RESEARCH ARTICLE

European Journal of Sport Sciences
www.ej-sport.org

Functional Training: Effect on Arm Muscle Endurance, Leg Muscle Endurance, Aerobic Capacity and Body Mass Index at the Judoka in the Train-to-Train Stage

Ira Purnamasari, Mona F. Febrianty, Dadan Mulyana,
Nidaul Hidayah, Geraldi Novian, Sanabela C. Putri

ABSTRACT

Judo is a competitive sport that requires aspects of physical condition as a determining factor for judo performance. Functional training is a training method that can support the improvement of physical condition. The purpose of this study was to determine the effect of Functional Exercise on arm muscle endurance, leg muscle endurance, aerobic capacity, and body mass index. The participants were female judoka athletes in Bogor aged 11 to 15 years and male judoka athletes aged 12 to 16 who were actively practicing and had a minimum kyu level of 5. The duration of the study was 16 meetings held 3 times a week. The method used is experimental. The instruments used were a one-minute push-up test, a one-minute sit-up test, multi-stage fitness, and measuring body weight and height. Functional training exercises have an effect on increasing arm muscle strength, there is no significant increase in leg muscle strength and aerobic capacity, and Body Mass Index Improvement using functional training methods can support judo performance from the training stage to the training stage.

Keywords: aerobic capaity, arm muscle strength, BMI, functional training, judo, leg muscle strength.

Published Online: December 30, 2022

ISSN: 2796-0048

DOI: 10.24018/ejsport.2022.1.6.48

Ira Purnamasari*
Sport Coaching Education Study Program, Faculty of Sport and Health Education, Universitas Pendidikan Indonesia, Indonesia
(e-mail: irapurnamasari@upi.edu)
M. F. Febrianty
Sport Physical Coaching Study Program, Faculty of Sport and Health Education, Universitas Pendidikan Indonesia, Indonesia
(e-mail: monafiametta@upi.edu)
D. Mulyana
Sport Coaching Education Study Program, Faculty of Sport and Health Education, Universitas Pendidikan Indonesia, Indonesia
(e-mail: mulyanadadan@upi.edu)
N. Hidayah
Sport Coaching Education Study Program, Faculty of Sport and Health Education, Universitas Pendidikan Indonesia, Indonesia
(e-mail: nidaul@upi.edu)
G. Novian
Sport Coaching Education Study Program, Faculty of Sport and Health Education, Universitas Pendidikan Indonesia, Indonesia
(e-mail: geraldi.novian@upi.edu)
S. C. Putri
Sport Coaching Education Study Program, Faculty of Sport and Health Education, Universitas Pendidikan Indonesia, Indonesia
(e-mail: sanabela.putri11@upi.edu)

Corresponding Author

I. INTRODUCTION

Judo is one of the competitive sports that contains a variety of falls, rolls, throws, joint locks, hold down a, strikes and chokes. Therefore, it takes good physical condition to be able to support the best appearance. Age category competition in Judo is divided into three groups, namely cadets, juniors and seniors. To get the best achievements in the golden age, continuous coaching is needed starting from the category, cadet, junior so that judo players can achieve the best results in the senior category. In all sports and mixed martial arts, including Judo, there has been a noticeable increase in the number of training activities. Currently, an examination of scientific data reveals that experts and trainers have focused their main efforts on structuring single-combat training to maximize the level of functional fitness for competitors (Osipov *et al*., 2017). One of the key indicators needed to forecast an athlete's success in judo is their capacity to make the most moves possible during a competitive bout (Podrigalo *et al*., 2017). The process of an athlete's preparation should be based on timely and correct information on the degree of physical condition of martial artists in

the current state of athletic development, which necessitates providing quality control over the efficacy of training exercises. In Judo Competition matches, in addition to the senior category, there are cadet and junior categories which are usually competed in national and international events.

