

## PHYSIOTHERAPEUTIC APPLICATIONS OF BIOMECHANICAL OPPOSING INDICATORS–BASED ON MEASUREMENTS OF TAEKWON-DO ATHLETS

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### Abstract

**Background.** In everyday life people constantly face the dilemma of speed and accuracy. The aim of the cognitive quantification was to increase the knowledge about kinematic effect of a target. The practical aim would be to apply kinematic effect of a target in clinical situations, to supply for physiotherapeutic programs. **Material and Method.** The analysis was performed 14 taekwondo ITF athletes. During research they performed front left and right kicks in a lateral standing position: into the air (without a physical target), to a table tennis ball hanging on a line and a training target. The laboratory for the analysis of movement named HML was used here. **Results.** The highest average maximum velocity was obtained by the kicks without a physical target ( $10,78 \pm 1,32$  m/s for men and  $8,51 \pm 1,50$  m/s for women) ( $p < 0,05$ ), then to the shield ( $9,98 \pm 1,40$  m/s for men and  $8,28 \pm 1,59$  m/s for women) ( $p < 0,05$ ) and to the ball ( $9,63 \pm 0,94$  m/s for men  $7,73 \pm 2,01$  m/s for women) ( $p < 0,05$ ). **Discussion.** The obtained results provided the argument supporting the thesis that the type of target influences on the method of solving the dilemma: the velocity of movement and its precision during a frontal kick. Both, in the case of women and men who practise taekwon-do, lowering the velocity of a kick, performed towards a precisely established target, in comparison with the velocity of a kick without a precisely established physical target (into the air) was observed. For many people with the dysfunctions of the movement organs, everyday functioning, especially related to movement, makes a challenge. In such a case crossing the road at the green light in particular time or stepping on the escalator (the examples of such barriers are numerous) are the tasks that reveal the dilemma of velocity and precision. There are many factors that may support the efficiency of these efforts. One of them may be the feeling of the efficiency of activity that has a psychological character.

**Key words:** quality of life, biomechanics, taekwon-do, movement analysis

**Яцек Воншик, Дорота Ортенбургер, Томаш Гура. Фізioterапевтичні застосування біомеханічних показників на основі вимірів спортсменів, які займаються тхеквондо. Мета дослідження.** У повсякденному житті люди постійно стикаються з дилемою швидкості та точності. Метою когнітивно-кількісного визначення було підвищення знань про кінематичний ефект цілі. Практична мета полягає в застосуванні кінематичного ефекту мішені в клінічних ситуаціях, постачанні фізioterапевтичних програм. **Матеріали і методи.** У досліді брало участь 14 тхеквондо-спортсменів. Під час дослідження вони виконували передні ліві та праві удари по боковій стійковій позиції: у повітря (без фізичної мети), по тенісному м'ячу, що висить на лінії, та по мішені. Використано лабораторію аналізу руху під назвою HML. **Результати.** Найвищу середню максимальну швидкість отримано ударами без фізичної мішені ( $10,78 \pm 1,32$  м / с – для чоловіків і  $8,51 \pm 1,50$  м / с – для жінок) ( $p < 0,05$ ), потім до щита ( $9,98 \pm 1,40$  м / с – для чоловіків і  $8,28 \pm 1,59$  м / с – для жінок) ( $p < 0,05$ ) та до м'яча ( $9,63 \pm 0,94$  м / с – для чоловіків  $7,73 \pm 2,01$  м / с – для жінок) ( $p < 0,05$ ). **Висновки.** Отримані результати підтверджують тезу про те, що тип цілі впливає на метод розв'язання дилеми: швидкість руху та її точність під час лобового удару. У випадках яких серед жінок, так і серед чоловіків, які практикують тхеквондо, знижується швидкість удару, що виконується в напрямку точно встановленої мети, порівняно зі швидкістю удару без точно встановленої фізичної мети (у повітря), для багатьох людей із порушеннями опорно-рухової функцій повсякденне функціонування, особливо пов'язане з рухом, ставить виклик. У випадку, що стосується перетину дороги на зелене світло в певний час або ступання на ескалатор (приклади таких бар'єрів численні), це будуть завдання, які виявляють дилему швидкості й точності. Є багато чинників, які можуть сприяти ефективності цих зусиль. Одним із них може бути відчуття ефективної діяльності, що має психологічний характер.

