

PROGRESSION OF COMBAT SPORT ACTIVITIES FOR YOUTH ATHLETES

ABSTRACT

Combat sport activities can play a role in the development of children and adolescents, and they are often a part of physical education classes and extracurricular activities. In addition to the psychological and social benefits these activities offer, they are also highly beneficial in physiological terms, as they are based on intermittent, metabolically demanding activities that help participants improve their physical fitness.

The aim of this work is to propose a logical progression of game-based activities that reproduce different technical-tactical and physiological requirements of combat sports. The five phases become progressively more difficulty with respect to both strategy and intensity.

INTRODUCTION

The number of young people participating in organized sports programs has increased significantly in recent years. A variety of reasons for increased participation include recreation (to improve health and wellness) and competitive (to achieve high levels of performance) (14). Consequently, it would appear advantageous to encourage participation in athletic activities that go beyond the most popular sports (swimming, soccer, basketball, etc.) in which a vast majority of adolescents participate.

Among these less popular athletic activities are combat sports (e.g. judo, wrestling, taekwondo, karate). Fewer young people tend to take up these sports due to their technical requirements, their high degree of specificity, and their individuality (i.e. one-on-one competition). Despite the lack of popularity, a number of studies have pointed out the benefits of involvement in these combat sports, especially judo. For example, the lessons learned in combat sports appear to improve motivational climate in the classroom, via increased participation during tasks and a reduced tendency to justify violence, similarly to and better than team sports (9). Youth participants in judo have been shown to achieve not only physiological benefits, such as enhanced body composition and strength, but also improved cognitive performance and greater satisfaction with their quality of life (7). Specifically, regular Judo training may potentially improve executive functions in school children (25). Meanwhile, psychosocial improvements may result from youth participation in combat sports. A German study (8) revealed that overweight children who had participated in judo programs showed improvements in emotional well-being, while Sterkowicz-Przybycień et al. (24) concluded that a school based judo program made a positive impact on the behavior of school children in their social relationships.

The category of combat sports includes activities that involve contact or “grappling dominant” (e.g. judo, wrestling, Brazilian jiu-jitsu), impact or “striking dominant” (e.g. taekwondo, karate, boxing) and some that involve both contact and impact (e.g. mixed martial arts, wushu, hapkido). In educational settings or during the initial stages of training, it is preferable to start with activities limited to contact rather than impact in order to avoid accidents and enhance the safety of participants. When introducing young people to combat sports, it is important to follow a coherent series of steps to ensure that they become familiar with the basic elements of combat and that they are properly motivated, protected from injury, and sufficiently prepared to progress to subsequent stages of training.

One way to introduce young people to combat sports is by creating simple situations that are not technically demanding and have few rules tied to a specific purpose related to the sport of interest. A number of different game-based activities that require an opponent (1-on-1) or multiple opponents (1-on-2, 1-on-3, etc.) can be helpful. Alternatively, these activities can be team-based which minimizes the individual or head-to-head aspect of most combat sports, while still emphasizing movement and interaction amongst the participants. The main aim of this paper is to propose a logical progression of game-based activities that reproduce different technical-tactical and physiological requirements of combat sports.

THE PHYSIOLOGY OF COMBAT SPORT ACTIVITIES

Most combat sports are characterized by intermittent, high-intensity efforts (5). According to Slimani, et al. (21), the effort expended in combat sports tends to be maximal or near-maximal, as these sports represent full-body exercise that involves a large number of muscle groups, with varying levels of effort from one sport to another and between competition and training. In judo, it has been shown that the intensity of effort tends to be near maximal during both competitive and training-based sparring situations (16,20). Chino et al. (3) measured intensity in freestyle wrestling matches using heart rate (HR), blood lactate concentration, and rating of perceived exertion (RPE), and concluded that intensity begins at submaximal levels at the start of a match and increases to maximal levels by the end. Given the high physical demand and nature of combat sports it is logical that training should be adapted to involve activities with sport-specific movements, tactics, strategy, and intensity.

