

The Effect of Warm-Up Activities in Game-Based Physical Education on Increasing Student Pulse

Gugun Gunawan^{1,2,*}, Hidayat Humaid³, Junaidi³, Firmansyah Dlis³, Sumbara Hambali⁴, Muslimin⁵, Aprizal Fikri⁵

¹Sport Education Study Program (S3), Universitas Negeri Jakarta, Moh Hatta Building, Rawamangun 13220, Jakarta, Indonesia

²Department of Physical Education, Health and Recreation, STKIP Pasundan 40512, Cimahi, Indonesia

³Sport Science Faculty, Universitas Negeri Jakarta, Rawamangun 13220, Jakarta, Indonesia

⁴Department of Physical Education, Health and Recreation, STKIP Pasundan, 40512, Cimahi, Indonesia

⁵Sports Education Study Program, Faculty of Teaching Training and Language, Universitas Bina Darma, Palembang, Indonesia

Received December 23, 2022; Revised March 24, 2023; Accepted April 20, 2023

Cite This Paper in the Following Citation Styles

(a): [1] Gugun Gunawan, Hidayat Humaid, Junaidi, Firmansyah Dlis, Sumbara Hambali, Muslimin, Aprizal Fikri, "The Effect of Warm-Up Activities in Game-Based Physical Education on Increasing Student Pulse," *International Journal of Human Movement and Sports Sciences*, Vol. 11, No. 3, pp. 598- 603, 2023. DOI: 10.13189/saj.2023.110312.

(b): Gugun Gunawan, Hidayat Humaid, Junaidi, Firmansyah Dlis, Sumbara Hambali, Muslimin, Aprizal Fikri (2023). *The Effect of Warm-Up Activities in Game-Based Physical Education on Increasing Student Pulse. International Journal of Human Movement and Sports Sciences*, 11(3), 598 - 603. DOI: 10.13189/saj.2023.110312.

Copyright©2023 by authors, all rights reserved. Authors agree that this article remains permanently open access under the terms of the Creative Commons Attribution License 4.0 International License

Abstract Warming up is an activity that must be done at the beginning whenever someone wants to do sports activities. Without good warm-up, it is feared that it will be bad for the body when doing sports. This study aims to determine the influence of warm-up activities in game-based physical education learning. The research subjects involved 35 grade V elementary school students. The research method uses experiments with its research design using one group pretest posttest design. The forms of play are given as many as 10 series of activities and tests using pulse measurements for 1 minute, carried out at the time before the game activity is given and after the game activity is given. The results of the study obtained that of the 10 kinds of play forms in the warm-up, all of them had a significant influence on increasing the pulse. This is evidenced by the results of effectiveness testing using paired sample t-test analysis using SPSS IBM 26 where a Sig. (2-tailed) score was obtained by $0.000 < 0.05$. It is hoped that physical education teachers must be more creative in providing every material to be studied, starting from the preliminary stage, core activities to closing activities.

Keywords Warm-up, Game, Pulse, Student, Elementary School

1. Introduction

Physical education as a process or event in learning for the growth or development of students improves motor skills or sports or physical fitness, this physical activity is certainly very good for the physical, mental and social growth of students [1]. Physical education as a process or event in learning student growth and development improves motor skills or sports or physical fitness [2]. Physical education is an important part of the School Plan [3] [4]. It is recommended that schools need to provide an average of 30 minutes/day for physical education, so that it will have a positive impact on children, not only health, but also academic performance, and their cognition [5]. Physical education is also seen as important because it is a medium for encouraging the development of values (attitudes, mental, emotional, spiritual, social), as well as habituation to a healthy lifestyle [6] [7].