**Ключові слова:** якість життя, біомеханіка, тхеквондо, аналіз руху.

**Яцек Воншик, Дорота Ортенбургер, Томаш Гура. Физиотерапевтические применения биомеханических показателей на основе измерений спортсменов, занимающихся тхэквондо. Цель исследования.** В повседневной жизни люди постоянно сталкиваются с дилеммой скорости и точности. Целью когнитивно-количественного определения было повышение знаний о кинематическом эффекте цели.

Практическая цель заключается в применении кинематического эффекта мишени в клинических ситуациях, разработки физиотерапевтических программ. **Материалы и методы.** В опыте участвовало 14 тхэквондо-спортсменов. Во время исследования они выполняли передние левые и правые удары по боковой стойкой позиции: в воздух (без физической цели), по теннисному мячу, висящему на линии и по мишени. Была использована лаборатория анализа движения под названием HML. **Результаты.** Самая высокая средняя максимальная скорость получена ударами без физической мишени ( $10,78 \pm 1,32$  м / с для мужчин и  $8,51 \pm 1,50$  м / с для женщин) ( $p < 0,05$ ), затем к щиту ( $9,98 \pm 1,40$  м / с – для мужчин и  $8,28 \pm 1,59$  м / с – для женщин) ( $p < 0,05$ ) и к мячу ( $9,63 \pm 0,94$  м / с – для мужчин  $7,73 \pm 2,01$  м / с – для женщин) ( $p < 0,05$ ). **Выводы.** Полученные результаты подтверждают тезис о том, что тип цели влияет на метод решения такой как дилеммы; скорость движения и ее точность при лобовом ударе. В случаях, если среди женщин и мужчин, практикующих тхэквондо, снижается скорость удара, он выполняется в направлении точно установленной цели, по сравнению со скоростью удара без точно установленного физической цели (в воздух). Для многих людей с нарушениями опорно-двигательной функции, повседневное функционирование, особенно связанное с движением, ставит вызов. В таком случае, пересекая дорогу на зеленый свет в определенное время или ступая на эскалатор (примеров таких барьеров много), ставятся задачи, которые проявляют дилемму скорости и точности. Есть много факторов, которые могут способствовать эффективности этих усилий. Одним из них может быть ощущение эффективной деятельности, которая имеет психологический характер.

**Ключевые слова:** качество жизни, биомеханика, тхэквондо, анализ движения.

**Introduction.** A more extended analysis of literature reveals many substantial reasons for conducting research among people who practice martial arts and fighting, high performance, or extreme sport in the context of the possibilities of applying the knowledge in the therapeutic context (rehabilitation, analgesic therapy, multimodal programs of chronic pain treatment) [1].

In everyday life people constantly face the dilemma of speed and accuracy. It considers, among others, the use of a revolving door to a shop or the attempt to validate a ticket on a moving bus, and in many other situations with the risk of falling. For the people who are completely healthy such complications are often not noticeable. However, for the people of limited psychomotor abilities caused by the disorders of different origins, the dilemma takes on an additional meaning. It reveals in the situations which, because of the risks of the secondary injury, become a challenge.

The way of overcoming such barriers influences directly the safety in everyday situations in rehabilitation and in sports. Similar problems may be noticed with the martial arts competitors who during their activities solve the problem of the speed and accuracy of hits, in order to make their actions effective.

There are reasons to suppose that the perception of the features of an object (or its lack) may change the kinetics of hits in a direct manner [2; 3]. Coordinated performance of the complex movement activities involves creating programmes of action before starting them. This is one of the reasons why knowledge of biomechanics and science of martial arts are very helpful. An increasingly growing number of researchers decide to search for biomechanical identification of factors determining an efficient performance sports techniques and other actions[4]. Taekwon-do along with other martial arts focus on a fast and precise delivery of strikes to the opponent's body. The strike velocity and accuracy are considered to be the key factors when it comes to victory[5].