Buchheit and Laursen (1) have defined high-intensity intermittent training (HIIT) as consisting of repeated periods of very intense effort, each lasting between 45 seconds and four minutes. As this type of training is usually performed above 90% VO_{2max} , it has been suggested to improve cardiorespiratory and metabolic functioning (1). Thus, HIIT places maximum stress on oxygen uptake and transport, which can act as a very effective stimulus to increase VO_{2max} (23). Furthermore, Kilian et al. (11) have shown that HIIT does not have the negative effects of stress hormones and immunological parameters on young people and adolescents when compared with high-volume training. Additional benefits of HIIT include angiogenesis (18), enhanced

mitochondrial development (10), improved anaerobic capacity (19), and delayed neuromuscular fatigue (15,22).

As combat sports are by their nature intermittent and tend to be highly physiologically demanding, it is not surprising that HIIT is one of the most common training methods for athletes in this kind of sport. Studies have shown this to be the case in judo (6), karate (17) and wrestling (4). In fact, Laursen and Buchheit (12) suggest fight-based HIIT as the most common, by far, HIIT approach used in a combat athlete's annual training plan.

Considering the similarities between combat sport activities and HIIT, it may be possible to structure the introduction of young people to combat sports using a series of game-based activities in order to leverage any potential positive physiological and psychosocial benefits. Potential advantages for this type of approach may include improved motivation, heightened tactical awareness, improvements in technical skill, and enhanced movement efficiency (13).

PRACTICAL APPLICATIONS

Methodology of combat sport activities

A number of difficulties arise when introducing children and adolescents to combat sports. First, there is a need to reconcile the essential components of the sport itself, including the direct confrontation with an opponent. Therefore, it is each participant's responsibility to ensure the physical safety of their fellow training partner/s. Second, beginners in combat sports often have trouble meeting the high technical demands of these activities. However, the progressions suggested here do not require any prior technical experience or knowledge which allows the participants to freely engage within their own level of comfort. One method to strike a balance between the requirements of these sports and the students' motivation is to start with game-based activities that place the individuals in direct opposition of each other. In this way, participants can begin learning from doing on the first day.

Combat sports require close physical contact and since not everyone is comfortable with being in close proximity to others, gradual steps must likely be taken to introduce children and adolescents to combat sport activities. These steps should consist of a series of phases with increasing levels of physical interaction.

The aim of the phases suggested here is to reproduce actions that are typical of combat sports, with activities becoming progressively more difficulty with respect to both strategy and intensity. Ultimately, participants will engage in activities that are conceptually specific to competitive events within combat sports. The methodology begins with the first phase, where the aim is to accept contact with progression to the last phase, where actions are performed on the opponent's body.