The scope of physical education subject matter given at the basic education level consists of six main elements, namely: games and sports, development activities, self-testing / gymnastics, rhythmic activities, aquatics (water

activities) and out-of-school education [8] and from these six elements, active student involvement is needed, so that goals can be achieved, namely: fun, social, identity, challenge, structure and feedback [9]. If you look at the characteristics of elementary school students, then these various activities should contain elements of games [10]. Games are carried out to foster children's learning motivation [11] therefore it is expected that starting from the initial learning activities student motivation must have been formed. Providing motivation to students must be built starting from the beginning of learning activities, this is useful for strengthening their passion to want to learn seriously [12]

Physical education learning activities in each material consist of several stages, starting from the initial activities, core activities and final activities [13]. Physical activity program has an influence on movement activities and mental health even in a large school environment which is better than in a narrow school environment [14]. In the initial activity, there was a warm-up activity, which aimed to prepare students' movement activities towards core activities. Warm-up activities are a common exercise routine that is always carried out in every sports activity to prevent injuries and improve the performance of athletes [15] purpose is to increase body temperature, increase blood supply to the muscles [16] besides that warming activity is also useful for increasing muscle temperature, nerve connectivity and accelerating metabolic reactions [17]. Therefore, a physical education teacher every time he performs his duties, must have careful planning, one of which is by dividing activities into at least three stages, namely introduction, core and closing, so that the learning process will later be more programmatic and minimize the name of misperceptions in achieving learning objectives.

The forms of heating in general are static heating and dynamic heating or jogging. These forms are commonly carried out in early warm-up activities, which of course have often been carried out. This is certainly a problem, it is feared that activities that have been and are often carried out will trigger a sense of boredom in students. Therefore, warming should be made to attract more attention, so that students are earnest in doing so. Some research on the use of games in warming up has already been carried out, it is mentioned that warming up with games can eliminate saturation or boredom in students [18], Warming up with games is also believed to increase the fun in students by up to 91.5% and can also increase the pulse to the training zone [19], In addition, warm-up activities using game activities are suitable for elementary school students, because they are proven to increase understanding, self-confidence and motivation to learn [20].

One of the forms of warming applied to this study is game-based warming. Games as an approach to the instruction of movement skills and movement abilities, also serves as an important facilitator of cognitive and affective growth in children as well as an important means of developing fine and gross motor skills [21]. The game activity carried out in this study is a series of movements that combine warm-up movements in place and change places with the addition of songs to the activity, so it is expected to increase student motivation and be able to train coordination between thoughts and movement instructions. This is presumably in line with the characteristics of students in elementary school, who are playing a lot in their time [22]. It is hoped that with these forms of game-based warming, students will be better prepared to learn especially when it comes to increasing their pulse, since one of the indicators of an increase in body temperature is the presence of an increase in pulse [23].

2. Method

The research method used in this study is an experimental method with a *one-group pretest-posttest design*. The study subjects involved 1 upper class of elementary school students in the West Bandung Regency area as many as 35 people, consisting of 16 male students and 19 female students. The instrument uses a pulse test for 1 minute, performed at the time before warming up and after warming up, this pulse measurement is done manually, namely by touching the surface of the body part of the radial artery located in front of the wrist [24]. The form of warm-up in the game is given as many as 10 types, consisting of 1 series ranging from stationary activities in place to moving to other places. One series of motions lasts 15 minutes, including about 5 minutes for on-site activities and 10 minutes for changing places. The data analysis technique used is to use a t-test statistical approach, so that the effectiveness of the application of the treatment given can be seen.

3. Results and Discussion

The research was conducted in elementary schools, especially in class V at SDN 3 Cikandang with a total of 35 respondents. The number of treatments given is ten times, with the frequency of giving 1 series form of play at each meeting. After processing and analyzing data using the SPSS IMB 26 assistance program, the results can be seen as follows:

