.

Results

Heart rate

There was no significant difference in maximal heart rate (HRmax) between katas. The highest mean value of the maximum heart rate achieved by our probands was during kata Gojushi Ho, 187 ± 8.2 bpm, the lowest value during kata Paiku 180 ± 13.5 bpm. The highest

value was reached by one of the probands during kata Suparinpei, the value was 195 bpm (fig. 3).

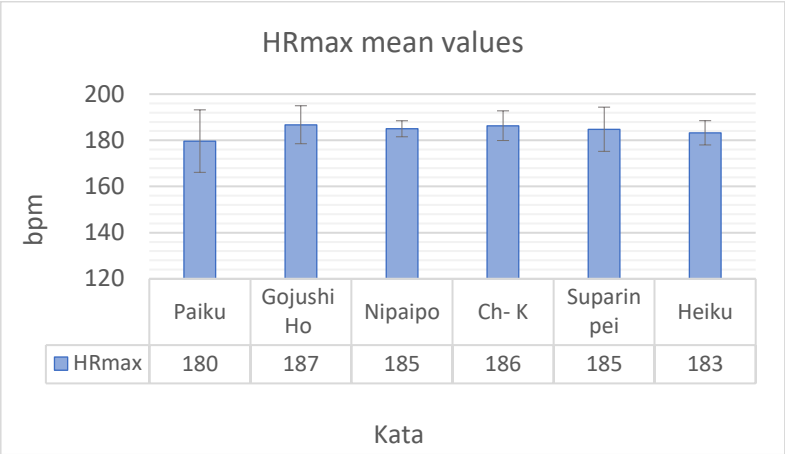


Figure 3
Maximal heart rate values in different katas

We have not found the significant difference in average heart rate (HRavg) between katas. The highest mean value of the average heart rate was reached during kata Chatanyara Kushanku, 171 ± 9.9 bpm, the lowest during kata Paiku 160 ± 13.3 (fig. 4).

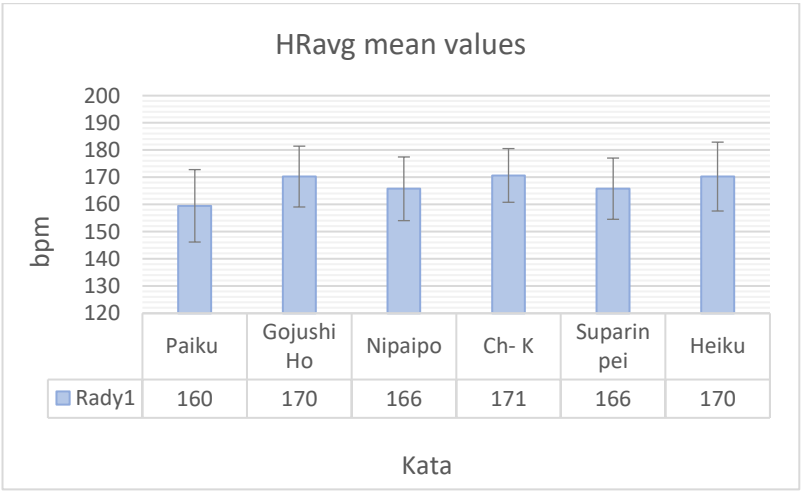


Figure 4
Average heart rate values in different katas

Lactate

There was a significant difference in level of blood lactate (La) reached in different katas ($p \leq 0.05$). The highest mean value of blood lactate was reached during kata Chatanyara Kushanku 8.3 ± 2.9 $mmol.l^{-1}$. The lowest mean value of blood lactate was reached during kata Paiku 4.5 ± 1.2 $mmol.l^{-1}$ (fig. 5).

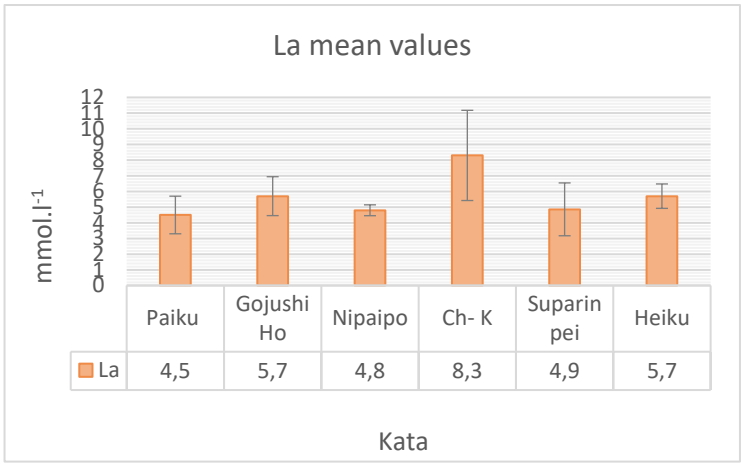


Figure 5
Mean blood lactate values in different katas

There was a significant difference in between the duration of performed katas ($p \leq 0.05$). In figure 6 we can see that the longest kata performed by our sample was kata Suparinpei (204 ± 13 s). Contrary, the shortest kata was Heiku (105 ± 16 s).

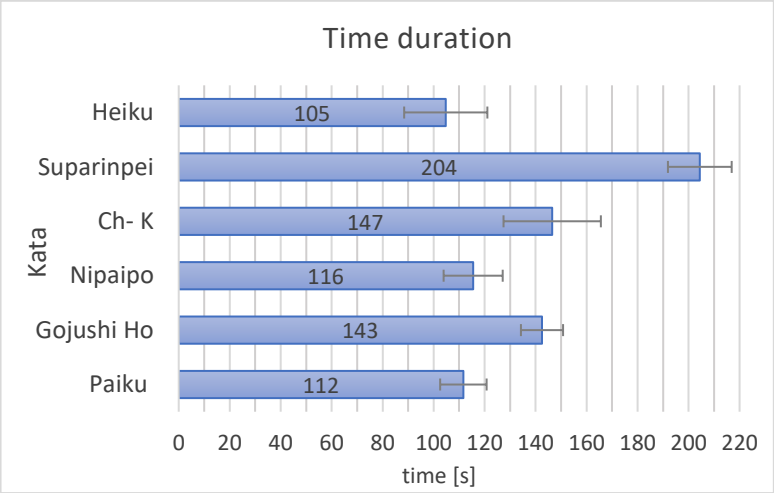


Figure 6
Time duration of performed katas

In Table 1 we can see a summary of the data obtained in our research. Overall highest values of the internal response of the body were observed during the Chatanyara Kushanku, which was the second longest kata in our group (147 ±19 s), Contrary, the lowest values of the internal response were observed during kata Paiku, which was the second shortest in our group (112 ± 9 s).

Table 1

Values HRmax, HRavg and La measured during selected katas

kata	Paiku	Gojushi Ho	Nipaipo	Ch-k	Suparinpei	Heiku	p
time [s]	112 ± 9	143 ± 8	116 ± 12	147 ± 19	204 ± 13	105 ± 16	0.05
HRmax [bpm]	180 ± 13.5	187 ± 8.2	185 ± 3.5	186 ± 6.4	185 ± 9.6	183 ± 5.3	ns
HRavg [bpm]	160 ± 13.3	170 ± 11.2	166 ± 11.7	171 ± 9.9	166 ± 11.3	170 ± 12.7	ns
La [mmol.l^{-1}]	4.5 ± 1.2	5.7 ± 1.2	4.8 ± 0.3	8.3 ± 2.9	4.9 ± 1.7	5.7 ± 0.8	0.05

Discussion

Our probands reached the highest mean values of maximum heart rate during kata Gojushi Ho (187 ± 8.2 bpm), then kata Chatanyara Kushanku (186 ± 6.4 bpm) and Suparinpei (185 ± 9.6 bpm). Longová (2009) found in her work similar results for kata Suparinpei. Hrubý & Polgár (2004) assumed that during the performance kata Suparinpei the probands would reach the highest values in heart rate among all the performed kata, but similarly to our results, the values in different katas were comparable. Kata Suparinpei is the longest among many other katas according to Argajová et al. (2020), contains the highest number of fast and slow techniques (203 s, 189 tech., 78 fast vs. 66 slow. Penov et al. (2020) recorded the mean maximum heart rate values of Bulgarian karatekas at the national championship during three rounds: 179 ± 11.55, 180 ± 11.63 and 181.5 ± 15.44 bpm.

We measured the highest average heart rate value during kata Chatanyara Kushanku (171 ± 9.9 bpm), followed by kata Heiku (170 ± 12.7 bpm) and Gojushi Ho (170 ± 11.2 bpm), and the lowest value during kata Paiku (160 ± 13.3 bpm). Arriaza (2009), in his research, recorded the average heart rate value during training (142 bpm). This low value is probably due to the reduced intensity of performing the kata, as it was training without the opponent, competitiveness, which eliminated the influence of the pre-competitive condition, including stress factor.

Highest mean blood lactate values were observed after performing kata Chatanyara Kushanku (8.3 ± 2.9 mmol.l^{-1}; highest 12.2 mmmol.l^{-1}; lowest 5.6 mmol.l^{-1}), followed by kata Gojushi Ho (5.7 ± 1.2 mmol.l^{-1}; highest 7.2 mmol.l^{-1}; lowest 4.3 mmol.l^{-1}) and Heiku (5.7 ± 0.8 mmol.l^{-1}; highest 6.7 mmol.l^{-1}; lowest 4.8 mmol.l^{-1}). Lowest values we found after execution kata Paiku (4.5 ± 1.2 mmol.l^{-1}; highest 6.3 mmol.l^{-1}; lowest 3.0 mmol.l^{-1}). Arriaza (2009) found mean lactate values in his sample 8.79 mmol.l^{-1}, with range of 6.8 – 10.6 mmol.l^{-1}, Penov et al. (2020) gradually recorded values 1.4 ± 0.32 mmol.l^{-1} in rest, 4.7 ± 1.91 mmol.l^{-1} after first, 6.8 ± 2.59 mmol.l^{-1} after second and 7.1 ± 2.35 mmol/ l^{-1} after third round in competition.

We found higher blood lactate values in comparison with Massuca et al. (2014), probably due to the longer duration and more difficulty of our kata. We ensured maximum effort of our probands by data collection during the competitions.

In terms of the average duration of individual kata, we recorded the following values. The longest kata in our sample was Suparinpei (204 ± 13 s), which consists of 189 techniques (0.93 movm./s) - 78 fast and 66 slow - 1.18 ratio (Augustovičová et al. 2018; Argajová et al. 2020), followed by kata Chatanyara Kushanku (147 ± 19 s) and Gojushi Ho (143 ± 8 s). Contrary, kata Heiku (105 ± 16 s) turned out to be the shortest kata in our sample. When we took a better look at the relationship between the duration of the selected katas and the internal response of the individual probands, we found interesting connections in several cases. Correlation between variables HRavg and La was assessed by a Spearman's correlation coefficient ($r = 0.907$; $p \leq 0.01$).

The results of our work support the known relationship between the execution time of selected katas and the internal response of the body. Many cases have shown that the different time execution of given kata leads to different observed values of maximal and average heart rate and blood lactate in karate competitors. The dynamic executing of kata, the increasing number of techniques per second, and shorter rest intervals, leads to the pronounced body response, such as the increasing heart rate and concentration of blood lactate. The increasing the frequency of techniques with the simultaneous increase of internal response we consider as the evidence of the perception of increased external intensity. On the contrary, when the executing is slower with longer breaks between rapid techniques, there is a rather moderate physiological response of the body, as we observed in our work. Based on this knowledge, we can distinguish better kata competitors from others.

Limitations of the study

In this pilot study we analysed only limited number of katas (6) performed by 3 karate competitors.

Conclusions

The present study is the first successful approach analyzing the effort profile of competitive kata based on the measurement of the results, with significant differences between Kata ($p \leq 0.05$). The variability of the actions of the competitive Katas causes a metabolic profile in which the aerobic metabolism is the predominant source, which explains why it was associated with effort intensity in Katas.

Acknowledgement

The listed study was supported by the project of Ministry of Education, science and research of Slovak Republic VEGA grant No. 1/0654/19.

References

1. ARGAJOVÁ, J., et al., 2020. Time-motion analysis of the most performed katas at the top-level karate competition, In: *European Colledge of Sport Sciences.* 25th ECSS Congress 1-3 July 2020 SEVILLA/SPAIN
2. ARRIAZA, R., 2009. Karate. In: CHAABÉNE, H., E. FRANCHINI, S. STERKOWICZ, M. TABBEN & K. CHAMARI, 2015. *Physiological responses to karate specific activities.* **30**(4), pp. 179-187.
3. AUGUSTOVIČOVÁ, D. et al., 2018. Top-level karate: analysis of frequency and saccessfulness of katas in K1 Premiere League. In: *Journal of Martial Arts Antropology.* **18**(4), pp. 46-53.
4. AUGUSTOVIČOVÁ, D. et al., 2019. The issue of early specialization in karate: the same pool of katas in all top-level WKF competition age categories. In: *Archives of Budo.* **15**, pp. 241-248.
5. BIELIK, V., 2014. *Laktát v športovom tréningu*. Bratislava : ADC media a.s. ISBN 978-80-970342-2-1.
6. BIELIK, V., M. ANEŠTÍK, J. PETROVIČ & J. IKÍNOVÁ, 2006. Analýza laktátu v praxi. In: *Telesná výchova a šport.* **16**(3), pp. 18-19.
7. BUSSWEILER, J. & U. HARTMANN, 2012. Energetics of basic Karate Kata. In: *European Journal of Applied Physiology.* **112**, pp. 3991–3996.
8. ČIERNA, D., 2014. Vplyv výberu kata na úspešnosť v súťaži karate. In: *Telesná výchova a šport*. **24**(3), pp. 12-16.
9. HAMAR, D. & J. LIPKOVÁ, 1996. *Fyziológia telesných cvičení*. Bratislava: Univerzita Komenského, 1996. ISBN 80-223-1024-7.
10. HRUBÝ, M. & V. POLGÁR, 2004. Analýza súboru cvičení kata v karate z hlediska bioenergetického krytí. In: *Telesná výchova a šport*. **14(**1), pp. 47-50.
11. CHREN, M., 2011. Zaťaženie v tanečnom športe. In: BIELIK, V. 2014. *Laktát v športovom tréningu.* Bratislava: ADC media a.s. ISBN 978-80-970342-2-1.
12. INVERNIZZI, P. L., S. LONGO & R. SCURATI, 2008. Analysis of heart rate and lactate concentrations during coordinative tasks: Pilot study in karate kata world champions. In: *Sport Sciences for Health*. **3**, pp. 41-46.

13. LONGOVÁ, K., 2009. *Intraindividuálne zmeny fyziologickej krivky a hodnôt krvného LA počas tréningového a súťažného zaťaženia v karate kata žien*. Bratislava. Bakalárska práca: Univerzita Komenského v Bratislave, Fakulta telesnej výchovy a športu.
14. MASSUCA, L. M. et al., 2014. Physiological and perceived exertion responses during specific training of Goju-Ryu Karate Kata. In: *Journal of Combat Sports and Martial Arts.* **5**(2), pp. 113-117.
15. PENOV, R. et al., 2020. Changes in heart rate and blood lactate concentration during karate kata competition. In: *Pedagogy of Physical Culture and Sports.* **24**(3), pp. 137-142.
16. WIRTZ, N. et al., 2014. Lactate Kinetics during Multiple Set Resistance Exercise. In: *Journal of Sports Science and Medicine.* **13**(1), pp. 73–77.
17. ŠTEFANOVSKÝ, M., A. PÉTEROVÁ & V. BIELIK, 2014. Utjecaj trenažnog i natjecateljskog opterécenja na organizam judaša. In: BIELIK, V. 2014. *Laktát v športovom tréningu*. Bratislava: ADC media a.s. ISBN 978-80-970342-2-1.
18. ZEMKOVÁ, E. et al., 2006. *Teória a didaktika karate*. Bratislava: Vydavateľstvo UK. ISBN 80-223-2041-2.

sciendo

DOI 10.2478/afepuc-2021-0003
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(1): 24-34

PERCEIVED ETIOLOGY OF ANTI-SOCIAL BEHAVIOR AMONG PLAYERS AND SPECTATORS OF SELECTED FOOTBALL CLUBS IN NIGERIA (PEABFC)

Samson Olusola Babatunde

Department of Human Kinetics and Health Education, Faculty of Education University of Lagos, Nigeria

Summary: Anti-social behavior at football contest is a well-recognized issue. Due to this fact, associations and government have devised variety of interventions and strategy characterized by high tension and tempo among players and spectators which usually generate disorderliness of varying intensify. This study focuses on investigation of etiological factors of anti-social behaviors among players and spectators of football clubs in Nigeria during matches, with a view to coming up with coherent strategies for its enervation. Self-development questionnaire tagged perceived etiology of anti-social behavior among football players and spectators of selected football clubs (SPEABFC) was used for data collection, with reliability value of 0.85. Two thousand seven hundred (2700) out of three thousand (3000) copies of questionnaire administered were retrieved and coded for analysis with adoption of percentages and chi-square x^2 tool at 0.05 level at significant. The study copiously found that poor officiating, winning at all costs, conduct of coach and alcohol consumption are significant in causing anti-social behavior among players and spectators. Consequently, it is re-concluded among others that known troublemakers should be disallowed from entering the game venue, sale of alcohol be restricted to a place far from game site .The outcome is highly significant in view of the fact it might be helpful to scientifically develop appropriate strategies to control sale of drugs and alcohol at game site. The study is greatly insightful to sensitizes the management of football competitions to look inward more effective methods capable of making soccer context anti-behavior free. A adage says prevention is better than cure, the research is highly informative to authorities concerned with organization of football competitions map out preventive measures to unethical attitude by players, spectators as well fans for better attendance at game site which is likely to translate into making more profit for the organizers. An adequate provision for police and other security agents will go a long way to reduce anti-social behavior. We are now in the world of business geared towards profitability, any competition occasioned by riot and chaos is likely to negate this objective as attendance may reduce thereby drastically cutting the expected profit. The promoters of competition will be abreast this fact and develop remedies to counter it ahead at planning stage. The erring players should be sanctioned accordingly. The use of credible and

competent officials with records of integrity and credibility will in part promote sanity during the matches.

Keywords: Etiology, footballers, spectators, competition, anti-social behavior, football clubs

Introduction

Sports all over the world have been recognized as an important instrument for integration, peace and togetherness. There is no doubt that sports are among tools employed for peace nationally and internationally (Babatunde, 2004). Sulainan (2012) stated that the only means by which people unite throughout the universe is through sports. No matter one's tribe, culture, religion, social background, sports remains only festival and accommodated throughout the whole world. The paradox to this position is that many of football matches according to Omotayo (2008) and Babatunde (2003) are often ended abruptly due to anti-social behavior demonstrated by players and spectators in protest of poor officiating and other related vices.

Anti-social behavior at football matches is a well-recognized issue which has prompted police, football associations and governments to develop numerous interventions and strategies to prevent and respond to such behavior. Babatunde (2000) and Sulaiman (2012) affirmed that anti-social behaviors do not originate form a vacuum or mass during sports competitions, being more pronounced in football contests, but due to the volatile nature of the games. Babalola and Oyeniyi (2003) indicted that more often than not, there are causative factors behind anti-social behavior during sports competition. Babatunde (2000) remarked that empirical observations clearly revealed that lack of sportsmanship spirit often ignites unethical attitude on the part of athletes, coaches, spectators, as well as supporters.

Babatunde and Oyeniyi (2003) reported that the ripple effect of antisocial behavior is violence which irrefutably negates the spirit of sports and its objectives of which promotion of peace, unity and character building are among. According to Babatunde (2000) Babatunde (2004), Babalola and Oyeniyi (2003), sports supposedly contributes to character development and tremendously aids in the formation of ethical behavior. Contrarily in recent time, according to Oyeniyi (2001) one begins to wonder however, after viewing the contemporary sports scene, if these ingredients are somewhat antiquated. Owolabi (1992) pointed out that antisocial behavior during sports like football, basketball and lots required aggression which may

eventually turn to violence in terms of destruction of valuable properties abruptly disruption of game, loss of lives and sustaining of injuries of varying severity.

Football game beyond doubt represents most popular game embraced by large number of people either as fans or spectators worldwide. Babatunde (2002), Oyeniyi (2001) and Babatunde (2003) elucidated that football game attracts the attention of both young and old worldwide. The relevance and popularity of football game cannot be over emphasized or underscored, judging from the fact that the game pulls high patronage from different segments of people as spectators, loyalists or supporters due to various underlying reasons such image making for clubs, state and nations. The economic values of the game to beneficiaries and anyone that has anything to do with the game, like betting which is now a legalized business is enormous (Babatunde 2005). All these according to Sulaiman (2012) may partly aggravate winning at all cost syndrome. Babatunde (2000) and Oyeniyi (2001) pointed out that winning at all costs and other related un- sportsmanship are among factors that may engender violence at sports contest.

Poor officiating being a strong issue that engenders anti-social behavior during football matches, as in the case where officials deliberately fail to adhere to rules and regulations of the game. Babatunde (2000), Babatunde (2004) and Sulaiman (2012) observed that many officials at football matches usually over project themselves by showing off which may direct the crown towards the officiating rather than towards contest. Oyeniyi (2001) is the same vein, indicated that incompetence on the part of officials could lead to bad officiating where officials are not up-to date with rules and regulations of sports being officiated thereby, leading to poor officiating that may irritated fans to trigger violence.

Consumption of alcohol is a known part of the experience of watching major national and international football events for fans and supporters in many parts of the world. According to Cooperation (2018), there is a long –standing relationship between international football and the alcohol beverages. Although there are restrictions of the use of alcohol at sports competition sites would casual observations reveals that brewery companies such as Heinekens, Guinness and lots have been official sponsors of champion leagues. Corporation, (2018) reported that Budweiser has been one of the main sponsors of FIFA world cup. The fact of this is that" he who pays the piper dictates the turn" measuring that the sponsors has moral and legal backing to display and sell their products which is alcohol at the game sites to recovered or revamp money expended on the sponsorship of the contests.

Hypotheses

1. Poor officiating would not be a significant etiology of anti-social behavior among football players and spectators of related football players clubs in Nigeria.
2. Winning at all costs would not be a significant etiology of anti-social behavior among players and spectators of selected football clubs in Nigeria.
3. Conduct of coach at football competition site would not be a significant etiology of anti-social behavior at players and spectators of selected football clubs in Nigeria.
4. Alcohol consumption by footballers and spectators during football game would not be a significant etiology of anti-social behavior in selected football clubs in Nigeria.

Alternative Hypotheses

1. Poor officiating would be a significant etiology of anti-social behavior among football players and spectators of football clubs in Nigeria.
2. Winning at all costs would be significant etiology of anti-social behavior among football plyers and spectators in Nigeria.
3. Conduct of coach at football competition site would be a significant etiology of anti-social behavior among football players and spectators in Nigeria.
4. Alcohol consumption by football players and spectators would not be a significant etiology during football game during football game in selected football clubs in Nigeria.

Method

The research was carried out to delineate the etiology of anti-social behavior during football contests among the footballers and spectators of selected clubs in Nigeria with a view to mapping out scientific strategies by which such ugly behavior can be averted or attenuated to the barest minimal.

The instrument of the study was a self- developed questionnaire tagged Perceived etiology of anti-social behavior among football players and spectators of selected football clubs in Nigeria (PEABFC). The questionnaire is patterned after Likert scaling of Strongly Agreed (SA) = 4 points, Agreed (A) = 3 points Disagreed (D) = 2 points and Strongly Disagreed (SD) = 1 points. The instrument was subjected to test-retest reliability with the value of 0.85 and a concomitant content validity arising from expert screening.

Fifty (50) football clubs and their spectators were used for the study. The clubs comprised premier league (Nigeria 1st league) national league (Nigeria 2nd league) division

1(3rd league) and Nigeria division 2 (Nigeria division 2). Three thousand (3,000) questionnaire forms were administrated to players, referees, coaches and spectators during football matches with the help of trained research assistants. Five (5) research assistants with one assigned to ten (10) clubs during the administration of the instrument. Out of three thousand (3,000) copies of questionnaire forms administrated two thousand seven hundred (2,700) correctly completed and returned which represents 90 % return rate were coded for analysis descriptive statistics of percent acted and chi-square (X^2) influential statistics were applied for the data analysis at 0.05 level of significance.

Data Analysis and Discussion

Table 1

Chi-square table of poor officiating

Responses	Frequencies	Frequencies %	X^2	Agreement Disagreement	Remarks
S.A	800	29.629	416.1	74.073	
A	1,200	44.444		25.927	**Significant**
D	315	11.667		100 %	
Total	2,700	100			

Chi Square Vaue X^2 = 416.1; df 3; P = 0.05; Table Value: 7.815; Hypothesis: Significant

Table 1 above provides cursory analysis of chi-square value on poor officiating as an etiology of anti-social behavior among football players and spectators of the clubs selected for the study. From the table it is vivid that the obtained chi-square X^2 value is significantly greater than the table value. This result logically depicts that the hypothesis which started that poor officiating would be an etiology of anti-social behavior among football players and spectators is rejected. This outcome without doubt corroborates the findings of Babatunde (2000) that poor officiating in terms of partiality and non- adherence to rules and regulations of the game by the official forms a major causative factor of unruly behavior among players and spectators.

Table 2

Chi-square X^2 table of winning at all costs as an etiology anti-social behavior during football matches

Responses	Frequencies	Frequencies %	X^2	Agreement Disagreement	Remarks
S.A	650	24.074	255.45	70.37	**Significant**
A	1,250	46.296		29.63	
D	590	21.852			
Total	210	77.78			
	2,700	100		100 %	

Chi Square Value X^2 = 255.45; df = 3; P = 0.05; Table Value: 7.815; Hypothesis: Significant

The Table 2 concentrates on the winning at all costs as an etiology of anti-social behavior among players and spectators. Babatunde (2000) observed that players who want to win at all costs do not always observe rules of the game, talk less of having regards for their opponents. The obtained chi-square (X^2) value as provided in table 2 is substantially bigger than the table value which justifies that the hypothesis that winning at all costs would not be the etiology of unethical behavior among players and spectators is refuted. Babalola and Oyeniyi (2003) unequivocally submitted that when players pursue winning at all costs, such player always disregard rules and regulations governing the game, thereby precipitating avoidable adverse behavior. Babatunde (2000) remarked that all over the world football game remains a sensitive enterprise that can generate friction particularly, if the rules are violated by the players or officials.

Sulaiman (2012), Oyeniyi (2001) and Babatunde (2000) found that winning at all costs make players not to display needed regards for the opponents on the field as stipulated in the rules of the game, which eventually degenerates to anti-social behavior. Sulaiman (2012) said that play to win at all costs may lead a player to cheat in order to reach his or her goal. It was further the mentioned that athletic point to their coaches as having a heavy influence on their decisions to win at all costs.

Table 3

Chi-square (X^2) table of conduct of coach as an etiology of anti-social behavior among players and spectators

Responses	**Frequencies**	**Frequencies %**	**X^2**	**Agreement Disagreement**	**Remarks**
S.A	750	27.778	356.64	77.778	**Significant**
A	1,350	50.000		22.222	
D	420	15.556			
Total	180	6.666		100%	
	2,700	100 %			

Chi Square X^2 Value = 356.64; df = 3; P = 0.05; Table Value: 7.815; Hypothesis: Significant

Table 3 gives vivid information of conduct of coach as a factor responsible for anti-social behavior of football players and spectators during football contests. Like leader, like follower, Babatunde (2000) elucidated that the remote and immediate conduct of coaches is often instrumental to undesirable behavior demonstrated, especially by the players. Empirical observations such as Sulaiman (2012), Omotayo (2008), Babalola and Oyeniyi (2003) reported that the attitude of players good is related to training and support received from their coaches. Judging from the statistical information provided in the table 3, the alternative hypothesis is accepted while null hypothesis is rejected.

Omotayo (2008) reported that coach is always accountable for the competent and non-competent of players on the field of play. Babalola and Oyeniyi (2003) elicited that bad conduct of coaches or games masters at competitions can lead to hooliganism. There are occasions where coaches actually and overly instrumental to unruly behavior of athletes or players by their negative dispositions. Babatunde (2000) exposed that adverse comments of coaches may spur unethical behaviors among players as well as spectators. Many of the players according Sulaiman (2012) dwell on the negative comments of the coaches to manifest undesirable behavior on the field of play.

Table 4

Chi-square (X^2) of alcohol consumption as an etiology of anti-social behavior among football players and spectators

Responses	**Frequencies**	**Frequencies %**	**X^2**	**Agreement Disagreement**	**Remarks**
S.A	730	27.037	309.69	81.481	**Significant**
A	1,470	54.444			
D	261	9.667		18.519	
	239	8.852		100 %	
Total	2,700	100			

Chi-square (X^2) = 309.69: df= 3; P = 0.05; Table Value: 7.815; Hypothesis: Significant

Alcohol is a common feature at national and international football events due to the fact that some of the events may have been sponsored by one beverage or the other. Although there are restrictions on alcohol consumption or display at football events observations confirm that due to issue of sponsorship by alcohol producers of sports events, alcohol is allowed at sports venue. Table 4 provides a glance at vivid empirical analysis l of anti-social behavior among footballers and spectators due to alcohol.