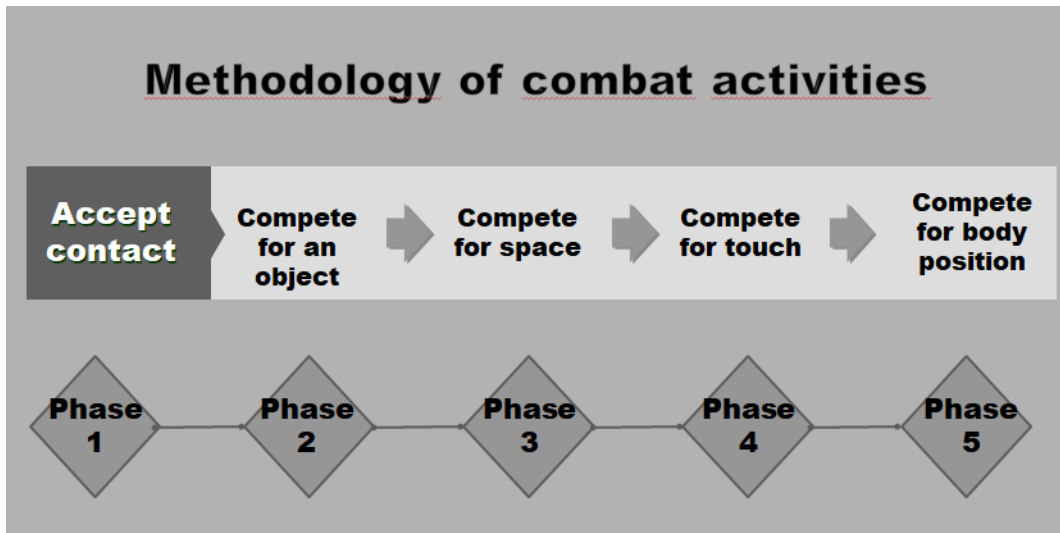






Figure 1. Graphical representation of the progression of combat sport activities.

Phase 1: Accept contact

This phase is considered an introduction because there is often reticence to initiate contact in children (especially between boys and girls). This step is used to progressively introduce participants to close physical contact, using exercises where it is necessary to touch via holding, hugging, or carrying. The goal is for students to gain an initial level of comfort with contact prior to moving onto the next phase.




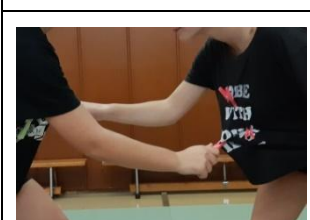
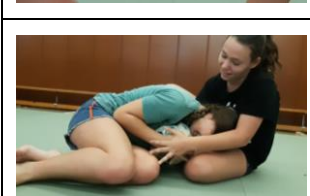
PHASE 1: ACCEPT CONTACT	
	<p>Cowboys One participant carries a partner on his or her back while standing.</p>
	<p>Wheelbarrow After selecting a partner, one participant gets into the pushup position while the other participant stands holding his or her feet. The pair moves in unison with one person in the pushup position supporting the movement with their arms and the other person standing with his or her legs.</p>

	<p>Ben-Hur In groups of four, two participants stand side-by-side facing in the same direction with the inside arm over the other person's far shoulder while a third participant bends over at the waist and places his or her head between them and places his or her arms around each person's waist forming a "chariot". The fourth participant climbs on the third participant's back and the group moves in unison to a pre-specified destination.</p>
	<p>Wedding carry One participant carries a partner cradled in his or her arms.</p>
	<p>Twister Both participants lay on the ground with their heads together and feet facing away from each other. From this position, they should raise their arms overhead and clasp each other's hands, and begin rolling across the mat.</p>
	<p>The Queen Two participants join hands and transport a third participant seated in their arms.</p>
	<p>Rolling logs A row of participants lay face down on the floor next to each other. The participant lying on one end of the row advances by rolling over the others until he or she reaches the other end, and so on.</p>

Phase 2: Compete for an object

This is the first phase in which direct opposition is proposed. Here, individuals are encouraged to engage in actions that require them to challenge for an element external to the body, such as a ball or a handkerchief. Consequently, these actions may decrease the emotional burden of confrontation. It is suggested to have one participant initiate/attack while the other defends and then exchange roles. However, this can be adapted for several participants attacking and defending at the same time.









PHASE 2: COMPETE FOR AN OBJECT


	<p>Pickpocket The game is carried out as a couple. Each member of the couple has a scarf attached to the waist and a ball under the arm. The goal is to take the scarf and/or the ball away from your partner while not letting them take yours.</p>
	<p>Remove the hat Each participant places a small cone on their head. Both individuals try to take the cone from the other without dropping or losing their cone to the opposition.</p>
	<p>Socks Each participant removes their shoes and wears one sock. While competing one-on-one, the object is to remove the partner's sock before having his or her own removed.</p>
	<p>Handkerchief Participants start with a handkerchief sticking out of their pants and are assigned a partner. The purpose of the game is to try to remove your partner's handkerchief while keeping your handkerchief intact. The whole class can compete against each other and the method of contact allowed can be altered to increase the difficulty of the game.</p>
	<p>Clothespins Participants start with 3-4 clothespins placed on their clothing and are assigned a partner. The purpose of the game is to remove the partner's clothespins before having his or her own removed.</p>
	<p>Treasure fight After selecting a partner, one of the participants holds a ball, while the other participant attempts to take the ball by trying to turn his or her partner over.</p>

Phase 3: Compete for space

During this phase, activities are proposed with a more strategic component because, although space is a material element, it is perceived closer than objects (personal space). The objective of these activities is to push the opponent out of a designated space, to keep your body inside the space, or to reach a designated space. Pulling, pushing, or blocking are typical actions utilized during these activities (2).

