Dryland Strength And Swimming Training For Performance: A Study In Elite And Sub-Elite Para Swimmer

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Abstract. Structured training is required to help improve the time speed performance of competitive swimmers. This study aims to analyse the effect of combined dryland strength training and swimming training programmes based on the best time on swimming performance in athletes with disabilities. The research subjects consisted of seven provincial-level swimming athletes with disabilities who underwent training camps in preparation for the Indonesia Paralympics Games. This research is experimental research with one group pretest-posttest design method. The training was conducted for 13 weeks with details of 3 dryland training sessions and eight swimming training sessions per week. Performance measurements were carried out by taking pre-test and post-test data on swimming speed with distances of 50 m, 100 m and 200 m according to the style of each athlete's race number. IBM SPSS Statistics version 21 was used to analyse normality and test the effect of training. Wilcoxon test was used to test the significance of the effect of training. The average performance improvement for the pre-test was 3.42±5.31, while the post-test result was 9.28±7.20 ($p<0.05$). In addition, the mean pre-test in elite athletes was 3.20±6.34 and for the post-test 10.6±6.76 ($p<0.05$). Furthermore, the mean pre-test in sub-elite athletes was 4.00±2.82 and for the post-test 6.00±9.89 ($p>0.05$). The study showed a significant effect of dryland strength and swimming training programmes on the swimming speed performance of athletes with disabilities.

Keywords: Disability, Endurance, Exercise, Strength, Periodisation

1 Introduction

Swimming is a very competitive sport; only a slight time difference can affect the outcome of a match, especially in numbers *sprinter* (1,2). The ability of speed and strength of muscular endurance is essential to reach the peak of performance when

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competing. Swimmers participating in a competition do the exercises *strength* and swim before the start of the competition (3). Strength training is the foundation for all athletes competing at a high level (4). The periodisation of strength training is also included in the planning of an exercise (5). The method commonly referred to in swimming sports for outdoor training is *dryland.* Swimming performance highly depends on muscle strength, especially over short distances (6). Muscle strength also influences the speed of swimming 50 meters freestyle (7). Apart from strengthening exercises, technical exercises in water must also be carried out. Improved swimming performance can also be caused by increased stroke length, speed, or both techniques (8).

According to Amara (9), Swimming performance can be improved by sport-specific exercises in the water and through exercise *dryland*. Strength performance is a crucial determinant of performance in swimming (9). Other studies prove that exercising *dryland strength* And in the water can optimise muscle strength and improve sprint swimming performance (6,10). In addition, Marinho et al. (11) show that strength training increases strength in the upper and lower limbs, improving swimmer performance. On the other hand, an injury prevention program for swimmers should include strengthening, stretching, and resistance exercises (12). Physiological adaptations must be achieved to improve performance in the long run (13). However, performance is also strongly related to muscle strength and power (11).

Studies on elite athletes have also shown a significant influence between strength training and performance (14). Manurut Hermosilla et al. (15) The success of a strength and conditioning program in swimming depends on several factors, including the type of exercise, training method and duration, periodisation, training performed, and level of swimmer (15). Strength and power development should always be carried out in parallel with swimming training throughout the season, regardless of swimming distance (13). The research conducted by Lopes et al. (16) Found a significant effect on competitive swimmers during eight weeks of strength training combined with aerobic swimming training. Training model *dryland* can be an alternative exercise for swimmers with limited sports facilities and infrastructure (17).

Dryland training targeting specific motor and coordination skills relevant to Paralympic swimming can improve strength, power, dive start, and free-swimming speed (18). Previous research on swimming exercise has generally been based on non-disabled swimmers, while there has been little relevant research on people with disabilities (2). The study of *dryland strength* And swimming training also in athletes with disabilities is rarely done. For this reason, this research is significant to be carried out as reference material, especially in *swimming*. This study aims to analyse the influence of exercise *dryland strength* and swimming training on performance in elite and sub-elite groups of disabled athletes.