The calculate chi-square x^2 value in The Table 4 is statistically greater than table value. Therefore, the null hypothesis which stated that alcohol consumption would not be an etiology of unruly behavior among football players and spectators is rejected, while the alternative hypothesis is accepted. This shows that alcohol or any hard drug consumption is a strong variable aggravating anti-social behavior among players and spectators during matches. Babalola and Oyeniyi (2003), Oyeniyi (2001) and Babatunde (2000) attested to the fact that the use of hard drugs and alcohol by players and spectators prior time the close to or during competition could induce hooliganism. This is due to the fact that drugs and alcohol when used by players and spectators do affect their level of judgement and behavior, which may lead to players and other stakeholders to play dangerously and act negatively which is capable of

causing injury and disorderliness. Babatunde (2004) reiterated that alcohol is often associated with crime, poverty and other social problems, including hooliganism and other related disorderliness. Corporation (2018) remarked that alcohol is recognized as a factor that may contribute to anti-social and violent behavior at football matches although the casual relationship remains unclear. Bushman & Cooper (1999) indicated that studies have described a link between alcohol consumption and display of aggression in some individuals. To support the link of alcohol and football matches, Eberhardt et al (2016) reported that almost half of surveyed fans at the 2014 World Cup reported having consumed alcohol prior to entering a stadium. In further support of legal availability of alcohol at football match venue, Elgan et al (2018) exposed that designated areas as created typically condoned off public spaces with specific regulations and security arrangements for fans, spectators to congregate, watch matches on giant screens and enjoy other forms of entertainment. In these spaces, alcohol sales and purchases are typically permitted via official vending points.

Conclusions

The thrust of the research is on the etiology of anti-social behavior of football players and spectators during competitions. The spectators comprise general crowd, supporters as well as fans. The outcomes of the research work analytically conclude the following:

1. Poor officiating is a critical factor for anti-social behavior among players and spectators
2. Winning at all costs is also found as a significant issue that generates disorderliness among football players and spectators during football matches.
3. Conduct and disposition of coaches are found to be significant causative factor of anti-social behaviors among players and spectators
4. The study identified alcohol among other predisposing factors of ugly behavior of players and spectators as a strewing indismissible root cause of unethical behavior during football matches.

Recommendations

There is no doubt that football game is an important and popular sports nationally and internationally. This is why the game attracts high magnitude of crowd across the world. In contrast to the inherent values of the game, the matches sometimes are characterized by anti-social behaviors due to variety of reasons. The study systematically isolated some of the factors behind the unethical behaviors during football matches, with a view to figure out scientific but

programmatic strategies by which such identified disorderliness can be arrested. Therefore, the following recommendations are proffered:

1. Officials to be in involved in officiating should be those with records of personal integrity, credibility and proficiency in professionalism. Any unprofessional conduct observed among the officials when officiating must be treated or dealt with in concomitant with rules and regulations as provided by body governing the game. Officials should as a matter of ethics attempt to be as unobtrusive as possible and of not becoming a dominant force on the field.
2. Education of players, fans as well as spectators on essence of sportsmanship would go a long way in reducing winning at all costs attitude of these stakeholders .This can be promoted by organizing seminars for all the stakeholders and via various media. Organizing spectators' education through various media and seminars, focusing on importance of desirable conduct at game site by the bodies concerned with organization of football contests will substantially help to reduce undesirable behavior among spectators and fans.
3. Players who demonstrate any unethical behavior on the field during the context should be disciplined as law provided. The law for misbehavior of any player during match must be strictly enforced by the governing body of the game.
4. The governing bodies of football games as a matter of policy must enforce restrictions of the sales of alcohol at the game sites by applying conferment of the sales and consumption of alcohol to a given place a bit far away from the field of play since the sale may not be totally prohibited or curtailed since the management of such breweries are often the sponsors of the competitions.

References

1. BABALOLA J. F. & P. O. OYENIYI, 2003. Cursory hooliganism during collegiate spent in Nigeria: *West African journal of physical & health education*. 7: 58-63, Ibadan, department of human kinetics and health education, university of Ibadan.
2. BABATUNDE, S. O., 2000. *Panacea to sport violence at collegiate level proceeding of the 1st 1 CHAPER* –SP, African regional conference 109-112.
3. BABATUNDE, S. O., 2005. Socio-cultural perspectives of sports participation. *Ilonri journal of health, physical education and relation department of physical and health education*. 4:43-50. University of Ilorin.

4. BABATUNDE, S. O., 2000. *Alcohol and alcoholism in ogundele, B.O (Ed) problems in health education.* Ibadan; Department of human kinetics and health education, university of Ibadan 115-133.
5. BUSHMAN B. & H.M. Cooper, 1990. Effects of alcohol on human aggression: *an integrative research review, psychological bulletin.* **07**(3): 341-54 Corporation (2018) https: //www.rand.org/ pubs/research- reports/ rr2777.html.Cording, S(2018) NO alcohol (advertising) No world cup:- FIFA'S influence on alcohol regulation.
6. CORPORATION, 2018.https//www.rand.org/research_reports/RR2777.htmml.
7. DURBEEJ N., T. H. ELGAN & C. D. JALLING GRRIPENBERY, 2017. Alcohol Intoxication at Sweedish Football matches Football matches: A study using piological sampling to assess blood alcohol concentration level among spectators, plos one 129110: e0188284.Eberhardt KA vinnemeier, C.D Health Risks Related to Mass Gathering/Sports Events and Implications for the Summer Olympic Games in Rio de Janeiro in 2016. *Travel Medicine and infectious Disease.* **14**(3):212-20.
8. EBERHARDT, K. A., C. D. Vinnemeier, J. Dehnerdt, T. Rolling, R. Steeffen & J. P. Cramer, 2016.*Travelerst the FIFA Word Cup* 2014 in Brazil:
9. ROLLIN T., R. STEFFEN & J. P. CREAMER, 2001B. *Traveler to the FIFA world cup 2014 in Brazil health risks related to mass gathering sports events and implications for the summer Olympic games in Rio de Janairo in 2016.*
10. ELGEN, T. H., H. D. N DURBEEJI & J. HOLDER GRIPENBERG, 2018. Over serving and Allowed Entry of Obviously Alcohol Intoxicated Spectators at Sporting Events'. Alcohol; *Clinical and Experimental Research.* **42**(2): 444-52. ESPN. 2018, UEFA Lifts Champions league and EuropA League Alcohol Ban' 26 June 2018;
11. OWOLABI, E. O, 1992. Reducing sports costs through effective control of violence in sports. In Adesanya, O. A Onifade A., Obayemi, W, Morakinyo E.O. Akaindetire I.O. (Eds) *Journal of Nigeria Academic of Sports Administration.* **I**(1x2).
12. SULAIMAN, O. F., 2012. Anti-Social Behaviors Causation Among Football Players and Spectators. An unpublished M.sc dissertation.
13. OMOTAYO, O. O., 2008. Selected Nigerian soccer players opinion on appropriation of identified solution to soccer game hooliganism and violence. *Nigerian journal of sports management*. **2(**39-44) Lagos: Nigeria society for sports management % department of physical and health education, Lagos state university Ojo.

14. OYENIYI, P. O., 2001. Sourcing funds for effective administration of school sports in Nigeria. In Y. AWOSIKA, J. F. BABALOLA, J. O. OSIKI & B. O. EMUNEMU (eds.) *Topical Issue in Education*: Papers In Honour of Prof. C.O. Udoh, Ibadan: CodatPublications, pp. 11 – 18.

DOI 10.2478/afepuc-2021-0004
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(1): 35-51

THE ANTHROPOMETRIC AND PHYSIOLOGICAL CHARACTERISTICS OF YOUNG ALGERIAN SOCCER PLAYERS

Wahib Beboucha, Adel Belkadi, Abdelkader Benchehida, Ali Bengoua

Laboratory for Optimizing Research Programmes on Physical and Sports Activities, Institute of Physical Education and Sport, University of Mostaganem (Algeria).

Summary: Objective: The aim of this paper was to describe the anthropometric and physiological characteristics of young soccer players (U13) which were associated with their being successful or not as soccer players, and also to determine standard levels in the light of a test battery and indicators to select and guide the young talents as a scientific means to facilitate the selection.
Method: A total of 390 soccer players age (U13). From 14 Algerian soccer clubs were enrolled and subjected to standard anthropometric, fitness (speed 20m, CMJ, skills-related performance testing. The testing battery will be described as will the process for converting test data into standardized scores. Data will be presented to show the strengths and weaknesses of some players.
Result: After analysing the results based on the standard criteria for the proposed tests as well as the overall performance variable. And the ability of each youth to be selected according to their potential, and therefore it was stressed that the proposed criteria, which are scientific support for the field observation, should be emphasized to facilitate this process for Algerian soccer players.
The findings from this study indicate that marked improvements and parameters associated with physical maturity such as height, weight, speed, VO2max, or chronological age are important to determine the success of a soccer player. At older ages, other factors such as agility seem to be more important. Nevertheless, players born in the 1st semester of the year are also more frequent in the older teams. These findings should be taken into account by trainers and coaches in order to avoid biasing their selection choices.

Keywords: standard levels, talents, battery test

Introduction

Soccer is recognized as the most widely practiced worldwide sport, 65 million players and 5 million referees and officials are actively involved in the game of Soccer (The FIFA 2014) and efficient organization of the team is essential for optimal development of the abilities

of every player (Gil et al. 2007), the control of the opponent, and the successful resolution of a match have received reasonable attention in the literature (Silva et al. 2010; Vescovi et al. 2011; Williams & Reilly 2000). Therefore, players are placed in certain positions to fulfil specific tasks (Bate & Jeffreys 2014; Drust, Reilly & Williams 2009). Both the tactic and the position of players on the soccer field are essential for the organization of a soccer match (da Costa et al. 2009; Kannekens, Elferink-Gemser & Visscher 2011). There is a growing body of literature that recognizes the importance of the growth, maturity status, functional capacities and skills of male youth soccer players (Malina et al. 2000, 2004, 2005; Malina 1994) with the aim of identification and selection of the best soccer player. Accordingly, many football clubs and national federations invest substantial resources into the detection, identification, and development of young talented soccer players, to ensure that the most promising players receive high-quality coaching and training conditions (Baker et al. 2017; Myers et al. 2014; Sarmento et al. 2018; Williams & Reilly 2000).

The context of modern football is characterized by repeated evaluation of footballers' potential to succeed at the elite, adult level and for test selection (Baker et al. 2017; Schorer & Elferink-Gemser 2013; Schorer et al. 2017; Söderström et al. 2018). Test selection begins with an assessment of sport-specific demands (physiological and biomechanical) (Cone 2012), followed by selection of tests and their associated validity and reliability (Cone 2012; Nabli et al. 2016; Wagner et al. 2019; Hoff 2005). Fitness testing may play an essential role in determining strength and conditioning before the athlete begins program and competitive season (baseline measurements)(Ferguson 2014; Walker & Turner 2009).The physiological demands of soccer require athletes to be trained in several fitness components (Svensson & Drust 2005), including aerobic capacity, aerobic power, speed, speed endurance, strength, power, and agility (da Silva, Guglielmo & Bishop 2010; Sayers, Sayers & Binkley 2008; Walker & Turner 2009; Yilmaz 2014). Therefore, when evaluating and preparing athletes for competition, the importance of physical assessment via the implementation of appropriate, valid, and reliable fitness testing cannot be overlooked (Sayers, Sayers & Binkley 2008). Fitness tests can be very effective for a number of reasons (Hoff 2005) including assessing an athlete's current level of fitness including the identification of an athlete's individual physical (Belkadi et al. 2019) strengths and weaknesses (Granacher et al. 2018; Hoff 2005; Sayers, Sayers & Binkley 2008; Zemková & Hamar 2018). Many physical tests have been implemented in clubs and academies over the years to evaluate physical performance in soccer players (Haugen & Seiler 2015). This long list includes linear sprinting, agility, repeated sprint ability,

VO2max, and Yo-Yo intermittent tests (Brocherie et al. 2015; Fernandez-Fernandez, Ulbricht & Ferrauti 2014; Lockie, Risso, et al. 2018; Nabli et al. 2016; Wagner et al. 2019).

There are several reports that have provided recommendations for what assessments should be included in a testing battery for soccer players (Cone 2012; Walker & Turner 2009; Sayers, Sayers & Binkley 2008). The tests selected for soccer players should specifically assess those factors that relate to soccer match play (Mohamed et al. 2019). The battery presented was adopted for a U13 years men's soccer from 14 teams. Explanations as to why these assessments were used by this team's coaching staff are provided. And this will serve to highlight the validity of the adopted assessments which is essential for appropriate athlete data collection (Miller 2012; Hoffman 2011). Furthermore, this particular testing battery has been adopted within formerly published scientific research in accordance with Lockie et al. (Lockie, Moreno, et al. 2018) also detailed the reliability and validity of each assessment. The testing battery also followed recommendations outlined in several National Strength and Conditioning Association text books and published paper (Baker et al. 2017; Sarmento et al. 2018; Wagner et al. 2019; Fernandez-Fernandez, Ulbricht & Ferrauti 2014; Miller 2012; Hoffman 2011; Bangsbo, Reilly & Williams 2014). The purpose of this article is to provide physical trainers and coaches of football clubs with evidence-based information enabling the effective implementation of an appropriate battery of football-specific fitness tests for U13. Firstly, this article will deal with the rationale for fitness tests and will be specifically intended for tests outside the laboratory. Various field tests, which assess the various components of physical condition declared specific to football will then be described and evaluated. Finally, a rationale for the choice of recommended tests will be reasoned and a timeline for implementation will be outlined.

Material & methods

Participants

The research was conducted on a sample of 390 soccer players belonging to the 14 top (U13) soccer club in Algeria which have at least 5 years of sport sand practice three training sessions per week (each about 90 min) and competed regularly in regional and national tournaments. The number of players in each team and their average age are shown in Table1. The average age of the soccer players (11.13 ± 2.65). All participants and their parents were informed about the purpose as well as experimental risks and benefits of the research. Parents or legal guardians provided written informed consent before the investigation. All Soccer players were free from any injury that would prevent maximal effort during performance

testing. The study was approved by the Ethics Committee of the University and conducted in accordance to the Declaration of Helsinki (World Medical Association 2013).

Table 1

Physical characteristics of the players in each competitive age group and results of comparisons between groups

	11-12 years (n =186)		**13 years (n =204)**		*p*	F	η^2
Variable	Mean	SD	Mean	SD			
Chronological age (CA), years	11,13	2,65	13,47	0,68	<0.01	732,58	0,82
Skeletal age (SA), years	12,29	1,56	13,98	1,28	<0.01	163,14	0,51
SA minus CA, years	0,16	0,91	0,51	0,60		2,81	0,18
Weight, kg	38,43	6,32	54,43	10,22	<0.01	149,96	0,49
Height, cm	144,93	6,82	163,83	9,42	<0.01	217,95	0,58
Sitting height, cm	73,33	3,22	82,03	5,02	<0.01	189,14	0,55
Estimated leg length, cm	72,03	4,62	82,13	5,32	<0.01	173,79	0,53
Sitting heightratio,%	50,83	1,42	50,33	1,32	<0.01	6,76	0,04
Sum of skinfolds, mm	32,73	14,62	36,63	16,22	<0.01	2,63	0,02

Study Protocol

To guarantee an appropriate execution of the exploratory tests, two acquaintance preliminaries were led in two separate days during the week preceding testing. Following two days from the last tests, players achieved two testing sessions split by 72 hours. Before every meeting, members were approached to abstain from hard physical exercises within 48 hours preceding testing (Chamari et al. 2004). They were likewise required to wear similar attire and footwear. The assessment of linear sprinting, jumping, and agility are common to soccer (G. Hoare & Warr 2000; Chamari et al. 2004) and were included in our battery of tests.

Anthropometry, Somatotype and Body Composition

In the first session, anthropometric characteristics including body height and mass were recorded. Each individual measurement and the sum of the 4 measurements were used for analysis. Fourskin folds (sub scapular, suprailiac, tricepsand medial calf). All the measurementswere made following the guidelines outlinedby the International Society for the Advancement of Kin- anthropometry (ISAK) by a level 2 ISAK anthropometrist.

Estimation of Aerobic Capacity

Aerobic abilities, agility and muscular power were tested. The yo-yo intermittent endurance test - level 1 (Krustrup et al. 2003; Bangsbo, Iaia & Krustrup 2008; Cusano, Ascione & Mezzapesa 2019). The test consists of repeated 2 × 20 m runs back and forth between the starting, turning, and finishing line at a progressively increased speed controlled by audio bleeps from a tape recorder (Bangsbo, Iaia & Krustrup 2008). Between each running bout, the subjects

have a 10 s active rest period consisting of 2 × 5 m of jogging. When the subjects twice have failed to reach the finishing line in time, the distance covered is recorded and represents the test result.

Estimation of the strength of the lower limbs

Performed five maximal CMJs on a piezo-electric force platform Quattro Jump (Kistler, Switzerland) connected to a portable computer force data were recorded with a sample rate of 500 Hz. This test involves the participant jumping, starting from an upright position, with arms free to move and was conducted following a protocol as in (Bosco 1992) recording the best of two jumps.

Estimation of speed abilities

The 20 m sprint is a well-known test considered suitable to discriminate the ability of soccer players to accelerate at a short distance as previously observed within the study (Moir et al. 2004). There is a 20 m track, in the stadium, with photocells positioned exactly 20 m from the starting line at height of 1 m. The participants started from a standing position placing their forward foot 30 cm before the first photocell and were asked to sprint 20 m. This test has demonstrated high levels of reliability: correlation coefficients of 0.91 between test and retest (Moir et al. 2004).

Estimation of the agility

A Illinois change of direction test (ICODT) was used to assess changes of direction (COD) profile among different patterns of movement including sprints, directional changes, turnings and slalom runs (Roozen 2004; Hachana et al. 2014). On command, from a standing position, participants ran from point A to point B as shown in Figure 1. They performed three trials resting 3 min in-between. Participants were also instructed not to cut over the cones but to move around without touching or hitting them. In case of failure, the trial was repeated after an extra recovery (~1 min).

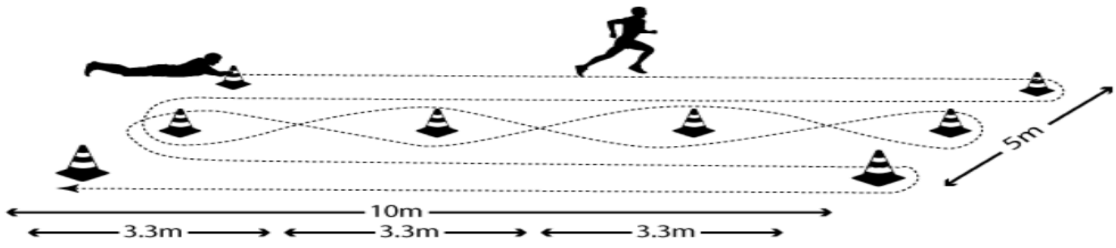


Figure 1
Illinois change of direction test (ICODT)

T-drill test with a ball

The main reason for choosing the T-drill classic test as a basis for a novel test was to determine agility outcomes and soccer shooting skills (Stewart, Carroll & Turner 2019; Šimonek 2019). The T-drill classic test is widely utilized to measure speed with directional changes such as forward sprinting, left- and right-side shuffling and back-pedaling. The Illinois agility test, which was also implemented in the current study, is commonly used to determine the ability to accelerate, decelerate, turn in different directions and run at different angles (Kutlu et al. 2012). Participants were instructed to sprint forward and kick the first ball with their right leg inside a soccer goal at ~10 m distance. Then, they shuffled to the left side kicking the second ball and shuffled back to the right side kicking the third and the fourth ball by alternating the shooting leg. After that, they ran backwards to the starting position. For each ball kicked inside the goal (score) 0.25 s was subtracted from the total time required to complete the course. For example, in the event of four scores, a reduction of 1s was applied to the total time. A recovery of 2 min was given between the trials.

Skills tests

The actual motor tasks of passing, controlling, dribbling and shooting the ball are fundamental aspects to the game of soccer (Ali 2011).

Dribbling tests

The ability to dribble the ball past opposing players is a hallmark of gifted players and hence is an oft-measured element of soccer skill (Kirkendall, Gruber & Johnson 1987; G. Hoare & Warr 2000; Rosch et al. 2000; Chamari et al. 2004). Most of the tests draw upon traditional coaching techniques of dribbling around cones placed 2 – 4 m away from each other in a figure-of-eight fashion (Sieghartsleitner et al. 2019) thus suggesting this type of test to be a valid and reliable indicator of soccer skill. Nevertheless, due to the nature of such tests they can be criticized for assessing the ‘‘technique’’ of dribbling rather than ‘‘skill’’ performance per/se.

Shooting tests

The clear aim of a soccer match is to score more goals than the opposing team. Therefore, one of the most highly valued and important skill elements within the game is the ability to score goals (Lyons, Al-Nakeeb & Nevill 2006). Goal-shooting tests are usually part of a battery of skill tests designed to assess overall soccer game performance (Haaland & Hoff 2003; Hachana et al. 2014). All of these tests require multiple attempts (using both feet) and aggregate points scored to determine overall performance. However, as shots are taken from a static position, it can be argued that they are assessing technique rather than skill. In addition,

there was no information on the speed of the shot, thus players could have hit the ball at speeds slower than those typical of match play. Furthermore, some of the tests required participants to shoot from relatively short distances (10 m) from the goal so they may have resembled more of a pass than a shot.

Passing tests

Accurately passing the ball to a team mate is an essential ability required by soccer players and many researchers have devised tests to examine this aspect (Rosch et al. 2000; Gil et al. 2007; Figueiredo et al. 2009; Walker & Turner 2009; Ali 2011). Studies were completed in this purpose (G. Hoare & Warr 2000) instructing players to pass the ball over distances of 5 m for 15 min; experienced coaches would then decide on performance ability.

Wall-pass tests

These tests require players to pass the ball through the air against a wall, control the rebound and make further air-borne passes against the wall typically with a set time limit and toward specific target a reason the wall (G. Hoare & Warr 2000; Williams & Reilly 2000; Silva et al. 2010; Turner et al. 2011; Hachana et al. 2014). Although a number of attributes are being assessed (including passing accuracy and control), this type of repeated wall-volley passing lacks ecological validity.

Statistical analysis

General characteristics of the participants were presented as means and standard deviations. Descriptive statistics were calculated by age group for all variables. Effect size was estimated with partial eta squared (η2)(Lakens 2013). Level of significance was accepted at $P < 0.05$.

Results

Table 2 provides an overview of the descriptive characteristics of the measured variables for U13 players. The analysis results show that all the applied variables are normally distributed (the data is not presented). Statistical differences between the groups in anthropometric measures and skill tests between players in different age are established in the variables: Fastest sprint ($F = 63,86$; $p = .0.01$), Agility shuttle run ($F = 102,41$; $p = .0.01$), Intermittent endurance run ($F = 82,75$; $p = .0.01$), Squat jump ($F = 57,94$; $p = .0.01$), Counter-movement jump ($F = 59,06$; $p = .0.01$), Ball control ($F = 23,54$; $p = .0.01$), Dribbling speed ($F = 107,55$; $p = .0.01$), Wall pass ($F = 39,51$; $p = .0.01$), Shooting accuracy ($F = 12,1$; $p = .0.01$).

Table 2

Descriptive statistics for age and the skill tests for the total sample (n = 390) of adolescent soccer players

	11-12 years (n = 186)		**13 years (n = 204)**				
Variable	**Mean**	**SD**	**Mean**	**SD**	**F**	**p**	**n2**
Fastest sprint, s	8,37	0,5	7,8	0,39	63,86	<0.01	0,29
Mean sprint, s	8,79	0,6	8,06	0,43	76,22	<0.01	0,33
Agility shuttle run, s	20,55	1,32	18,69	0,92	102,41	<0.01	0,4
Intermittent endurance run, m	1371	731	2556	912	82,75	<0.01	0,35
Squat jump, cm	23,8	4,3	28,8	4	57,94	<0.01	0,27
Counter-movement jump, cm	26,2	4,5	31,9	4,9	59,06	<0.01	0,27
Ball control, no. Hits	23.9*	22,1	68.4*	82,3	23,54	<0.01	0,13
Dribbling speed, s	15,77	1,81	13,36	0,88	107,55	<0.01	0,41
Wall pass, points	18	3,2	21,2	3,2	39,51	<0.01	0,2
Shooting accuracy, points	6,5	2,5	8,1	3,1	12,1	<0.01	0,07

Discussions

The findings of the current study show that talent selection models with the single dimensions lead in general to significant predictions with the aim of an early differentiation between 11 – 12 years and 13 years old players. Many talent identification models showed superiority over random predictions and were also calibrated appropriately for the U11, U12, and U13 age groups). Compared to the significance of predictions and the higher explained variance from the more extensive, multidimensional selection models within a similar group of participants, the less extensive models in the current study indicate substantially lower prognostic validity (Sieghartsleitner et al. 2019). This may underline the assumed advantages of multidimensionality over less extensive models (Vaeyens et al. 2008; Williams & Reilly 2000; Zuber et al. 2016). However, as long as these multidimensional models are not easily applicable to talent selection in the field (Belkadi et al. 2015), the immediate comparison between possible predictors of later performance may be of certain relevance within talent research.

The findings from this study support the discriminant validity of tests as a talent identification tool for measuring skill proficiency. High-level players displayed proficient skill behaviours for soccer-specific actions related to passing and controlling the ball along with completing more total involvements. This study's methodological approach provides coaches with a simplistic way of assessing soccer-specific skills in a practical setting. Set teams allow for players to self-discover technical and tactical strategies for problem solving with their teammates to meet the constraints of the fitness tests and adapt these as the relationship with their teammates develops (Davids et al. 2013). As players in a talent identification setting often

develop with the same teammates, it seems logical to use set teams within small-sided games. However, it is important for future research to also investigate the use of small-sided games for measuring skill proficiency when players compete in randomized teams. Randomizing teams will likely impose different technical and tactical constraints on players as they will have to adapt their behaviour according to the proficiency of their teammates. This approach may allow coaches to determine the cooperative nature of players with a diverse number of individuals.

As expected, anthropometric characteristics increased across the age groups as did the performance in functional capabilities. Previews study Deprez et al. (2014a) was evaluated in comparison with our study on the anthropometric and functional profile of 390 young soccer players between 11 and 13 years old in Algeria. An increase in anthropometric and function al measurements was observed as age increased. It has been verified that between the U11 and U12 categories, selection processes focus primarily on anthropometric characteristics of the goalkeepers and specific motor skills for midfield players. After the peak growth rate (U13), anaerobic performance becomes an important indicator (Saddek et al. 2020) to distinguish attackers from other positions.

Based on the immediate comparisons of different predictors of future performance in youth football, the current research contrasted the value of two different areas of motor performance for early talent selection. In doing so, there was a continuous superiority of sprint in descriptive values within each analysed age group through early (U11/U12) and middle adolescence (U13) despite the higher measurement reliability of the sprint test. None of the four comparisons at the different age groups led to a significant difference between sprint of U12 and U13 ($.07 \leq N2 \leq .65$).

Aerobic endurance assessed by the Yo-Yo Intermittent Recovery Test Level 1 was shown to be a predictor of defensive tactical performance in the U13 category, and explained 53% of the variance (Borges et al. 2018). The soccer defensive principles require constant movements of the player in the game space to regain ball possession. It is possible that the aerobic metabolism contributes significantly to supplying the energy demands of these movements where players with superior cardio- respiratory fitness are able to advance to the opponent's field to attack and/or return to cover and defend their zone more effectively (Santos and Soares 2001).

In the U13 category, training experience explained 19% of the variance in defensive tactical performance. Figueiredo et al. (2011), analysing predictors of functional capabilities

and specific motor skills in 390 young Algerian soccer players, concluded that training experience influenced shooting accuracy (R2 = 0.07) and dribbling ability (R2 = 0.41). Together these findings and the results of the present study demonstrate the importance of training experience in technical and tactical development in youth soccer.

Collectively, the Yo-Yo test, the Counter Movement Jump, abdominal strength, and body mass predicted 43 % of the variance in defensive tactical performance of 11 – 13 year-old soccer players. It is possible that the strongest players were encouraged by coaches to adopt more defensive roles and tactics, as greater body size and physical strength contribute to an advantage in the defensive system, since invasion sports are characterized by intense physical contact (Costa et al. 2010). Consistent with this finding, Deprez et al. (2014a) reported that U11 and U13 defenders were less tall and less heavy than midfielders and attackers, suggesting prevalence of taller, stronger players, more advanced in the maturational process.

As a practical application of these results, it is suggested that clubs and federations avoid selecting players guided by unilateral criteria favoring only physical and morphological advantages (Vandendriessche et al. 2012). Tactical, technical, and psychological qualities together with functional capabilities manifest themselves in symbiosis during the game and should be seen in that way during selection, detection, and sporting formation processes (Jones and Drust 2007).

A possible limitation of the study was the adoption of a cross-sectional design to the detriment of the longitudinal section which limits understanding of the variables during the maturational process. Future research should seek to employ more accurate measures of maturation. However, this study may contribute to future research involving the underlying processes in the development of young soccer players aiming to optimize this complex process identification.