There is a concept of long-term athlete development that has been developed and is commonly used, namely LTAD (Balyi *et al*., 2013). In the Long-Term Athlete Development (LTAD) model for Judo, 15-year-old enter the train-to-train stage, when they have developed proficiency in the performance components of athlete development (physical, technical-tactical, mental, and emotional). Rapid physical growth, development of sporting abilities, and commitment occur at this stage. In Indonesia, junior judo players usually practice in clubs that are fostered by schools, so they usually carry out training activities in the school environment, the problem is the limited infrastructure owned by clubs that join the school. Therefore, we need a training method that can be used without requiring a lot of infrastructure to support the improvement of the performance of junior judo. One method that can deal with the lack of infrastructure in the club is the functional training method.

In general, the definition of functional training is a type of exercise that is carried out using simple tools or not using tools at all, such as using one's own weight. In general, functional training is a sport movement that is adapted to body movements in daily activities, mostly involving activities targeted at the core muscles (abdomen and lower back). This type of exercise is in great demand because it is flexible, it can be done anywhere and anytime. Functional training is also proven to improve stability, strength, mobility, endurance and flexibility of the body. Initially, functional training was often used by therapists to rehabilitate the condition of patients with movement disorders. However, over time, this type of therapy was modified by other branch trainers such as strength and conditioning trainers, fitness trainers, martial arts trainers and also began to be used as an exercise method in the field of fitness.

The basic concept of functional training refers to performing free movements in all areas of movement, integrated movements, involving the whole body, as well as complex movements that require a physical and mental level (Florina, 2018). Cardiovascular and metabolic effects are obtained due to exercise intensity, posture is improved and injuries are prevented by using all muscle groups. Functional training improves muscle endurance, speed, strength, power and flexibility. Daily activity can be improved through functional training, unlike traditional training with heavy weights, because it trains balance and coordination, along with increasing strength and type of movement. The emphasis is on movements that work the upper with the lower body. We know that recently, it has been indicated that more attention should be paid to the possible differences in the prevalence of sport addiction among different sports, especially in competitive disciplines (Kostorz & Cynarski, 2022). This also applies specifically to the sport of Judo, therefore, proper training is needed.

Someone who does functional training has the following advantages: Improve movement patterns, increase movement efficiency, improve physical condition, improve coordination and mobility, increase calorie burning, increase aerobic capacity, increase lean muscle mass, in addition to physically, someone who trains functionally. training will experience psychological effects, one of which is reducing anxiety levels (de Sousa Junior *et al*., 2021). Professional athletes now place a lot of emphasis on so-called functional training, which enables them to develop exceptional levels of strength and endurance as well as to get their bodies ready for particular demands. What functional training approach should be employed depends on the type of martial arts (Martínez-Abellán *et al*., 2010). To improve speed, strength, and other types of endurance in athletes, functional training for martial artists entails a rigid program of specified weight exercises, with and without a partner, with training loads similar to the contest level (Cherepov & Shaikhetdinov, 2016; Latishev & Chochorai, 2005) . Based on the background that has been stated, this research will focus on the effect of functional training on aspects of physical condition, BMI and the impression of judo at the training to train stage.

II. Material and Methods

The method used in this research is the experimental method, by applying the exercise program treatment. The design approach used in this study is: pre-test-post-test group design. The population used in this study is the Judoka of Bogor who is in the training to train stage. The number of judo in the selected population is 32 people. The selection of these athletes was carried out with the consideration of wanting to see the achievements of the 6-week training program. The research instrument used in this study was to collect data in the field. The research instruments that will be used to determine aspects of the physical condition of the judo at the training to train stage are: Push-ups, Wall Sits, Bleep Test (VO2max). The instrument used for body mass index is the measurement of BMI (Body Mass Index) which is determined by the Ministry of Health of the Republic of Indonesia. For the measurement of anxiety using research instruments that will be made in such a way that there is conformity with the sample to be taken.

European Journal of Sport Sciences
www.ej-sport.org

III. RESULTS

The (2-tailed) pre AME and Post AME significance values were 0.088 and 0.200 (p>0.05). This means that H_0 is accepted, so it can be concluded that the data for the two groups are normally distributed.The (2-tailed) pre LME and Post LME significance values were 0.200 and 0.026(p>0.05). This means that H_0 is rejected, so it can be concluded that one the data in the groups is not normally distributed. The (2-tailed) pre-AC and Post AC significance values were 0.052 and 0.094 (p>0.05). This means that H_0 is accepted, so it can be concluded that the data for the two groups are normally distributed. The (2-tailed) pre BMI and Post BMI significance values were 0.048 and 0.056 (p>0.05). This means that H_0 is rejected, so it can be concluded that one the data in the groups is not normally distributed. More details can be seen in Table I.