*It is noticeable that the concepts concerning human psychophysical improvement deriving from the East and from the West correspond well with each other. The rule «maximum gain with minimum effort», which is well-known in physiology and respected in biomechanics, is clearly visible in taekwon-do, Korean martial art in which parts of the body (especially hands and legs) perform each movement with maximum efficiency. It is confirmed by research in the area of biomechanics which in detail identifies small elements which may improve movement efficiency [2]. In Choi's [6] description concerning the eastern concept of taekwon-do, a rule of maximum gain with minimum effort may be seen very clearly as a criterion for optimization of psychomotor improvement. Study on methods of improving functional capability, whose significant aspect is movement optimization are bringing more and more new findings from around the world [4].*

There are indications in the movement theory that what happens after should be seen, as described in this work, as a *kinematic effect of a target*, which is an essential aspect of this programme[5].

The aim of this paper is to present an interdisciplinary approach to improving the functional capacity of an individual. The aim of the cognitive quantification was to increase the knowledge about *kinematic effect of a target*. The practical aim would be to apply kinematic effect of a target in clinical situations, to supply for physiotherapeutic programs.

**Material and Methods of the Study.** The analysis was performed 14 taekwondo athletes ITF (International Taekwon-do Federation) 6 women (age:  $19,8 \pm 3,8$  lat; body mass:  $167,7 \pm 6,4$  kg; height:  $57,7 \pm 6,5$ ) and 8 men (age:  $18,3 \pm 1,7$  lat; body mass:  $70,4 \pm 6,0$ ; height:  $176,2 \pm 3,0$  kg) During research they performed front left and right kicks in a lateral standing position: into the air (without a physical target), to a table tennis ball hanging on a line and a training target. The laboratory for the analysis of movement named HML was used here.

For all registered maximum velocities the mean and standard deviation was indicated. The normality of the distribution was checked with the Shapiro-Wilk's test. The differences between comparable groups were assessed on the basis of t-test. The statistical significance was assumed at the level of  $p < 0,05$ . All measurements were performed with the use of IBM SPSS Statistics 20,0.

**Results of the Study. Discussion.** Tables contains obtained values of legs' foot average maximum velocity, depending on the target of kicking for females (table 1) and males (table 2). The highest average maximum velocity was obtained by the kicks without a physical target ( $10,78 \pm 1,32$  m/s for men and  $8,51 \pm 1,50$  m/s for women).

Table 1

**Mean Velocity at Front Kicking for Females  
(Statistical Validity  $p < 0,05$ )**

	Średnia	SD	Min	Max
Air, m/s	8,51	1,50	6,36	12,99
Shield, m/s	8,28	1,59	4,87	11,13
Table tennis ball, m/s	7,73	2,01	5,13	13,71

Table 2

**Mean Velocity at Front Kicking for Males  
(Statistical Validity  $p < 0,05$ )**

	Średnia	SD	Min	Max
Air, m/s	10,78	1,32	8,65	13,44
Shield, m/s	9,98	1,40	7,26	12,40
Table tennis ball, m/s	9,63	0,94	8,07	11,77

The obtained results provided the argument supporting the thesis that the type of target influences on the method of solving the dilemma: the velocity of movement and its precision during a frontal kick. Both, in the case of women and men who practise taekwon-do, lowering the velocity of a kick, performed towards a precisely established target, in comparison with the velocity of a kick without a precisely established physical target (into the air) was observed.

Based on this, we may assume that the increase of the precision influences negatively on velocity, along with the mechanism: «the speed-accuracy trade off» [3]. There are substantial mentions to think that such activities go along with the concept of the distribution of resources referred to in the cognitive psychology [7]. This concept talks about the selectiveness of concentration on a particular task in the categories of the distribution of energetic resources of the nervous system, under the rule: «something at the cost of something else».

For many people with the dysfunctions of the movement organs, everyday functioning, especially related to movement, makes a challenge. In such a case crossing the road at the green light in particular time or stepping on the escalator (the examples of such barriers are numerous) are the tasks that reveal the dilemma of velocity and precision. There are many factors that may support the efficiency of these efforts. One of them may be the feeling of the efficiency of activity that has a psychological character.

It can be observed that in the research over the effectiveness of tasks connected with extreme sport challenges, the aspects of physical education, biomechanics, physiotherapy, medicine, psychology and other fields run through each other. In sport science and physiotherapy more and more frequently the research concentrates on the connections at the level of the body, emotions, and cognition- in the search for fuller solutions (effective and certain) within these fields. Expected solutions to a large extent concern the widely understood effectiveness of undertaken actions: on one hand, they concern the results in the rehabilitative processes, on the other, the solutions refer to the results in a qualifying sport.