Conclusion

This study was the first to examine the applicability of battery test as an assessment tool to determine the skill proficiency of youth soccer players. It was observed that players from the high-level academy displayed a significantly greater number of attempted and completed passes, touches, and overall skill involvements when compared with low-level players. In addition, skill proficiency remained relatively constant across different small-sided games (Bennett 2019).

Collectively, these findings support the use of battery test as a skill assessment tool for talent identification purposes. The information gained from such assessments can assist coaches in determining the potential of youth soccer.

Funding: financing was granted by Algerian General Directorate for Scientific Research and Technological Development (DGRSDT-MESRS) during this study.

Conflicts of interest: the authors state no conflicts of interest regarding this study.

Acknowledgements: We thank the Algerian General Directorate for Scientific Research and Technological Development (DGRSDT-MESRS) for their co-operation and help in setting up the study. also, for maintaining and supporting finances and quality of research.

References

1. ALI, A., 2011. Measuring soccer skill performance: a review. *Scandinavian Journal of Medicine & Science in Sports.* **21**(**2**), pp. 170-183. ISSN 1600-0838. DOI 10.1111/j.1600-0838.2010.01256.x.
2. BAKER, J., S. COBLEY, J. SCHORER, N. WATTIE, S. COBLEY, J. SCHORER & N. WATTIE, 2017. *Routledge Handbook of Talent Identification and Development in Sport* [en línea]. S.l.: Routledge. [Consulta: 23 enero 2020]. ISBN 978-1-315-66801-7. Disponible en: https://www.taylorfrancis.com/books/e/9781315668017.
3. BANGSBO, J., F. M. IAIA & P. KRUSTRUP, 2008. The Yo-Yo intermittent recovery test. *Sports medicine.* **38**(**1**), pp. 37-51.
4. BANGSBO, J., T. REILLY & A. M. WILLIAMS, 2014. *Science and Football III*. S.l.: Routledge. ISBN 978-1-317-83294-2.
5. BATE, R.G. & I. JEFFREYS, 2014. *Soccer Speed*. S.l.: Human Kinetics. ISBN 978-1-4925-8480-3.
6. BELKADI, A., A. BENCHEHIDA, O. BENBERNOU & M. SEBBANE, 2019. Competencies and training needs and its impact on determining the professional skills of Algerian elite coaches. *International Journal of Physical Education, Fitness and Sports.* **8**(**3**), pp. 51-61. ISSN 2457-0753. DOI 10.26524/ijpefs1936.
7. BELKADI, A., B. OTHMAN, S. M. MOHAMED, J. GLEYSE, B. ADEL, B. OTHMAN, S. MOHAMED, L. M. ABDELHAFID & J. GLEYSE, 2015. Contribution to the Identification of the Professional Skills Profile of Coaches in the Algerian Sport Judo System. *International Journal of Sports Science.* **5**(**4**), pp. 145-150. ISSN 2169-8791.

8. BENNETT, K. J. M., 2019. *An Australian perspective on talent identification and development in soccer*. S.l.: s.n.
9. BORGES, P. H., S. CUMMING, E. R. RONQUE, F. CARDOSO, A. AVELAR, L. RECHENCHOSKY, I. T. DA COSTA & W. RINALDI, 2018. Relationship between tactical performance, somatic maturity and functional capabilities in young soccer players. *Journal of human kinetics.* **64**(**1**), pp. 160-169.
10. BOSCO, C., 1992. *L'évaluation de la force par le test de Bosco*. S.l.: Società stampa sportiva.
11. BROCHERIE, F., O. GIRARD, R. FAISS & G. P. MILLET, 2015. High-intensity intermittent training in hypoxia: a double-blinded, placebo-controlled field study in youth football players. *The Journal of Strength & Conditioning Research.* **29**(**1**), pp. 226-237.
12. CHAMARI, K., Y. HACHANA, Y. B. AHMED, O. GALY, F. SGHAIER, J. C. CHATARD, O. HUE & U. WISLØFF, 2004. Field and laboratory testing in young elite soccer players. *British journal of sports medicine.* **38**(**2**), pp. 191-196.
13. CONE, J. R., 2012. Soccer-Specific Performance Testing of Fitness and Athleticism: The Development of a Comprehensive Player Profile. *Strength & Conditioning Journal.* **34**(**5**), pp. 11-19. ISSN 1524-1602. DOI 10.1519/SSC.0b013e3182575e8c.
14. CUSANO, P., A. ASCIONE & G. N. MEZZAPESA, 2019. Reliability of aerobic and anaerobic field tests in in measuring athletes' performances: A statistical approach on a cohort of 100 subjects. En: Accepted: 2018-10-29T10:14:04Z [en línea], [Consulta: 6 junio 2020]. ISSN 1988-5202. DOI 10.14198/jhse.2019.143.02. Disponible en: http://rua.ua.es/dspace/handle/10045/82692.
15. DA COSTA, I. T., J. M. G. DA SILVA, P. J. GRECO & I. MESQUITA, 2009. Tactical principles of Soccer: concepts and application. *Motriz.* **15**(**3**), pp. 657-668.
16. DA SILVA, J. F., L. G. A. GUGLIELMO & D. BISHOP, 2010. Relationship Between Different Measures of Aerobic Fitness and Repeated-Sprint Ability in Elite Soccer Players. *The Journal of Strength & Conditioning Research.* **24**(**8**), pp. 2115-2121. ISSN 1064-8011. DOI 10.1519/JSC.0b013e3181e34794.
17. DRUST, B., T. REILLY & A. M. WILLIAMS, 2009. *International Research in Science and Soccer*. S.l.: Routledge. ISBN 978-1-135-99955-1.
18. FERGUSON, B., 2014. ACSM's Guidelines for Exercise Testing and Prescription 9th Ed. 2014. *The Journal of the Canadian Chiropractic Association.* **58**(**3**), pp. 328. ISSN 0008-3194.

19. FERNANDEZ-FERNANDEZ, J., A. ULBRICHT & A. FERRAUTI, 2014. Fitness testing of tennis players: How valuable is it? *Br J Sports Med.* **48**(**Suppl 1**), pp. i22-i31.
20. FIGUEIREDO, A. J., C. E. GONÇALVES, M. J. COELHO E SILVA & R. M. MALINA, 2009. Youth soccer players, 11-14 years: maturity, size, function, skill and goal orientation. *Annals of Human Biology.* **36**(**1**), pp. 60-73. ISSN 1464-5033. DOI 10.1080/03014460802570584.
21. G. HOARE, D. & C. R. WARR, 2000. Talent identification and women's soccer: an Australian experience. *Journal of sports sciences.* **18**(**9**), pp. 751-758.
22. GIL, S. M., J. GIL, F. RUIZ, A. IRAZUSTA & J. IRAZUSTA, 2007. Physiological and anthropometric characteristics of young soccer players according to their playing position: relevance for the selection process. *Journal of Strength and Conditioning Research.* **21**(**2**), pp. 438-445. ISSN 1064-8011. DOI 10.1519/R-19995.1.
23. GRANACHER, U., C. PUTA, H., H. W. GABRIEL, D. G. BEHM & A. ARAMPATZIS, 2018. *Neuromuscular Training and Adaptations in Youth Athletes*. S.l.: Frontiers Media SA. ISBN 978-2-88945-627-7.
24. HAALAND, E. & J. HOFF, 2003. Non-dominant leg training improves the bilateral motor performance of soccer players. *Scandinavian journal of medicine & science in sports.* **13**(**3**), pp. 179-184.
25. HACHANA, Y., H. CHAABÈNE, G. B. RAJEB, R. KHLIFA, R. AOUADI, K. CHAMARI & T. J. GABBETT, 2014. Validity and Reliability of New Agility Test among Elite and Subelite under 14-Soccer Players. *PLOS ONE.* **9**(**4**), pp. e95773. ISSN 1932-6203. DOI 10.1371/journal.pone.0095773.
26. HAUGEN, T. & S. SEILER, 2015. Physical and physiological testing of soccer players: why, what and how should we measure? *Sportscience.* **19**, pp. 10-27.
27. HOFF, J., 2005. Training and testing physical capacities for elite soccer players. *Journal of Sports Sciences.* **23**(**6**), pp. 573-582. ISSN 0264-0414. DOI 10.1080/02640410400021252.
28. HOFFMAN, J., 2011. *NSCA's Guide to Program Design*. S.l.: Human Kinetics. ISBN 1-4925-8277-8.
29. KANNEKENS, R., M. T. ELFERINK-GEMSER & C. VISSCHER, 2011. Positioning and deciding: key factors for talent development in soccer. *Scandinavian Journal of Medicine & Science in Sports.* **21**(**6**), pp. 846-852. ISSN 1600-0838. DOI 10.1111/j.1600-0838.2010.01104.x.

30. KIRKENDALL, D. R., J. J. GRUBER & R. E. JOHNSON, 1987. *Measurement and evaluation for physical educators*. S.l.: s.n. ISBN 0-87322-081-1.
31. KRUSTRUP, P., M. MOHR, T. AMSTRUP, T. RYSGAARD, J. JOHANSEN, A. STEENSBERG, P. K. PEDERSEN & J. BANGSBO, 2003. The Yo-Yo Intermittent Recovery Test: Physiological Response, Reliability, and Validity. *Medicine & Science in Sports & Exercise.* **35**(**4**), pp. 697-705. ISSN 0195-9131. DOI 10.1249/01.MSS.0000058441.94520.32.
32. KUTLU, M., H. YAPICI, O. YONCALIK & S. CELIK, 2012. Comparison of a new test for agility and skill in soccer with other agility tests. *Journal of Human Kinetics.* **33**, pp. 143-150. ISSN 1640-5544. DOI 10.2478/v10078-012-0053-1.
33. LAKENS, D., 2013. Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *Frontiers in Psychology* [en línea], **4**. [Consulta: 3 febrero 2021]. ISSN 1664-1078. DOI 10.3389/fpsyg.2013.00863. Disponible en: https://www.frontiersin.org/articles/10.3389/fpsyg.2013.00863/full.
34. LOCKIE, R. G., M. R. MORENO, A. LAZAR, A. J. ORJALO, D. V. GIULIANO, F. G. RISSO, D. L. DAVIS, J. B. CRELLING, J. R. LOCKWOOD & F. JALILVAND, 2018. The physical and athletic performance characteristics of Division I collegiate female soccer players by position. *The Journal of Strength & Conditioning Research*. **32**(**2**), pp. 334-343.
35. LOCKIE, R. G., F. G. RISSO, D. V. GIULIANO, A. J. ORJALO & F. JALILVAND, 2018. Practical Fitness Profiling Using Field Test Data for Female Elite-Level Collegiate Soccer Players: A Case Analysis of a Division I Team. *Strength & Conditioning Journal.* **40**(**3**), pp. 58. ISSN 1524-1602. DOI 10.1519/SSC.0000000000000343.
36. LYONS, M., Y. AL-NAKEEB & A. NEVILL, 2006. Performance of soccer passing skills under moderate and high-intensity localized muscle fatigue. *Journal of Strength and Conditioning Research.* **20**(**1**), pp. 197.
37. MALINA, R. M., 1994. Physical growth and maturation of young athletes. En: 389, *Exerc Sport Sci Rev.* **22**, pp. 389-433. 14
38. MALINA, R. M., S. P. CUMMING, A. P. KONTOS, J. C. EISENMANN, B. RIBEIRO & J. AROSO, 2005. Maturity-associated variation in sport-specific skills of youth soccer players aged 13–15 years. En: 515, *J Sports Sci.* **23**, pp. 515-522. 18
39. MALINA, R. M., J. C. EISENMANN, S. P. CUMMING, B. RIBEIRO & J. AROSO, 2004. Maturity-associated variation in the growth and functional capacities of youth football (soccer) players 13–15 years. En: 555, *Eur J Appl Physiol.* **91**, pp. 555-562. 19

40. MALINA, R. M., M. E. PENA REYES, J. C. EISENMANN, L. HORTA, J. RODRIGUES & R. MILLER, 2000. Height, mass and skeletal maturity of elite Portuguese soccer players aged 11–16 years. En: 685, *J Sports Sci.* **18**, pp. 685-693. 20
41. MILLER, T. A., 2012. *NSCA's Guide to Tests and Assessments*. S.l.: Human Kinetics. ISBN 1-4925-8278-6.
42. MOHAMED, K. S., K. MOHAMED, S. MOHAMMED, D. MOKRANI & A. BELKADI, 2019. The Effect of Heavy Weight Training on Physiological Abilities of Soccer Players Under the Age 21 Years Old. *Acta Facultatis Educationis Physicae Universitatis Comenianae.* **59**(**1**), pp. 33-43. DOI 10.2478/afepuc-2019-0004.
43. MOIR, G., C. BUTTON, M. GLAISTER & M. H. STONE, 2004. Influence of familiarization on the reliability of vertical jump and acceleration sprinting performance in physically active men. *Journal of strength and conditioning research*. **18**(**2**), pp. 276-280.
44. MYERS, B. A., W. L. JENKINS, C. KILLIAN & P. RUNDQUIST, 2014. NORMATIVE DATA FOR HOP TESTS IN HIGH SCHOOL AND COLLEGIATE BASKETBALL AND SOCCER PLAYERS. *International Journal of Sports Physical Therapy.* **9**(**5**), pp. 596-603. ISSN 2159-2896.
45. NABLI, M. A., N. B. ABDELKRIM, I. JABRI, T. BATIKH, C. CASTAGNA & K. CHAMARI, 2016. Fitness Field Tests' Correlation With Game Performance in U-19-Category Basketball Referees. *International journal of sports physiology and performance.* **11**(**8**), pp. 1005-1011.
46. ROOZEN, M., 2004. Illinois agility test. *NSCA's Performance Training Journal.* **3**(**5**), pp. 5-6.
47. ROSCH, D., R. HODGSON, L. PETERSON, T. GRAF-BAUMANN, A. JUNGE, J. CHOMIAK & J. DVORAK, 2000. Assessment and evaluation of football performance. *The American journal of sports medicine.* **28**(**5_suppl**), pp. 29-39.
48. SADDEK, B., J. B. J. COQUART, L. MOUROT, B. ADEL, M. M. IDRISS, B. ALI & M. DJAMEL, 2020. Comparison of Two Tests to Determine the Maximal Aerobic Speed. *Acta Facultatis Educationis Physicae Universitatis Comenianae.* **60**(**2**), pp. 241-251. DOI 10.2478/afepuc-2020-0020.
49. SARMENTO, H., M. T. ANGUERA, A. PEREIRA & D. ARAÚJO, 2018. Talent Identification and Development in Male Football: A Systematic Review. *Sports Medicine (Auckland, N.Z.).* **48**(**4**), pp. 907-931. ISSN 1179-2035. DOI 10.1007/s40279-017-0851-7.

50. SAYERS, A., B. E. SAYERS & H. BINKLEY, 2008. Preseason Fitness Testing in National Collegiate Athletic Association Soccer. *Strength & Conditioning Journal.* **30**(**2**), pp. 70-75. ISSN 1524-1602. DOI 10.1519/SSC.0b013e31816a8849.
51. SCHORER, J. & M. ELFERINK-GEMSER, 2013. How good are we at predicting athletes' futures. *Developing sport expertise: researchers and coaches put theory into practice. 2nd ed. London: Routledge*, , pp. 30-40.
52. SCHORER, J., N. WATTIE, S. COBLEY & J. BAKER, 2017. Concluding, but definitely not conclusive, remarks on talent identification and development. *Routledge Handbook of Talent Identification and Development in Sport*. S.l.: Routledge, pp. 466-476.
53. SIEGHARTSLEITNER, R., C. ZUBER, M. ZIBUNG, B. CHARBONNET & A. CONZELMANN, 2019. Talent selection in youth football: Technical skills rather than general motor performance predict future player status of football talents. *Current Issues in Sport Science (CISS)* [en línea], **0**(**0**). [Consulta: 19 junio 2020]. ISSN 2414-6641. DOI 10.15203/CISS_2019.011. Disponible en: https://atem-journal.com/ojs2/index.php/ciss/article/view/2946.
54. SILVA, M. J. C., A. J. FIGUEIREDO, F. SIMÕES, A. SEABRA, A. NATAL, R. VAEYENS, R. PHILIPPAERTS, S. P. CUMMING & R. M. MALINA, 2010. Discrimination of U-14 Soccer Players by Level and Position. *International Journal of Sports Medicine.* **31**(**11**), pp. 790-796. ISSN 0172-4622, 1439-3964. DOI 10.1055/s-0030-1263139.
55. ŠIMONEK, J., 2019. *Agility in Sport*. S.l.: Cambridge Scholars Publishing. ISBN 1-5275-4222-X.
56. SÖDERSTRÖM, T., J. FAHLÉN, M. FERRY & J. YU, 2018. Athletic ability in childhood and adolescence as a predictor of participation in non-elite sports in young adulthood. *Sport in Society.* **21**(**11**), pp. 1686-1703. ISSN 1743-0437. DOI 10.1080/17430437.2017.1409726.
57. STEWART, P. F., N. P. CARROLL & A. N. TURNER, 2019. Strength, Power, Speed, and Agility in Soccer. *Elite Soccer Players: Maximizing Performance and Safety*, pp. 175.
58. SVENSSON, M. & B. DRUST, 2005. Testing soccer players. *Journal of Sports Sciences.* **23**(**6**), pp. 601-618. ISSN 0264-0414. DOI 10.1080/02640410400021294.
59. THE FIFA, 2014. International Federation of Association Football (FIFA). The FIFA Big Count. Retrieved from. *International Federation of Association Football (FIFA)*. [en línea].

Disponible en: http://www.fifa.com/worldfootball/bigcount/allplayers.html. Updated February 3rd, 2014.

60. TURNER, A., S. WALKER, M. STEMBRIDGE, P. CONEYWORTH, G. REED, L. BIRDSEY, P. BARTER & J. MOODY, 2011. A Testing Battery for the Assessment of Fitness in Soccer Players. *Strength & Conditioning Journal.* **33**(**5**), pp. 29. ISSN 1524-1602. DOI 10.1519/SSC.0b013e31822fc80a.
61. VESCOVI, J. D., R. RUPF, T. D. BROWN & M. C. MARQUES, 2011. Physical performance characteristics of high-level female soccer players 12–21 years of age. *Scandinavian Journal of Medicine & Science in Sports.* **21**(**5**), pp. 670-678. ISSN 0905-7188. DOI 10.1111/j.1600-0838.2009.01081.x.
62. WAGNER, H., B. SPERL, J. W. BELL & S. P. VON DUVILLARD, 2019. Testing specific physical performance in male team handball players and the relationship to general tests in team sports. *The Journal of Strength & Conditioning Research.* **33**(**4**), pp. 1056-1064.
63. WALKER, S. & A. TURNER, 2009. A One-Day Field Test Battery for the Assessment of Aerobic Capacity, Anaerobic Capacity, Speed, and Agility of Soccer Players. *Strength & Conditioning Journal.* **31**(**6**), pp. 52. ISSN 1524-1602. DOI 10.1519/SSC.0b013e3181c22085.
64. WILLIAMS, A. M. & T. REILLY, 2000. Talent identification and development in soccer. *Journal of Sports Sciences.* **18**(**9**), pp. 657-667. ISSN 0264-0414. DOI 10.1080/02640410050120041.
65. WORLD MEDICAL ASSOCIATION, 2013. World Medical Association Declaration of Helsinki: ethical principles for medical research involving human subjects. *JAMA*. **310**(**20**), pp. 2191-2194. ISSN 1538-3598. DOI 10.1001/jama.2013.281053.
66. YILMAZ, G., 2014. The Effects of Power, Speed, Skill and Anaerobic Capacity of Different Training Models in Young Male Basketball Players. *The Anthropologist.* **18**(**3**), pp. 877-883. ISSN 0972-0073. DOI 10.1080/09720073.2014.11891619.
67. ZEMKOVÁ, E. & D. HAMAR, 2018. Sport-Specific Assessment of the Effectiveness of Neuromuscular Training in Young Athletes. *Frontiers in Physiology* [en línea], **9**. [Consulta: 23 enero 2020]. ISSN 1664-042X. DOI 10.3389/fphys.2018.00264. Disponible en: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5904431/.

sciendo

DOI 10.2478/afepuc-2021-0005
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(1): 52-61

THE COMPETENCE OF PROFESSORS OF PHYSICAL AND SPORTS EDUCATION IN THE USE OF MODERN TEACHING STRATEGIES FOR MIDDLE SCHOOL UNDER THE SECOND GENERATION CURRICULUM

Bengueneb Abdarahmane, Atallah Ahmed, Djourdem Bendehiba

University of Abdelhamid Ibn Badis, Mostaganem, Laboratory of Programs Optimization in APS, Algeria

Summary: The study aims at identifying the degree of competency of the teacher of physical education and sports in using modern teaching strategies in light of what was stipulated by the second generation. The Study sample consists of **60** intermediate education teachers, and relies on a list prepared by the research team consisting of two axises, each axis containing 16 items that include familiarity with and employing modern strategies in the study of physical education and sports, as well as the general organization of the lesson the data are processed statistically using the arithmetic means standard deviation, and the results showed that the teachers of Physical education and sports in middle school do not use modern teaching strategies. This is due to their lack of competence.

Keywords: Competency – the teacher of physical Education and Sports – Teaching Strategies – second Generation

Introduction

The school is an educational institution which contributes to the education of the individual and helps him to grow in all aspects of his physical, psychological, mental, spiritual and social personality. It also helps to develop the will of individuals and to correctly orient their preferences and desires and modify their behavior and provide them with expertise and skills to help them adapt to the society in all areas (Bekhtaoui 2020). By expanding the process of education and improving the quality of learning at different levels of education in order to prepare children and young people in a more complex life throughout. The current century, which is characterized by rapid technological development, is a real measure of the development of the scientific and cultural level reached by the country. And to achieve the new

and modern tasks of physical and sports education requires a departure from the traditional system of teaching based on authoritarianism at work to modern teaching, which calls for the modernization and development of curricula and their content and teaching methods to ensure that they keep up with the new developments and contemporary trends.

The process of modernization and renewal in the field of methods teaching strategies is no longer an area of discussion, but have become urgent and vital in order to balance life rapidly changing in the age of globalization and the role that educational systems should play in the interest of the student, and the learner according to these strategies, is the main focus of the educational process, where the educational curriculum is adapted from the first generation to the second generation in order to detect and enhance the potential abilities of the pupils for the results of studies such as Kaddour & Habib (2018) and Shaheen (2006), which confirmed the importance of training and forming teachers to use various strategies in teaching, including the active learning strategy of collaborative learning, problem solving, learning by play, brainstorming, which are strategies that confirm the learner's activity in the educational process and seek to work with others in order to achieve related objectives with its comprehensive and integrated growth.

There is no doubt that the professor of physical and sports education in the middle school stage has an important role in the educational process and its main engine and is able to enhance the educational objectives and ensure the provision of educational skills to the students. Professor of Structural and Sports Education for modern teaching strategies within the class requires the availability of a range of conditions, including the selection of objectives and the organization of the content of learning, related by implementing the presentation of the lesson and the method of using educational aids and methods. This is interesting to the issue of preparing professors and studying their teaching competencies at the moment, given the importance of the role of the professor in the teaching process (Shagra 2020), where this preparation requires a special priority to show their abilities, skills and the extent to which they use the art of teaching developments and changes (Haymen 2017). It identifies the competencies necessary for the teacher of physical education to play his role to the fullest. Since change is an important, objective and orderly process, the professor has been given in his room and during his class full freedom to act using what he sees as appropriate educational methods to achieve the technical and scientific competencies required by the good functioning of the class. This enabled the professor to employ competencies consistent with his personality, abilities and inclinations in line with the reforms that have touched the educational system in

terms of improving the educational action and adapting teachers and learners to these developments, the most prominent of which is the second generation curriculum, which was installed at the beginning of the school year 2016/2017 in compulsory education, especially in the middle school, which was based on a set of modern educational developments, as it is based on the principle of approaching competencies inspired by social structure (Haymen 2017).

In this regard, the modern trend gives the teacher the responsibility to help the student to follow the education and interest in encouraging them to take up their school work and their life matters in more creative ways, but the educational reality in the field of physical education now is completely contrary to what should be the fact that although these professional experiences are proving to be of great importance in practicing teaching work in a scientific and systematic manner, many workers in the field of education are still lacking knowledge of how to apply during the physical education lessons for proper preparation for students, especially at the level of their physical and skill abilities, this is because the understanding of the teaching process is still limited to some individual characteristics.

Several studies, including Bensikadour (2020) and Benkhaled (2015), have indicated that the use of modern active strategies in the physical and sports education contributes to the improvement and development of the educational process efficiently and effectively. And that's what matches with the conclusions of the survey and personal interview with the workers in this field of education where we noted a set of positive and negative educational practices for the teachers of physical education and sports when practicing some aspects of teaching competencies and this is what prompted us to do the current research to know and evaluate the competence of the professor of physical and sports education in the use of modern teaching strategies for the middle education under the second generation curriculum.

Based on all of the above, the questions of the problem can be raised as follows:

General question: What is the level of competence of the professor of physical and sports education in the use of modern teaching strategies for the middle school under the second generation curriculum?

Sub-questions: Does the professor of physical education and sports have the competence in the general organization of the physical and sports education lesson? IS the professor of physical and sports education competent to use the modern foundations in the teaching of physical and sports education?

Material & methods

Participants

2-1 The method followed in the study: The researcher used the descriptive method in a survey method due to its suitability for the nature of the current study.

2-2 Research community: The research community included teachers of physical and sports education of the middle schools in Mostaganem, where they were estimated at 189 intermediate education professors.

2-3 Sample search: Random sample among the simplest methods samples. The researcher randomly selected 60 professors of physical and sports education of middle school of Mostaganem.

2-4 Data collection tools: considered as the first stage carried out by the student to design and build up the questionnaire, and that the measured property should be based on a theoretical basis explain the educational literature has included various studies, topics, books, magazines and periodicals that are related to the subject of research and that has been used a number of sources and modern scientific references.

After drafting the questionnaire in its initial form it was presented to a group of arbitrators numbering (10) professors where the agreed journal of observations was introduced in terms of reducing in the number of axises and questions until it took its final picture.

2-5 Statistical Tools: The researcher used statistical methods like the SPSS Program in order to calculate: Percentage, Interations, Alpha – Krumbach Coefficient, Standard Deviation, the average Arithmetic, Quadratic Test(K2).

Table 1

shows the items of the questionnaire

Number	Axes	Number of items
1	The first axis: the general organization of the physical education lesson.	16
2	The second axis: knowledge and employment of the modern foundations in the lesson of the physical education.	16

2-6 The Evaluation method and the correction key: The student researcher Mohammed (Allawi 1988) followed the method of scoring the questionnaire where the interrogator answers the items in the light of a three-step scale. (Strongly agree, agree, disagree) what corresponds to points according to each level 3-2-1 if the statement is positive and vice versa 1-2-3 if the statement is negative.

Results

3-1 Presentation and discussion of the results of the first hypothesis

The professor of physical and sports education has the competence in the general organization of the study (lesson) of physical and sports education.

Table 2

Shows the degree of competence in the general organization of the physical and sports education lesson

The first axis: the general organization of the study of physical and sports education	**Strongly agree**	**Agree**	**I don't agree (disagree)**	**Estimated grade**	**Percentage**	**K2**
I often do my lessons with vigour.	3	10	47	76	42,22	55,90
I think the volume of the quest for physical and sports education is sufficient to achieve the objectives	57	2	1	176	97,78	102,70
I often used alternative methods to teach some athletics events during the physical education course	6	6	48	78	43,33	58,80
The institution I teach in has a valid platform to teach some of the activities of speed, long jump and push in	56	3	1	175	97,22	97,30
The institution has the athletics gear necessary to teach some speed, long jump and push in activities.	48	8	4	164	91,11	59,20
The requirements of teaching the second generation curriculum in physical and sports education require the teacher's knowledge of strategies, methods and ieaching methods	5	32	23	102	56,67	18,90
In preparing for physical and sports education, I often rely on online educational notes.	19	28	13	126	70,00	5,70
I make pre-planning, To study and prepare for the necessary tools and procedures for public safety during the lesson	2	10	48	74	41,11	60,40
I work on developing the student's ability to investigate from the validity of the skilled performance through the duty card	5	20	35	90	50,00	22,50
I make sure to call and organize students in regiments with responsibilities.	3	13	44	79	43,89	45,70
I do warm-up exercises while correcting performance in different situations without opening the way for creative practice.	3	9	48	165	91,67	59,70
I find it difficult to translate the goals of the second generation curriculum into educational modules and use an attached guide in the teaching of physical and sports education	20	13	27	127	70,56	4,90
A special configuration for the education of athletics activities for students is rarely programmed	36	17	7	91	50,56	21,70
My lessons help to take into account the differences between the individuals, talent discovery and ensuring participation in school sports	3	12	45	162	90,00	48,90
My lessons help to give students basic skills in handball, basketball and volleyball.	1	3	56	175	97,22	97,30
My lessons earn students the sportsmanship of accepting defeat and winning and developing a spirit of leadership.	2	6	52	170	94,44	77,20

K2 table $X^2 = 5.99$ at liberty score 2 and indication level 0.05

Through the results recorded in the table above for the first axis, the general organization of the lesson of physical education and sports, after the statistical treatment of the vertebrae and the calculation of the differences in responses using the appropriate statistical method of testing good conformity, the values of K2 were all statistically significant, with the calculated values ranging from 102.70 as the highest value to K2 and the lowest value of 18.90, which is higher than the scheduled value $X^2 = 5.99$ at the degree of freedom 2 and the indication level of 0.05. Starting from analyzing the results of the first axis items, the research team concluded that the physical and sports education lesson does not receive the great attention from the teachers of the subject in the middle school and the research team attribute this to the failure of organizing the general material of the planning and preparation of educational units that give students the spirit of initiative and leadership and take into account the differences and The lack of educational institutions in the means and equipment for athletics activities (speed-jump, throwing) on the other hand , as well as the inability to translate the objectives of the second generation curriculum of the material into educational units that would work to produce the quota properly. The results of the current study are consistent with the Madjadi (2013) study of the field of grade management and general organization of the physical and sports education quota. This is what the Study of Madani (2020) pointed out to the lack of teachers of physical and sports education in the middle and second phases to the efficiency of the management and organization of the class and the researcher attributed this deficiency to years of experience and scientific qualification

3-2 - View and discuss the results of the second hypothesis

The professor of physical and sports education is competent to use the modern foundations in the teaching of physical and sports education.