TABLE I: NORMALITY TEST PRETEST AND POSTTEST ARM MUSCLE ENDURANCE (AME), LEG MUSCLE ENDURANCE (LME), AEOBIC CAPACITY (AC) AND BODY MASS INDEX (BMI)

Null Hypothesis	Sig.	Decision
The Distribution of Pre _AME is normal with mean 21.15 and standard deviation 4.757	0.088[1]	Reject the null Hypothesis
The Distribution of Post_AME is normal with mean 20.86 and standard deviation 4.671	0.200[1,2]	Reject the null Hypothesis
The Distribution of Pre _LME is normal with mean 21.15 and standard deviation 4.757	0.200[1,2]	Reject the null Hypothesis
The Distribution of Post_LME is normal with mean 20.86 and standard deviation 4.671	0.026[1]	Reject the null Hypothesis
The Distribution of Pre _AC is normal with mean 21.15 and standard deviation 4.757	0.052[1]	Reject the null Hypothesis
The Distribution of Post_AC is normal with mean 20.86 and standard deviation 4.671	0.094[1]	Reject the null Hypothesis
The Distribution of Pre _BMI is normal with mean 21.15 and standard deviation 4.757	0.048[1]	Reject the null Hypothesis
The Distribution of Post_BMI is normal with mean 20.86 and standard deviation 4.671	0.056[1]	Reject the null Hypothesis

For Arm Muscle Endurance (AME) The Preliminary Test has an average value (mean) of 33.2813 from 32 data. The data distribution (Std. Deviation) obtained is 10.54096 with a standard error of 1.86340. The Final Test for Arm Muscle Endurance has an average value (mean) of 31.9688 from 32 data. The data distribution (Std. Deviation) obtained is 10.85234 with a standard error of 1.91844. The Preliminary for Aerobic Capacity (AC) Test has an average value (mean) of 32.1281 from 32 data. The data distribution (Std. Deviation) obtained is 5.77465 with a standard error of 1.02082. The Final Test for Aerobic Capacity (AC) has an average value (mean) of 32.6094 from 32 data. The data distribution (Std. Deviation) obtained is 6.18460 with a standard error of 1.09329. More details can be seen in Table II.

TABLE II: PAIRED SAMPLES STATISTICS AME AND AC

Pair		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-AME	33.2813	32	10.544096	1.86340
	Post_AME	31.9688	32	10.85234	1.91844
Pair 2	Pre-AC	32.1281	32	5.77465	1.02082
	Post_AC	32.6094	32	6.18460	1.09329

The significance value (2-tailed) is 0.352 (p>0.05). So it can be concluded that there is no significant effect of giving the Functional Training Model to increasing the athlete's arm muscle strength. The significance value (2-tailed) is 0.352 (p>0.05). So it can be concluded that there is no significant effect of giving the Functional Training Model to increasing the athlete's arm muscle strength. More details can be seen in Table III.

TABLE III. PAIRED SAMPLES TEST AME AND AC

					95% confidence Interval of Difference				
		Mean	Std Deviation	Std Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	Pre AME- Post AME	1.31250	7.85940	1.38936	-1.52112	4.14612	0.945	31	0.352
Pair 2	Pre AC- Post AC	-0.48125	2.11072	0.37313	-1.24224	0.27974	-1.290	31	0.207

Negative Ranks or difference (negative) between Leg Muscle Strength for Pre Test and Post Test. Here there are 4 negative data (N), which means that 4 athletes experienced a decrease in leg muscle strength from the pre test value to the post test value. The mean rank or average decrease is 18.00, while the number of negative rankings or Sum of Ranks is 72.00. Negative Ranks or difference (negative) between Leg

Muscle Strength for Pre Test and Post Test. Here there are 4 negative data (N), which means that 4 athletes experienced a decrease in leg muscle strength from the pre test value to the post test value. The mean rank or average decrease is 18.00, while the number of negative rankings or Sum of Ranks is 72.00. Negative Ranks or difference (negative) between Leg Muscle Strength for Pre Test and Post Test. Here there are 4 negative data (N), which means that 4 athletes experienced a decrease in leg muscle strength from the pre test value to the post test value. The mean rank or average decrease is 18.00, while the number of negative rankings or Sum of Ranks is 72.00. More details can be seen in Table IV.