2 Methods

2.1 Research Design and Participant

The design of this study was an experimental study without a control group. The methods used are *one group pre-test and post-test only design* (19). The study subjects consisted of seven provincial athletes with disabilities who underwent *training camps* to prepare for the Indonesian Paralympic Games. The characteristics of athletes are distinguished based on the level of achievement obtained during their career as athletes. Five elite athletes (2 women and three men) have *track record* Achievements in several *national and international events, and the other two* are rookies.

2.2 Data Collection and Procedures

All athletes undergo four months or thirteen weeks of training. Periodisation is carried out to create a structured and well-planned program to improve all athletes' performance. Exercise program *dryland strength* which is done three times the frequency each week (20–22). One session before swimming training, one session after swimming training and one-morning session without any swimming session on the same day. Implementation of exercises *dryland strength* conducted on Monday, Wednesday and Saturday. The exercise program involves upper extremity muscles and lower extremity muscles. The number of reps is 12, and 4 sets interspersed with 60-90 seconds breaks.

The morning session exercise occurs at 06.00-09.00, while the afternoon session is at 15.30-17.30. The swimming training program is as much as eight times per week, every Monday to Friday in the morning and evening. Before stepping on the core of the exercise, the athletes perform *stretching* first outside the pool. After that, during the pool, do *warming up* with intensity or *Pace* 50% of *Personal Best Time* individual athletes. After entering the exercise's core, the program is divided into two types: using and without tools. The supporting tools used during training include a *pull buoy, paddle, snorkelling, fins, and nose clip*. The *Drill Method is* a comprehensive plan of systematic presentation of material whose implementation is based on an approach determined by training so that specific knowledge and skills can be thoroughly possessed and mastered by students and athletes (23). After the core exercises are performed, *cooling down* in the pool with the same intensity as *warming up,* i.e. 50%.

Taking test data must prepare tools such as flags, whistles, stopwatches, whiteboards, test forms, and ballpoint pens. The special tools for visually impaired athletes are the boundary rope as *Lane* and a ball stick as a sign or cue. Pickup distance *Test* Starting from the lowest distance, namely 50 meters, 100 meters and 200 meters, by finishing according to the race number followed. The numbers followed have been adjusted to the type of disability of the athletes and classified according to International Paralympic Committee standards (2). Before the test begins, each athlete is welcome to perform *stretching* and warming up in ponds at a distance of 100 to 200 meters. The test starts from the beginning of the block, and when the whistle blows, the swimmers start the race. The swimmers are instructed to reach maximum swimming speed as quickly

as possible and maintain it for as long as possible. Race times are recorded using a *stopwatch* from the first whistle until the swimmer completes his test distance marked by touching the wall with one hand. After finishing one style, the swimmers *recover* for 5-10 minutes until the pulse is regular. Furthermore, when all tests are completed, swimmers cool down at a distance of 100 meters (11).

2.3 Statistical Analysis

The data obtained is then analysed descriptively to see the average value and standard deviation. Non-parametric tests are performed using Shapiro-Wilk to test data normality. At the same time, the paired t-test through the Wilcoxon test is carried out to determine the effect of giving exercise. The same test is also done to determine the difference between elite and sub-elite athletes' pre-test and post-test. The results of the development of the swimming test are seen from the percentage value. *IBM Statistical Application* version 21 is used to analyse all data.

3 Results

The statistical descriptive data results related to the research subject's character can be seen in Table 1. 71.4% (5) are elite athletes, and 28.6% (2) are sub-elite athletes. In addition, based on limitations or types of disabilities, they are also presented in Table 1. Athletes with visual impairment were 28.6% (2) and 71.4% (5) with physical disabilities. Another characteristic is the male-dominated sex. While it can be seen based on age categories, the subject is more under 20 years old.