Table 1. Description of Research Results

		Mean	N	Std. Deviation	Std. Error Mean
Games 1	Pretest	75.06	35	13.405	2.266
	Posttest	116.17	35	26.580	4.493
Games 2	Pretest	68.71	35	14.480	2.448
	Posttest	107.26	35	26.666	4.507
Games 3	Pretest	69.69	35	12.732	2.152
	Posttest	85.86	35	19.263	3.256
Games 4	Pretest	74.66	35	11.985	2.026
	Posttest	112.06	35	23.457	3.965
Games 5	Pretest	76.46	35	10.988	1.857
	Posttest	111.40	35	22.500	3.803
Games 6	Pretest	62.97	35	12.126	2.050
	Posttest	145.03	35	17.323	2.928
Games 7	Pretest	75.63	35	12.274	2.075
	Posttest	122.77	35	21.957	3.711
Games 8	Pretest	72.83	35	12.965	2.191
	Posttest	118.06	35	23.924	4.044
Games 9	Pretest	84.37	35	15.145	2.560
	Posttest	128.86	35	31.385	5.305
Games 10	Pretest	62.97	35	12.126	2.050
	Posttest	142.63	35	21.037	3.556

After having treated as many as 10 types of games, it can be directly seen in table 1 that it provides an increase in pulse. The pulse measurement is directly measured for one minute after the learner is given each series of games. It can be seen in table 1 between the pulse before warming up and after warming up with the game has increased. One type of game called "Three G" consists of two items of motion activity, namely the movement in the place of the song and the movement of changing places, and the series is called the game "Three G1" for game 1, "Three G2" for game 2, "Three G3 for game 3, and so on. For more details, the following in detail is presented the form and name of the activity on each type of game:

Table 2. Types of Warm-Up Activities with Games

Game Name	Activity Type	
	Movement in Place	Moving Motion
Three G1	Bangun Tidur	Suit Run
Three G2	Naik Delman	Domikado Zigzag Run
Three G3	Bangun Tidur	Six Box Dadu
Three G4	Burung Kakak Tua	Mouse and Cat
Three G5	Potong Bebek Angsa	Three Hompimpa
Three G6	Topi Saya Bundar	Zombie Game
Three G7	Pelangi-Pelangi	ABC Game
Three G8	Cicak di Dinding	The Police Gamaes
Three G9	Naik Kereta Api	3K Move Place
Three G10	Aku Anak Gembala	Continue The Song

Table 3. Paired Sample t-test Results

		Mean	Std. Deviation	Std. Error Mean	t	d	Sig. (2-tailed)
Games 1	Pretest - Posttest	-41.114	24.691	4.174	-9.851	34	.000
Games 2	Pretest - Posttest	-38.543	22.827	3.858	-9.989	34	.000
Games 3	Pretest - Posttest	-16.171	20.329	3.436	-4.706	34	.000
Games 4	Pretest - Posttest	-37.400	22.108	3.737	-10.008	34	.000
Games 5	Pretest - Posttest	-34.943	26.737	4.519	-7.732	34	.000
Games 6	Pretest - Posttest	-82.057	19.509	3.298	-24.884	34	.000
Games 7	Pretest - Posttest	-47.143	24.873	4.204	-11.213	34	.000
Games 8	Pretest - Posttest	-45.229	22.761	3.847	-11.756	34	.000
Games 9	Pretest - Posttest	-44.486	32.899	5.561	-8.000	34	.000
Games 10	Pretest - Posttest	-79.657	24.691	4.174	-19.086	34	.000

Based on these results, it can be seen that descriptively judging from the average there is an improvement between the initial test results and the final test. This is evidenced by the results of the significance test using the paired sample t-test that out of 10 forms of game-based warm-ups all have a significant effect, because it is seen in the Sig. (2-tailed) score column which is $0.000 < 0.05$. This means that game-based heating has a significant influence on the increased pulse rate of grade V elementary school learners. The forms of warming must be packaged properly, this is because so that students are ready to carry out their core movements [25], ready in terms of its physiology as well as in terms of psychology [26], [27]. Good warm-up activities can increase body temperature and heart rate [28], [29], So that blood flow throughout the body is distributed smoothly and the body is better prepared to move well. Some research results also state that warming up in the form of games can eliminate boredom or boredom, increase motivation and self-confidence when studying and can increase concentration so that they are able to understand the lessons or material given [18]–[20].