Table 3

Demonstrates the degree of competence in the use of modern foundations in the teaching of physical and sports education

The second axis: knowledge and employment of modern foundations in the study of physical and sports education	Strongly agree	agree	I don't agree (disagree)	Estimated grade	Percentage	K2
I had a special composition for modern strategies in physical education and sports	48	7	5	163	90,56	58,90
I had a special training in the field of roads and teaching methods.	46	10	4	162	90,00	51,60
I often involve my students in completing the lesson according to the goals set.	6	47	7	119	66,11	54,70
I often use collaborative learning to teach various physical and sports activities.	7	44	9	118	65,56	43,30
I have a knowledge of modern teaching methods in physical and sports education.	8	40	12	116	64,44	30,40
I count and rely on teaching experience.	3	12	45	78	43,33	48,90
I often design an assignment card explaining the performance and feedback criteria according to the purpose and objective of the lesson.	31	25	4	147	81,67	20,10
I often pave the way to practices according to the students' inclinations without prior preparation.	35	20	5	150	83,33	22,50

I find it difficult to improve and develop the physical and skill performance of students during the physical and sports education course	15	26	19	116	64,44	3,10
I always design educational positions in the form of problems and solutions are left to the student	25	23	12	133	73,89	4,90
My students had the opportunity to discover the right performance with questions from me to get the right answer.	31	25	4	147	81,67	20,10
I often rely on collaborative learning in the design of learning attitudes	7	44	9	118	65,56	43,30
I often rely on the meeting of pedagogical team in the development of my teaching skills according to the outputs of the second generation curriculum	26	13	21	125	69,44	4,30
I rarely work on diversity in the recruitment of teaching strategies.	8	14	38	150	83,33	25,20
I'm usually responsible for all the lesson decisions on my own, and the role of the students lies only in work.	2	17	41	81	45,00	38,70
I often rely on my own way of controlling and taking out the lesson.	8	20	32	96	53,33	14,40

K2 table $X^2 = 5.99$ at D.H2 and the indication level 0.05

Through the results recorded in the table above for the second axis, the knowledge and employment of the modern foundations in the study of physical and sports education and after the statistical treatment of items and by calculating the differences in responses using the appropriate statistical method of testing good conformity, the values of K2 were all statistically significant, with the calculated values ranging from 58.90 k the highest value to K2 and the lowest value of 14.4 is greater than the scheduled value $X^2 = 5.99$ at the degree of liberty 2 and the indication level of 0.05.

Based on the analysis of the results of the second axis paragraphs, the research team concluded that there is a great lack of competencies of teachers of physical and sports education in the middle school in terms of knowledge and theory of modern teaching strategies, especially based on cooperative learning and solving problems focused on the learner and relying on the old approach i.e. traditional teaching based on privacy, which directly affects the class, and the level of the student and the extent of its integration into the class. The results of the study that the teachers of physical education in the secondary level are not familiar with the teaching competence, including the competence of the use and employment of teaching strategies in the study of physical and sports education, and the results of the current study differed with the study of Kaddour & Habib (2018), which resulted that the teachers of physical and sports education are competent in the use of modern teaching strategies of self-learning, collaborative learning and learning by play. Madani (2020) also attributed this to the years of experience and scientific qualification variable, which in turn affects the degree of practicing the efficiency of employing and using modern strategies in teaching physical education and sports.

Discussions

- There is a discrepancy in the use of teaching strategies by teachers of physical and sports education in the middle school.
- No differences in the degree of the practice and the use of the teachers of physical and sports education for teaching strategies under the second generation curriculum.
- Teaching physical and sports education in the middle school is limited to authoritarianism and that the teacher is the focus of the educational process and the role of the learner remains negative.

Conclusion

As the reforms that covered all fields, it was necessary to revolutionize the educational system and rebuild strong educational systems that raise the level of the aspirations of the learner and to appreciate these reforms and changes had to be carried out by researchers of the educational sector to carry out a comprehensive evaluation of the educational system in the form of the educational process in a special form in light of the developments and challenges of the present. And based on the premise, the development of the material stems from the development of the teaching process by re-modifying the educational curriculum in line with the modern active strategies. The researcher's team concluded that despite the fact that teachers of physical education and sports in the middle school are aware of modern strategies by 85 %, and their application within lessons are almost non-existent and it is clear that 79 % do not use it despite their knowledge and this is what the problem of the research at hand appreciates.
Finally, we hope that we have contributed to this modest work in a positive way to present and address the aspects of the study, and there is no doubt that things were worth it. We have interpreted and deepened, but we have not met their right, and we hope that we have given new horizons for research and studies in this subject despite all the difficulties and challenges.

References

1. HAYMEN, A., 2017. *Evaluation of the teaching qualifications of the teacher of sports education in the basic stage of the first edition.Alexandria.* Alxendaria: Al Waffa Donia Printing House.
2. AL-HAYEK, S. K., 2018. *Contemporary Methods and Strategies In Teaching Physical Education Jordan Hashemite Kingdom Of Jordan.* Jordan.

3. ASUN, S. & M. CHIVITE, 2020. Perception Of Professional Competences in Physical Education Teacher Education (PETE). *Sustainability.* ***12***(12), 12-38. https://www.mdpi.com/2071-1050/12/9/3812/htm
4. DAVIS, R., 2000. *Teacher Evalution.* USA: Introduction.
5. BKHTAOUI, D. & D. MOKRANI, 2020. Analysis OF educational Process In Teaching Physical And Sports Activites Collectives Competency Approach. *Physical Education and Sport Through The Centuries.* ***7*** (2), 189-198. https://content.sciendo.com/view/journals/spes/7/2/article-p189.xml?rskey=AnRkFa&result=1
6. BENKHALED, H., 2015. *Using some educational strategies to embody the applicationApproach ing competencies in the physical and sports education lesson.* Mostaganem.
7. IBRAHIM, N. & M. KHAFAHA, 2002. *Teaching in physical education.* Alexandaria, Egypte: Radiation Libarary and Printing Press.
8. BRAHIMI, K. et al., 2018. The Effectiveness of using the selfL learning Strategy to Learn the Skill of sending Tennis to Students(16-18) years in Volleyball. *Journal of Sports System.* ***5***(1), 208-222. https://www.asjp.cerist.dz/en/article/50324.
9. MADANI, B., 2020. A calendar analytical study of the objectives of educational units based on pedagogical competences for teachers of physical and sports education. *Journal of Sports System.* ***6***(2), 234-254. https://www.asjp.cerist.dz/en/article/100065.
10. BENSIKADOUR, H. et al., 2020. The effectiveness of the active learning strategy in the workshops in the practice of athletics activities children to improve the elements of physical performance and digital achievement in the running sequence (4-60). *Sports Creativity.* ***11*** (1), 437-454. https://www.asjp.cerist.dz/en/article/116200.
11. MAHER, M. R. et al., 2013. Initial training and appropriation of professional skills by trainee teachers in physical education and sports (EPS). *IOSR Journal Of Rresearch Method In Education (IOSR-JRME).* ***1*** (6), 1-12. https://www.researchgate.net/publication/315317468
12. CARLSON, S. A., J. E. FULTON & S. M. LEE, 2008. Physical Education and Academic Arshivement In Elementary School. *Amarican Journal Of Public Health.* 721-727.
13. SALAH, H., 2018. *Modern Teaching Strategies.* Amman, Jordan: Dar Al-Massira For Pubilshing.

14. SHAGRA, Y. B., 2020. *The level of qualification of the teachers of physical and sports education and its relation to certain variables.*
15. TALEB, A., 2015. The competence of the Professor of Physical and Sports Education and its impact on the educational scientific quality in secondary school.Sports Creativity. *Scientific Journal Of Science and Technology For Physical and Sports Activities*. ***12***(12), 208-229. https://www.asjp.cerist.dz/en/article/127.

DOI 10.2478/afepuc-2021-0006
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(1): 62-71

PHYSICAL AND MOVEMENT SKILL LEVEL OF PUPILS FROM THE FIRST GRADE OF PRIMARY SCHOOL IN SVIT IN COMPARISON WITH NATIONAL RESEARCH OF PRIMARY SCHOOLS

Ladislava Doležajová[1], Lenka Poništová[2], Olympia Mókusová[1]

[1] Comenius University in Bratislava, Faculty of Physical Education and Sport, Slovakia
[2]Teacher et a primary school in Poprad, Slovakia

Summary: The aim of the work was to compare the level of somatic and selected motor abilities of pupils of the 1st year in Svit with a national research of primary schools. The goal was to choose boys for athletic training based on individual and overall physical performance. The parameters showing the bodily development of the probands were body height, body weight and BMI index. To determine the all-round readiness of students, we used a test set consisting of the following tests: maximum forward bend, endurance in pull-ups, long jump from standing position, shuttle run 4 x 10 m and endurance Beep test. We processed empirical data using statistical-mathematical characteristics. We used the Shapiro-Wilk test to calculate the normality of the data and then calculated the statistical significance of the mean values using the Parametric Unpaired T-test. We recorded significant differences at the 1% and 5% level of statistical significance when comparing the results of our groups with the national ones in individual motor tests: maximum forward bend, long jump from a place, shuttle run 4 x 10 m and endurance Beep test. Differences in somatic indicators and performance between Svit students were confirmed without statistical significance. In the end, we evaluated the level of performance of pupils according to the standards of the population on the basis of their achieved results. We recommended children who achieved the highest points of overall readiness for athletic preparations, as well as those who showed an above-average level of performance in individual tests.

Key words: national testing, physical performance, primary schools, boys

Introduction

Since the 1st of September 2018, a nationwide testing of the movement preconditions of pupils in the first and third grades of primary schools was organized every year with the intention of identifying sports talent (Šimonek & Židek 2019).

The authors Šimonek & Židek (2019) and Ružbarský (2018) agree on the reason for choosing children aged from 6 – 7. The main reason is the fact that few of these children participate in some controlled sports training or devote themselves to it for a short time, thus suppressing the influence of the social environment on the development of physical preconditions.

Ružbarský (2018) stated that the aim of the national testing is to determine the physical performance of children in Slovakia and, in addition, to bring them to sports, so that physical activity becomes part of their daily routine or. of life. This will also increase the likelihood of identifying sports-gifted children. Primary school pupils from the first grade take tests in four types of tests. First, somatic parameters (height and body weight) are determined, then the level of static and dynamic force is determined, as well as the level of endurance, speed, mobility and coordination. This diagnosis also differs from other motor tests in schools by additional, specific tests, which determine the manipulation and decision-making abilities of students, which are important especially for sports games. The goal is also supplemented by the National Sports Centre institution. It is published on their website that the project is aimed at finding out the state of movement preconditions of children at such an early age, because for the healthy development of a child and for sports performance in adulthood, comprehensive physical training and regularity of movement in childhood is decisive. Pupils' innate preconditions can be proven already in this type of testing of pupils, and thus they have the opportunity to show better results in the chosen sport, which also increases their motivation for further sports activities.

Šimonek (2018) defined the aim of regular testing of motor performance of schoolchildren as improving the selection and training of talented sports youth and finding out the status and trend of the level of physical performance of children and youth. The effectiveness of such a selection of sports talents among children in primary schools should be increased, which is also reflected in the composition and number of members in sports clubs. The described testing according to Šimonek & Židek (2019) has not only the task of selecting sports talents from among students, but also serves for research activities that deal with the health and condition of children in Slovakia.

The aim of the work was to compare the somatic and selected movement skills of first-grade pupils in Svit with the national research of primary schools.

Characteristics of the sample

Testing of students was carried out in 2018 at two primary schools in Svit. 42 boys of the first grade of primary school in Svit took part in the deliberate research. First-grade teachers, gymnasts, 8th and 9th grade students and one author of the paper were involved in the testing. Students performed testing, which took place in 3 cycles. The first cycle took place at both schools in the first lesson in the classroom. It was carried out by class teachers and consisted of measurements of somatic indicators (body height and body weight). Subsequently, all students went to the school gym. In the second cycle, students were divided alphabetically into groups, where 4 stages from motor tests were created. After completing 4 motor tests, students had a half-hour break. The third cycle consisted of further motor tests. Based on a personal and written request from the management at primary schools and an explanation that it will be the use of data for research purposes, the author was allowed to use data from both schools.

Methods

The data collection consisted of measuring body height and body weight. For our research, we selected only some movement skills – sit-ups per 1 min., maximal forward bend in sitting position, standing long jump, shuttle running 4x10 m and endurance shuttle running Beep test. The given instructions were followed during the testing. Measurements were performed at primary schools on 10. 10. and 25. 10. 2018.

Methods of processing and evaluation of the obtained data

We used mathematical-statistical characteristics to process and evaluate the obtained data. From statistical methods, we used the Shapiro - Wilk test to evaluate the normality of the data, and then we calculated using a parametric unpaired t-test. In this work, we evaluate the results in percentages. In the research, we compared the performance of students measured with the results of the whole Slovakia and with the norms of the population (Sedláček & Cihová 2009). Level in the motor test sit-ups per 1 min. we calculated according to z-points and the level in the test the maximal forward bend in sitting position was recalculated according to the made scale to the values according to Sedláček & Cihová (2009). Based on the total sum of points from the entire test battery, we evaluated the versatile physical readiness of each tested student. Subsequently, we selected probands from the group, which we would include in specialized preparations focused primarily on athletic all-round exercise training. We

concretized the interpretation of the resulting values using theoretical research methods (analysis, synthesis, induction and deduction).

Results

The groups of pupils from Svit (n = 42) and Slovakia (n = 9,443) compare boys who are only 6 years old according to the decimal age and the homogeneity of both groups was preserved. In Table 1 there are shown the statistical characteristics of somatic indicators of pupils for the first grades of primary schools from Svit and from the whole of Slovakia.

Table 1

Mathematical-statistical characteristics of somatic indicators of pupils of the first grade of primary schools in Svit (n = 42) and national testing (n = 9,443)

Pupils	Body height [cm]		Body weight [kg]		BMI	
	Svit	Slovakia	Svit	Slovakia	Svit	Slovakia
X	122,88	122,90	24,48	24,40	16,17	16,10
Xmin	109,00	98,00	19,00	14,00	13,02	10,30
Xmax	139,00	157,00	41,00	65,00	24,64	33,10
Vr	30,00	59,00	22,00	51,00	11,62	22,80
Sd	5,24	5,80	4,12	4,70	2,05	2,36

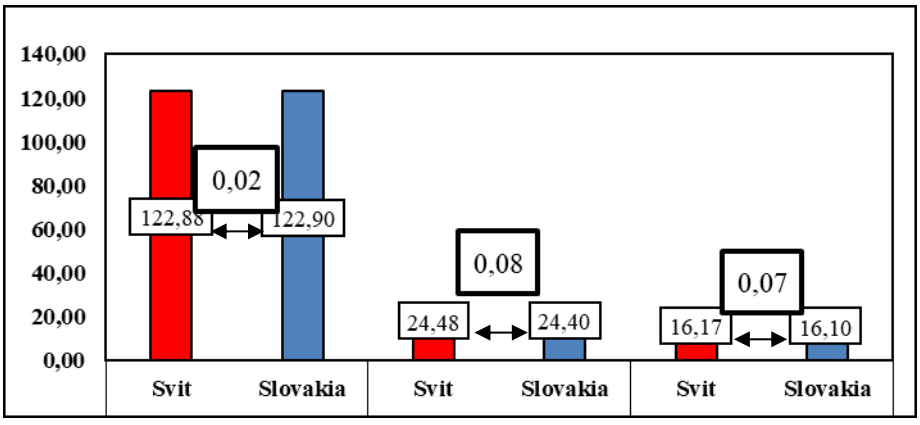


Figure 1

Comparison of physical indicators of pupils (n = 42) of the first grade of primary school in Svit with the national average (n = 9443)

Based on Table 1 we see that the average values for all three monitored somatic indicators are almost identical. This is also confirmed by Figure 1, where we did not find significant differences between any monitored parameters that could affect performance in the monitored motor skills. Of course, we noticed the biggest differences in the variation ranges between students from Svit and Slovakia. In body height and body weight, the differences are

exactly the same 29 cm resp. 29 kg. This is also related to the large variation range of BMI values 11, 62, resp. 22, 80 in favour of students from Svit.

The first motor test was the maximal forward bend, which was performed in the school gym with the help of a bench and a created scale. Pupils in Slovakia achieved an average performance of 3.90 cm. The average performance for boys in the first grade of primary school in Svit was 3.02 cm (Figure 2). In this comparison, we did not confirm any significant differences in performance, the differences were 22.56 % in favour of students from national research. Among the students, we found individuals who achieved a performance better than 8 cm, and thus demonstrated above-average performance compared to population standards, because they would get more than 8 points in the points evaluation (Sedláček & Cihová 2009).

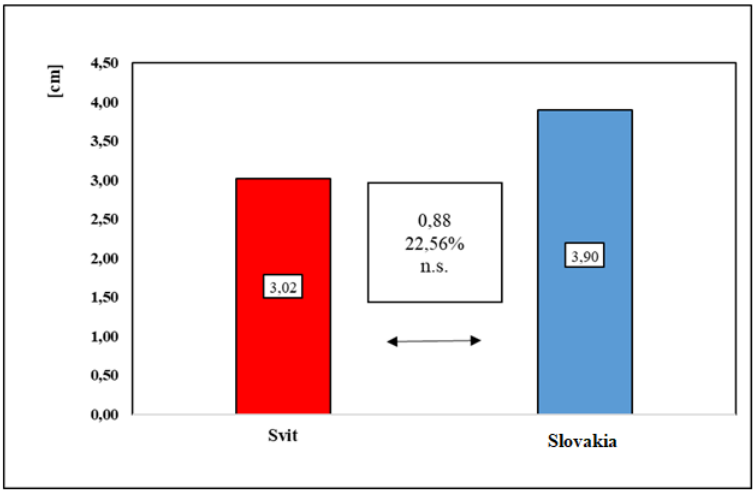


Figure 2

Comparison of the performance of pupils (n = 42) of the first grade of primary school in Svit with the national average (n = 9443) in the motor test maximal forward bend

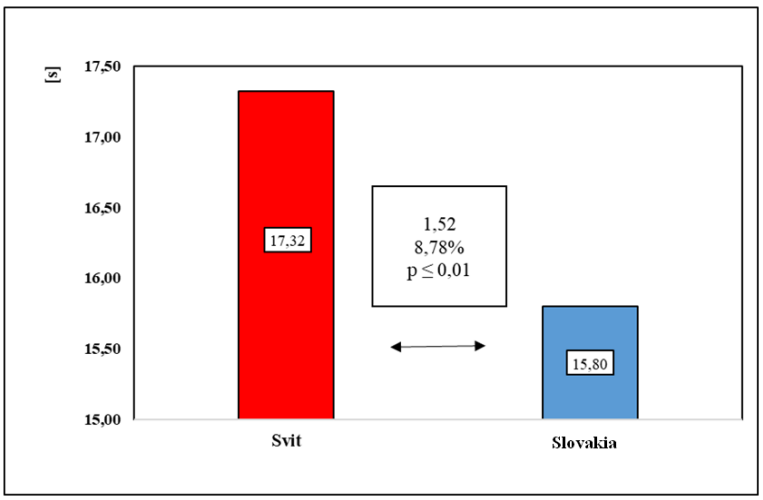


Figure 3

Comparison of the performance of pupils (n = 42) of the first grade of primary school in Svit with the national average (n = 9443) in the motor test shuttle run 4 x 10m

In a 4 x 10 m shuttle run, pupils from Slovakia (Figure 3) achieved an average output of 15.80 s. The group consisting of pupils from Svit reached an average time of 17.32 s. After subtracting the values, we found a difference in time of 1.52 with (https://www.testovanieziakov.sk/content/files/NSC_NP_vysledky.pdf). This value of the difference created 8.78 % of the performance of students from Svit. The difference between the groups of students was significant at the 1 % level of statistical significance.

Higher homogeneity of performance was demonstrated among probands from Svit, whose standard deviation reached the value of 2.27. In contrast, the value of this degree of variability in the nationwide group of students is 3.38. This difference in values is mainly influenced by the different number of probands of individual groups, but also by extreme values. While in the group of pupils from Svit the maximum power was 24.30 s and the minimum power was 14.20 s, in the group of pupils from Slovakia the values were as follows 77.00 resp. 10.10 s.

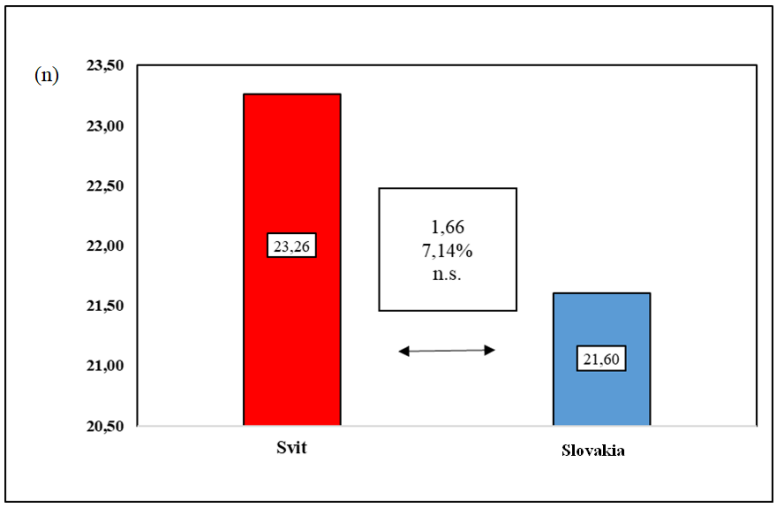


Figure 4

Comparison of the performance of pupils (n = 42) of the first grade of primary school in Svit with the national average (n = 9443) in the motor test sit-ups per 1 minute

In Figure 4 we can see that the average performance in the test of sit-ups per 1 min. There were 21.60 repetitions of pupils in Slovakia. We recorded a better result in the group of boys from Svit, whose average value reached 23.26 repetitions. The difference between the groups was 1.66 repetitions, which is 7.14 % and we did not find any significant differences between the groups. We noticed a big difference in the maximum number of repetitions. The best student in Slovakia managed to perform 77 repetitions, while the best boy from Svit only 41. Therefore, there was a big difference between the variation ranges of individual groups of 77 and 39. It follows that in Slovakia there was a 6-year-old student who did not even one repetition. We recalculated the individual performances using z-points. We did not find that we

had a student from Svit in the group, in which we would notice above-average performance in this test. The best proband scored 2.25 points, making it one of the population averages.

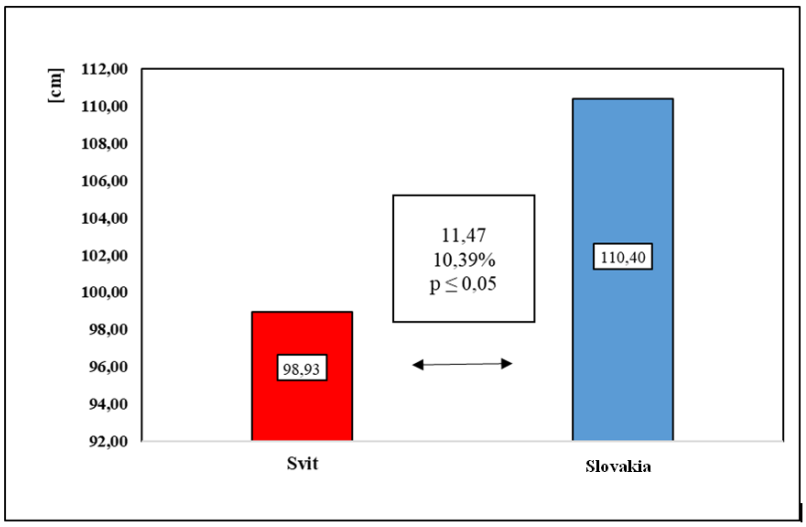


Figure 5
Comparison of the performance of pupils (n = 42) of the first grade of primary school in Svit with the national average (n = 9443) in the motor test standing long jump

The national average of pupils in this test was 110.40 cm. An average of 98.93 cm was calculated within probands from Svit (Figure 5). The difference between the groups is 11.47 cm, which makes a 10.39 % difference in terms of percentages. Between students from Slovakia and Svit, we confirmed a significant difference in performance in stading long jump at the 5 % level of statistical significance. The minimum and maximum values of pupils from Svit were 60 resp. 129 cm and national research 11 resp. 192 cm. The higher homogeneity of the group was confirmed in the group of pupils from Svit, which was proved by the standard deviation of pupils from Svit 17.53 as a measure of the variability of the all-Slovak group 19.46 cm.

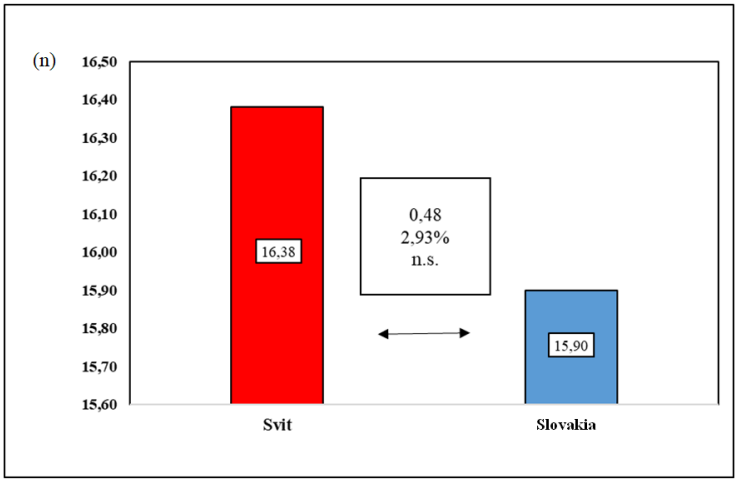


Figure 6
Comparison of the performance of pupils (n = 42) of the first grade of primary school in Svit with the national average (n = 9443) in the motor test endurance shuttle running Beep test

In Slovakia, in the endurance shuttle running Beep test, an average of 15.90 length was run by primary school students from the first grade. This value was lower compared to the students from Svit, who managed to overcome 16.38 lengths. The difference between the groups thus climbed to 0.48 and represented 2.93 %, and we did not find any significant differences between the groups. There was a small difference between these rates in the extreme performance of students. The best student in Slovakia ran 40 lengths and the best proband from Svit 36 lengths. There was a small difference even at the lowest values of running lengths. There was a pupil among national research who managed to run only 1 length and the pupil ran only 3 lengths from Svit.

Another objective of our research was to find individuals who demonstrated higher all-round motor readiness, but also individual above-average performance in some of the monitored test. There are many publications (Havlíček & Kuchen 1963 - 1971; Grasgruber & Cacek 2008; Vičan 2019) characterizing performance standards influencing the motivation and orientation of children to individual sports. To evaluate these parameters, we scored the results measured by us according to population standards (Sedláček & Cihová 2009). The authors use a 10-point scale, where values 5 – 6 represent the average level of population performance, values 7 – 8 represent above-average performance and values 9 – 10 represent a significant above-average population performance. For the inclusion of children in the selection of students with higher physical readiness, we set a point limit of 25 points. This lower limit of points is the average of the physical performance of the population from the five tests we monitored. We also included children according to Glesk (1989), who did not meet the standards set by us, but achieved excellent results only in some indicators that have an affinity for athletic disciplines such as level in aerobic endurance, in standing long jump and so on. From all the students, we selected 8 students for the athletic training. Of these, only 4 overcame the 25-point scale in the range of 25 – 28 points. The other 4 would gain above-average performance, ie. 7 points and more in the tests we followed in the research. However, we did not specifically evaluate the test of endurance over grasp in this paper in terms of differences in performance between students from Svit and the national survey.