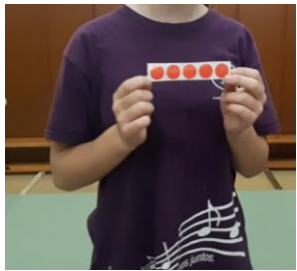



PHASE 3: COMPETE FOR SPACE


	<p>Black hole Two participants hold one another by the shoulders over a circle drawn on the floor between them. The purpose is to get the other player to step into or land in the circle.</p>
	<p>Bonfire Set up groups of 4 ensuring everyone is holding hands and place a cone in the middle of the group. At the sound of an auditory command/signal all of them start to stretch backwards. The objective is to not to touch the cone or pass over it.</p>
	<p>The island Place 5-6 participants on a large safety mat (or the “island”). The purpose is to get the others off of the imaginary island and eventually become the last person left on the island.</p>
	<p>Tiny bed Two people lying down inside a mat. The aim is to remove your partner off of the mat by pushing them with the body rather than the arms.</p>
	<p>Squatter An individual, with their hands behind their back, must keep one foot inside a hoop that is on the floor. The other individual, outside the hoop, tries to remove their foot out of the hoop by pushing them with their hands behind their back and only allowed to hop on one leg.</p>
	<p>Diamond In groups of 4, individuals remain inside a square outlined by four cones while holding onto a belt. At the command/signal each individual attempts to reach out and touch the cone closest to them.</p>
	<p>The donkey After being assigned a partner, one participant gets on his or her hands and knees while the other participant lies at his or her side. In response to a command/signal, the partner on their hands and knees moves to a designated place, while the other partner tries to prevent this by trying to immobilize his or her partner.</p>
	<p>Gladiator Begin in pairs, on top of a large mat, with each person holding an exercise ball. The objective is to get the other off of the mat by pushing them with the ball.</p>

	<p>Turtles One person lying face down tries to move forward with the partner on their back as if they were the shell of a turtle. The goal is to reach a certain marker/distance.</p>
---	--

Phase 4: Compete for contact

At this moment in the progression, participants will begin to act directly on the body of others which is a defining characteristic of most combat sports. These activities require contact with different parts of the body as specified within the specific rules. In this phase, activities must be set up to have one of the partners as the aggressor and the other as the defender, or where groups of participants are assigned to be either aggressors or defenders.




<p>PHASE 4: COMPETE FOR CONTACT</p>	
	<p>Stickers Everyone has 5 stickers. The goal is to be the first person to apply all the stickers on other people. It is possible to play this game one-on-one or in group.</p>
	<p>Bodyguard In a group of four, one person is the attacker (i.e. the fan), one person is the defender (i.e. the star), and two people are the bodyguards that will defend the star. The star and the bodyguards must stay in a line and try to defend the star while the fan tries to touch him.</p>
	<p>Touch the leg In pairs, one faces the other. The aim is to touch your partner's legs as many times as possible.</p>
	<p>Touch the feet Begin in pairs facing each other. The aim is to touch your partner's feet as many times as possible with your own foot.</p>





	<p>Touch the head Start with one person standing and one person lying on their back. The partner standing tries to touch the head of the partner as many times as possible.</p>
---	--

Phase 5: Compete for body position

This phase is considered the most similar to the practice of grappling combat sports. The hand to hand competition in this phase involves gripping actions, unbalancing, and maintaining a variety of positions on the ground, which are very similar to the pinning and throwing techniques used in judo, Brazilian jiu-jitsu and wrestling.