Pulse is one of the parameters that can be used to see a person's readiness to carry out sports activities. Games can provide fun for the culprit, so that later it can increase the motivation of students in warming up. In addition to increasing students' psychological pleasure in warming up with games, it can also prove success in improving basic movement skills in students when doing sports activities [30]. Through games, it is hoped that it will increase students' motivation and interest in learning to be higher, so that optimal learning outcomes will be obtained [31]. Researchers added a simple warm-up series to be able to make students participate in warming up and used several warm-up series in the form of games so that without realizing it, student motivation is focused on a game-based warm-up series so that students don't feel bored in warming up [32]. Motivation can also affect student learning outcomes themselves [33] by applying a warm-up model with a game form can increase student interest because it

can make students feel happy and enjoy the process [34].

One of the successes in the learning process occurs because it uses game learning by applying game models through group game simulations that vary from actual games to actual games so as to increase student participation in learning activities [35]. Of course, the more students actively learn, the more physical activity is also carried out, and of course it will increase the frequency of the pulse. As it is known that several things can affect the pulse include gender, age, body position, and physical activity [36]. The series of games used for heating here is indeed a combination of static, dynamic forms of heating and also moving from one position to another, which is usually all done separately [37]. However, the forms of warming up in this study are to combine some types of warm-ups into a series of games that use larger muscles, where the forms of exercise of large muscles are such as walking, jogging, running, cycling and others [38].

The increase in pulse rate is also influenced by the intensity of the exercise performed, usually a high intensity of exercise will increase the pulse rate faster [39], but this is highly discouraged in warming up, because it will damage some organ functions and also muscles [40]. This is in line with the statement that when warming up directly with high intensity, it will result in the body's ability to neutralize the lactic acid pile is not proportional to the speed of lactic acid formed due to the severity of sports activities carried out [41]. Warm-up activities should be carried out systematically, starting with light movements, such as static gymnastics on the spot, then moving dynamically, both in place to moving places [42].

Warm-ups are generally used for someone who wants to do sports activities, and of course this is highly recommended, especially if the exercise to be done has a moderate or high intensity level. The form of warming up does vary, ranging from stretching which of course is an absolute requirement for every beginning of sports activities to prevent muscle injuries, and prepare physically, mentally and also emotionally [29] [30]. That way, this

warm-up activity needs to be made as interesting as possible so that students are motivated to do it, so that they will be more active in carrying out the learning process.

4. Conclusions

Based on the results of research that has been carried out, it can be concluded that the provision of warm-up in game-based physical education learning can significantly increase the pulse frequency in elementary school level students. The application of warm-ups through games also makes students motivated to warm up and move more actively, which of course is good for the development of students, both in aspects of skills, social and also knowledge. It is hoped that physical education teachers must be more creative in providing material, from preliminary activities, core activities to closing activities. The results of this study are expected to contribute a little science about the application of warming with game forms which are a series of various types of warm-ups, which can certainly have an impact on students' readiness to learn.