Conclusion

From the results of a nationwide survey comparing our testing, several measured values are a bit incomprehensible to us. These are mainly the measured maximum values in the national survey. We are looking for an explanation in several factors. We see the first negative

factor of such measured "incredible, extreme performances" in the fact that the testing was carried out throughout Slovakia by many examiners who had no experience and followed only written instructions. The second factor that may have influenced the results of national testing may have been the integration of children with health disorders. There could be schools that included these children in the testing and the children had problems with the implementation of individual tests. We recommend that for such disadvantaged children, either safer alternatives of motor tests be devised or children be involved in testing, but only in those tests that would not endanger the child's health. However, it should be taken into account that these children should not be included in the national average results. We would include 8 boys in the athletic training based on the standards we set.

References

1. GLESK, P., 1989. *Atletická príprava detí vo veku 10 až 14 rokov.* Bratislava: 1. vydanie. ISBN 80-7096-062-0.
2. GRASGRUBER, P., & J. CACEK, 2008. *Sportovní gény.* Brno: Computer press. ISBN 978-80-251-1873-3.
3. HAVLÍČEK, I., & A. KUCHEN, 1963 – 1971. Kritéria výberu detí do ľahkoatletickej prípravy. In: *Acta Facultatis educationis physicae univeritas comenianae.* Bratislava: Fakulta telesnej výchovy a športu, s. 503-517. 67-556-74.
4. NÁRODNÉ ŠPORTOVÉ CENTRUM, 2019. *Všeobecné informácie* [online]. [cit. 2020-24-03]. Dostupné z: https://www.testovanieziakov.sk/stranka/vseobecne-informacie
5. NÁRODNÉ ŠPORTOVÉ CENTRUM, 2019. *Výsledky prvého celoštátneho testovania pohybových predpokladov žiakov 1. ročníkov základných škôl.* [online]. 2019 [cit. 2020-25-03]. Dostupné z: https://www.testovanieziakov.sk/content/files/NSC_NP_vysledky.pdf
6. NÁRODNÉ ŠPORTOVÉ CENTRUM, 2019. *Geografické dáta.* [online]. 2019 [cit. 2020-25-03]. Dostupné z: https://www.testovanieziakov.sk/statistiky/geograficke-data
7. RUŽBARSKÝ, P., 2018. Pohybová výkonnosť detí sa v porovnaní s minulosťou výrazne zhoršila. https://zivot.pluska.sk/rozhovory/zacnu-testovat-prvakov-pohybova-vykonnost-deti-porovnani-minulostou-zhorsila)
8. SEDLÁČEK, J. & I. CIHOVÁ, 2009. *Športová metrológia.* Bratislava: ICM AGENCY. ISBN 978-80-98257-15-7.
9. ŠIMONEK, J., 2018. Povinné testovanie pohybovej výkonnosti žiakov 1. ročníka ZŠ podľa nového zákona o športe. In: *Športový educator.* **9**(2), 3-7.

10. ŠIMONEK, J., & R. ŽIDEK, 2019. *Talent v športe (vyhľadávanie, identifikácia a rozvoj).* Nitra: Pedagogická fakulta Univerzita Konštantína Filozofa. ISBN 978-80-558-1413-1.
11. VIČAR, M., 2018. *Sportovní talent komplexní přístup.* Praha: Grada Publishing, a.s. ISBN 978-80-271-0841-1.

(https://www.testovanieziakov.sk/statistiky/somatometricke-udaje)

(https://www.testovanieziakov.sk/stranka/metodicke-pokyny-pre-testovanie)

sciendo

DOI 10.2478/afepuc-2021-0007
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(1): 72-85

RELATIONSHIP BETWEEN REACTION TIME, MEDAL WINNING AND PERFORMANCE IN THE 60 m HURDLE INDOOR EVENT BEFORE AND AFTER THE CHANGE OF FALSE START RULE

Konstantinos Ntolaptsis and Vassilios Panoutsakopoulos

Department of Physical Education and Sports Sciences at Thessaloniki, Aristotle University of Thessaloniki, Thessaloniki, Greece

Summary: 60 m hurdles races are included in the World Indoor Athletics Championships and consist the shortest hurdle race distance. Thus, it is possible that the reaction time (RT) affects the finish time (t60mH) and the rank of the hurdlers. The aims of this research were: a) to examine the relationship between RT and t60mH, b) the possible differentiation of RT: c) between the hurdlers who won a medal in World Indoor Athletics Championships (WM) and those who did not (NMW), d) between hurdlers who competed before (BRC) and after (ARC) the change of the starting rules in 2009. Analysis included 70 performances (WM: n = 28; NMW: n = 42; BRC: n = 32; ARC, n = 38). The differences between WM and NMW and BRC and ARC were examined with independent samples T-test, while the possible relationship between RT and t60mH with Pearson's correlation. The results showed that RT was not significantly different ($p < .05$) between WM and NMW and between BRC and ARC. A weak, but significant, positive correlation ($r = .228$, $p = .016$) between RT and t60mH was observed. Results revealed that RT is a factor that affects t60mH. In conclusion, the essential focus on the reaction time at the starting blocks must be given during the training process.

Key-words: Track and field, hurdlers, reaction time, starting block, sprint.

Introduction

The 60 m hurdles race is part of the indoor track and field events and it is included in the World Indoor Championships program since their inauguration in at 1985. The rules of the 60 m hurdles are the same to those applied for the 110 m and 100 m hurdle race, for men and women respectively, of the outdoor track and field athletics. The differences between the indoor and

outdoor high hurdle events are that in the indoor race: a) athletes should clear only five, instead of ten, hurdles and, b) the distance from the last hurdle to the finish line is smaller by 3.30 m.

Quite similar to the pattern of the 110 m hurdle race (Tsiokanos et al. 2018), analysis revealed that, during the 60mH race, the speed of the athletes follows a consistent pattern (Panoutsakopoulos et al. 2020). In specific, there is a gradual increase of speed from the start till the 4th hurdle, followed by a second acceleration phase after the clearance of the 5th hurdle till the finish line (Kuitunen & Poon 2010). The structure of the 60mH performance is comprised by four main components: a) the start and the sprint to the first 1st hurdle, b) the clearance of the hurdles, c) the sprint of the intermediate distance between the hurdles, d) the sprint from the last hurdle to the finish line. Previous studies have shown that the most decisive factors for the performance are: a) the horizontal sprint velocity, b) the hurdle clearance time (Kuitunen & Poon 2010; Muller & Hommel 1997; Panoutsakopoulos et al. 2020). As for the latter, analysis of the technique index, namely the difference between the performance in a hurdle race and in a race of the same distance without hurdles (Stein 2000), is related with performance in 60mH (Kaisidou et al. 2021), thus indicating the importance of the fast hurdle clearance (Bedini 2016).

Concerning the first component of the race, there are some differences in the way that the hurdlers execute the start of the race compared to sprinters (Bezodis et al. 2019a), due to the presence of the 1st hurdle after 13.72 m from the start line. Furthermore, one of the important factors of this phase is the reaction time (RT) at the sound of the starter's gun. RT is considered the time between the sound signal of the start and the first motor response of the athlete. Although studies proved a significant correlation between RT and the result at the small sprinting distances (Delalija & Babic 2008; Gurses & Kamis 2019; Tønnessen et al. 2013), other studies claimed that there is no correlation between these two variables (Pilianidis et al. 2012a; Panoutsakopoulos et al. 2020). According to past research, the magnitude of RT increases as the running distance decreases (Collet 1999; Delalija & Babic 2008; Juhas et al. 2015). Based on this evidence, since the 60-m hurdle race is the smallest distance of the hurdle events, RT is more likely to be a deciding factor of 60mH performance, considering that a 20ms difference in RT could be translated as a 20 cm difference at the finish line in the 200 m sprint race (Mitašík et al. 2020).

Past research showed that false start regulations may have an effect on elite athletes' RT (Haugen et al. 2013). The current competition rules state that the athletes' RT should surpass the 100 ms threshold to be considered legal (rule 16.6; World Athletics 2019). In addition, with the

exception of the combined events, once an athlete makes a false start, he/she does not have a second opportunity to compete as is immediately disqualified (rule 16.8; World Athletics 2019). This strict start rules regarding the inability to execute a false start is implemented since 2010. This stricter false start rule could have an impact on athletes starting performance, since their caution for not being disqualified due to a false start could be translated as a delay in their RT and, eventually, in larger official time (Collet 1999). Previous studies regarding this topic revealed larger RT in elite male sprinters after the introduction of the stricter false start rules (Haugen et al. 2013; Mitašík et al. 2020 Pilianidis et al. 2012b). Since the importance of RT for the final performance is increased when the distance of the race is shorter, sprinters try to decrease RT (Collet 1999). Thus, it is of interest to examine the effect of the change of start rules in the RT exhibited by elite 60mH hurdlers, as the indoor 60mH is the shortest hurdle event.

Aim of Study

The purpose of this present study was to examine the relationship between RT and performance of elite male athletes who competed on major indoor events in the 60 m hurdle race. Furthermore, additional aims were to examine the possible differentiation of RT: a) over time, b) between the hurdlers who won a medal in a major indoor event and those who did not, and c) between hurdlers competed before and after the change of the false start rule. It was hypothesized that:

1. Medal winners will exhibit a lower RT,
2. RT will be improved over time,
3. RT will be larger after the change of the false start rule in 2009, and
4. RT and performance in the 60-m hurdle race will be related.

Methods

Study design

For the purposes of the study, the official performances (t60mH) of the hurdlers who competed at the finals of the 60 m hurdle race in the World Athletics Indoor Championships were recorded. The exclusion of the data from the previous rounds was based on the concept of increased ecological validity, as athletes were found to exhibit lower RT in the final of an event rather than in the qualifying rounds (Collet 1999; Tønnessen et al. 2013). In addition, data were retrieved from

9 events that were held from 2003 to 2018. This range was selected because there were also changes in the false start rules in 2003. The collected performance data were classified depending on: a) if the athlete won a medal or not in 60 m hurdle race, b) if the event took place from 2003 to 2009 or from 2010 to 2018.

Sample

The final sample included 70 performance cases. From those, 28 cases were from athletes that won a medal (WM; n = 28) and 42 from athletes who didn't win a medal (NMW; n = 42). Also, 32 of the cases were retrieved before the change of the rules (BRC; n = 32) and 38 after (ARC; n = 38). The study was conducted in accordance with the recommendations of the Declaration of Helsinki and the ethical standards of the Institutional Research Committee Guidelines. Nevertheless, there was an exception, as no informed consent was obtained, since the data were acquired from publicly available resources.

Procedure

Performance data of the 60 m hurdle event in the World Indoor Championships held from 2003 to 2018 were obtained from Wikipedia (https://en.wikipedia.org/wiki/0000_IAAF_World_Indoor_Championships_%E2%80%93_Men%27s_60_metres_hurdles where 0000 is the year of the competition) after checking the validity of the presented information with the official results published in the public databases of the World Athletics (https://www.worldathletics.org/competitions/world-athletics-indoor-championships/history/). The criteria considered in order to include a performance in the analysis were: a) the athlete was not banned for doping for the period which his performance was documented, b) t60mH was provided in the publicly available resource, and c) RT was also available.

Statistical analysis

Normality of distribution was assessed using the Kolmogorov - Smirnov test (p > .05). Since the results showed that the variables were normally distributed, separate independent samples T–tests were used to examine the possible differences in RT and t60mH between WM and NMW and between BRC and ARC. In addition, the relationship between RT and t60mH was tested with Pearson's correlation. The differentiation RT and t60mH among championships was checked with repeated-measures ANOVA with Bonferroni adjustments. Significant differences were followed up with Scheffe post hoc analysis. For all tests, the IBM SPSS Statistics v.25 software

(International Business Machines Corp., Armonk, NY) was used, with the level of significance set at $a = 0.05$.

Results

The descriptive statistics concerning RT and t60mH in the examined championships are presented in Table 1. t60mH was not differentiated through time ($F_{8,61} = .695$, $p = .694$). However, RT ($F_{8,61} = 4.602$, $p < .001$) was different in the 2008 World Athletics Indoor Championship compared to the earlier events.

Table 1

Descriptive statistics for reaction time (RT) and official 60 m hurdle race performance (t60mH) in each examined event

Parameter	RT				t60mH			
Event	**mean**	**SD**	**min**	**max**	**mean**	**SD**	**min**	**max**
2003 ($n = 8$)	0.142*	0.015	0.116	0.163	7.57	0.077	7.47	7.67
2004 ($n = 8$)	0.138*	0.010	0.116	0.149	7.57	0.174	7.36	7.87
2006 ($n = 8$)	0.145*	0.021	0.124	0.186	7.53	0.066	7.43	7.62
2008 ($n = 8$)	0.196	0.040	0.136	0.249	7.63	0.129	7.46	7.91
2010 ($n = 8$)	0.157	0.022	0.134	0.196	7.53	0.157	7.34	7.81
2012 ($n = 8$)	0.157	0.020	0.135	0.202	7.58	0.100	7.44	7.74
2014 ($n = 7$)	0.152	0.024	0.143	0.174	7.51	0.058	7.45	7.60
2016 ($n = 8$)	0.152	0.024	0.127	0.200	7.51	0.162	7.41	7.88
2018 ($n = 7$)	0.154	0.017	0.129	0.176	7.59	0.121	7.46	7.77

NOTE: *: $p < .05$ compared to 2008

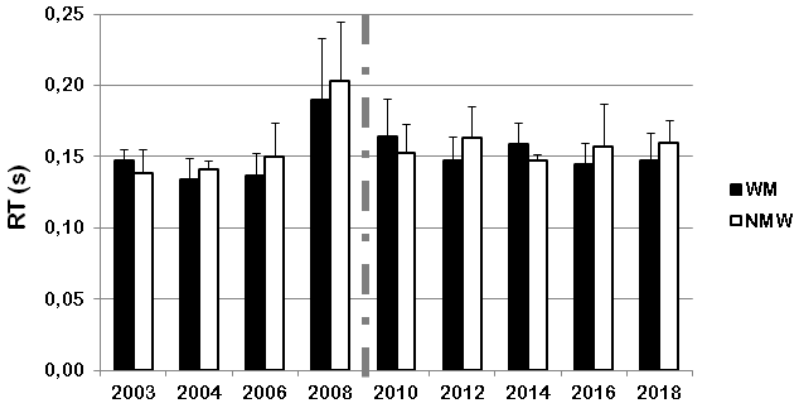


Figure 1

Results for reaction time (RT) observed in medal winners (WM) and no-medal winners (NMW) at each examined World Athletics Indoor Championship. The gray dashed line indicates the year that the false start rule changed.

Additional results concerning the respective descriptive statistics for WM and NMW are depicted in Figures 1 and 2.

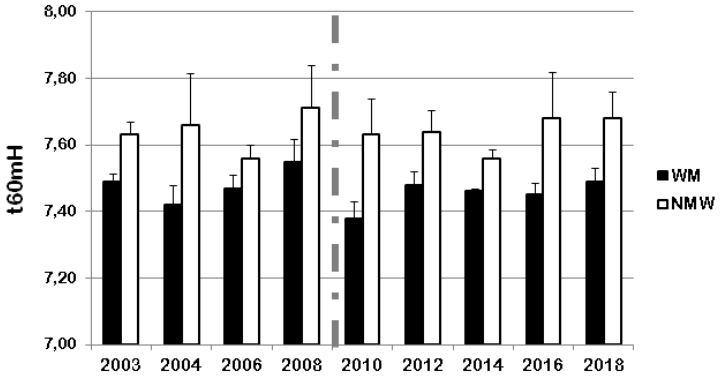


Figure 2

Results for the official 60 m hurdle race performance (t60mH) of the medal winners (WM) and no-medal winners (NMW) at each examined World Athletics Indoor Championship. The gray dashed line indicates the year that the false start rule changed

According to the results of the T-tests, RT was not significantly ($p > .05$) different in both comparisons (Table 2). As for t60mH, WM were significantly ($p < .05$) faster than NMW. On the opposite, t60mH was not significantly ($p > .05$) different between BRC and ARC.

Table 2

Results (mean ± standard deviation) for reaction time (RT) and official 60-m hurdle race performance (t60mH)

Parameters	**WM (*n*=28)**			**NMW (*n*=42)**			***t***	***p***	**BRC (*n*=32)**			**ARC (*n*=38)**			***t***	***p***
RT (s)	0.153	±	.027	0.156	±	.027	.352	.726	0.156	±	.034	0.155	±	.019	.069	.945
t60mH (s)	7.47	±	.062	7.64	±	.102*	8.869	<.001	7.57	±	.119	7.56	±	.125	.379	.706

NOTE: WM: cases of performances won a medal; NMW: cases of performances not winning a medal; BRC: cases of performances before the change of the starting rules; ARC: cases of performances after the change of the starting rules.; *: $p < .05$.

Table 3

Pearson correlation coefficients (r) of the relationship between reaction time and official 60-m hurdle race performance

Cases	***r***	***p***
All cases ($n = 70$)	.23*	.016
WM ($n = 28$)	.18	.367
NMW ($n = 42$)	.44**	.003
BRC ($n = 32$)	.31	.085
ARC ($n = 38$)	.29	.081

NOTE: WM: cases of performances won a medal; NMW: cases of performances not winning a medal; BRC: cases of performances before the change of the starting rules; ARC: cases of performances after the change of the starting; * $p < .5$; **: $p < .01$.

The Pearson's correlation analysis revealed that there was a weak, but statistically significant (r = .44, p = .016) positive correlation between RT and t60mH (Table 3). In further detail, a positive moderate correlation was found between RT and t60mH for NMW (r = .23, p = .003). On the other hand, in the other examined subgroups (WM, ARC and BRC), no significant ($p < 0.05$) correlations were observed.

Discussion

Due to the short distance of the 60 m hurdle race, it was assumed that the reaction time may affect the final performance and the rank of the athletes. The results showed that reaction time was not different between the hurdlers who won medal and to those who did not, between those who competed before and after the change of the rules at 2009 and it was not decreased over the examined period of time. Regarding the relationship between reaction time and 60 m hurdle performance, a weak, yet significant positive correlation was observed, thus partly confirming the hypotheses of the study.

Compared to the latest event, namely the 2018 World Athletics Indoor Championships, where the average reaction time was .154 s (Walker et al. 2019), the data in the present study showed an almost equal average (.155 s and .156 s for ARC and BRC, respectively). A similar finding was observed concerning the 60 m hurdle performance, where the average value for the athletes who competed at the final of the 2018 Championship was 7.59 s (Walker et al. 2019), thus slightly above the average performance of the sample examined in the present study (7.57 s). The reaction time observed accounted for approximately 2.1% of the total 60 m hurdle performance. This is in reasonable agreement with the notion that the total start can account for approximately 5% of the overall race time (Harland & Steele 1997).

Past research concerning the 2003 false start rule change showed that it had an effect on the reaction time in the 100/110 m hurdle race (Ditrolo & Kilding 2004). This is not in agreement with the present findings, as the change to the current false start rule did not alter the reaction time in the finals of the men's 60 m hurdles races held at World Athletics Indoor Championships. This finding confirms previous findings for the 200 m race (Mitašík et al., 2020). This can attributed to the fact that the hurdlers participating in the final of a major competition are the top, experienced and highly skilled athletes in the event and thus master the sprint start performance (Tønnessen et al. 2013). On the other hand, the correlation revealed for between reaction time and 60 m hurdle

performance may be a result of the short distance of the event, as found in previous studies (Delalija & Babic 2008, Gurses & Kamis 2019, Tønnessen et al. 2013). The shorter the race, the more reaction time is important for the final performance. Thus, since winning or losing is decided at hundredths of seconds, the factors that affect the final performance play a considerable larger role. So, it is important that practitioners should emphasize on the necessary monitoring of the reaction time in the training process (Mitašík et al. 2020).

In general, several factors have an impact on reaction time. Among them is the effect of the distance between the starting gun and the athlete (Majumdar & Robergs 2011) and of the running lane (Brown et al. 2008). Other contributing factors are the age, training, performance level and experience of the athletes (Tønnessen et al. 2013, Bezodis et al. 2019b). In addition, reaction time is affected by gender (Babic & Delalija 2009, Lipps et al. 2011, Mitašík et al., 2020), various psychomotor parameters (Collet 1999, Ille et al. 2013, Stadler et al. 2020) and the false start measurement technology (Haugen & Buchheit 2016, Milloz et al. 2021). As for the psychological factors, concentration is of importance for a fast reaction time (Collet 1999). However, increased external pressure results in slower reaction time (Tønnessen et al. 2013). In the case of the false start rule, the fear of disqualification may inhibit the ability to perform a fast reaction time at the sprint start (Tønnessen et al. 2013). The above indicate the importance of implementing training drills that improve the reaction skills in a regular and systematic manner.

Unlike the 100 m race, where a decreasing trend is observed in the start reaction in the 2010s (Zhang et al. 2021), there were no significant changes in average reaction time in the indoor 60 m hurdles race. This can attributed to the differences between hurdlers and sprinters concerning the start and the initial acceleration after the exit from the starting blocks. A recent study in elite athletes showed that hurdlers use a starting block arrangement with larger inter-block distance and with the front block placed closer to the start line (Bezodis et al. 2019a). In the same study, a higher body center of mass position while in the starting blocks was recorded for the hurdlers than the sprinters. These alterations possible change the neuromechanics of the sprint start movement that have an effect on exit velocity (Mero et al. 2006; Schot & Knutzen 1992). In addition, hurdlers use to get out of the blocks in an upright trunk position as, besides accelerating, hurdlers have to cover the first meters of the race regulating their step parameters aiming to negotiate the clearance of the first hurdle (Panteli et al. 2020). Thus, a specific step pattern is adopted (González-Frutos et al. 20019, 2020). It was found that the vast majority of hurdlers, after the false start rule change in

2009, use a 7-step approach to the first hurdle (López del Amo et al. 2018). This fact changes the selection of the front leg in the starting blocks, as, with this arrangement, the rear leg is the push-off leg for the clearance of the first hurdle. Normally, at the rear starting block, less resultant mean force is applied (Nagahara et al. 2020). In the case of a 7-step approach, the impulse in the front block, which is larger than the rear, is generated from the swing/lead rather than the push-off/trail leg for the hurdle clearance. This might have a negative effect on the effectiveness of the sprint start.

As for the limitations of the study, one of the factors that weren't taken under consideration was the effect of contacting the hurdle during its clearance. Contacting the hurdle affects the final performance with various ways, since it is translated: a) as an increase at the hurdle clearance time, b) as a loss of rhythm at the approach of the next hurdle, and c) as an overall loss of athlete's horizontal velocity, one of the most decisive factors of performance (Iwasaki et al. 2020). Despite the above, the 100 ms threshold itself is questionable and it is suggested to be either lower (80 – 85 ms according to Komi et al. 2009, Pain & Hibbs 2007) or higher (115 ms according to Brosnan et al. 2017, Lipps et al. 2011). Nevertheless, future research on the effect of the false start rule change on sprint start reaction time should consider all disciplines at various performance levels in relation with the performance structure of the event.

Conclusion

Reaction time was not different before and after the change of the rules at 2009 in the shortest hurdle race event, the indoor 60 m hurdle race in particular. However, performance was affected by the reaction time at the start. The results of the present study showed that there was a weak, but significant correlation between reaction time and the finish time. Thus, the exit from the blocks, especially in racing events with short distance, not only matter regarding the finish time of the athletes, but also as a factor which could be decisive for the outcome of the race. Based on this, it is suggested that, during the training process, the essential focus must be given on the exit from the blocks and the reaction time to the stimulus of the starter's gun.

Acknowledgement

Part of this study was presented in the 21st National Physical Education and Sports e-Congress that was held in Thessaloniki, Greece (December 19-20th, 2020).

Conflict of Interest

The authors declare that they have no conflict of interest.

References

1. BABIC, V. & A. DELALIJA, 2009. Reaction time trends in the sprint and hurdle events at the 2004 Olympic Games: Differences between male and female athletes. In: *New Studies in Athletics.* **24**(1), pp. 59-68. https://www.worldathletics.org/download/downloadnsa?filename=e03fa901-4dc1-417c-8f90-878df2f54f34.pdf&urlslug=reaction-time-trends-in-the-sprint-and-hurdle.
2. BEDINI, R., 2016. Technical ability in the women's 100m hurdles. In: *New Studies in Athletics.* **31**(3-4), pp. 117-132. https://www.worldathletics.org/download/downloadnsa?filename=aa261a4e-3c9c-4048-8dcb-e3ed664b1e43.pdf&urlslug=technical-ability-in-the-womens-100m-hurdles.
3. BEZODIS, I. N., A. BRAZIL, H. C. VON LIERS UND WILKAU, et al., 2019a. World-class male sprinters and high hurdlers have similar start and initial acceleration techniques. In: *Frontiers in Sports and Active Living.* **1**, 23. https://doi.org/10.3389/fspor.2019.00023.
4. BEZODIS, N. E., S. WILLWACHER & A. I. T. SALO, 2019b. The biomechanics of the track and field sprint start: a narrative review. In: *Sports Medicine.* **49**(9), pp. 1345-1364. https://doi.org/10.1007/s40279-019-01138-1.
5. BROSNAN, K. C., K. HAYES & A. J. HARRISON, 2017. Effects of false-start disqualification rules on response-times of elite-standard sprinters. In: *Journal of Sports Sciences.* **35**(10), pp. 929-935. https://doi.org/10.1080/02640414.2016.1201213.
6. BROWN, A. M., Z. R. KENWELL, B. K. V. MARAJ & D. F. COLLINS, 2008. Go" signal intensity influences the sprint start. In: *Medicine and Science in Sports and Exercise.* **40**(6), pp. 1142-1148. https://doi.org/10.1249/MSS.0b013e318169770e1.
7. COLLET, C., 1999. Strategic aspects of reaction time in world-class sprinters. In: *Perceptual and Motor Skills.* **88**(1), pp. 65-75. https://doi.org/10.2466/pms.1999.88.1.65.
8. DELALIJA, A. & V. BABIC, 2008. Reaction time and sprint results in athletics. In: *International Journal of Performance Analysis in Sport.* **8**(2), pp. 67 -75. https://doi.org/10.1080/24748668.2008.11868436.

9. DITROLO, M. & A. KILDING, 2004. Has the new false start rule affected the reaction time of elite sprinters? In: *New Studies in Athletics.* **19**(1), pp. 13-19. https://www.worldathletics.org/download/downloadnsa?filename=6101da77-01a4-4725-a22e-fe2a6d55d388.pdf&urlslug=has-the-new-false-start-rule-affected-the-rea.
10. GONZÁLEZ-FRUTOS, P., S. VEIGA, J. MALLO & E. NAVARRO, 2019. Spatiotemporal comparisons between elite and high-level 60 m hurdlers. In: *Frontiers in Psychology.* **10**, 2525. https://doi.org/10.3389/fpsyg.2019.02525.
11. GONZÁLEZ-FRUTOS, P., S. VEIGA, J. MALLO & E. NAVARRO, 2020. Evolution of the hurdle-unit kinematic parameters in the 60 m indoor hurdle race. In: *Applied Sciences.* **10**(21), 7807. https://doi.org/10.3390/app10217807.
12. GURSES, V. V. & O. KAMIS, 2019. The relationship between reaction time and 60 m performance in elite athletes. In: *Journal of Education and Training Studies.* **6**(12a), pp. 64–69. https://doi.org/10.11114/jets.v6i12a.3931.
13. HARLAND, M. J. & J. R. STEELE, 1997. Biomechanics of the sprint start. In: *Sports Medicine*, **23**(1), pp.11–20. https://doi.org/10.2165/00007256-199723010-00002.
14. HAUGEN, T. A., S. SHALFAWI & E. TØNNESSEN, 2013. The effect of different starting procedures on sprinters' reaction time. In: *Journal of Sports Sciences.* **31**(7), pp. 699-705. https://doi.org/10.1080/02640414.2012.746724.
15. HAEUGEN, T. & M. BUCHHEIT, 2016. Sprint running performance monitoring: methodological and practical considerations. In: *Sports Medicine.* **46**(5), pp. 641-656. https://doi.org/10.1007/s40279-015-0446-0.
16. ILLE, A., I. SELIN, D. MANH-CUONG & B. THON, 2013. Attentional focus effects on sprint start performance as a function of skill level. In: *Journal of Sports Sciences.* **31**(15), pp. 1705-1712. https://doi.org/10.1080/02640414.2013.797097.
17. IWASAKI, R., H. SHINKAI & N. ITO, 2020. How hitting the hurdle affects performance in the 110 m hurdles. In: *ISBS Proceedings Archive.* **38**(1), pp. 268-271. https://commons.nmu.edu/isbs/vol38/iss1/69.
18. JUHAS, I., M. MATIC & N. JANKOVIC, 2015. Comparative analysis of reaction time of elite sprinters at the world championships in 2013 and 2015. In: *Godišnjak Fakulteta Sporta i Fizičkog Vaspitanja.* **21**, pp. 43-52. https://doi.org/10.5937/gfsfv1521043J.

