PICIGIN AS A WATER SPORT: EARLY STUDY

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Abstract

All forms of sports recreation are objects of research in kinesiology. Some games are, from the culturological and regional point of view, more important than established and recognized sports or sports disciplines. Therefore, it is important to obtain an insight about them as well. Picigin is such a game. In order to understand it better, we determined kinematic parameters important for its description and compared them with corresponding parameters of some recognized sports. The research was focused on movement intensity and volume extensity. Instruments and algorithms for movement estimation and detection have been investigated. Obtained results confirmed differences in movement intensity and volume for different playing positions. Also, results implied that picigin does not fall behind some other sports games regarding observed kinematic parameters. Graphical presentation of obtained results showed continuity in movement of picigin players and confirmed the dynamic character of the game. Therefore, it can be considered a high-intensity sports game.

Keywords*: picigin, kinematic analysis, video analysis, perspective transformation*

Introduction

Picigin is an amateur game that is played with a small ball on sand beaches in shallow water. Croatian dictionary (Anić, 1998) defines picigin as „*a ball game played by standing in shallow sea and tossing the ball without it touching the sea-surface*". It is believed that its origin dates back to 1908 in Split, Croatia. The cult picigin playground is Bačvice, a sand beach in Split. From there it has, probably due to its attractiveness, spread throughout the Croatian coastline and specific local playing styles and variations have developed. It should be pointed out that the playing style of this game in Split differentiates from the majority of other styles, especially in the emphasized movement activity of the players, that is also provided by the convenient (flat) terrain configuration and available playground size (over 150 x 50 m). Picigin is played all year-round, and since 2005 so-called „Picigin World Championship" is organized each year in Split. Referees grade the overall performance and artistic impression of each team (Picigin Bačvice, 2009).

Figure 1. *Picigin player in typical sea-surface sliding action*

Basic goal is very simple – the ball should stay in the air as long as possible without falling into the sea. The playing ball is a peeled and faceted tennis ball having around 7 cm in diameter. It has to be waterproof, without surface stitches, without grease coating or other similar substances. Playing court is a large, flat sea shoal with dimensions of around 50 m x 30 m and with sea depth between 10 and 30 cm. Each team has 5 players with possible additional substitutes. Keeping the ball in the air as long as possible while presenting an attractive game and achieving better artistic impression towards the referees, in order to better other teams is the main goal of each team.

Initially, players are positioned in a pentagonal shape as presented in Fig. 2. They are arbitrarily passing ball to each other with intention to make the game as attractive as possible, which means that passes are frequently made not directly to the player but to the space where he probably could reach it after running/sprinting. Because of the passing of the long and fast balls, starting formation varies i.e. players are moving around the wide area of the playing court. After the ball falling into the sea, players take initial position. All body parts can be used in the game. Player must not hold the ball in the hand, it must be stroked (usually with the palm) in order to pass it to the other player. In the Provisional decision of the Croatian minister of culture from 2007 that protects picigin as nonmaterial cultural good of Croatia, it is accentuated that the playing rules are regulated by members of the "Picigin Bačvice" ecological society (Picigin Bačvice, 2011). With the advance of computer and video technology, analyses of various motorical activities have become manifold and detailed (Perl, 2006).

Such analyses broaden our knowledge on the load and intensity of the particular sport, whether it is an individual or a team sport. That knowledge is also important for the sport preparation and training process. For this occasion, we have used a 2D analysis approach because the research focus was on the movement analysis of the all players.

Previous research

There is no previous research for this particular game but methodologically, a similar research in other sports activities exists. Prozone video system analysis of professional soccer players during UEFA Champion League games registered average trajectory length of 11.01±1.12 km (Di Salvo et al., 2007). Central defenders demonstrate shortest trajectory lengths (10.02±0.653 km) as well as the smallest high intensity movement results 0.571±0.209 km which is only 5% of the total player movement. These results are higher than the results obtained for the professional national level players (Randers et al. 2007, Odetoyinbo et al., 2007). Therefore, the empirical research observed differences in movement volume according to the competition level, as well as differences between playing positions. Maybe unexpected, but Scott et al. (2007) measured even higher movement extensity values for the female soccer players in comparison to the available results of the male players (AS±SD=11979±1325 m).