REFERENCES

- [1] S. Hambali, A. S. Hanif, Widiastuti, F. Dlis, Samsudin, and A. Sobarna, "The Effectiveness of Learning Passing Volleyball for Student on Website-Based," *Int. J. Hum. Mov. Sport. Sci.*, vol. 10, no. 2, pp. 324–330, 2022, doi: 10.13189/saj.2022.100224.
- [2] T. G. Johnson and L. Turner, "The Physical Activity Movement and the Definition of Physical Education," *J. Phys. Educ. Recreat. Danc.*, vol. 87, no. 4, pp. 8–10, 2016, doi: 10.1080/07303084.2016.1142192.
- [3] M. Thorburn and J. Dewey, "Learning, Culture and Social Interaction John Dewey, subject purposes and schools of tomorrow: A centennial reappraisal of the educational contribution of physical," *Learn. Cult. Soc. Interact.*, no. April, pp. 0–1, 2018, doi: 10.1016/j.lcsi.2018.04.001.
- [4] M. Thorburn, *Transformative Learning and Teaching in Physical Education*. New York: Routledge, 2017.
- [5] J. L. Barrett *et al.*, "Cost Effectiveness of an Elementary School Active Physical Education Policy," *Am. J. Prev. Med.*, vol. 49, no. 1, pp. 148–159, 2015, doi: 10.1016/j.amepre.2015.02.005.
- [6] M. Kirkham-King, T. A. Brusseau, J. C. Hannon, D. M. Castelli, K. Hilton, and R. D. Burns, "Elementary physical education: A focus on fitness activities and smaller class sizes are associated with higher levels of physical activity," *Prev. Med. Reports*, vol. 8, 2017, doi: 10.1016/j.pmedr.2017.09.007.
- [7] S. Baena-Morales, D. Jerez-Mayorga, P. Delgado-Floody, and J. Martínez-Martínez, "Sustainable development goals and physical education. A proposal for practice-based models," *Int. J. Environ. Res. Public Health*, vol. 18, no. 4, pp. 1–18, 2021, doi: 10.3390/ijerph18042129.
- [8] E. Prasetyo, A. Setyawan, and ..., "Evaluasi Pelaksanaan Pembelajaran Pendidikan Jasmani Olahraga dan Kesehatan di Kelas III SDN Buluh 2," ... *Pendidik*. ..., 2020, [Online]. Available: <https://prosiding.ikippgribojonegoro.ac.id/index.php/Prosiding/article/view/1015>
- [9] Y. Chen, Y. Lu, and C. Lien, "Learning environments with different levels of technological engagement: a comparison of game-based, video-based, and traditional instruction on students' learning," *Interact. Learn. Environ.*, vol. 29, no. 8, pp. 1363–1379, 2019, doi: 10.1080/10494820.2019.1628781.
- [10] S. Hambali, "Pendekatan Bermain dalam Pembelajaran Passing Atas pada Permainan Bolavoli," *J. Teach. Phys. Educ. Elem. Sch.*, vol. 2, no. 1, pp. 46–52, 2018, [Online]. Available: <http://ejournal.upi.edu/index.php/tegar/index>
- [11] T. Gabbett, D. Jenkins, and B. Abernethy, "Game-Based Training for Improving Skill and Physical Fitness in Team Sport Athletes," *Int. J. Sports Sci. Coach.*, vol. 4, no. 2, pp. 273–283, 2009, doi: 10.1260/174795409788549553.
- [12] A. Kawano, "A model and evaluation method of learning motivation in the education and training of professional engineers," *Proceedings of 2016 IEEE International Conference on Teaching, Assessment and Learning for Engineering, TALE 2016*. pp. 311–318, 2017. doi: 10.1109/TALE.2016.7851813.
- [13] M. L. Kroote and C. A. Bucher, *Management of Physical Education and Sport*, Twelfth. New York: McGraw-Hill, 2007.
- [14] A. Chaeroni, A. Komaini, N. W. Pranoto, and D. Antoni, "The Effect of Physical Activity Programs and School Environments on Movement Activities and Mental Health," *Int. J. Hum. Mov. Sport. Sci.*, vol. 10, no. 2, pp. 131–137, 2022, doi: 10.13189/saj.2022.100201.
- [15] C. Marques and D. A. Marinho, "Warm-Up and Performance in Competitive Swimming," pp. 319–330, 2014, doi: 10.1007/s40279-013-0117-y.
- [16] J. Grzegorz, M. Olszewska, D. Boguszewski, D. Białoszewski, and P. Reaburn, "Infrared Physics & Technology Is it possible to create a thermal model of warm-up? Monitoring of the training process in athletic decathlon," *Infrared Phys. Technol.*, vol. 76, pp. 555–559, 2016, doi: 10.1016/j.infrared.2016.04.017.
- [17] J. Zois, D. J. Bishop, K. Ball, and R. J. Aughey, "High-intensity warm-ups elicit superior performance to a current soccer warm-up routine," *J. Sci. Med. Sport*, vol. 14, no. 6, pp. 522–528, 2011, doi: 10.1016/j.jsams.2011.03.012.
- [18] S. Lusianti, "Pengaruh Pemberian Permainan Sebagai Bentuk Pemanasan Terhadap Minat Siswa Dalam Mengikuti Pelajaran Pendidikan Jasmani," *J. Sport. J. Penelit. Pembelajaran*, vol. 1, no. 1, p. 32, 2015, doi: 10.29407/js_unpgri.v1i1.573.
- [19] Astiati, T. J. Samodra, and U. Gustian, "Tanggapan siswa terhadap pemanasan yang dilakukan dengan modifikasi permainan tradisional," *Edu Sport. Indones. J. Phys. Educ.*, vol. 2, no. 2, pp. 85–91, 2021, doi: 10.25299/es:ijope.2021.vol2(2).6809.
- [20] R. Zakaria, "Games As Warming Up Activities in the Classroom for Indonesian EFL Students," *KnE Soc. Sci.*, vol. 2021, pp. 266–276, 2021, doi: 10.18502/kss.v5i3.8549.