TABLE IV: WILCOXON SIGNED RANKS TEST LME

		N	Mean Rank	Sum of Ranks
Post_LME - Pre_ LME	Negative Ranks	4[a]	18.00	72.00
	Positive Ranks	27[b]	15.70	424.00
	Ties	1[c]		
	Total	32		

Negative Ranks or difference (negative) between Leg Muscle Strength for Pre Test and Post Test. Here there are 4 negative data (N), which means that 4 athletes experienced a decrease in leg muscle strength from the pre test value to the post test value. The mean rank or average decrease is 18.00, while the number of negative rankings or Sum of Ranks is 72.00. More details can be seen in Table V.

TABLE V: TEST STATISTICS LME

	Post_LME-Pre_LME
Z	-3.450b
Asymp.Sig. (2 tailed)	0.001

Negative Ranks or difference (negative) between Body Mass Index for Pre Test and Post Test. Here there are 17 negative data (N), which means that 17 athletes experienced a decrease in their Body Mass Index from the pre-test value to the post-test value. The mean rank or average decrease is 14.82, while the number of negative rankings or Sum of Ranks is 252.00. Positive Ranks or difference (positive) between Body Mass Index for Pre Test and Post Test. Here there are 8 positive data (N), which means that 8 athletes experienced an increase in their Body Mass Index from the pre-test value to the post-test value. The mean rank or average increase is 9.13, while the total positive rankings or Sum of Ranks is 73.00. Positive Ranks or difference (positive) between Body Mass Index for Pre Test and Post Test. Here there are 8 positive data (N), which means that 8 athletes experienced an increase in their Body Mass Index from the pre-test value to the post-test value. The mean rank or average increase is 9.13, while the total positive rankings or Sum of Ranks is 73.00. More details can be seen in Table VI.

TABLE VI: WILCOXON SIGNED RANKS TEST BMI

		N	Mean Rank	Sum of Ranks
Post_BMI - Pre_ BMI	Negative Ranks	17[a]	14.82	252.00
	Positive Ranks	8[b]	9.13	73.00
	Ties	7[c]		
	Total	32		

Based on the “Test Statistics” output, it is known that the sig (2-tailed) value is 0.016<0.05. This means that Ho is rejected, so it can be concluded that there is a significant effect of giving the Functional Training Model to the athlete’s Body Mass Index. More details can be seen in Table VII.

TABLE VII: TEST STATISTICS BMI

	Post_BMI-Pre_BMI
Z	-2.408b
Asymp.Sig. (2 tailed)	0.016

IV. DISCUSSION

Functional training is a type of exercise that is carried out using simple tools or not using tools at all, such as using your own body weight. In general, functional training is a sport movement that is adapted to body movements in daily activities. This type of exercise is in great demand because it is flexible, it can be done anywhere and anytime. Functional training is also proven to improve stability, strength, mobility,

endurance and flexibility of the body. In this study the forms of exercise given are: Step Up, Plank, T Push Up, X-Ups and Squat Jump. Previous studies have shown that there is evidence that functional training is beneficial for the overall physical fitness of athletes (Xiao *et al*., 2021). This form of exercise is chosen according to the needs of the Judo sport. The results of this study there is a significant effect of the results of functional training on the reduction of BMI, there is a significant effect of the functional training model on increasing flexibility ability, there is a significant effect of the functional training model on increasing the athlete's power ability. These results indicate that the functional training method can be used to reduce BMI. Although research shows BMI can be lowered by using other exercises, it turns out that functional exercises have beneficial effects for that (Purnamasari *et al*., 2021).