When participants have reached this phase, they have completed their introduction through a natural progression of activities culminating the movements, the technical-tactical strategies, and the physiological responses associated with combat sports. At this stage, participants can become more involved in a particular sport, provided that they have access to the necessary facilities and qualified instruction.

<p>PHASE 5: COMPETE FOR BODY POSITION</p>	
	<p>Circle of strength In groups of four everyone should hold hands in a circle. The goal is to make your partners fall. It is permissible to execute a “barai” (sweeping technique with the foot)</p>
	<p>Balance on the line As a couple both participants should stand with their feet in a line facing each other. The object of the game is to move your partner’s feet off the line.</p>
	<p>Alligators Begin with two people, face to face in a push-up position. The objective is to make the other fall by pulling on each other’s wrist.</p>

	<p>Scottish encounter In pairs and standing, both partners should try to lift up the other at the same time.</p>
	<p>Swiss encounter Begin with two people holding one hand together. The aim is to be the first to hug your partner around their back (i.e. your chest to their back).</p>
	<p>Don't get up One partner is on their hands and knees while the other one is standing. At the command/signal the partner in quadruped tries to stand up while the one standing has to prevent them from getting up.</p>
	<p>Omelet One of the partners lies face down while the other partner tries to flip them over without standing up.</p>

How do we manage effort?

As suggested previously, the efforts expended during combat sport activities may be very similar to those expended during HIIT. The manipulation of some variables, such as the duration of the work or rest intervals and the number of repetitions, is likely to have an effect on exercise intensity during the acute physiological response. Laursen and Buchheit (12) suggest implementing short (10 - 60s) and long (90s - 5min) duration work bouts into HIIT in order to develop the phosphagen/glycolytic and glycolytic/oxidative systems, respectively.

In the case of combat sport activities, we can manage these variables (work/rest intervals) using partner changes, role changes in offense or defense, and issuing specific instructions to alter the technical-tactical strategy. These variations would allow for the design of work-to-rest intervals very similar to designing HIIT protocols.

Same activity for four bouts of 90 sec. Work-to-rest intervals are to change participants' rol						
90 sec Body guard	90 sec Rest and switch rol	90 sec Body guard	90 sec Rest and switch rol	90 sec Body guard	90 sec Rest and switch rol	60-90 sec Body guard
Two activities for four bouts of 60 sec. Work-to-rest intervals are to change participants' rol, change activity and change the partner.						
60 sec Treasure	60 sec Rest and switch rol	60 sec Treasure	60 sec Rest and new activity instructions	60 sec Swiss encounter	60 sec Rest and change the partner	60 sec Swiss encounter

Table 6. Workouts examples using work/rest intervals for partner changes, role changes in offense or defense or issuing specific instructions for the next activity.

Cardiopulmonary responses are usually the first variables to consider when programming HIIT. However, the contribution of anaerobic glycolytic energy and neuromuscular load (1) should also be considered when working with children or adolescents. These variables may be accounted for by adjusting the designated space, speed of movement and/or leverage used within a given activity. For example, a larger space may extend the work bout due to the partner's greater potential to evade, while the shape of the confined area (e.g. circle, square, octagon) may present distinct tactical options for the participants involved in these activities (12). Also, the instructions and/or restrictions placed on the participants by the coach, and the speed of movement or leverage needed to overcome a partner's resistance would likely increase the metabolic demands of the game.

How do we assess the process?

In order to understand the imposed demands of applying suggested combat sport activity progressions, easily administered instruments are needed to monitor the training process.

From a physiological perspective, the rating of perceived exertion (RPE) provides a valid and reliable assessment method for monitoring internal training load in combat sports (21). RPE is a subjective method characterized by scores with verbal links (i.e., from "rest" to "maximal"), referring to the athlete's perception of efforts into a numerical score between 0 (i.e., rest) and 10 (i.e., maximal). A synthesis of the RPE literature and its correlation with physiological variables may be useful and of great relevance in understanding the level of effort as well as the underlying physiological demands of game-based combat sport activities. Moving beyond this approach, methods to quantify based on heart rate (HR) have also been used, even though, Franchini, Artioli, & Brito (5) showed that the HR does not see an effect from changes in the pause/work ratio in different judo-specific training tasks.