Professional female soccer players run 28% longer in high intensity than their (also female) colleagues at lower competition levels (Mohr et al., 2007). Šibila et al., (2004) analyzed volume and intensity of cyclic activities of male handball players during a game. Average distance for a wingman was 3.855 m, backcourt player 3.432 m, pivot 3.234 m and goalkeeper 1753 m. Measured average speed for wingman was 1,60 m/s, backcourt player 1,43 m/s, pivot 1,34 m/s and goalkeeper 0,73 m/s. Overall workload of squash players (Vučković et al., 2005) depends on the competition level, and the results showed significantly higher values for international players in comparison to Slovenian national selection players. More than 77% of total movement of top level cricket players is a walking movement (Rudkin et al., 2007). Due to fact that cricket players have lower content of high intensity activities during game if comparing to soccer or hockey players, it is logical to classify it into energetically non-demanding sports. In contrast to cricket, beach soccer is a very high intensity game (Castellano et al., 2010).

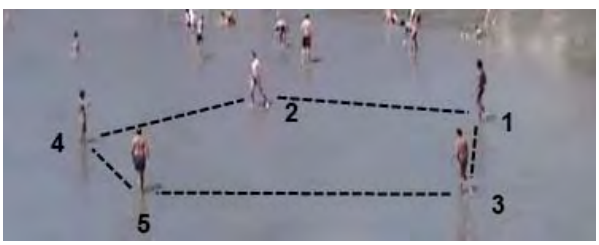

Figure 2. *Initial player formation*

The players are above 90% *HRmax* workload more than half of the game time. Payers average distances per minute are around 100 m. This area of research is distinctly interdisciplinary because in addition to the knowledge in the area of kinesiology, it requires development and inclusion of various procedures and methods for automated processing of data acquired from different sensors (Dabnichki and Baca, 2008). Taking into account that visual information is dominant especially for tracking global player movements, researchers from the computer vision field are actively engaged in these investigations (Needham et al., 2001, Perš and Kovačič, 2001, Bennett et al., 2008). Generally, a player-tracking and global movement activities analysis in two dimensions (2D) is sufficient (Kristan et al., 2009). The number of used cameras depends on the size of playground area, camera positioning and the image resolution required for accurate tracking (Vuc et al., 2009). For the purpose of this research, we used semi-automatic 2D player tracking and analysis, because the focus of our research is on global player movement analysis and the comparison of obtained results and other sports games. With respect to the estimated size of the court, only one camera was used for tracking.

Methods

Research was conducted on one team with players who have been actively playing this traditional game for several years. Players have participated in all "Picigin World Championships" up to date, three of them were medalists and two obtained best player or the most attractive player award. Some of the players are current or former athletes in other sports (triatlon, waterpolo). Average age was 28,8±6,3 years, height 184,4±4.8 cm, and weight 84±6,5 kg. Players are positioned in pentagonal shape formation (Fig. 2) according to the following standard positions: "main runner" (1), "supporting runners" (2. and 3.) and "play makers" (4. and 5.).

Game was tracked during 15 minutes and players were previously informed about camera recording of their play and its purpose. Subjective impression of the authors was that the intensity of the play was at the usual level. Movement activity parameters for the players at different playing positions were observed: extensity (distance covered), movement intensity (velocity). Overall movement distance was established (distance covered in time) ranging from low intensity walk to high intensity sprint. Average and maximal speed, number of runs with and without diving, as well as the number of dives from the spot were also measured and graphically presented. Course of the play was recorded with a static digital camcorder. "Game" was played on Bačvice beach. Camera calibration was done before the game. Calibration includes tagging and measuring accurate world coordinates for four referent points (A, B, C, D in Fig. 3). Markers were forming a 15 m x 15 m rectangle on the terrain where afterwards the picigin game took place (Fig. 3).

Next step is calculation of the transformation matrix from the known position of the referent points in the world coordinate system and obtained position values in the camera image coordinate system. Position of any object in the camera field-of-view (FOV) can be calculated on the basis of the obtained transformation matrix. For the implementation of this procedure called perspective transformation, software pack. MATLAB was used.