Muscle endurance often plays a major role in Judo Performance (Purnamasari *et al*., 2022). To get the greatest contraction, muscle strength must be stimulated as much as possible throughout training. Additionally, when the actions used during training are comparable to those used during competition, muscular strength training is more effective. The power needed for exercise and athletic competition is typically produced by concentric and eccentric muscular contractions. Additionally, many competitive sports depend on the strength and explosive power of the upper arm muscular group. Judo sports involve throwing opponents on their backs using different techniques (eg, legs, ashi-waza, te-waza, koshi-waza, and sutemi-waza) or to score goals during basic combat (grapple) using immobilization (ossae-waza, shimewaza), or elbow joint locks (kansetsu-waza). This combat sport involves a large neuromuscular demand, suggesting that a good level of physical fitness in strength and flexibility appears to be important to its competitors. For example, competitors are matched by weight, therefore, higher overall body strength is an important advantage. Each fight typically lasts up to 4 minutes and is characterized by intermittent high-intensity training similar to wrestling; however, manipulation of the choke and joint lock is allowed. To perform this technique, participants strain their muscles and joints, particularly those associated with shoulder, trunk, and hip movements.

The most frequent component of functional training across trials was mobility exercises. Results indicate positive impacts on muscle strength, balance, mobility, and daily living tasks, especially when the training program was tailored to that goal. Functional training may be used to enhance older adults' functional performance (Liu *et al*., 2014). In this study, functional training was not given to older judo players, but was given to judo players aged 12–16 years. this allows for differences in the effect of functional training given to people at an older age compared to people aged 12-16 years. The need for judo players aged 12–16 years to increase muscle strength is by applying a higher training volume compared to the functional training program given in this study. Therefore, maintaining a certain level of physical fitness is one of the most important factors for the physical and mental health of children and adolescents, especially trough this exercise (Pierantozzi *et al*., 2022). The current analysis from this systematic review provides strong evidence that functional training improves physical fitness in terms of speed, muscle strength, strength, balance, and agility, while there is moderate evidence of effects on flexibility and muscular endurance. The results support the principle of specificity in training, whereby the best gains in performance are achieved when training closely matches performance (Xiao *et al*., 2021).

A training cycle that incorporates both cardiorespiratory fitness training and muscle strength training may improve athletic performance more than single-mode training. However, each training modality's physiological effects may potentially conflict with one another, enhancing athletic performance less than single-mode training. Young athletes may react differently to concurrent training (CT) compared to adults because anthropometric, physiological, and biomechanical differences between young and adult athletes can affect the responses to exercise training (Martijn *et al*., 2018). Increase in the leg muscle endurance test is caused by the selection of the type of functional training exercise that is in accordance with the muscles used in the muscle endurance test. practice. step up and squat jump exercises are exercises for leg muscle endurance in this study. In Judo matches, weight is something that must be considered. Because the Judo competition system itself is limited by body weight for each class of competition (Purnamasari *et al*., 2021), therefore a BMI that corresponds to the category of judo competition classes is urgently needed. Being overweight that doesn't match the competition category will result in an increase in BMI. Therefore reducing BMI is needed for judo players, in order to control their weight. In this study, the BMI of judo players has decreased, so it can be concluded that functional training can reduce BMI in judo players at the training to train stage. BMI reduction has an impact on cardiorespiratory endurance. In this study, an increase in leg muscle endurance was in line with a decrease in BMI in judo players at the training to train stage (Jayusfani *et al*., 2015).

V. CONCLUSION

Based on the results of research, calculations, and data analysis, it can be concluded that there is no significant increase effect in providing a functional training model on arm muscle endurance, aerobic

capacity, Functional Training Programs can improve Leg Muscle Endurance and Body Mass Index. Further research is needed to determine methods that can be used to increase muscle endurance and aerobic capacity for judo athlete at the training to train stage. In addition, further research is needed to use a functional training model with a judo sample in the training to compete stage to support maximum performance.

VI. FUNDING

Thanks to Universitas Pendidikan Indonesia for funding this research and publication.