For the evaluation of the children's attitude during their participation in the combat activities, a checklist that covers aspects of safety, motivation and the use of tactical principles is provided in Table 5.

Table 5

CHECKLIST ABOUT ATTITUDE DURING COMBAT SPORT ACTIVITIES	
1. Emotional control is maintained during COMBAT	YES-NO
2. Takes care of peers...safety is priority	YES-NO
3. Active participation	YES-NO
4. Uses tactical principles of ACTION-REACTION	YES-NO

CONCLUSIONS

The work executed with combat sport activities involves a large number of muscle groups and it is evident that the strength and VO₂max of children and adolescents can be developed in a playful way. Its structure, similar to the HIIT, can help organize the work and rest times managed from switching roles or partners, as well as the parameters of the games.

The proposal of a progression based on the combat objective helps to sequence the contact from simple to complex and ensures that the proposal is successful at any stage of learning. The progression of contact during combat-based games as well as the restrictions that can be imposed during the games ensures successful learning at any stage.

The acquisition of many skills from combat activities has a direct transfer to team sports. For example, many of the games proposed in phases 2 and 3, where you are competing for an object or for space, have application to sports such as, football, rugby, basketball, etc. Similarly, stage 4 where you are competing for touch has direct transfer with impact/striking combat sports such as, karate, taekwondo, fencing, kendo and phase 5, where you are competing for body position, has direct transfer with contact/grappling combat sports such as judo and wrestling.

REFERENCES

1. Buchheit, M and Laursen, PB. High-Intensity Interval Training, Solutions to the Programming Puzzle. *Sport Med* 43: 927–954, 2013.
2. Carratala, V, Carratalá, E, and Hueli, JM. Judo: la actividad física y deportiva extraescolar en los centros educativos. Ministerio de Educación, Cultura y Deporte, Consejo Superior de Deportes, 2000.
3. Chino, K, Saito, Y, Matsumoto, S, Ikeda, T, and Yanagawa, Y. Investigation of exercise intensity during a freestyle wrestling match. *J Sports Med Phys Fitness* 55: 290–296, 2015.
4. Farzad, B, Gharakhanlou, R, Agha-Alinejad, H, Curby, DG, Bayati, M, Bahraminejad, M, et al. Physiological and performance changes from the addition of a sprint interval program to wrestling training. *J strength Cond Res* 25: 2392–2399, 2011.
5. Franchini, E, Artioli, GG, and Brito, CJ. Judo combat: time-motion analysis and physiology. *Int J Perform Anal Sport* 13: 624–641, 2013.
6. Franchini, E, Julio, UF, Panissa, VLG, Lira, FS, Gerosa-Neto, J, and Branco, BHM. High-