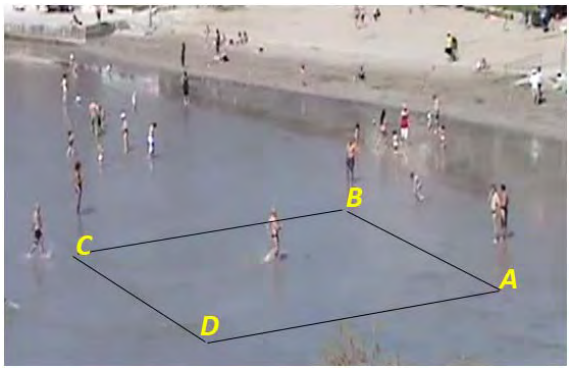

Figure 3. *Referent points used for the perspective projection procedure*

Computer program written in MATLAB provided semi-automatic tracking of each player on the recorded video, and player position in each video frame was recorded in corresponding matrix. By applying transformation matrix, actual world coordinates for each player's every frame (every 0.04 s) were calculated and recorded in a new matrix. World coordinate player positions were filtered with simple low-pass filter in order to remove impact of possible player detection errors. Finally, overall movement activity, average speed and speed for each player in every frame could be calculated on the basis of obtained filtered values.

Results and discussion

Intensity and extensity in picigin are very heterogeneous because the overall movement activity of a picigin player includes acyclic movement structures (passing the ball, dives from the spot, sliding-dives...) as well as cyclic structures (high-intensity running, low-intensity running, walking, lateral movement, back-movement). Average result during observed 15 minutes of play for one player was 39 runs with tasks and dives, i.e. in average, one game-related task every 23 seconds. Total of 194 such activities, one every 4.6 sec were registered which certainly adds to the game dynamics. Such movements are performed within a varying medium, and different combinations of movements occur in intervals. High-intensity and low-intensity workload were continuously alternating with the relatively standstill or very slow walking intervals during the game (Fig. 4). Considering differences in tasks relating to particular playing positions and also different water depths the players are moving through, differences in movement intensity and extensity for particular playing positions were expected (Table 1., 2., and 3.).

Table 1. Average distance, number of runs and player dives in 15 minutes. AM - Arithmetic mean, SD - standard deviation.

Player position	Distance m/15 min	Runs (without dive)	Runs (with dive)	Diving from the spot	Total
1 (main runner)	1585,3	10	28	3	41
2 (supporting runner 1)	1414,8	22	12	2	36
3 (supporting runner 2)	1407,8	27	10	8	45
4 (play 1)	1260,5	20	9	4	33
5 (play 2)	1117,2	21	14	4	39
Total	6785,6	100	73	21	194
AM±SD	1357,1 ± 176,7	20 ± 6,2	14,6±7,73	4,2 ± 2,28	38,8 ± 4,6

Table 2. Average speed, distance in m/min, max. registered speed and estimated movement volumes during standard playtime. AM - Arithmetic mean, SD - standard deviation.

Position	Distance in m/15 min	Av erage speed km/h (m/s)	Average distance in m/min	Max registered speed in m/s (km/h)	Estimated distance in m (75 min)	Estimated distance in m (90 min)
1	1585,3	6,35 (1,76)	105,69	9,17 (33,02)	7926,5	9511,8
2	1414,8	5,66 (1,57)	94,32	8,77 (31,57)	7074,0	8488,8
3	1407,8	5,634 (1,565)	93,85	8,86 (31,89)	7039,0	8446,8
4	1260,5	5,043 (1,40)	84,03	7,70 (27,72)	6302,5	7563,0
5	1117,2	4,471 (1,24)	74,48	8,32 (29,95)	5585,0	6703,2
AM±SD	1357,12 ± 176,68	5,43 ± 0,71	90,47± 11,78	8,56 ± 0,57	6785,4 ± 883,72	8142,72 ± 1060,06

Table 3. Comparison of the movement volume and intensity for picigin and other sports. AM - Arithmetic mean, SD - standard deviation.