- [21] H. Akbari, B. Abdoli, M. Shafizadeh, and H. Khalaji, "The Effect of Traditional Games in Fundamental Motor Skill Development in 7 - 9 Year - Old Boys," vol. 19, no. 2, pp. 123–129, 2009.
- [22] R. Garris, R. Ahlers, and J. E. Driskell, "Games, motivation, and learning: A research and practice model," *Simul. Gaming*, vol. 33, no. 4, pp. 441–467, 2002, doi: 10.1177/1046878102238607.
- [23] J. A. Gilbert and J. A. Gilbert, "Using Target Heart-Rate Zones in Your Class," vol. 3084, no. June, 2016, doi: 10.1080/07303084.2005.10608219.
- [24] W. F. Ganong, *Fisiologi Kedokteran*. Jakarta: Penerbit Buku Kedokteran EGC, 2008.
- [25] E. M. rque. Segura, L. T. Vidal, A. Waern, J. Duval, L. P. Bel, and F. A. Bertran, "Physicalwarm-up games exploring the potential of play and technology design," *Conf. Hum. Factors Comput. Syst. - Proc.*, vol. 41, pp. 1–14, 2021, doi: 10.1145/3411764.3445163.
- [26] A. Gaetano and R. Gaetano, "Physiological effects of warm-up and problems related to team sports," *Sport Sci.*, vol. 10, no. 2, pp. 56–61, 2017, [Online]. Available: <http://www.sportscience.ba/pdf/br20a.pdf#page=56>
- [27] E. Gencer, "Psychological Aspect of Pre-competition Warm-up: Motivational Process and Outcomes," *J. Educ. Issues*, vol. 7, no. 1, p. 431, 2021, doi: 10.5296/jei.v7i1.18535.
- [28] I. Hunter, J. T. Hopkins, and D. J. Casa, "Warming up with an ice vest: Core body temperature before and after cross-country racing," *J. Athl. Train.*, vol. 41, no. 4, pp. 371–374, 2006, [Online]. Available: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1748408/pdf/i1062-6050-41-4-371.pdf>
- [29] D. K. Mukhopadhyay, "Modern Scientific Innovations in Warming Up and Cool- Down in Sports," *J. Adv. Sport. Phys. Educ.*, vol. 5, no. 7, pp. 166–175, 2022, doi: 10.36348/jaspe.2022.v05i07.007.
- [30] A. F. Suhendra, Y. T. J. Samodra, and U. Gustian, "Pengembangan Pemanasan Dengan Game Bagi Siswa Smp," *J. RESPECS*, vol. 3, no. 2, pp. 32–44, 2021, doi: 10.31949/respecs.v3i2.1037.
- [31] K. Prasetyo, "Penerapan Pendekatan Bermain Untuk Meningkatkan Hasil Belajar Lompat Jauh Gaya Jongkok Pada Siswa Kelas 5 Sekolah Dasar," *Sch. J. Pendidik. dan Kebud.*, vol. 6, no. 3, p. 196, 2016, doi: 10.24246/j.scholaria.2016.v6.i3.p196-205.
- [32] J. C. Rosser, D. A. Gentile, K. Hanigan, and O. K. Danner, "The effect of video game 'Warm-up' on performance of laparoscopic surgery tasks," *J. Soc. Laparoendosc. Surg.*, vol. 16, no. 1, pp. 3–9, 2012, doi: 10.4293/108680812X13291597715664.