Table 1. Charteristic of participant

Characteristic	N	Percentage
Gender		
Male	5	71.4
Female	2	28.6
Age		
< 20 year old	4	57.1
> 20 year old	3	42.9
Category Athlete		
Elite	5	71.4
Sub-Elite	2	28.6
Disability		
Visual Impairment	2	28.6
Physical Impairment	5	71.4

Table 2. Dryland strength item exercise for swimming performance

Part	Item Exercise	Repetition	Set
Upper Extremity	Regular Push-Up	12	4
Lower Extremity	Lunges	12	4
Upper-Back Extremity	Back-Extension	12	4
Core	Crunch	12	4
Upper Extremity	Wide Push-Up	12	4
Lower Extremity	Wall Sit	45 second	4
Upper-Back Extremity	Dynamic Bridge Pose	12	4
Core	Heels Tap	12	4
Upper Extremity	Shoulder Tap	12	4
Lower Extremity	Squat	12	4
Upper-Back Extremity	Dynamic Side Plank	12	4
Core	Leg Raise	12	4
Upper Extremity	Superman Push-Up	12	4
Lower Extremity	Calf Raise	12	4
Upper-Back Extremity	Bear Crawl	12	4
Core	Plank	45 second	4

Table 3. Swimming training programme in para swimmer athletes

No	Low Volume (2000 meters)	High Volume (3000 meters)
1	Warming Up 6x50 m change style pace: 50-60%	Warming Up 6x50 m change style pace: 50-60%
2	Swimming 1x400 m (4 Sets); (50M first 100%; 50M next 80%)	Swimming 1x200 m (4 sets); (100m first 100%; 100m next 80%)
3	Swimming 1x50 m (6 Set); 35m first 90%; 50m next 80%)	Swimming 4x50 m (3 sets); (25m first 90%; 25m next 80%)
4	Swimming 1x100 m (4 Set); 50m first 90%; 50m next 80%)	Swimming 1x100 m (4 set); (50m first 100%; 50 next 80%)
5	Swimming 1x50 m (6 Set); (35m first 100%; 15 m next 80%)	Swimming 4x50 m (3 Set); 25m first 90%; 25m next 80%)
6	Cooling Down 6x50 m change style; 40-50%)	Cooling Down 6x50 m change style; 40-50%)

Table 4. Statistical descriptive results pre-test and post-test and results Wilcoxon test

Variable		Pre-Test		Post-Test		With	p-value
		Mean	SD	Mean	SD		
Performance	Elite athletes	3.20	6.34	10.6	6.76	-2.041b	0.041*
	Sub elite athletes	4.00	2.82	6.00	9.89	-0.447b	0.665
	Total	3.42	5.31	9.28	7.20	-2.047b	0.041*

*significantly p<0.05 (CI=95%)