	AM (±SD) (m/min)	**Total distance (m) AM (± SD)**	**Playing time (min)**	**Average speed km/h (m/s)**
Squash (national)	62,6 (± 64,8)	617 ± 307	9,85 ± 4,74	3,76 (1,04)
Squash (international)	66,7 (± 63,6)	1118 ± 425	16,75 ± 6,68	4,01 (1,11)
Handball (backcourt and wingman)	85,2	3432	40	5,15 (1,43)
Picigin	**90,5 (± 11,78)**	**1357,1 (± 176,7)**	**15:00 (± 0:00)**	**5,43 (1,51)**
„main runner"	**105,7**	**1585,3**	**15**	**6,35 (1,76)**
Beach soccer	96.2 (± 15.1)	1135 (± 26.8)	11:48 ± 3:05	5,94 (1,60)
UEFA Champion League 2006	122,3 (± 12,4)	11010±1120	90	7,34 (2,04)
Šahtar	103,0	136000	120	6,18 (1,72)
Barcelona	106,1	140000	120	6,36 (1,76)
Srna (right back)	109,2	13100	120	6,55 (1,82)
Xavi (midfielder)	127,5	15300	120	7,65 (2,12)

These expectations were confirmed for all playing positions. The highest movement extensity was determined for the main runner followed by supporting runners while movement values for the playmakers demonstrated lowest rates. „Main runner", besides the highest velocity, is also distinguished by acrobatics (highest number of dives - Table 1.).

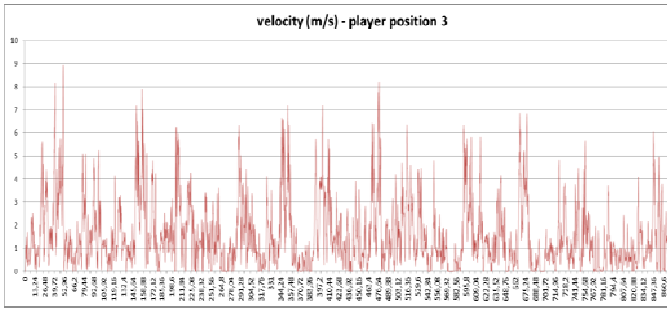

Figure 4. *Supporting runner (player position 3) velocity for each frame during 15 min (intervals of 13,24")*

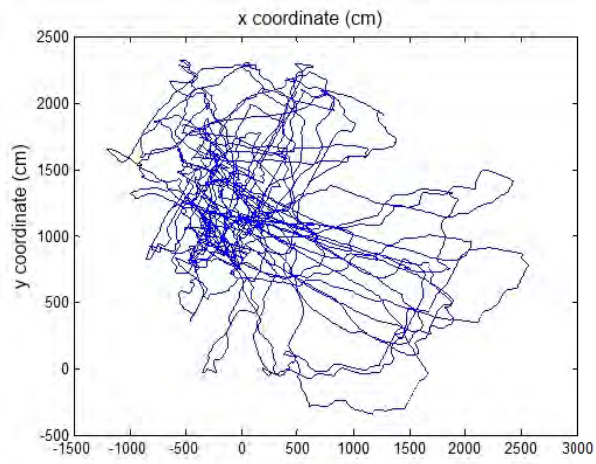

Figure 5. *Movement of the supporting runner in position 3 during 15 min (values in cm).*

These two components are important for the attractiveness of the game. This implies that the player on this position besides the strong technical attributes, should have these two aforementioned components emphasized. Measured values can be achieved only by individuals with certain characteristics, and furthermore, the repeatability of the results can be achieved only by trained individuals. Therefore, training level and explosive strength is an important parameter for successful playing on the position of a main runner at registered movement velocity levels. The obtained results for other playing positions are comparable, and thus there is no room in those categories for unprepared or untrained individuals (in order to play at demonstrated level). Besides particular player position tasks, these results were influenced by the team game dynamics as well. Consequently, subjective opinion based on the experience of the authors about movement of the picigin players was confirmed by kinematic analysis. For the illustration, anticipated distance values for the 75 and 90 minute length of play are calculated in Table 2. Although our measurement and recording lasted 15 minutes, usual playing time is indeed between 60 and 90 minutes, making it possible to compare measured values with a soccer game or some other sports activity. Shortened playing time (15 minutes) is adequate for the competition rules because it is more appropriate for the spectators and referees.