- [33] I. R. Ary and A. Kristiyandaru, "Motivasi Siswa Mengikuti Pembelajaran Pendidikan Jasmani, Olahraga, Dan Kesehatan: Intrinsik Dan Ekstrinsik," *Pendidik. Jasm. Kesehat. Dan Rekreasi*, vol. 09, no. 1, 2021.
- [34] Y. N. Hanief and S. Sugito, "Membentuk Gerak Dasar Pada Siswa Sekolah Dasar Melalui Permainan Tradisional," *J. Sport. J. Penelit. Pembelajaran*, vol. 1, no. 1, pp. 60–73, 2015, doi: 10.29407/js_unpgri.v1i1.575.
- [35] I. K. Fikri, "Penerapan Model-Model Permainan Untuk Meningkatkan Partisipasi Siswa Pada Pembelajaran Aktivitas Permainan Rounders," *J. Pendidik. Jasm. Dan Olahraga*, vol. 1, no. 1, p. 57, 2016, doi: 10.17509/jpjo.v1i1.3664.
- [36] I. N. Sandi, "PENGARUH LATIHAN FISIK TERHADAP FREKUENSI DENYUT NADI," *Sport Fit. J.*, vol. 4, no. 2, pp. 1–6, 2016, [Online]. Available: <https://ojs.unud.ac.id/index.php/sport/article/view/24030/15688>
- [37] T. Koesharawati, H. S. Rejeki, and Y. T. J. Samodra, "Percepatan Recovery dengan Indikator Denyut Nadi: Kaitannya dengan Latihan yang Telah Dilakukan," *J. Pendidik. Kesehat. Rekreasi*, vol. 8, no. 2, pp. 386–396, 2022, doi: 10.5281/zenodo.6786181.
- [38] W. D. McArdle, F. I. Katch, and V. L. Katch, *Exercise Physiology: Nutrition, Energy, and Human Performance*, Internatio. Philadelphia: Lippincot Williams & Wilkins, 2010.
- [39] S. B. Park *et al.*, "High-intensity warm-up increases anaerobic energy contribution during 100-m sprint," *Biology (Basel)*, vol. 10, no. 3, pp. 1–12, 2021, doi: 10.3390/biology10030198.
- [40] R. A. Tanzila and M. F. Bustan, "Pengaruh Latihan Interval Intensitas Tinggi terhadap Denyut Nadi Mahasiswa Kedokteran," *Glob. Med. Heal. Commun.*, vol. 5, no. 1, pp. 47–50, 2017, [Online]. Available: <https://ejournal.unisba.ac.id/index.php/gmhc/article/viewFile/2010/pdf>
- [41] B. D. Laksana, S. Ugelta, and Jajat, "Recovery Kondisi Denyut Nadi dengan Joging dan Istirahat Dinamis," *J. Keolahragaan*, vol. 5, no. 2, pp. 12–19, 2019, doi: <http://dx.doi.org/10.25157/jkor.v5i2.2151>.
- [42] R. Merino-Marban, V. Fuentes, M. Torres, and D. Mayorga-Vega, "Acute effect of a static- And dynamic-based stretching warm-up on standing long jump performance in primary schoolchildren," *Biol. Sport*, vol. 38, no. 3, pp. 333–339, 2021, doi: 10.5114/BIOLSPORT.2021.99703.
- [43] L. Brick, *Bugar Dengan Senam Aerobik*. Jakarta: PT. Raja Grafindo Persada, 2011.