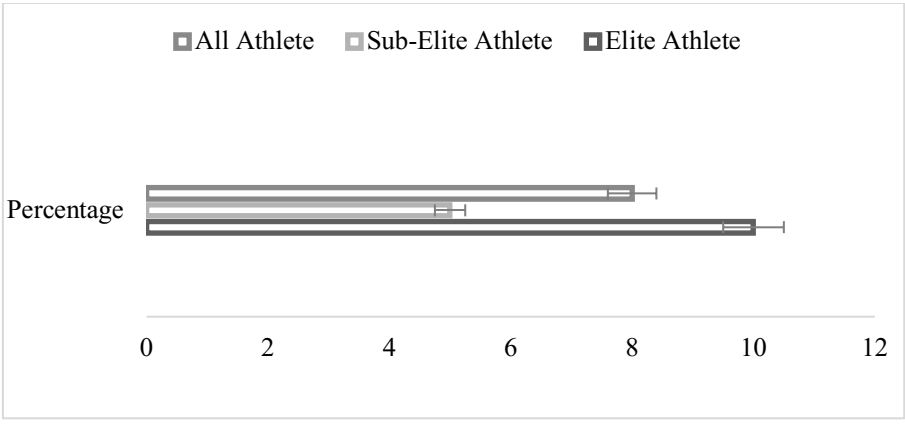

Figure 1. Graphic percentage (%) of performance swimming

Based on Table 4 describing *the Wilcoxon test results*, it can be seen that there are significant results in the pre-test and post-test with p-value = *0.041* (p<0.05). Furthermore, there are differences between the two in the different tests carried out in the elite and sub-elite athlete groups. The significance value in the elite athlete group shows that *p-value* = 0.041 (p<0.05) means a significant difference between the pre-test *and* post-test. Conversely, sub-elite athletes showed a value of p = 0.665 (p > 0.05), meaning

there is no significant difference in pre-test *and* post-test *results.* Figure 1. shows the development of the performance percentage of all athletes. The elite athlete group has a more significant percentage when compared to the sub-elite athlete group.

4 Discussion

The results showed that exercise *dryland strength* And swimming training could have a significant influence on the results of the performance speed of para-athletes *swimmer*. Other studies also mention that swimmers who undergo an exercise in water and *dryland* can improve performance (24). Strength training is an exercise protocol *dryland.* The most commonly applied to improve swimming performance. This research aligns with that conducted by Subekti et al. (17) that there are significant results in practice *dryland* against swimming performance. In addition, other researchers mention that using *theraband* at *dryland exercise* can also improve athletes' swimming performance (25,26). Program *dryland strength* during the *in-season period* should still be included in the exercise routine to improve swimming performance (14) further.

Based on the research results, the elite athlete group showed a significant influence on training interventions *dryland* and training carried out on swimming performance. The research conducted by Jone et al. (27), Elite swimmers exhibit superior strength and power characteristics compared to younger, less experienced swimmers (27). In addition, the ability of the elite male and female swimmers shows that the exercise program *dryland* In the form of upper leg strength training and lower leg extensor strength devoted to producing better lap times (27). It can be seen in figure 1. shows that the percentage of performance of elite athletes is much better than sub-elite. In addition, the percentage of elite athletes exceeds the overall percentage of the development of swimming performance. Moreas' study et al. (28) also found that senior swimmers were faster at each start and swimming at the 50-meter freestyle than junior athletes. According to Hellard et al. (29), This swimming exercise is associated with exercise *dryland,* which is focused on increasing maximum muscle strength. This dryland exercise modality proved sufficient to elicit changes in muscle strength, functional performance, and postural control in elite Paralympic swimmers (30). Other studies have suggested that the results of exercise interventions in *dryland* specialised over four years can improve the functional and physical requirements of top-level Paralympic swimmers (31). Swimmers with disabilities must practice stroke speed more, slightly decreasing stroke length, to achieve higher swimming speeds (32).

Elite athletes have gone through various experiences and have a longer training age when compared to sub-elite athletes. The level of performance and achievement is also a measure of the success of elite athletes in facing various kinds of training and difficulties faced during training. While in sub-elite athletes, they must have more flight hours to match the performance of elite athletes. Swimmers may have to start early to achieve their best performance on time and not miss their chance (33). The accumulation of training time and competition experience that is, deliberate training, thus contributing to the achievement of elite performance (34). According to Born et al. (33), approximately eight years of accumulated competition training required to achieve top

elite performance (> 900 FINA points) still provides sufficient time to build a strong foundation with broad and varied skill acquisition before reaching peak performance age.

5 Conclusion

This study found a significant effect of *dryland strength training* and swimming training on the speed performance of disabled swimmers. *Elite swimmers* have better abilities when compared to sub-elites. The elite group's development percentage was also significant compared to the overall data. *Dryland strength exercises* can be done in as many as three weekly sessions. While in the swimming training program, practising with medium and high volumes with 8 sessions before the pre-competition period is recommended. The combination of dryland strength and pool training should be included in the program planner for trainers with disabilities. More specific research needs to be done to discuss the long-term dryland strength periodisation program and kinematics of swimming technique training in athletes with disabilities.

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