Additionally, it should be noted that shortened playing time equalizes environment variations for the successive teams playing in the competition (tide, wind, waves). It can be stated that the game rhythm during the 60 or 90 minute game is approximately at the same level as during the measured 15 minute sequence. Average as well as attained speed has been calculated (Table 3 and Fig. 4). In order to obtain comparable results (Table 3), overall distances per minute and top speeds were also calculated. Measured values are similar to other high intensity sports activities. Game has its continuity and tempo with almost uniform time distance between consecutive top speeds (Fig. 4). As it can be observed in Fig. 4, there were no longer resting periods for the player on position 3. Also, it should be noted that measured moving velocities of the picigin players were achieved under domain specific conditions that are causing movement deceleration (water resistance and sand bottom), so it can be said that picigin movements have higher specific difficulty levels than corresponding movements in other sports. There is no dominant player movement direction and players generally have tendency to maintain initial positions (Figure 5). Superimposed movement trajectories for all five players are resulting with total playing court dimensions of around 40 x 30 meters. Obtained data makes possible to calculate completed distances for different movement intensities which should give even better insight into picigin movement intensity (overall and according to playing positions).

Conclusion

Measurements of cyclic activities represent only part of the picigin game. Besides running at different intensities (walking, slow running, cruising, sprinting, lateral movement, backward movement), picigin players are burdened with various acyclic activities such as: different types of ball strokes, jumps, dives, standing ups etc. These activities are combined with high intensity movements during play and they represent significant part of the overall workload during demonstrated game. With respect to numerical differences in calculated volumes and intensities as well as counted number of dives and runs for a particular playing position, we can claim that players within a team have a different sports load which confirms the subjective prediction of the authors. Main runner is the player with the highest sports load. He has highest movement volume and highest number of counted high intensity activities.

Significantly lower values were registered for the playmakers. Overall measured movement of the observed team is indicating that picigin can be classified into energetically demanding activities. Also, picigin is comparable to some recognized sports regarding movement volume, so there is basis for its classification as a high intensity movement sports but this is a statement that should be confirmed on a larger number of teams.

Future research should include method proposal and conduction of a functional measurement of the players load, because it can't be measured by current methodology. This game is older than some sports; it is some kind of regional tabu that is played outdoors under all weather conditions and temperatures which is sufficient cause for conducting the presented research.

However, we think that this is contribution to its understanding from the energetic aspect. Directions for understanding it as a sports game that demands exceptional anthropometric quality with accent to motorics and coordination were given. It is a demanding game and, in some parameters, can be compared to recognized sports disciplines.

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PICIGIN KAO VODENI SPORT: POČETNO ISTRAŽIVANJE

Sažetak

Predmet kinezioloških istraživanja su svi oblici sportske rekreacije. Neke su igre, u kulturološkom i regionalnom smislu, važnije i od „najvažnijih" sportova ili disciplina da ih je zbog same autohtonosti važno proučavati. Takav je i Picigin. Kako bi ga bolje razumjeli, utvrdili smo neke kinematičke parametre koji opisuju picigin i usporedili ih sa sličnim gibanjima u drugim sportovima. Naglasak je bio na istraživanje ekstenziteta i intenziteta kretanja. Provjerena je mogućnost instrumentarija i algoritama za procjenu gibanja te su dobiveni rezultati potvrdili razlike u intenzitetu i volumenu opterećenja igrača picigina obzirom na igračke pozicije. Također, dobiveni rezultati ukazuju kako picigin ne zaostaje za ostalim sportovima s obzirom na promatranje kinematičke parametre. Grafičkim pokazateljima utvrdio se kontinuitet gibanja igrača u piciginu, kojim je potvrđen dinamičan karakter igre. Stoga picigin možemo svrstati u skupinu zahtjevnih sportskih igrara visokog intenziteta.

***Ključne riječi**: picigin, kinematička analiza, video analiza, perspektivna transformacija*

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