For many people with the dysfunctions of the movement organs, everyday functioning, especially related to movement, makes a challenge. In such a case crossing the road at the green light in particular time or stepping on the escalator (the examples of such barriers are numerous) are the tasks that reveal the dilemma of velocity and precision. There are many factors that may support the efficiency of these efforts. One of them may be the feeling of the efficiency of activity that has a psychological character[8]. Therapists need both to monitor patients and clients progress in achieving their goals and help the clients develop the skills to do themselves, for future. It's also important that the patient and therapist re-evaluate their goals to determine whether they still relevant to the client's lifestyle.

The process of rehabilitation constitutes a «fight» for health. Fighting for health is often difficult and complicated. The proper solution of the presented dilemma may mean for a particular person the difference between health and illness (in some cases- death), under the rule of one possibility [9]. This is one of the reasons why biomechanical identification of movements makes an important element of many research works. Detailed analysis of human performance shows that minor elements, that were been taken into consideration earlier, may improve efficiency.

Improving a functional capability may be effective only when it is based on comprehensive activities of specialists from many areas oriented at an individual therapy of a specific person. This denotes personalized activities based on joint arrangements made between the therapists and an individual sportsman and/or an individual patient. However, detailed criteria (speed indicators and motion precision indicators) of each set goal should be agreed on, together with acceptable cost, which can be lifted by the body. It is about optimizing therapy, i.e. gaining maximal effect with minimal loss of energy. Clinical practice indicates that the improvement of an individual's psychophysical functioning encourages strengthening positive therapeutic effects [10]. Formal exercise programmes (used conjunction with others methods of treatment) are one of main forms of conservative treatments used to treat painful musculoskeletal conditions.

The results and considerations presented herein may serve as the material for the comparisons for other researchers and may indicate the path for further searching of an interdisciplinary character in the clinical situations.

**Conclusions.** Summarizing the above, we can say that the target has an impact on the movement kinematics. The conducted research allowed to obtain empirical data and increase knowledge within the impact of the psychological factors (different targets) on the movement kinematics with reference to the results of the measurement of velocity of a punch performed towards different targets by taekwon-do competitors. This is the starting point for further analysis in the clinical context.

#### *Sources and Literature*

1. Wąsik J, Wójcik A. Health in the context of martial arts practice. *PhysActiv Rev.* 2017. № 5. P. 91–94.
2. Wąsik J., Shan G. Target effect on the kinematics of Taekwondo Roundhouse Kick – is the presence of a physical target a stimulus, influencing muscle-power generation? *Acta of bioengineering and biomechanics.* 2015. № 17(4). P.115–120.
3. Fitts P. The information capacity of the human motor system in controlling the amplitude of movement. *J Exp Psychol.* 1954. № 47(6). P. 381–391.
4. Nguyen D. M., Laffont I., Dupeyron A. Martial arts use in physical and rehabilitation medicine: Literature review and perspectives. *Annals of physical and rehabilitation medicine.* 2016. 59s. S. 55–56.
5. Wasik J., Ortenburger D., Gora T. The kinematic effects of taekwondo strokes in various conditions the outside environment. Interpretation in the psychological aspect and perspective of application in sport, health-related training and survival abilities. *ArchBudo.* 2016. № 12. P. 287–292.
6. Choi H. Taekwon-do. The Korean Art of Self-Defence, International Taekwon-do Federation. New Zealand, 1995.
7. Kahneman D. Attention and effort, Prentice Hall. Englewood Cliffs, 1973.
8. Ortenburger D., Wąsik J., Gora T. Selected dimensions of the self-esteem and a kinematic effect of the intentional target at taekwondo athletes. *Arch BudoSci Martial Art Extreme Sport.* 2016. № 12. P. 117–121.
9. Kalina R. M. Teoriasportówwalki. *CentralnyOśrodekSportu.* Warszawa, 2000.
10. Optimization of quality of functional improvement – aspects of psychomedical treatment / Szerla M., Wasik J., Ortenburger D. et al. *Medical Studies.* 2016. № 2. P. 150–156.

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