19. KAISIDOU, V., L. GAITANIDIS & V. PANOUTSAKOPOULOS, 2021. Relationships between technique index and performance in 60-1 m hurdle indoor races in elite male heptathletes. In: *Trends in Sport Sciences (in press)*.
20. KOMI, P. V., M. ISHIKAWA & J. SALMI, 2009. IAAF Sprint Start Research Project: Is the 100 ms limit still valid? In: *New Studies in Athletics.* **24**(1), pp. 37-47. https://www.worldathletics.org/download/downloadnsa?filename=af62a171-5e94-4178-a30d-55a0b88d3f1d.pdf&urlslug=iaaf-sprint-start-research-project-is-the-100.
21. KUITUNEN, S. & S. POON, 2010. Race pattern of 60-m hurdles in world-class sprint hurdlers: A biomechanical analysis of World Indoor Championships 2010. In: JENSEN R., W. EBBEN, E. PETUSHEK, C. RICHTER, & K. ROEMER *(Eds.), Proceedings of the 28th International Conference in Sports Biomechanics*, pp. 728–729. Marquette, MI: I.S.B.S. https://ojs.ub.uni-konstanz.de/cpa/article/view/4572.
22. LIPPS, D. B., A. T. GALECKI & J. A. ASHTON-MILLER, 2011. On the implications of a sex difference in the reaction times of sprinters at the Beijing Olympics. In: *PLoS ONE.* **6**(10), e26141. https://doi.org/10.1371/journal.pone.0026141.
23. LOPEZ DEL AMO, J., M. RODRIGURZ, D. HILL & J. GONZALEZ, 2018. Analysis of the start to the first hurdle in 110 m hurdles at the IAAF World Athletics Championships Beijing 2015. In: *Journal of Human Sport and Exercise.* **13**(3), pp. 504-517. https://doi.org/10.14198/jhse.2018.133.03.
24. MAJUMDAR, A. S. & R. A. ROBERGS, 2011. The science of speed: Determinants of performance in the 100 m sprint. In: *International Journal of Sports Science & Coaching.* **6**(3), pp. 479-493. https://doi.org/10.1260/1747-9541.6.3.479.
25. MERO, A., S. KUITUNEN, M. HARLAND, H. KYROLAINEN & P. V. KOMI, 2006. Effects of muscle–tendon length on joint moment and power during sprint starts. In: *Journal of Sports Sciences.* **24**(2), pp. 165-173. https://doi.org/10.1080/02640410500131753.
26. MILLOZ, M., K. HAYES & A. J. HARRISON, 2021. Sprint Start Regulation in Athletics: A Critical Review. In: *Sports Medicine.* **51**(1), pp. 21-31. https://doi.org/10.1007/s40279-020-01350-4.
27. MITAŠÍK, P., L. DOLEŽAJOVÁ, A. LEDNICKÝ & D. VÉGH, 2020. Changes in the start reaction times in the 200 m run at the world championships after the tightening of false start

rule. In: *Acta Facultatis Educationis Physicae Universitatis Comenianae.* **60**(2), pp. 207-216. https://doi.org/10.2478/afepuc-2020-0017.

28. MULLER, H. & H. HOMMEL, 1997. Biomechanical research project at the VIth World Championships in Athletics, Athens 1997. In: *New Studies in Athletics.* **12**(2-3), pp. 43-73. https://www.worldathletics.org/download/downloadnsa?filename=4b65d42f-9bce-4333-92d8-52e8e1be2b33.pdf&urlslug=biomechanical-research-project-at-the-vith-wo.
29. NAGAHARA, R., S. GLEADHILL & Y. OHSIMA, 2020. Improvement in sprint start performance by modulating an initial loading location on the starting blocks. In: *Journal of Sports Sciences.* **38**(21), pp. 2437-2445. https://doi.org/10.1080/02640414.2020.1787698.
30. PANOUTSAKOPOULOS, V., A. S. THEODOROU, M. C. KOTZAMANIDOU, E. FRAGKOULIS, A. SMIRNIOTOU & I. A. KOLLIAS, 2020. Gender and event specificity differences in kinematical parameters of a 60 m hurdles race. In: *International Journal of Performance Analysis in Sport.* **20**(4), pp. 668-682. https://doi.org/10.1080/24748668.2020.1776064.
31. PANTELI, F., A. SMIRNIOTOU & A. THEODOROU, 2020. Kinematic parameters of hurdle clearance motion in young, novice athletes. In: *ISBS Proceedings Archive.* **38**(1),75. https://commons.nmu.edu/isbs/vol38/iss1/75.
32. PILIANIDIS, T., A. KASABALIS, N. MANTZOURANIS & A. MAVVIDIS, 2012a. Start reaction time and performance at the sprint events in the Olympic Games. In: *Kinesiology*. **44**(1), pp. 67–72. https://hrcak.srce.hr/83585.
33. PILIANIDIS, T., N. MANTZOURANIS & A. KASABALIS, 2012b. Start reaction time and performance at the sprint events in World Athletic Championships. In: *International Journal of Performance Analysis in Sport.* **12**(1), pp. 112-118. https://doi.org/10.1080/24748668.2012.11868587.
34. SCHOT, P. K. & K. M. KNUTZEN, 1992. A biomechanical analysis of four sprint start positions. In: *Research Quarterly for Exercise and Sport*. **63**(2), pp. 137-147. https://doi.org/10.1080/02701367.1992.10607573.
35. STADLER, K. M., W. WOLDD & J. SCHULER, 2020. On Your Mark, Get Set, Self-Control, Go: A differentiated view on the cortical hemodynamics of self-control during sprint start. In: *Brain Sciences.* **10**(8), 494. https://doi.org/10.3390/brainsci10080494.

36. STEIN, N., 2020. Reflections on a change in the height of the hurdles in the women's sprint hurdles event. In: *New Studies in Athletics*. **15**(2), pp. 15-20. https://www.worldathletics.org/download/downloadnsa?filename=b246e5ed-97cf-4670-9000-eb39843eb76d.pdf&urlslug=reflections-on-a-change-in-the-height-of-the.
37. TØNNESSEN, E., T. HAUGEN & S. SHALFAWI, 2013. Reaction time aspects of elite sprinters in athletic world championships. In: *Journal of Strength and Conditioning Research.* **27**(4), pp. 885-92. https://doi.org/10.1519/JSC.0b013e31826520c3.
38. TSIOKANOS, A., D. TSAOPOULOS, A. GIAVROGLOU & E. TSAROUCHAS, 2018. Race pattern of men's 110-m hurdles: Time analysis of Olympic hurdle performance. In: *Biology of Exercise.* **14**(2), pp. 15-36. https://doi.org/10.4127/jbe.2018.0136.
39. WALKER, J., L. POLLITT, G. P. PARADISIS, I. BEZODIS, A. BISSAS & S. MERLINO, 2019. *Biomechanical Report for the IAAF World Indoor Championships 2018: 60 Metres Hurdles Men*. Birmingham, UK: International Association of Athletics Federations. https://www.worldathletics.org/download/download?filename=0d4bc5cd-4a8b-4faa-81e0-898e90a091c5.pdf&urlslug=Men%E2%80%99s%2060m%20hurdles%20%E2%80%93%202018%20IAAF%20Indoor%20Championships%20Biomechanical%20Report.
40. WORLD ATHLETICS, 2019. *Competition and Technical Rules* (2020 edition). Monaco*: World Athletics*. https://www.worldathletics.org/about-iaaf/documents/book-of-rules.
41. ZHANG, J., X. Y. LIN, & S. ZHANG, 2021. Correlation analysis of sprint performance and reaction time based on double logarithm model. *Complexity.* 6633326. https://doi.org/10.1155/2021/6633326.

sciendo

DOI 10.2478/afepuc-2021-0008
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(1): 86-96

DIAGNOSTICS OF SWIMMING SKILLS IN PREPARATORY SWIMMING TEACHING OF CHILDREN WITH AUTISTIC SPECTRUM DISORDER

Kristýna Hubená

Charles University, Faculty of Physical Education and Sport, Department of Swimming Sports, Czech Republic

Summary. Aim: The aim of this study is to present the results of the evaluation of the Preparatory Swimming Intervention Programme for Children with Autism Spectrum Disorder (PAS). **Methods:** The study used a method of participating observation by which evaluators diagnosed swimming skills. The diagnostic tool was Štochl's scale of swimming skills evaluation (Štochl et al. 2005). A nonparametric sign test was chosen for the analysis of the results. **Results:** The results of the sign test showed that all probands studied had an overall improvement in all skills between measurements 1 and 2, 3 and 4 and also 1 and 4. In a comparison of individual probands, swimming skills improved between the 1st and 2nd measurements in two of them. The third proband achieved the greatest improvement between the 3rd and 4th measurements, the fourth between the 1st and 4th measurements. The fifth proband did not achieve a statistically significant improvement in the acquisition of swimming skills. **Conclusions:** The results of this study show that for the area of preparatory swimming lessons for children with PAS, it is possible to use the Štochl scale (Štochl 2002) for diagnosing swimming skills, thus enabling quantitative data to monitor the level of acquired swimming skills in these individuals.

Key words: Diagnostics of swimming skills, Štochl scale of swimming skills assessments, children with autism spectrum disorder.

Introduction

The concept of swimming literacy has long been an established term. Currently, it is divided into primary and secondary literacy. According to Čechovská & Miler (2019), primary swimming literacy represents safe management of the aquatic environment, which presupposes the acquisition of self-rescue skills appropriate to the age of individuals. Subsequent swimming literacy already presupposes mastering swimming skills that can be used for life to promote health. These are skills that are dominated by swimming locomotion, ie. mastering one or more

swimming methods (backstroke, butterfly, breaststroke, front crawl) or their appropriate modifications. Swimming literacy should apply to the entire population, i.e., children, adults, but also to people with special needs.

Individuals (children and adults) with autism spectrum disorder (ASD) are also included in the group of people with special needs. Autism spectrum disorders or autism belong to the category of pervasive developmental disorders. The disability manifests itself in the field of communication, thinking and social interaction (Šedibová 1998). Autism spectrum disorders are incurable. A relatively large proportion of individuals diagnosed with the disorder are unable to live independently in adulthood. The only possible therapy for individuals with ASD is choosing the right educational approach. The best known are, for example, the Higashi educational program, the TEACCH program, structured learning or an intensive behavioural program.

Diagnostics of swimming skills in swimming lessons

Swimming lessons are one form of the educational process. Its goal is to acquire high-quality comprehensive swimming skills that will enable safe management of the aquatic environment even in adverse conditions. In didactics of swimming, it is a long-term process, which is divided into three consecutive stages - the preparatory, basic and improvement stage of swimming lessons (Macejková 2005). The effectiveness of swimming lessons, i.e., swimming training, can be determined on the basis of targeted diagnostics, such as the evaluation of swimming skills according to the Štochl scale (Pecha et al. 2009; Štochl 2002), evaluation of swimming distance in 12 minutes - Cooper's test (Čechovská & Miler 2008), determining the effectiveness of swimming starts or turns (Polach et al. 2019) or discovering the effectiveness of swimming lessons from the point of view of didactic interaction of teacher - pupil (Hubená et al. 2019) etc.

The main goal of preparatory swimming lessons is the adaptation of the individual to the aquatic environment and the acquisition of basic swimming skills (Čechovská 2007). The subject of diagnostics should therefore be the quality of these acquired skills. The Štochl scale of swimming skills assessment seems to be the most suitable diagnostic method for these needs (Štochl et al. 2005). Its use is desirable in both swimming lessons of intact children and adults (e.g., Dančová 2012), as well as people with special needs and people with autism spectrum disorder (Baštová 2014). In foreign literature, this issue is addressed e.g., Kraft (2019), Lawson et al. (2019) etc. In Czech literature, they deal with this topic, for example. Hubená and Baštová

(2019), in which the authors focus mainly on the organization of swimming lessons and the compilation of its content according to the principles of structured learning.

Aim

The aim of this study is to present the results of the evaluation of the intervention program of preparatory swimming lessons for children with ASD. The evaluation was performed using the Štochl scale of swimming skills evaluation.

Methods

Research Sample

The study population was children with autism spectrum disorder who attended swimming lessons at one of Prague's swimming pools. The research group consisted of 5 boys aged 5-10 years. The following autism spectrum disorders have been diagnosed in these individuals: childhood autism, atypical autism, and Asperger's syndrome. Probands participated in the entire ten-month swimming intervention program for children with ASD. Despite the individual modification of the program, one proband left the program due to panicked fear of the aquatic environment.

Collecting data

The ten-month intervention program implemented within the swimming lessons of children with ASD took place in the school year 2016/2017 at the swimming pool in the permanent health centre - Cordeus in Prague 6. The chosen intervention program was divided into two consecutive courses - 1st and 2nd half - year. In each semester, the probands completed 18 lessons lasting 30 minutes. The lessons took place once a week. A maximum of 3 children could participate in one lesson in the presence of two swimming instructors and one assistant.

The content of the first half of the year was focused on adaptation to the conditions of swimming lessons and the acquisition of basic swimming skills - swimming breathing, merging, immersion and orientation below the surface, falls and dives into the water and the basics of stroke movements. In the second half of the year, attention was focused on the development of these skills and, according to the individual capabilities of individuals, on the practice of swimming locomotion. The content was compiled in accordance with the principles of structured learning. The evaluation of swimming skills took place in the following terms: 1st measurement: September 2016 - initial diagnostics, 2nd measurement: end of January 2017 - diagnostics after the 1st half, 3rd measurement: end of June 2017 - diagnostics after the 2nd half year, 4th measurement: September 2017 - final evaluation of the intervention program.

Participatory observation was used to assess swimming skills. This evaluation was performed by two swimming instructors with several years experience. All measurements were made using the Štochl Scale of Swimming skills Assessment (Štochl 2002), which focuses on the following skills: dunking of the head, starfish (supine position), starfish in the abdominal position, exhaling into the water, jumping into the water from the edge of the pool, retrieval of 2 objects, rotation around the longitudinal axis (rolling barrels). The evaluation was recorded in pre-prepared forms. The measured values were then entered into MS Excel. A nonparametric sign test was used to analyse the obtained data. There was no significant difference between the two evaluators in any of the evaluations (in none of the measurements was the difference greater than 2 degrees). For this reason, compliance was not verified statistically.

Results

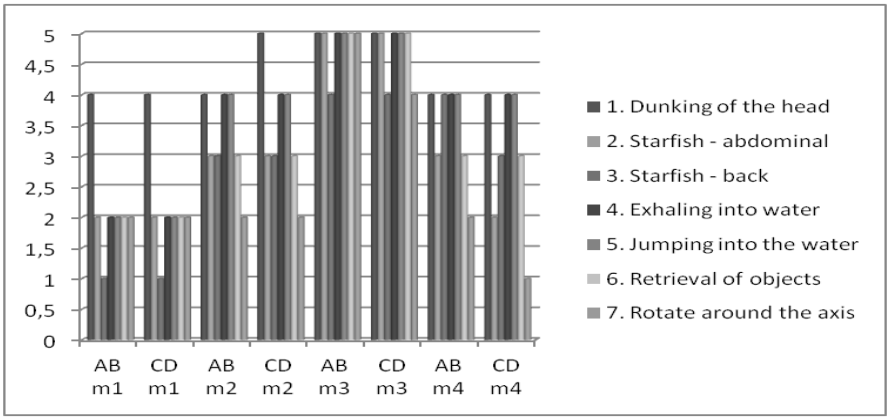
The results of individual probands are shown in graphs. The rating by instructor No. 1 is marked as AB and instructor No. 2 is marked with the abbreviation CD. Measurements 1 - 4 are marked as m1, m2, m3 and m4.

Evaluation of proband No. 1. (Fig. 1)

The biggest improvement was achieved by proband No. 1 in the skill of a starfish on his back. In the 1st measurement, he was evaluated with 1 point by the instructors. He then reached the highest value in the 3rd measurement, where he was able to take up the position on his back, but without sufficient endurance (4 points). The individual also achieved a significant improvement in the skills of exhaling into the water and jumping into the water from the edge of the pool.

Figure 1

Evaluation of proband No. 1

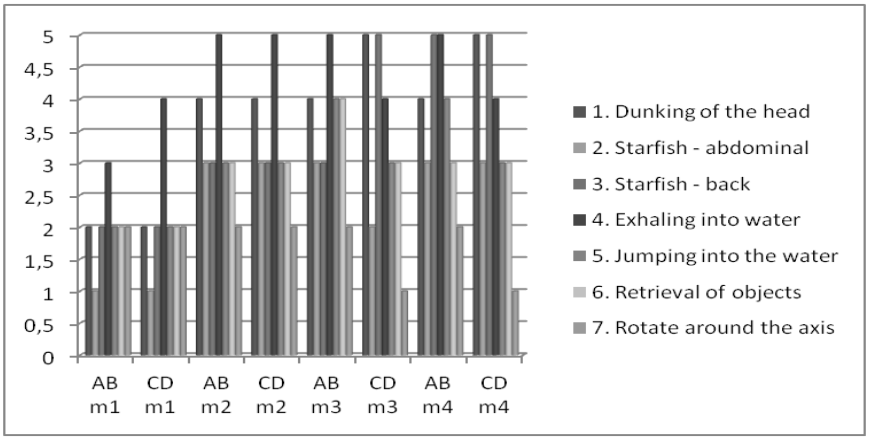


Evaluation of proband No. 2. (Fig. 2)

Proband No. 2 showed the greatest improvement in the swimming skills of the starfish in the supine position. During the first measurement, the instructors rated them 2 points. In the 2nd measurement, this proband was able to take up a floating position on his back with the help of a teacher. In the 4th measurement, he was able to take up this position himself, without the help of a teacher and with a certain endurance. There was almost no improvement in his ability to rotate around the longitudinal axis of the body (freestyle rotation).

Figure 2

Evaluation of proband No. 2

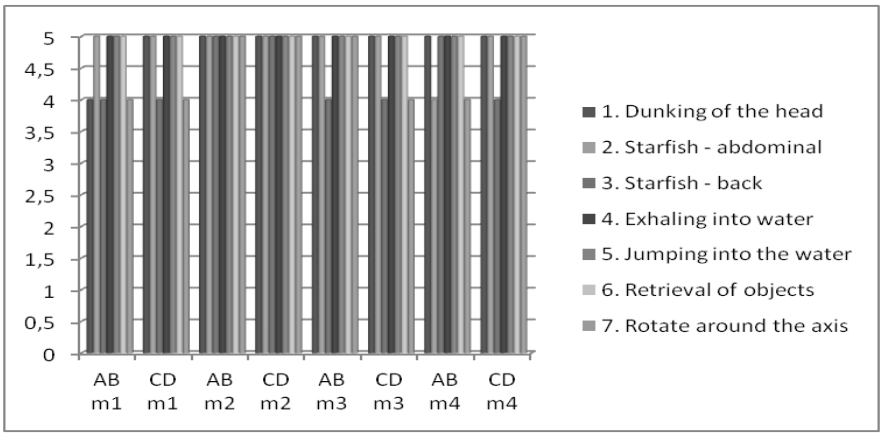


Rating of proband No. 3 (Fig. 3)

Proband No. 3 shows a score of 4 or 5 for all swimming skills. Apparently, this is an individual who has already completed some swimming lessons, in which the process of adaptation to the aquatic environment and the training of basic swimming skills took place. For both instructors, there is a match of 5 points in swimming skills, exhaling into the water, jumping into the water from the edge of the pool and retrieving 2 objects.

Figure 3

Evaluation of proband No. 3

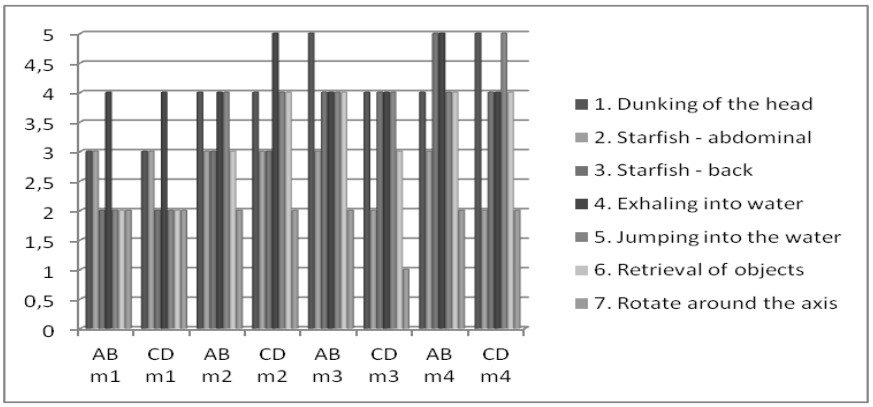


Rating of proband No. 4 (Fig. 4)

This proband achieved a significant improvement in the skill of a starfish in the supine position and jumping into the water from the edge of the pool. The stable design of this proband exhibits the ability to exhale into water. The instructors rated him 4 points - exhalation by mouth only, quick execution, and in two cases even 5 points - deepened full exhalation associated with dunking of the head, performed slowly.

Figure 4

Evaluation of proband No. 4

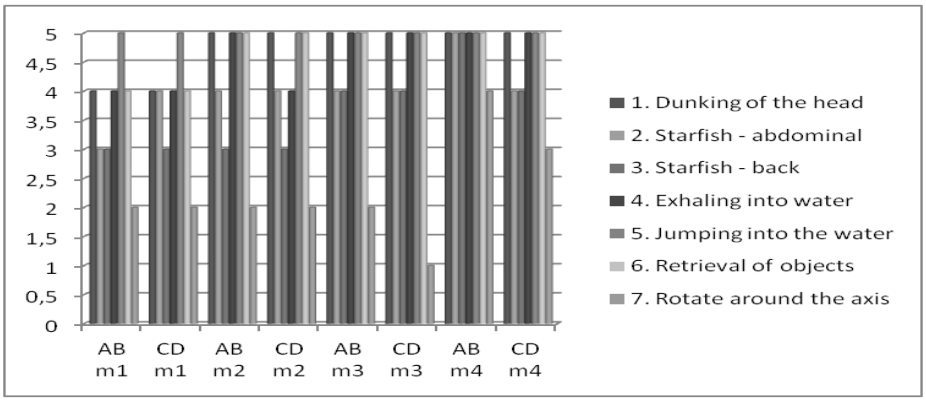


Rating of proband No. 5 (Fig. 5)

This proband showed the most stable rating in the ability to jump into the water from the edge of the pool. In all measurements, the instructors evaluated 5 points, i.e., that the jump was independent, decisive "on their feet", and it was possible to distinguish reflection, the flight phase and controlled impact. Similar results were achieved with the skill of catching 2 objects. Skill number 7 caused the highest difficulty for the proband - turning around the longitudinal axis of the body.

Figure 5

Evaluation of proband No. 5



According to the results performed using the sign test, it is clear that in all examined probands there was an overall improvement of all skills between measurements 1 and 2, 3 and 4 and also 1 and 4. Between the 2nd and 3rd measurements, the swimming skill "turning around the longitudinal axis" showed a significant deterioration with a significant level ($p \leq 0.01$). For other skills, the probands showed improvement. Due to the fact that it was a small research group, a more significant improvement can be observed in the skills of "head dunking" between the 1st and 2nd measurements and "starfish in the supine position" between measurements 3 and 4 and 1 and 4. In a comparison of individual probands, swimming skills improved between the 1st and 2nd measurements for two of them. Another proband achieved the greatest improvement between the 3rd and 4th measurements, the fourth between the 1st and 4th measurements. One proband had already a relatively high level of acquired swimming skills at the beginning of the testing, so there was no considerable improvement in the level of statistical significance.

Discussion

The presented study focuses on the issue of evaluation of swimming skills in preparatory swimming lessons for children with autism spectrum disorder. Although, in terms of content, this teaching is based on the preparatory swimming instruction of intact individuals, it is necessary to follow the principles and recommendations of education of people with ASD during its implementation. The created intervention program was based on the principles of structured learning, which is one of several educational approaches for these individuals.

Similar research was performed on children with ASD by Baštová (2014). The evaluation of swimming skills in this work is performed using a modified 3-point Štochl scale. The author states that attention was focused on finding out the real possibilities of the given individuals and a 5-point scale could skew the results of the study. Other authors who used this standardised scale in their work was Štochl et al. (2005) and Dančová (2012). However, a comparison with this study is out of place, because in their work the research groups consisted of intact children of preschool and younger school age. Despite its standardisation, Štochl's scale is not used by foreign authors to evaluate the swimming skills of people with ASD.

A definite limitation of this study is the size of the selected research group. However, this is a very specific group, which, unlike intact individuals, requires a different approach in the process of swimming education (e.g., a small number of individuals in a group). Thanks to

this, it is not possible to organise preparatory swimming lessons for children with ASD in the same way as for intact individuals (10 beginners or 15 swimmers per teacher).

Another drawback is the evaluation of swimming skills. The standardised Štochl's scale was a suitably chosen diagnostic tool for a group of children with ASD. However, if there is an individual in the group for whom the set intervention programme was not the first swimming lesson experience, the assessment of skills according to this range is not very meaningful. For more able individuals, it would be more appropriate to perform, for example, a diagnosis of the technique of one of the swimming methods (ideally a crawl or backstroke). Vetešníková (2017) dealt with the creation of an evaluation scale for the technique of the swimming style backstroke. However, the scale is created for intact children of a younger school age. In the case of children with ASD, it would be necessary to make certain adjustments that would at least partially take into account the degree of disorders of these individuals as well as the associated defects that affect their gross and fine motor skills.

In addition to the quantitative data obtained, it should be mentioned that the intervention program provided further information on the swimming education of children with ASD. It is mainly about planning the intervention program itself, its implementation in the form of finding a suitable pool, environment, assistants or setting up an appropriate motivational system for children. Another important area, which stands outside the quantitative data, is the area of interaction and communication with children with ASD from the teacher's perspective. Many individuals with ASD have difficulty communicating, especially speech comprehension. It is all the more necessary to include illustrative movement demonstrations in order to understand the given movement tasks. However, this presupposes the presence of an instructor and an assistant with children in the water, at least in preparatory swimming lessons.

This intervention swimming program was designed for moderately to highly functional children with ASD. For low-functioning individuals, in whom the intellect and general motor skills are severely impaired, their medical diagnosis allows the acquisition of basic swimming skills to a limited extent, in many cases they will not be acquired at all. For these children, swimming serves as one of the forms of rehabilitation and maintaining at least some social contact.

Conclusion

The issue of education of individuals with autism spectrum disorder is currently receiving much attention. Following the example of inclusive education, these children are also

included in mainstream education, and also in leisure activities. However, it is not always possible to accomplish this model of current education of people with special needs. Such an example is swimming lessons, where it is difficult or even impossible to practice an inclusive model of teaching.

If possible, the content of swimming lessons for people with ASD should be based on the content of lessons for intact children and adults. The fulfilment of this content should then be in accordance with one of the educational approaches that is suitable for these individuals. Structured learning was chosen for the implementation of this intervention program. The use of its principles (structuring, individualization, visualization, motivation) enabled probands to orient themselves more easily in the structure of swimming lessons and in the assigned tasks, which led to a successful adaptation to the aquatic environment and subsequently the acquisition of basic swimming skills. The results of the study cannot be generalised to the whole population of children with ASD participating in some type of swimming lessons. The aim of this paper was rather to point out the form of teaching for these individuals and especially the diagnosis of acquired skills, as an integral part of any educational process.

This study was created with the support of Charles University in the research project Programs for the Development of Scientific Areas at Charles University Progress Q19 Socio-scientific aspects of the study of human movement II.

References

1. BAŠTOVÁ, M., 2014. *Specifika plavecké výuky dětí s poruchou autistického spektra*. Prague. Charles University Master. Faculty of Physical Education and Sport, Department of Swimming Sports.
2. ČECHOVSKÁ, I., 2007. *Plavání dětí s rodiči: výuka kojenců, batolat a předškolních dětí:do 6 let. 2.,* upr. vyd. Prague: Grada Publishing.
3. ČECHOVSKÁ, I. & T. MILER, 2019. Movement and swimming literacy. In: ČECHOVSKÁ, I., T. MILER. *Didactics of swimming*. Selected chapters. Prague: Karolinum. pp. 9 - 16.
4. ČECHOVSKÁ, I. & T. MILER, 2019. *Plavání*. 2., upr. vyd. Prague: Grada Publishing.
5. DANČOVÁ, B., 2012. *Plavecká gramotnost 11 – 12 ročných detí*. Prague. Charles University Master. Faculty of Physical Education and Sport, Department of Swimming Sports.