- Intensity Intermittent Training Positively Affects Aerobic and Anaerobic Performance in Judo Athletes Independently of Exercise Mode. *Front Physiol* 7: 268, 2016.
7. Fukuda, DH, Stout, JR, Burris, PM, and Fukuda, RS. Judo for children and adolescents: Benefits of combat sports. *Strength Cond J* 33: 60–63, 2011.
 8. Geertz, W, Dechow, A-S, Pohl, E, Zyriax, B-C, Ganschow, R, and Schulz, K-H. Physical and Psychological Well-Being in Overweight Children Participating in a Long-Term Intervention Based on Judo Practice. *Adv Phys Educ* 7: 85, 2016.
 9. Hortiguuela, D, Gutierrez-Garcia, C, and Hernando-Garijo, A. Combat versus team sports: the effects of gender in a climate of peer-motivation, and levels of fun and violence in physical education students. *Ido Mov Cult J Martial Arts Anthropol* 17: 11–20, 2017.
 10. Hoshino, D, Kitaoka, Y, and Hatta, H. High-intensity interval training enhances oxidative capacity and substrate availability in skeletal muscle. *J Phys Fit Sport Med* 5: 13–23, 2016.
 11. Kilian, Y, Engel, F, Wahl, P, Achtzehn, S, Sperlich, B, and Mester, J. Markers of biological stress in response to a single session of high-intensity interval training and high-volume training in young athletes. *Eur J Appl Physiol* 116: 2177–2186, 2016.
 12. Laursen, PB and Buchheit, M. Science and Application of High-Intensity Interval Training. Champaign, IL: Human Kinetics, 2018.
 13. Little, T. Optimizing the use of soccer drills for physiological development. *Strength Cond J* 31: 67–74, 2009.
 14. Lloyd, RS, Oliver, JL, Faigenbaum, AD, Howard, R, Croix, MBADS, Williams, CA, et al. Long-term athletic development-part 1: a pathway for all youth. *J Strength Cond Res* 29: 1439–1450, 2015.
 15. Miramonti, AA, Stout, JR, Fukuda, DH, Robinson IV, EH, Wang, R, La Monica, MB, et al. Effects of 4 weeks of high-intensity interval training and β -Hydroxy- β -Methylbutyric free acid supplementation on the onset of neuromuscular fatigue. *J Strength Cond Res* 30: 626–634, 2016.
 16. Morales, J, Franchini, E, Garcia-Massó, X, Solana-Tramunt, M, Buscà, B, and González, L-M. The work endurance recovery method for quantifying training loads in Judo. *Int J Sports Physiol Perform* 11, 2016.
 17. Ravier, G, Dugue, B, Grappe, F, and Rouillon, JD. Impressive anaerobic adaptations in elite karate athletes due to few intensive intermittent sessions added to regular karate training. *Scand J Med Sci Sports* 19: 687–694, 2009.
 18. Robinson, MM, Dasari, S, Konopka, AR, Johnson, ML, Manjunatha, S, Esponda, RR, et al. Enhanced protein translation underlies improved metabolic and physical adaptations to different exercise training modes in young and old humans. *Cell Metab* 25: 581–592, 2017.
 19. Rodas, G, Ventura, JL, Cadefau, JA, Cussó, R, and Parra, J. A short training programme for the rapid improvement of both aerobic and anaerobic metabolism. *Eur J Appl Physiol* 82: 480–486, 2000.
 20. Sbriccoli, P, Bazzucchi, I, Di Mario, A, Marzattinocci, G, and Felici, F. Assessment of maximal cardiorespiratory performance and muscle power in the Italian Olympic judoka. *J Strength Cond Res* 21: 738–744, 2007.
 21. Slimani, M, Davis, P, Franchini, E, and Moalla, W. Rating of perceived exertion for quantification of training and combat loads during combat sport-specific activities: a short review. *J Strength Cond Res* 31: 2889–2902, 2017.
 22. Smith, AE, Moon, JR, Kendall, KL, Graef, JL, Lockwood, CM, Walter, AA, et al. The effects of beta-alanine supplementation and high-intensity interval training on

- neuromuscular fatigue and muscle function. *Eur J Appl Physiol* 105: 357, 2009.
23. Sperlich, B, De Marées, M, Koehler, K, Linville, J, Holmberg, H-C, and Mester, J. Effects of 5 weeks of high-intensity interval training vs. volume training in 14-year-old soccer players. *J Strength Cond Res* 25: 1271–1278, 2011.
 24. Sterkowicz-Przybycień, K, Kłys, A, and Almansba, R. Educational judo benefits on the preschool children's behaviour. *J Combat Sport Martial Arts* 5: 23–26, 2014.
 25. Wai, LA Lo, Zhenwen, L, Wenfeng, L, SuyingLuo, Zhi, Z, Shaozhen, C, et al. The Effect of Judo Training on Set-Shifting in School Children. *Biomed Res Int*, 2019.