REFERENCES

Balyi, I., Way, R., & Higgs, C. (2013). *Long-term athlete development*. Human Kinetics. https://doi.org/10.1249/jsr.0b013e3181fe3c44.

Cherepov, E., & Shaikhetdinov, R. (2016). Effectiveness of functional training during physical conditioning of students practicing martial arts. *Journal of Physical Education and Sport*, 16(2), 510–512.

De Sousa Junior, I., Nunes, R. S. M., Corrêa, H. de L., & Vieira, E. (2021). Functional training program: the impact on depression, anxiety and sleep quality in adolescents. *Sport Sciences for Health*, 17(1), 233–242.

Florina, O. (2018). Functional training vs traditional training benefits for martial arts practitioners. *Scientific Bulletin of Naval Academy*, XIX(1), 366–374. https://doi.org/10.21279/1454-864x-18-i1-056.

Jayusfani, R., Afriwardi, A., & Yerizel, E. (2015). The relationship between BMI (body mass index) and cardiorespiratory endurance in unand medical education students. *Jurnal Kesehatan Andalas*, 4(2), 409–414.

Kostorz, K., & Cynarski, W. J. (2022). Exercise dependence in practitioners of martial arts and combat sports. *International Journal of Environmental Research and Public Health*, 19, 1–14. https://doi.org/10.3390/ijerph192416782.

Latishev, S. ., & Chochorai, Z. Y. (2005). S*pecial strength training of martial artists*. Donetsk: DonDUET.

Liu, C., Shiroy, D. M., Jones, L. Y., & Clark., D. O. (2014). Systematic review of functional training on muscle strength, physical functioning, and activities of daily living in older adults. *European Review of Aging and Physical Activity*, 11(2), 95–1106.

Martijn, G., Prieske, O., Hortobagyi, T., & Urs Granacher. (2018). The effects of concurrent strength and endurance training on physical fitness and athletic performance in youth: a systematic review and meta-analysis. *Frontiers in Physiology*, 9, 1057.

Martínez-Abellán, Alberto, García-Pallarés, J., López-Gullón, J. M., Otegui, X. M., Baños, V. M., & Martínez-Moreno., A. (2010). Anaerobic factors predictors of success in Olympic wrestling. *Cuadernos de Psicología Del Deporte*, 10(2), 17–23.

Osipov, A. *et al*. (2017). The use of functional training–Crossfit methods to improve the level of special training of athletes who specialize in combat sambo. *Journal of Physical Education and Sport*, 17(3), 2013–2018. https://doi.org/10.7752/jpes.2017.03201.

Pierantozzi, E., Morales, J., Fukuda, D. H., Garcia, V., Antonia, M. G., Guerra-balic, M., & Carballeira, E. (2022). Effects of a long-term adapted judo program on the health-related physical fitness of children with ASD. *International Journal of Environmental Research and Public Health*, 19(16731), 1–14.

Podrigalo, L. V., Volodchenko, A. A., Rovnaya, O. A., Ruban, L. A., & Sokol., K. M. (2017). Analysis of adaptation potentials of kick boxers' cardio-vascular system. *Pedagogics, Psychology, Medical-Biological Problems of Physical Training and Sports*, 21(4), 185–191.

Purnamasari, I., Arfin Deri Listiandi, Geraldi Novian, & Budi Hidayat. (2022). Physical condition of West Java judo athletes during the Covid-19 pandemic: an overview of the general preparation stage. *JOSSAE* (*Journal of Sport Science and Education*), 7(1 SE-Articles), 24–33. https://journal.unesa.ac.id/index.php/jossae/article/view/12300.

Purnamasari, I., Ariati, C., Mulyana, B., & Novian, G. (2021). Decreasing body mass index: continuous run exercise for judo athletes in Bogor. *Jurnal Sains Keolahragaan Dan Kesehatan*, 6(1), 61–69. https://doi.org/10.5614/jskk.2021.6.1.7.

Xiao, W. *et al*. (2021). Effect of functional training on physical fitness among athletes: a systematic review. *Frontiers in Physiology*, 12(September), 1–12. https://doi.org/10.3389/fphys.2021.738878.