6. HUBENÁ, K., V. SÜSS & I. ČECHOVSKÁ, 2019. Diagnostics of didactic competencies of students of the faculty of physical education and sport. In: *Acta Facultatis Educationis Physicae Universitatis Comenianae* [online], 2019, 59(2), 214-223 [cit. 2020-12-01]. Accessible from: https://content.sciendo.com/view/journals/afepuc/59/2/article-p214.xml?rskey=8dUDgR&result=1
7. HUBENÁ, K., M. BAŠTOVÁ, 2019. Swimming lessons for people with autism spectrum disorder. In: ČECHOVSKÁ, I., T. MILER. *Didactics of swimming*. Selected chapters. Prague: Karolinum. pp. 24 - 33.
8. KRAFT, E., 2019. Examining the Perceived Impacts of Recreational Swimming Lessons for Children with Autism Spectrum Disorder. In: *International Journal of Aquatic Research and Education* [online]. 2019, 10(4), 6. [cit. 2020-12-02]. Dostupné z: https://scholarworks.bgsu.edu/cgi/viewcontent.cgi?article=1456&context=ijare.
9. LAWSON, L. M., J. D´ADAMO & K. CAMPBELL et. al., 2019. A Qualitative Investigation of Swimming Experiences of Children with Autism Spectrum Disorders and Their Families. In: *Insights of Clinical Medicine Insights: Pediatric* [online]. 2019, 13. [cit. 2020-12-02] Dostupné z: https://journals.sagepub.com/doi/10.1177/1179556519872214.
10. MACEJKOVÁ, Y. et. al., 2005. *Didaktika plávania*. Bratislava: ICM AGENCY.
11. PECHA, O., J. ŠTOCHL, K.A. HAGTVET, & I. ČECHOVSKÁ, 2009. Generalisability of assessing fundamental aquatic skills in preschool children: a three-facet design. In: *Acta Universitatis Carolinae Kinanthropologica.* **45**(2), pp. 119-131.
12. POLACH, M., D. THIEL & Z. SVOZIL, 2019. Turns as one of the important factors of swimming performance. In: *Tělesná kultura* [online]. 2019, 42 (1), 9-13 [cit. 2020-12-01]. Accessible from: https://telesnakultura.upol.cz/artkey/tek-201901-0001_obratky_jako_jeden_z_dulezitych_faktoru_plaveckeho_vykonu.php?back=%2Fsearch.php%3Fquery%3Dpolach%2Bin%253Aauth%2Bname%26s%2Bf%%26s%BBname02
13. ŠEDIBOVÁ, A., 1998. *Autizmus: ABC autistickej triedy*: praktická príručka pre pracovníkov v autistických triedach. Bratislava: Merkur Print.
14. ŠTOCHL, J., 2002. Scale for evaluating swimming skills of preschool children. In: *Tělesná výchova a sport mládeže.* **68**(7), pp. 26 - 30.
15. ŠTOCHL, J., I. ČECHOVSKÁ & V. PAVELKOVÁ, 2005. Evaluation of the scale of swimming skills for preschool children. In: *Acta Universitatis Carolinae Kinanthropologica.* **41**(1), pp. 87-98.

16. VETEŠNÍKOVÁ, B., 2017. *Hodnotící škála pro techniku plaveckého způsobu znak pro děti v mladším školním věku*. Prague. Charles University Bachelor. Faculty of Physical Education and Sport, Department of Swimming Sports.

sciendo

DOI 10.2478/afepuc-2021-0009
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(1): 97-106

TEST AND RE-TEST RELIABILITY OF THE SPECIAL JUDO FITNESS TEST

Miloš Štefanovský, Matej Poliak, Dušana Augustovičová, Stanislav Kraček, Radovan Hadža

Comenius University in Bratislava Faculty of Physical Education and Sports, Slovakia

Summary: Background. When analyzing the available literature, we found differences and considerable variability in the Special Judo Fitness Test (SJFT) reliability methods. **Problems and Aim.** For this reason, we have set our goal to determine the reliability and measurement error of all parameters by SJFT. **Methods.** The research sample consisted of 15 judo athletes (17.13 ± 1.96 years, body height 174.4 ± 10.64 cm, body weight 72 ± 15.37 kg) who trained in judo on average 8.73 ± 2.12 years in two different Slovak judo clubs. The results were processed using interclass correlation analysis and measurement error percentage. **Results.** Our results indicate poor reliability for HR_0 (α= 0.374, *Err* = 4.2 %) and moderate reliability for the following parameters: the number of throws in section A (α = 0.641, *Err* = 5.9 %), section B (α = 0.512, *Err* = 6.0 %), and section C (α = 0.644, *Err* = 5.9 %), respectively. Moderate reliability was also found for the total number of throws (α = 0.687, *Err* = 5.1 %). Good reliability was found for HR_1 *(*α = 0797, *Err* = 3.5 %) and SJFT index *(*α = 0.807, *Err* = 4.5 %). **Conclusions.** According to the results of this study, by testing the special level of judo fitness, as well as its changes, we recommend using the HR_1 and SJFT index as good reliable parameters.

Key Words: judo, level of fitness, reliability, measurement error.

Introduction

Due to the multifactorial structure of the sports performance (SSP) in combat sports, as well as the constantly changing conditions in the match, and the resistance of the opponent, it makes the assessment of the athlete's fitness level a very complicated process. Several authors have tried in the past to identify factors of SSP in combat sports, especially by using correlation and regression analysis procedures (Zemková 1999; Feč 2004; Štefanovský 2008). This approach made it possible to test combat sports athletes using a wide range of motor tests, mainly focused on the level of fitness (Matejová et al. 2018; Zemková 2018). However, most of these tests have a general nature and only marginally cover the special level of fitness.

Conventional standardized tests do not take into consideration the opponent´s active resistance, specific movement structures, or decision-making factor. The contemporary trend points to the use of specifically designed tests, which better simulate the competitive load and specific movement (Tabben et al. 2014; Chaabene et al. 2015; Šimenko & Karpljuk 2015; Karimi 2016; Štefanovský et al. 2016; Šiška et al. 2016; Madaiová & Čierna 2018).

To assess the specific level of fitness in judo, Sterkowicz (1995) created a Specific Judo Fitness Test (SJFT). The test was designed to evaluate the specific abilities of judo athletes. SJFT partially respects the time structure of a real judo contest and uses the throwing technique over the shoulder (Ippon-Seoi-Nage). According to Detanico and dos Santos (2012), the SJFT test can be used to identify anaerobic and aerobic capacity, but care should be taken when using recovery HR to infer aerobic capacity. Moreover, the SJFT seems able to induce glycolytic and aerobic demands similar to those of judo combat, being thus an important tool to evaluate the specific performance of the athlete. Currently, the test is used in many countries, where judo is well developed (Štefanovský 2015). More than a hundred scientific papers can be found via Google Scholar, ResearchGate, Scopus, Web of Science, or PubMed databases, in which SJFT has been used to assess the judokas of the different levels. In most scientific papers, the authors refer to the test as a reliable tool, sensitive enough to assess changes in fitness level, with the ability to distinguish judokas by age and sex, and it correlates with the laboratory tests (eg. VO2mox or Wingate) and the number of attacks during a competitive contest (Franchini et al. 2007; Radovanovic et al. 2009; Wolska et al. 2009; Franchini et al. 2011; Detanico et al. 2012). However, in the work of Szmuchrowski et al. (2013), there was no correlation between the Wingate test and SJFT. The authors concluded that the Wingate test of upper and lower limbs is not sensitive enough to adequately assess the anaerobic capacity of judo athletes. Stekowicz (1995) reports that the value of the Spearman correlation coefficient for SJFT is 0.97 ($p \leq 0.01$) when the test is repeated twice. Franchini et al. (1999) report a correlation coefficient value of 0.73 ($p \leq 0.05$) for the parameter total number of throws and 0.89 ($p \leq 0.05$) for the „SJFT index". However, it is important to consider that the Spearman correlation coefficient has been criticized when used to test reliability (Thomas & Nelson 1990; Franchini et al. 2010).

Franchini et al. (1999) report that the performance in SJFT can be improved by a) an increased number of throws, which represents an improvement in speed, anaerobic capacity, and/or technique; b) decreasing the heart rate at the end of the test, indicating higher cardiovascular performance with equal effort (same number of throws); c) decreasing heart rate 1 min after the end of the test, indicating a better recovery, which is due to improved aerobic performance; d) a combination of two or more of the factors.

Iredale (2003), Franchini et al. (1999), and Sterkowicz (1995) in their studies presented only the reliability of some SJFT parameters by using of Pearson Correlation or ICC method. Our work was aimed to assess the reliability and to determine the measurement error of all SJFT parameters in the group of high-performance judo athletes.

Methods

Participants

The research sample consisted of 15 judo athletes (17.13 ± 1.96 years, body height 174.4 ± 10.64 cm, body weight 72 ± 15.37 kg) who trained in judo on average 8.73 ± 2.12 years. The participants were members of two Slovak judo clubs Dukla Banská Bystrica and Slávia Bratislava and their judo technical level was from second Kyu to first Dan. Judo athletes included in this study regularly attended national or international tournaments. All probands, or their legal representatives, signed voluntarily a consent agreement form. The study design received ethical approval from the local Ethics Committee. None of the athletes were engaged in any weight-loss procedures during the testing period and did not take any medicaments.

Procedures

Participants began the testing protocol with warming-up and dynamic stretching. The warm-up consisted of 5 min running around the tatami with low intensity and 10 min of dynamic stretching whereupon, afterward, SJFT was conducted. Immediately after the test, the participants stood still, and the heart rate was monitored. Re-test was realized after seven days, on Monday (after two days of passive recovery), under the same conditions. We did not intervene in the weekly judo training program, which respected the content of the relevant micro-cycle of both judo clubs.

The SJFT was performed in three sections, divided into 15 s section A, 30 s section B, and 30s section C with a 10s break between them. During each section, an athlete throws two equally heavy sparring partners (± 2 kg), placed 6m apart, as many times as possible, using the ippon-seoi-nage technique. The test begins in the middle, at a distance of 3 m apart from both sparring partners. The choice of this technique is based on the following aspects: a) biomechanical – the athlete grasps his partner only with one hand and the turn into the technique allows him to immediately run to the next partner, b) frequency of use in competitions – this technique is one of the most used at the competitions (Adam et al. 2016) and most of the judo athletes can apply the technique properly, at a high level. Any incorrectly performed throwing technique during the test is not included in the result. Heart rate is recorded immediately after

the end of the test (HR_0) as well as 1 min after its end (HR_1). To monitor the heart rate, we used the Sportester POLAR RS800CX G3 (Made in Finland). The judo athlete wears the heart rate monitor during the whole test. From the total number of throws (TT) and HR_0 and HR_1 was calculated SJFT index (Index = HR_0 + HR_1 / TT), while the lower the index value, the better performance in the test, respectively, the more throws, the better performance. Top-level judo athletes (men) can throw more than 30 times and the SJFT index is at 11.20 or below (Ceylan & Balci 2018; Merola et al. 2019).

Statistical analysis

To process the empirical data, we used Cronbach's Alpha method with respective 95 % Confidence Interval (95 % CI). The coefficients of correlation were interpreted according to Koo & Li (2016), where values less than 0.5 are indicative of poor reliability, values between 0.5 and 0.75 indicate moderate reliability, values between 0.75 and 0.9 indicate good reliability, and values greater than 0.90 indicate excellent reliability. The measurement error (ε) was expressed as the mean percentage error. The level of statistical significance was set at $p \leq .05$.

Results

Our results (Table 1) indicate poor reliability for heart rate (HR_0) immediately after the test (α = 0.374, *Err* = 4.2 %), moderate reliability for the number of throws in section A (α = 0.641, *Err* = 5.9 %), section B (α = 0.512, *Err* = 6.0 %), and section C (α = 0.644, *Err* = 5.9 %), respectively. Moderate reliability was also found for total number (TT) of throws (α = 0.687, *Err* = 5.1 %). Good reliability was confirmed for the heart rate (HR_1) 1 min after the end of the test *(*α = 0797, *Err* = 3.5 %) and SJFT index *(*α = 0.807, *Err* = 4.5 %).

Table 1

Mean values of SJFT parameters and ICC correlation

	Test	**Re-test**	**Cronbach´s Alpha**	**95 % CI**
Section A [n]	5.6 ± 0.63	5.53 ± 0.52	0.641	-0.032 - 0.794
Section B [n]	10.07 ± 0.70	10.13 ± 0.83	0.512	-0.198 - 0.731
Section C [n]	8.87 ± 0.52	9.27 ± 0.70	0.644	-0.050 - 0.740
TT [n]	24.60 ± 1.55	24.93 ± 1.87	0.687	0.046 - 0.813
HR_0 [b/min]	192.33 ± 7.26	192.20 ± 8.50	0.374	-0.331 - 0.668
HR_1 [b/min]	172.13 ± 8.31	169.87 ± 8.55	0.797	0.253 - 0.867
SJFT Index	14.86 ± 1.02	14.59 ± 1.22	0.807	0.280 - 0.875

Section A - number of throws in the 15 s section; section B - number of throws in the 30 s section; section C - number of throws in the last 30 s section; TT – total number of throws; HR_0 - heart rate at the end of the test; HR_1 - heart rate 1 min after the end of the test; SJFT index = HR_0 + HR_1 / TT.

Discussion

This research aimed to determine the reliability and percentage measurement error of all SJFT parameters. The research sample was composed of high-performance judo athletes. Although the weekly micro-cycle training content was not uniform among the athletes involved in this work, we assumed that there will be no significant changes in the level of fitness between the test and retest within 7 days.

Surprisingly, only poor reliability with relatively low measurement error was found for the parameter HR_0. Lower HR after the SJFT or a faster HR recovery has been interpreted as an improvement in aerobic fitness.

Our results showed good reliability of parameters HR_1 and SJFT index and their measurement error were quite low. HR_1 indicates a decrease in heart rate after the first min of recovery. The rate of decrease in heart rate during the first min after the exercise is an undemanding, non-invasive, valid, and simple indicator of parasympathetic activity (Lahiri et al. 2008). In judo, the cardiovascular system adapts to a mixture of strength, anaerobic and aerobic load. The decrease in athlete´s HR is due to the chronically increased systolic volume of the heart and two adaptation mechanisms contribute to its increase, which is a) the thickening of the left ventricle wall due to the strength training, and b) an increase of cardiac cavity volume due to aerobic exercise (Hamar & Lipková 1996). A high load of strength appears in judo performance in situations when overcoming the opponent's resistance, as well as in strength and condition training. A faster heart rate recovery can be a significant advantage especially when a repeated high performance during competition day is necessary, caused by interruptions during a match, in overtime situations, or when judo athletes undergo multiphase training units per day (Franchini et al. 2013). Achten, Jeukendrup (2006) report that a decrease in HR during the rapid recovery phase is not only conditioned by the level of aerobic fitness, but also by neural mechanisms associated with motor centers in the cortex. Daanen et al. (2012) in a systematic literature analysis found that the heart rate recovery of well-trained individuals was faster compared to untrained subjects. However, in these two works, no significant differences were found between trained and untrained subjects. The authors concluded that heart rate recovery after exercise can be a valuable tool for monitoring the athlete´s level of fitness. Sterkowicz et al. (1999) found a significant correlation ($r = -0,63$) between VO_2max and HR_1 after SJFT and concluded that heart rate recovery is a good indicator of the aerobic level of fitness in judo. Franchini et al. (2001) tested female judo athletes 70 and 30 days before the top-level competition. Parameters in SJFT did not change significantly except SJFT index

(13.09 ± 1.55 vs. 12.62 ± 1.48; $p \leq .05$). The difference between HR_0 and HR_1 increased from 17 to 21 beats per minute 30 days before the event, which may indicate a slightly (insignificant) improved cardiovascular adaptation to the training load. Significant changes may occur only after a long-term training period. If we consider the measurement error for the HR_1, it was the lowest of all other parameters.

The SJFT index is calculated from the parameters obtained during the test (SJFT = HR_0 + HR_1 / TT). The SJFT index reflects the specific training of the cardiovascular system, the speed of throwing and running between two sparring partners, as well as the ability of the subject to resist fatigue during lactate accumulation. The reliability of the SJFT index using the interclass correlation coefficient method was verified in the work Iredale (2003). She found an ICC value for the SJFT index of 0.84 and the measurement error was 3.4 %. The Cronbach's Alpha coefficient in our work for the same parameter is very similar ($\alpha = 0.807$) and the standard error of measurement was slightly higher, namely 4.5 %. However, with especially well-trained individuals, it might be a problem to detect changes in the HR_1 below 5 %. However, even though it is not a laboratory test with strict standard conditions, we do not consider the measurement error as high.

According to Cronbach's Alpha calculated values for individual sections (A, B, and C), as well as for the total number of throws (TT), we found the moderate reliability of these parameters. These will not be suitable to distinguish judo athlete´s special level of fitness. Measurement error in the range of 5 - 6 % for the throws indicates the inability of the test to detect changes in very well-trained judo athletes. One of the limitations of the SJFT test is the use of the Ippon-seoi-nage (shoulder throw) technique. For example, Sterkowicz & Franchini (2002) found that the SJFT index was significantly lower for those judo athletes who preferred this technique and considered it as a personal throw (tokuj-waza), compared to others. However, in this study, the TT parameter did not differ significantly, regardless of preferred techniques. We can say that the execution quality of each throw and using of different kind of sparing partners (eg different height, limb length, or center of gravity height) can also affect the number of throws in each section as well as the total number of throws. Sometimes, we also noticed a worse quality of throwing execution in some judo athletes. This should be taken into consideration as well. Both the examiner and the test subject must pay attention to the quality of the technical execution during the whole test, and this should meet the basic prescribed standards.

Another limitation of the SJFT is, it does not consider how many times the proband runs the 6 m distance between the two sparring partners. During the test, it happened several times

that the athlete runs to the partner, but he does not manage to make the throw due to the end of the time limit. However, the last 6m distance was not included in the performance result.

According to our results, we recommend to coaches and athletes: a) to record a new SJFT parameter – the total number of 6m runs passed, b) to use the HR_1 and SJFT parameter, as good reliable parameters, with low measurement error, when assessing the level of judo athletes fitness, c) to maintain a high level of objectivity of testing, it is important to execute the throwing technique on the highest quality. In future works, the changes in the HR_1 and SJFT index parameters should be monitored during the different periods of the one-year training cycle.

Conclusions

Field test like the Judo fitness test is a good alternative method to measure the fitness of judo athletes without the expense, time, and expertise required for laboratory testing. However, as we found out, not all parameters in this test are suitable and reliable in evaluating the level of fitness. We found low reliability of parameter HR_0. The number of throws in sections A, B, and C, as well as TT, are parameters with moderate reliability and we do not recommend them to assess the level of judo athlete's fitness. Only HR_1 and SJFT index were proven as highly reliable parameters with a relatively low measurement error, and the ability to control the cardiovascular response to a specific load.

References

1. ACHTEN, J., A. E., JEUKENDRUP, 2006. Heart Rate Monitoring. In: *Sports medicine.* ***33***(7), pp. 517-538.
2. ADAM, M., P., KLIMOWICZ, R., PUJSZO, 2016. Judoists' tactical and technical efficiency during the World Championships in 2014 and 2015. In: *Baltic Journal of Health & Physical Activity.* **8**(2), pp. 19-28.
3. CEYLAN, B. & S. S. BALCI, 2018. The Comparison of Judo-Specific Tests. In: *Ido Movement for Culture-Journal of Martial Arts Anthropology*. **18**(4), pp.54-62.
4. CHAABENE, H., Y., HACHANA, E., FRANCHINI, M., TABBEN, B.,MKAOUER, Y.,NEGRA, K., CHAMARI, 2015. Criterion-related validity of karate specific aerobic test (KSAT). In: *Asian Journal of Sports Medicine*. ***6***(3).
5. DAANEN, H., et al. 2012. A Systematic Review on Heart-Rate Recovery to Monitor Changes in Training Status in Athletes. In: *International Journal of Sports Physiology and*

Performance. **7**(3*)*, pp. 251-260.

6. DETANICO, D., J. DAL PUPO, E. FRANCHINI, S. GIOVANA DOS SANTOS, 2012, Relationship of aerobic and neuromuscular indexes with specific actions in judo. In: *Science and Sports.* **27**, pp. 16-22.
7. DETANICO, D. & S. G. SANTOS, 2012. Especific evaluation in judo: a review of methods. In: *Brazilian journal of Kinanthropometry and Human Performance.* **14**, pp. 738-748.
8. FEČ, R., 2004. *Hodnotenie pohybových schopností a športovej výkonnosti v džude. Dizertačná práca*. Prešov: PuvP FhaPV.
9. FRANCHINI, E. et al., 1999. Análise de um teste específico para o judo. In: *Revista Kinesis.* ***21***, pp. 91-108.
10. FRANCHINI, E. et al., 2010. Special Judo Fitness Test: development and results. In: *Advancements in the Scientific Study of Combative Sports.* Warmick, E., J. et al. Nova Science Publisher, pp. 41 - 59.
11. FRANCHINI, E. et al., 2013. Judo combat: Time-motion analysis and physiology. In: *International Journal of Performance Analysis in Sport.* **13***(*3), pp. 624-641.
12. FRANCHINI, E. et al., 2011. Physiological profiles of elite judo athletes. In: S*ports Medicine.* **41**(2), pp. 147-166.
13. FRANCHINI, E. et al., 2001. Estudo de caso das mudanças fisiológicas e de dese desempenho de judocas do sexo feminino em preparacao para os Jogos Pan-Americanos. [Case study of physiological and performance changes of female judokas in preparation for Pan-American games. In: *Revista Brasileira de Ciencia e Movimento.* ***9***(2), pp. 21-27.
14. FRANCHINI, E. et al., 2007. Physical Fitness and Anthropometrical Profile of the Brazilian Male Judo Team. In: *Journal of Physiological Anthropology.* ***26*** (2), pp. 59-67.
15. HAMAR D. & J. LIPKOVÁ, 1996. *Fyziológia telesných cvičení*. Bratislava: Comenius University.
16. IREDALE, F., 2003. Determining reliability in a judo specific fitness test. International Judo Federation. In: *3rd IJF Conference* [*CD-rom*]. Osaka: International Judo Federation.
17. KARIMI, M., 2016. The validity of the Special Judo Fitness Test in Iranian Male Wrestlers. In: *International Journal of Wrestling Science.* ***6****(*1), pp. 34-38.
18. KOO, T. K. & M. Y. LI, 2016. A Guideline of Selecting and Reporting Intraclass Correlation Coefficients for Reliability Research. In: J*ournal of Chiropractic Medicine.* **15**(2), pp. 155-163.
19. LAHIRI, M. K. et al., 2008. Assessment of Autonomic Function in Cardiovascular Disease. In: *Physiological Basis and Prognostic Implications*. **51**(18), pp. 1725-1733.

20. MADAIOVÁ, V. & D. ČIERNA, 2018. Zmeny úrovne výkonnosti v disciplíne agility detí v súťažnej sezóne 2017. In: D. ČIERNA *Úpoly v minulosti a v súčasnosti.* Bratislava, Slovakia: ICM Agency, pp. 16-29.
21. MATEJOVÁ, L., A. STRZELCZYK & M. ŠTEFANOVSKÝ, 2018. Fyziologický profil slovenských zápasníkov a džudistov. In: D. ČIERNA *Úpoly v minulosti a v súčasnosti.* Bratislava, Slovakia: ICM Agency, pp. 39-53.
22. MEROLA, P. K. et al., 2019. High load inspiratory muscle warm-up has no impact on Special Judo Fitness Test performance. In: I*do movement for culture. Journal of martial arts anthropology. **19(***1), pp. 66-74.
23. RADOVANOVIC, D. et al., 2009. Oxidative stress biomarker response to concurrent strength and endurance training. In: *General Physiology and Biophysics. **28***(Special Issues), pp. 205-211.
24. ŠIMENKO, J. & D. KARPLJUK, 2015. Specialni judo fitnes test. In: "*Šport : Revija Za Teoretična in Praktična Vprašanja Športa. **63***(1/2), pp. 42-46.
25. ŠIŠKA, Ľ., J. BROĎÁNI, M. ŠTEFANOVSKÝ & S. TODOROV, 2016. Basic reliability parameters of a boxing punch. In: *Journal of Physical Education and Sport. **16(***1), pp. 241-244.
26. ŠTEFANOVSKÝ, M., 2008. *Hierarchia motorických faktorov v štruktúre športového výkonu v džude dorastencov.* Bratislava: Faculty of Physical Education and Sport.
27. ŠTEFANOVSKÝ M., 2015. *Fyziologické, motorické a somatické charakteristiky džudistov z hľadiska veku a úrovne trénovanosti.* Bratislava, Slovakia: Slovak Scientific Society for Physical Education and Sport.
28. ŠTEFANOVSKÝ M., et al., 2016. Influence of selected phases of the menstrual cycle on performance in Special judo fitness test and Wingate test. In: *Acta Gymnica. **46***(3), pp. 136-142.
29. STERKOWICZ, S., 1995. Test specjalnej sprawno ś ci ruchowej w judo. In: *Antropomotoryka.* (*12)*, pp. 29-44 .
30. STERKOWICZ, S., A. ZUCHOWICZ & R. KUBICA, 1999. *Levels of anaerobic and aerobic capacity indices and results for the special fitness test in judo competitors*. In: J*ournal of Human Kinetics. **2(***1), pp. 115-135.
31. STERKOWICZ, S. & E. FRANCHINI, 2002. Testing fitness for judo taking experience, tokui-waza and weight category into consideration. In: *Mataruna, L. Anais do 11 Workshop Cientifico International de Judo. Niterói: Fedracao de Judo do Estado do Rio de Janeiro.*
32. SZMUCHROWSKI, L. A. et al., 2013. Correlation between the performance in the Special

Judo Fitness Test and the Wingate Anaerobic Test. *Archives of Budo.* ***9***(3), pp. 175-179.

33. STERKOWICZ-PRZYBYCIE, N., 2017. Special Judo Fitness Test: Results and Applications. In: *Science and Medicine in Combat Sports*; Drid, P., Ed.; Nova Science Publishers, Inc. Hauppauge, NY, USA, 2017; pp. 145-173.
34. TABBEN, M. et al., 2014. Validity and reliability of a new karate-specific aerobic field test for karatekas. In: *International Journal of Sports Physiology and Performance.* ***9***(6), pp. 953-958.
35. THOMAS, J. R. & J. K. NELSON, 1990. *Research methods in physical activity*. Champaign, Human Kinetics.
36. WOLSKA, B. et al., 2009. The Level of Aerobic and Anaerobic Capacity and the Results of a Special Mobility Fitness Test of Female Judo Contestants. In: *Baltic Journal of Health and Physical Activity.* ***1***(2), pp.124-131.
37. ZEMKOVÁ, E., 1999. *Štruktúra športového výkonu v karate.* Bratislava. Comenius University in Bratislava. Disertation. Faculty of Physical Education and Sport Kinanthropology.
38. ZEMKOVÁ, E., 2018, Posudzovanie limitujúcich faktorov výkonnosti karatistov. In: D. Čierna, *Úpoly v minulosti a v súčasnosti.* Bratislava, Slovakia: ICM Agency, pp. 121-139.

DOI 10.2478/afepuc-2021-0010
© Acta Facultatis Educationis Physicae Universitatis Comenianae 2021, 61(1): 107-121

EXPLANATORY LEARNING RESEARCH: PROBLEM-BASED LEARNING OR PROJECT-BASED LEARNING?

Sinta Naviri[1], Sumaryanti Sumaryanti[2], Paryadi Paryadi [3]

[1]Sports Science, Postgraduates Program, Universitas Negeri Yogyakarta, INDONESIA
[2]Sports Science of Faculty, Universitas Negeri Yogyakarta, INDONESIA
[3]Faculty of Teacher Training and Education, Universitas Mulawarman, INDONESIA

Summary. Problems in learning are one of the obstacles to student's success in understanding and achieving success. Learning problems also occur in physical education learning, the problems that have occurred in the last decade are caused by the individual students. To minimize and even overcome these learning problems an appropriate learning approach model is needed. In the last 5-10 years, the learning approach models that are often used are problem-based learning and project-based learning. This study aims to review and examine problem-based learning approaches and project-based learning approaches in designing and improving physical education learning. The literature review that will be discussed is about the characteristics, advantages, and disadvantages of each learning approach model. The results of the literature review are expected to be able to be used as a study or information that can be used as a theoretical basis for further research in the use of a learning approach model to complete or improve physical education learning including problem-based learning and project-based learning.

Key words: Physical Education Learning, Problem-based Learning, Project-based Learning

Introduction

Physical education is one of the lessons that have been obtained from Elementary School (SD) to Senior High School (SMA) levels (Burhaein, Tarigan & Phytanza 2020; Purnomo, Tomoliyus & Burhaein 2019). Junaedi & Wisnu (2016) revealed that physical education has the meaning, namely, a part of overall education that prioritizes physical activity and fostering a healthy life for physical, mental, social, and emotional growth and development that is harmonious and balanced (Burhaein 2017a; Burhaein, Ibrahim & Pavlovic 2020). Physical education, sports, and health are integral parts of education as a whole which aims to develop

aspects of physical fitness, movement skills, critical thinking skills, social skills, reasoning, emotional stability, moral action, aspects of a healthy lifestyle, and the introduction of a clean environment through physical activity, sports, and selected health that is planned systematically to achieve the goals of national education (Burhaein, Phytanza & Demirci 2020; Phytanza & Burhaein 2020). Herdiyana & Prakoso (2016) and Paramitha & Anggara (2018) explained if physical education learning has a goal, namely to develop the abilities and habits of students through physical activities. Physical education learning has an important role in student life (Phytanza, Burhaein, Sukoco & Ghautama 2018). This is intended through physical education learning to be able to shape student character. In line with this opinion Soedjatmiko (2015) explained that through physical education learning, the formation of student character and morals can be developed and formed, the characters that will usually be formed by learning physical education are responsibility, creativity, accepting defeat, and so on. Tutkun, Gorgut & Erdemir (2017) revealed that physical education can grow and shape children's character to be better, it is further revealed that learning physical education is more effective and affects the morale and character of students. Physical education affects the character building of students, including work ethic, control, and management arrangements in setting goals, hard work, responsibility, sportsmanship, cooperation, leadership (Burhaein 2017b; Opstoel et al. 2020; Pramantik & Burhaein 2019).

Although physical education learning affects character building, in field implementation there are several factors that hinder the success of the given learning. The inhibiting factor is caused by the infrastructure or the students themselves. In line with this Osborne, Belmont, Peixoto, De Azevedo & De Carvalho (2016) explain if in Physical Education learning some obstacles cause learning to be less than optimal, the obstacles that are meant are factors that exist in students. Students in urban areas have obstacles in carrying out learning and physical activities, including those caused by available facilities or personal problems that come from themselves (Armando & Rahman 2020; Dimyan 2016). In physical education learning, several factors affect the inadequacy of being well, these factors include facilities, abilities, and willingness of the child. Furthermore, it was revealed that of the three factors, the willingness and ability of the child ist one of the most influencing factors (Betram & Kaleeswaran 2017; Phytanza & Burhaein 2019). Revealed that physical education learning is not optimal due to the intrapersonal obstacles experienced by students including their social ecology, namely, individual personal circumstances, environment, fatigue, laziness, stress about learning (Anjali & Sabharwal 2018; Saputri & Suharjana 2020).

Based on the explanation of the challenges or obstacles that cause the unsuccessfulness of learning physical education, it is from within the students themselves. Based on these problems, several previous research studies revealed that problem-based learning techniques and project-based learning are good learning approaches to solve these problems. Problem-based learning is an approach that is often used because problem-solving is done by those concerned. In line with this statement Estrada (2017) revealed that problem-based learning is a good approach to use in the luxury of learning problems because this approach is centered on students thinking critically to solve the problems at hand. Prabandaru, Lismadiana & Nanda (2020) revealed that learning using problem-based learning is one of the good approaches in overcoming physical education learning problems. Furthermore, it was revealed that the problem-based learning modeled the learning approach by letting students solve the problems faced by themselves with the help of the teacher, of course. In contrast to platform based learning, project-based learning is an approach taken to reduce learning problems based on projects/media that will be used in solving problems related to physical education learning (Metzler 2017). In line with this opinion, (Mudianti, Astra & Suwiwa 2018) the project-based learning model is developed based on the level of student thinking development by centering on student learning activities so that it allows them to move according to their skills, comfort, and interest in learning. Project-based learning in physical education learning can improve learning. It is further revealed that this model helps students to make problems solving with a project/program that will help them (Simonton, Layne & Irwin 2020). The learning approach model through project-based learning can improve students' critical thinking skills, this is because students are involved in projects in alignment or in learning (Pratama & Prastyaningrum 2016).

Based on this explanation, the problems that occur in Physical Education learning and the learning approach model are used to reduce them, namely problem-based learning and project-based learning in previous studies. This paper is a literature review meaning that it will review previous research on the Problem-based Learning and TGT approaches. This research will discuss which one is more effective in solving physical education learning problems. In this study, we will explain and describe the weaknesses and strengths of each approach, which will then conclude which is a better approach in solving physical education learning problems.

Methods

This research is a type of literature review (Fraenkel, Wallen & Hyun 2012), which means that it will review the results of previous research which reveal the problem-based learning and project-based learning approaches in solving problems faced in physical education learning. This learning approach model will be studied by conveying the respective advantages and disadvantages of problem-based learning and project-based learning. Furthermore, literature review research is a qualitative descriptive research type. The data in this study were obtained through documents collected from previous research by collecting and analyzing scientific journal file documents that have been published. The discussion in this study will examine each of the 15 journals on problem-based learning and project-based learning approaches in solving physical education learning problems.

Result and Discussion

The data collection carried out results in form of information from several research articles that discussed problem-based learning approach models and project-based learning in solving physical education learning problems. The data collection carried out is a collection of articles in the last 5 years, namely from 2015 to 2020.

Table 1 below presents journal documents including year, title and research results regarding problem-based learning. Based on table 1 above which displays 10 scientific articles that have been published in reputable journals from the 2015-2020 level with a problem-based learning approach model as a solution to physical education learning problems that are considered the most effective. This learning approach model is not only popular or often found in physical education learning, but is popular and widely used in other learning subjects. Further on what is meant by the problem-based learning approach model will be examined in the discussion.

After describing the articles that have been published regarding problem-based learning, then in table 2 below will display journals related to the project-based learning approach model used in the completion of physical education learning. The articles to be discussed or reviewed are articles published in reputable journals with a period from 2015 – 2020, some of these journals will be presented in table 2.

Table 1

Results of Collection of Scientific Publication Article Documents Using the Problem-based Learning Approach Model

Publication Year	**Article Title**	**Journal Name**
2015	Applying Problem-based learning in the Sports Science Curriculum	Athens Journal of Sports

2017	Training online physical education: a phenomenological case study	Education Research International
2017	The influence of problem-based learning on learning effectiveness in students of varying learning abilities within physical education	Innovations in Education and Teaching International.
2018	Bridging the gap between education and employment: a case study of problem-based learning implementation in Postgraduate Sport and Exercise Psychology	Higher Education Pedagogies
2018	Does Problem-Based Learning Improve Critical Thinking Skills?	Cakrawala Pendidikan
2018	Project-Based Learning: Implementation & Challenges	International Journal of Education, Learning, and Development
2019	Application of Problem-based Learning Model in Improving Learning Outcomes of Passing Under Volleyball for Class VIII-2 Junior High School 27 Medan TP 2018/2019	*Jurnal Ilmu Keolahragaan* (Journal of Sports Science)
2019	**A systematic review of problem-based learning in education**	Creative Education
2020	The effectiveness of problem-based learning model learning outcomes of basketball learning through audiovisual media in class I IPS 1 SMAN 2 kendal student	Journal of Sport Coaching and Physical Education
2020	The effectiveness of problem-based learning approach in the teaching of hang style long jump	*Jurnal Ilmial Bina Edukasi* (Bina Edukasi Scientific Journal)

Table 2

Results of Collection of Scientific Publication Article Documents Using Project-based Learning Approach Models

Publication Year	**Article Title**	**Journal Name**
2020	Pengaruh Model Pembelajaran Project-based Learning Terhadap Perkembangan Konsep Diri Mahasiswa	SPORTIVE: Journal of Physical Education, Sport, and Recreation
2020	The Effectiveness of the Project-Based Learning (PBL) Approach as a Way to Engage Students in Learning	Sage Journal
2020	A review of project-based learning in higher education: Student outcomes and measures	International Journal of Educational Research
2015	Exploring contributions of project-based learning to health and wellbeing in secondary education	Sage Journal
2016	Jumping In: Redefining Teaching and Learning in Physical Education Through Project-Based Learning	Strategies A Journal for Physical and Sport Educators
2020	Tales from PE: Using Project-Based Learning to Develop 21st-Century Skills in PETE Programs	Strategies A Journal for Physical and Sport Educators
2019	Effect of Project-based Learning Model Assisted by Student Worksheet on Critical Thinking Abilities of High School Students	AIP Conference Proceedings
2015	The Strengths and Weaknesses of the Implementation of Project-based Learning: A Review	International Journal of Science and Research

2016	The Effect of Project-Based Learning on Learning Motivation and Problem-Solving Ability of Vocational High School Students	International Journal of Information and Education Technology
2019	Advantages and Challenges of Online Project-based Learning	Rochester Institute of Technology RIT Scholar Works
2017	Professors' and Students' Perception of the Advantages and Disadvantages of Project-based Learning	International Journal of Engineering Educatio

Discussion

Discussion on literature review research that discusses problem-based learning and project-based learning approaches will reveal the advantages and disadvantages of each of them. Furthermore, there will be conclusions about which learning approach model is better in solving physical education learning problems based on the results of previous research that have been published by various reputable journals in the 2015-2020 period.

Characteristics of Problem-based Learning

The characteristics of Problem-based Learning are as follows: 1) the problem becomes the starting point in learning; 2) the problems raised are problems that exist in the real world that are not structured; 3) problems require multiple perspectives; 4) problems, challenging students' knowledge, attitudes, and competencies which then require identification of learning needs and new fields of learning; 5) learning self-direction is the most important thing; 6) utilization of various knowledge sources, their use, and evaluation of information sources are essential processes in PBM; 7) learning is collaborative, communicative, and cooperative; 8) development of inquiry and problem-solving skills as important as mastering the content of knowledge to find solutions to a problem; 9) openness of the learning process includes synthesis and integration of a learning process, and; 10) PBM involves evaluating and reviewing student experiences and the learning process.

Advantages of Problem-based Learning

The problem-based learning approach is implemented by giving students the authority or to think critically about what problems they face and how to solve them. Problem-solving using PBL approaches can provide space for students to interact with their friends in solving their learning problems. PBL is also able to generate critical thinking spirit in students so that students can find solutions to problems faced by themselves in physical education learning in the field. (Goad & Jones 2017). Luo (2019) approaching PBL mentioned, that the PBL method

has the advantage of being able to motivate to learn by thinking creatively and providing opportunities to interact with one another. PBL is also an approach forcing students to be able to identify weaknesses during learning so that they can overcome learning problems when there is physical activity in the field. Through problem-based learning, motivates students to be able to discuss and then identify the problems faced, then students are forced to be able to think critically to be able to overcome problems in learning but are still assisted by the teacher (Narmaditya, Wulandari & Sakarji 2017).

Adhie, (2020) revealed that the increase in physical education learning can be conveyed if the existing problems can be overcome, it is revealed that the PBL learning approach model can provide high effectiveness for problem-solving. PBL is considered the best used because it can provide encouragement and the ability to think critically of students to be able to express the difficulties faced during physical education learning. Aldabbus, (2018) revealed that in the learning process in the classroom, the PBL approach has the advantage of being able to provide space for each student to find out what problems are faced in learning and being able to make decisions in the solution. The learning approach model of the PBL learning model can provide great effectiveness for learning, through the PBL approach model students are expected to be active and able to voice the difficulties that have been identified themselves in physical education learning (Zakaria, Maat & Khalid 2019)

Disadvantages of Problem-based Learning

When we take a look from the literature review, the results of previous research found several facts that state the disadvantages of the problem-based learning approach model. Although it has many advantages, as with other learning approach models, problem-based learning has shortcomings in its implementation. In line with this opinion, several studies have revealed the same thing. In the learning approach model using problem-based learning, students are required to have good self-confidence, the weakness of this learning approach model is if a student is not able to foster self-confidence so that he is unable to think critically. Furthermore, in this approach, another weakness is the inability of students to find the problems faced so that they are unable to find solutions, especially in learning physical education in which there is physical activity (Konstantaki 2015). Heaviside, Manley & Hudson (2018) revealed that the PBL approach requires a level of self-awareness of each individual in the physical activities of physical education learning that is carried out and requires a fairly long process in carrying out the PBL approach properly.

Suzianto & Damanik (2014) claimed that PBL also does not escape from the shortcomings in its application, namely the condition of most schools is not conducive to the PBL learning approach model. In its implementation, PBL requires facilities and infrastructure that not all schools have. For example, many schools do not yet have sufficient sports equipment to complete the implementation of PBL. PBL implementation takes a long time. The standard of 40 – 50 minutes for one lesson hour that is often found in various schools is not sufficient for the standard time for implementing PBL which involves student activities outside of school. The PBL model does not cover all basic information or knowledge. Students cannot gain an overall understanding of the material. This is due to the insufficient one-hour standard in schools for the implementation of PBL. Aji & Fahmi (2020) said, that the weakness in this learning is that teachers are required to be able to pay attention and guide students in implementing the Problem-based Learning (PBL) learning model, learning using the PBL model also requires a long time. Also, schools must provide good facilities. So if the facilities are not good, this learning model will be difficult to develop.

Characteristics of Project-based Learning

Project-based Learning is a learning approach model that has the following characteristics: a) students make decisions about a framework, b) there are problems or challenges posed to students, c) students design processes to determine solutions to problems or challenges proposed, d) students are collaboratively responsible for accessing and managing information to solve problems, e) the evaluation process is carried out continuously, f) students regularly reflect on the activities that have been carried out, g) the final product of learning activities will be evaluated regularly qualitative, h) learning situations are very tolerant of errors and changes. Then, Project-based Learning is a learning model that emphasizes more on science process skills and is related to real or everyday life so that the characteristics of the material that are appropriate in the application of this Project-based Learning Model are: Having basic competencies that emphasize more on aspects of skills or knowledge in the level of application, analysis, synthesis, and evaluation (modifying, trying, making, using, operating, producing, reconstructing, demonstrating, creating, designing, testing, etc.), Can produce a product, Has a relationship with real problems or everyday life.

Advantages of Project-based Learning

The advantage of the project-based learning approach is that it is right on target and the problem will be resolved so that the problems that occur will not happen again. In line with this

statement Allison et al. (2015) explained that learning using a project-based learning approach model can provide enthusiasm and make learning more effective. The use of projects in learning can improve the ability to think creatively for teachers and students. Coyne, Hollas & Potter (2016) revealed that the advantages possessed by the project-based learning model are that it has a variety of benefits that can have a positive effect on physical education, including involving and motivating students, increasing content knowledge, fostering collaboration, and meeting the needs of students with various skills and learning styles. Project-based learning is a learning approach model that is widely used in the 21st century, this is because they have advantages in learning through constructivist projects or media in learning, through project-based learning students are encouraged to understand learning through understanding each other through inquiry processes and working together. with friends collaboratively to complete or convey the learning received (Oliver, Rodriguez & Pagan 2020).

Astra, Rosita & Raihanati (2019) revealed that learning through project-based learning through projects or student worksheet (LKS) media can generate enthusiasm and critical thinking skills in students compared to direct learning. Furthermore, it is explained that by using this learning approach model, students are more able to collaborate with other students in completing or understanding learning according to their thinking. Yani (2020) revealed that completion or learning using project-based learning is able to improve student learning concepts and self-concepts. It is further explained that this approaching model can solve problems using projects or media in learning. This method of project-based learning and collaborative learning in disciplinary subjects of learning, repeated learning, and authentic learning can results in student involvement. It is further explained that this learning model can increase student involvement by allowing knowledge and information sharing and discussion (Almulla 2020). Guo, Saab, Post & Admiraal (2020) states that learning using a project-based learning model is one way of improving learning achievement, this type of approach involves students in thinking about solving problems through media or projects. It is further explained that this approach of the model will increase the competence of teachers in providing learning due to the discussion or participation of students and teachers in learning.

Disadvantages of Project-based Learning

When we take a look from the literature review, the results of previous research found several facts that mention the disadvantages of the project-based learning approach model. Even though it has many advantages, as with other learning approach models, project-based learning has shortcomings in its implementation. Sumarni (2013) explained that project-based

learning approach model has shortcomings, namely, the difficulty will be experienced by the teacher in applying to large classes with a large number of students then the other disadvantages are that it is difficult to generate motivation with a large number of students, difficulty in making students concentrate on learning tasks, difficulties in helping students relate new content to their previous knowledge, and difficulties in performing cooperative learning activities. Chiang & Lee (2016) explained that in the project-based learning approach model there are weaknesses including, the need for more attention from students in motivating themselves, then another shortcoming is the need for adequate facilities to support learning through this model because the use of projects often involves good facilities.

The project-based learning model approach requires someone to understand and participate in increasing motivation and existing abilities to help work on projects to help solve problems or learn. Not least, it is often time-consuming and needs adequate facilities. In line with this statement. Mihić & Završki (2017) explained if in the implementation of project-based learning there were difficulties, namely, in planning and it took a long time to implement and the lack of experience of students in a more active learning role and their negative reactions to changes. In solving problems using project-based learning, it is necessary to be precise about what will be done, then each learning problem possessed by students has a difference between one and another which requires that the project to be carried out includes these things (Amissah 2019).

Conclusion

Based on the explanation of the discussion of the literature study above, the relevance of previous research is problem-based learning and project-based learning. The author revealed that the problem-based learning approach model is better to use, this is because in the problem-based learning model students can identify problems or obstacles that occur to themselves in learning. Furthermore, it was expressed in problem-based learning that besides identifying students, they were also required to think about solving problems in learning and could be discussed with the teacher. Problem-based learning improves critical thinking, maximizes ability and self-confidence in problem-solving. Although the conclusion reveals that problem-based learning is better, the author suggests conducting an in-depth research review of the two learning approach models.

Acknowledgment

The author would like to thank profusely all participants and parties involved in this research.

Conflict of Interest

The author states there is no conflict of interests.

References

1. ADHIE, O. C., 2020. the Effectiveness of Problem-Based Learning Approach in the Teaching of Hang style Long Jump. Jurnal Ilmiah Bina Edukasi. 13(2), 24–30. https://doi.org/10.33557/jedukasi.v13i2.1152
2. AJI, R. B. & D. A. FAHMI, 2020. Efektivitas Model Pembelajaran Problem-based Learning Terhadap Hasil Belajar Bola Basket. 5(1), 42–47.
3. ALDABBUS, S., 2018. Project-based Learning: Implementation & Challenges. International Journal of Education, Learning and Development. 6(3), 71–79.
4. ALLISON, P., S. GRAY, J. SPROULE, C. NASH, R. MARTINDALE & J. WANG, 2015. Exploring contributions of project-based learning to health and wellbeing in secondary education. Improving Schools. 18(3), 207–220. https://doi.org/10.1177/1365480215599298
5. ALMULLA, M. A., 2020. The Effectiveness of the Project-Based Learning (PBL) Approach as a Way to Engage Students in Learning. SAGE Open. 10(3). https://doi.org/10.1177/2158244020938702
6. AMISSAH, P. A. K. 2019. *Advantages and Challenges of Online Project-based Learning*.
7. ANJALI & M. SABHARWAL, 2018. Perceived barriers of young adults for participation in physical activity. *Current Research in Nutrition and Food Science*, *6*(2), 437–449. https://doi.org/10.12944/CRNFSJ.6.2.18
8. ARMANDO, D. & H. A. RAHMAN, 2020. The Effect of Training Methods and Eye-Foot Coordination on Dribbling Abilities in Students Aged 12 – 13 Years. Acta Facultatis Educationis Physicae Universitatis Comenianae. 60(1), 117–133. https://doi.org/10.2478/afepuc-2020-0010
9. ASTRA, I. M., E. I. ROSITA & R. RAIHANATI, 2019. Effect of project-based learning model assisted by student worksheet on critical thinking abilities of high school students. AIP Conference Proceedings. 2019(November). https://doi.org/10.1063/1.5132637
10. BETRAM, S. J. G. & P. KALEESWARAN, 2017. Challenges in Physical Education and Sports Sciences - a Comparative Study. 2(2), 107–108.

11. BURHAEIN, E., 2017a. Aktivitas Fisik Olahraga untuk Pertumbuhan dan Perkembangan Siswa SD. Indonesian Journal of Primary Education. 1(1), 51–58. https://doi.org/10.17509/ijpe.v1i1.7497
12. BURHAEIN, E., 2017b. Aktivitas Permainan Tradisional Berbasis Neurosainslearning Sebagai Pendidikan Karakter Bagi Anak Tunalaras. Jurnal SPORTIF : Jurnal Penelitian Pembelajaran. 3(1), 55. https://doi.org/10.29407/js_unpgri.v3i1.580
13. BURHAEIN, E., B. K. IBRAHIM & R. PAVLOVIC, 2020. The Relationship of Limb Muscle Power, Balance, and Coordination with Instep Shooting Ability : A Correlation Study in Under-18 Football Athletes. International Journal of Human Movement and Sports Sciences. 8(5), 265–270. https://doi.org/10.13189/saj.2020.080515
14. BURHAEIN, E., D. T. P. PHYTANZA & N. DEMIRCI, 2020. The development and validation of a revised Friendship Activity Scale and Adjective Checklist for use in the Indonesian Unified Sports program. International Sports Studies. 42(e), 18–28. https://doi.org/10.30819/iss.42-e.03
15. BURHAEIN, E., B. TARIGAN & D. T. P. PHYTANZA, 2020. The experience and understanding of the K-13 curriculum implementation of Indonesian teachers of Adapted Physical Education (APE). International Sports Studies. 42(e), 29–42. https://doi.org/10.30819/iss.42-e.04
16. CHIANG, C. L. & H. LEE, 2016. The Effect of Project-Based Learning on Learning Motivation and Problem-Solving Ability of Vocational High School Students. International Journal of Information and Education Technology. 6(9), 709–712. https://doi.org/10.7763/ijiet.2016.v6.779
17. COYNE, J., T. HOLLAS & J. P. POTTER, 2016. Jumping In: Redefining Teaching and Learning in Physical Education Through Project-Based Learning: Column Editor: Anthony Parish. Strategies. 29(1), 43–46. https://doi.org/10.1080/08924562.2016.1113910
18. DIMYAN, C. D., 2016. Approaches to Overcoming Barriers to Physical Activity in Urban Areas.
19. ESTRADA, L., 2017. Using Problem-Based Learning to Develop an Innovative Fitness Unit. Strategies. 30(4), 54–56. https://doi.org/10.1080/08924562.2017.1321450
20. FRAENKEL, J. R., N. E. WALLEN & H. H. HYUN, 2012. How to design and evaluate research in education. New York: Mc Graw Hill.
21. GOAD, T. & E. JONES, 2017. Training Online Physical Educators: A Phenomenological Case Study. Education Research International. https://doi.org/10.1155/2017/3757489

22. GUO, P., N. SAAB, L. S. POST & W. ADMIRAAL, 2020. A REVIEW OF PROJECT-BASED LEARNING IN HIGHER EDUCATION: STUDENT OUTcomes and measures. International Journal of Educational Research. 102(April), 101586. https://doi.org/10.1016/j.ijer.2020.101586
23. HEAVISIDE, H. J., A. J. MANLEY & J. HUDSON, 2018. Bridging the gap between education and employment: A case study of problem-based learning implementation in postgraduate sport and exercise psychology. Higher Education Pedagogies. 3(1), 463–477. https://doi.org/10.1080/23752696.2018.1462095
24. HERDIYANA, A. & G. P. W., 2016. Pembelajaran Pendidikan Jasmani Yang Mengacu Pada Pembiasaan Sikap Fair Play Dan Kepercayaan Pada Peserta Didik. Jurnal Olahraga Prestasi. 12(1), 115109. https://doi.org/10.21831/jorpres.v12i1.9498
25. JUNAEDI, A. & H. WISNU, 2016. Survei Tingkat Kemajuan Pendidikan Jasmani, Olahraga, Dan Kesehatan Di Sma, Smk, Dan Ma Negeri Se-Kabupaten Gresik. Jurnal Pendidikan Olahraga Dan Kesehatan. 3(3), 834–842.
26. KONSTANTAKI, M., 2015. Applying Problem-based learning in the Sports Science Curriculum. Athens Journal of Sports. 2(1), 7–16. https://doi.org/10.30958/ajspo.2-1-1
27. LUO, Y. J., 2019. The influence of problem-based learning on learning effectiveness in students' of varying learning abilities within physical education. Innovations in Education and Teaching International. 56(1), 3–13. https://doi.org/10.1080/14703297.2017.1389288
28. METZLER, M. W., 2017. Instructional models in physical education. (3rd Ed). https://doi.org/https://doi.org/10.4324/9781315213521
29. MIHIĆ, M. & I. ZAVRŠKI, 2017. Professors' and students' perception of the advantages and disadvantages of project-based learning. International Journal of Engineering Education. 33(6), 1737–1750.
30. MUDIANTI, N. P. N. N., I. K. B. ASTRA & I. G. SUWIWA, 2018. Pengaruh Model Pembelajaran Project-based Learning Berbantuan Media Kartu Bergambar Terhadap Hasil Belajar Teknik Dasar Kuda-kuda Pencak Silat. E-Journal Pendidikan Jasmani, Kesehatan Dan Rekreasi, 8.
31. NARMADITYA, B. S., D. WULANDARI & S. R. B. SAKARJI, 2017. DOES PROBLEM-BASED LEARNING IMPROVE CRITICAL THINKING SKILLS? 32(3), 14–21.
32. OLIVER, L. E., L. RODRIGUEZ & A. PAGAN, 2020. Tales from PE: Using Project-Based Learning to Develop 21st-Century Skills in PETE Programs. Strategies. 33(4), 45–48. https://doi.org/10.1080/08924562.2020.1764305

33. OPSTOEL, K., L. CHAPELLE, F. J. PRINS, A. DE MEESTER, L. HAERENS, J. VAN TARTWIJK & K. DE MARTELAER, 2020. Personal and social development in physical education and sports: A review study. European Physical Education Review. 26(4), 797–813. https://doi.org/10.1177/1356336X19882054
34. OSBORNE, R., R. S. BELMONT, R. P. PEIXOTO, I. O. DE AZEVEDO & A. F. P. DE CARVALHO, 2016. Obstacles for physical education teachers in public schools: An unsustainable situation. Motriz. Revista de Educacao Fisica. 22(4), 310–318. https://doi.org/10.1590/S1980-6574201600040015
35. PARAMITHA, S. T. & L. E. ANGGARA, 2018. Revitalisasi Pendidikan Jasmani untuk Anak Usia Dini melalui Penerapan Model Bermain Edukatif Berbasis Alam. Jurnal Pendidikan Jasmani Dan Olahraga. 3(1), 41. https://doi.org/10.17509/jpjo.v3i1.10612
36. PHYTANZA, D. T. P. & E. BURHAEIN, 2019. Aquatic activities as play therapy children autism spectrum disorder. International Journal of Disabilities Sports and Health Sciences. 2(2), 64–71. https://doi.org/10.33438/ijdshs.652086
37. PHYTANZA, D. T. P. & E. BURHAEIN, 2020. The Effects of Tenure, Teacher Certification, and Work Motivation on Special Needs Teacher Performance. Universal Journal of Educational Research. 8(9), 4348–4356. https://doi.org/10.13189/ujer.2020.080962
38. PHYTANZA, D. T. P., E. BURHAEIN, S. SUKOCO & S. W. GHAUTAMA, 2018. Life Skill Dimension based on Unified Sports Soccer Program in Physical Education of Intellectual Disability. Yaşam Becerileri Psikoloji Dergisi. 2(4), 199–205. https://doi.org/https://doi.org/10.31461/ybpd.453865
39. PRABANDARU, R. D., L. LISMADIANA & F. A. NANDA, 2020. Problem-based learning approach to improve service skills of badminton in physical education learning. International Journal of Education and Learning. 2(1), 14–24. https://doi.org/10.31763/ijele.v2i1.74
40. PRAMANTIK, I. A. D. & E. BURHAEIN, 2019. Disabilities Sports & Health Science A Floor Time Approach to Improve Learning Outcomes of the Body Roll to the Side in Adaptive Physical Education Learning : Classroom Action Research Study on Two Cerebral Palsy Students. International Journal of Disabilities Sports and Health Sciences. 2(2), 45–53. https://doi.org/10.33438/ijdshs.652061
41. PRATAMA, H. & I. PRASTYANINGRUM, 2016. PENGARUH MODEL PEMBELAJARAN PROJECT-BASED LEARNING BERBANTUAN MEDIA

PEMBELAJARAN PEMBANGKIT LISTRIK T. Jurnal Penelitian Fisika Dan Aplikasinya (JPFA). 6(2), 44–50.

42. PURNOMO, I. D., T. TOMOLIYUS & E. BURHAEIN, 2019. Development of Learning Activities Playing a Ball on a Goal To Improve Manipulative Skills For Lower Class Students. Proceedings of the 1st International Conference on Science and Technology for an Internet of Things. https://doi.org/10.4108/eai.19-10-2018.2281716
43. SAPUTRI, N. & SUHARJANA, 2020. Development of hockey game and model for learning physical education in children's elementary school. Acta Facultatis Educationis Physicae Universitatis Comenianae. 60(November), 133–145. https://doi.org/10.2478/afepuc-2020-0011
44. SIMONTON, K. L., T. E. LAYNE & C. C. IRWIN, 2020. Project-based learning and its potential in physical education: an instructional model inquiry. Curriculum Studies in Health and Physical Education. (December). https://doi.org/10.1080/25742981.2020.1862683
45. SOEDJATMIKO, 2015. Membentuk Karakter Siswa Sekolah Dasar Menggunakan Pendidikan Jasmani Dan Olahraga. Journal of Physical Education Health and Sport. 2(2), 57–64. https://doi.org/10.15294/jpehs.v2i2.4588
46. SUMARNI, W., 2013. The Strengths and Weaknesses of the Implementation of Project-based Learning: A Review. International Journal of Science and Research. 4(3), 2319–7064.
47. SUZIANTO & S. DAMANIK, 2014. Penerapan Model Problem-based Learning Dalam Meningkatkan Hasil Belajar Passing Bawah Bola Voli Siswa Kelas Viii-2 Smp Negeri 27 Medan Tp. 2018/2019. Jurnal Ilmu Keolahragaan. 18(1), 14–24.
48. TUTKUN, E., I. GORGUT & I. ERDEMIR, 2017. Physical Education Teachers' Views about Character Education. International Education Studies. 10(11), 86. https://doi.org/10.5539/ies.v10n11p86
49. YANI, A., 2020. Pengaruh Model Pembelajaran Project-based Learning Terhadap Perkembangan Konsep Diri Mahasiswa. SPORTIVE: Journal Of Physical Education, Sport and Recreation. 4(1), 1. https://doi.org/10.26858/sportive.v4i1.17165
50. ZAKARIA, M. I., S. M. MAAT & F. KHALID, 2019. A Systematic Review of Problem-based Learning in Education. Creative Education. 10(12), 2671–2688. https://doi.org/10.4236/ce.2019.1012194