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A Meta Analysis of The Impact of Dry-Land Training On The Performance Improvement of Water Polo Athletes

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Abstract

This research was aimed at studying dry-land training on the performance of water polo athletes, starting from the dry-land training model to improving the performance of water polo athletes. The research method used was the quantitative methods with meta-analysis techniques. The research method presented an analysis of the publication of scientific journals in reputable international journals and reputable national journals relating to dry-land training on improving the performance of water polo athletes. The samples of this study were scientific articles that were published in an international journal, indexed in the highly reputable Scopus database category Q1/Q2 with H-Index, and articles that were published in an international journal with the Elsevier homepage with Impact Factors from 2014-2020. The instrument used in this study was the code submission sheet. The data analysis was conducted through SPSS version 21. The test result obtained significance values p <0.05, so that the dry land training model provided a valid effect size in improving the performance of water polo athletes. Therefore,   was refused. The conclusion of this study is that the dry-land training model provides a significant effect on the performance of water polo athletes. The study also concludes that the Athlete's age, exercise intensity, and compliance with training rules become the factors that affect the improvement of water polo athlete performance.

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INTRODUCTION

The achievements in water polo are progressive dynamic. It means that every time phase is always changing and tends to increase, along with the development of science and technology. Therefore, the water polo sports coaching system has to always be improved in order to achieve the desired peak performance. One thing that must be considered in the coaching process is the training process. To score high achievement, a trainer in his training program plan must be of high quality and quantity and be conducted with good technique (Nugent et al., 2017). A number of studies have examined the effect of the dry-land training method with other types of exercise in improving physical condition, but studies that use meta-analysis in assessing the effect size of the dry-land training model are still limited.

Water polo is a team sport with 13 players, in which 7 are core players including one goalkeeper and 6 others as reserves. Every player has his main position, but during the match there is a possibility that each player will occupy another position which requires him to continue to play in that position. The five positions in water polo are center, winger (2m, left and right), back, driver (5m, left and right), and goalkeeper (Sarimanah & Mulyana, 2020). The team with the most scores is the winner. Winning is the goal of competitions for all sports including water polo. It's also worth noting that winning is a skill that can't be learned overnight. Therefore it is necessary for the players to do regular training in order to be in excellent performance when competing. Water polo is dominated by complex movements. In terms of energy, water polo is classified into mixed anaerobic-aerobic (50% -50%) sports (Lozovina et al., 2009).

Dry land training refers to all forms of on-land exercise. Exercise is a systematic process of practicing or working, which is performed repeatedly, with the increasing number of training loads or work. Dry-land training is very helpful for athletes because in addition to improving physical condition (Morais et al., 2016), it can also reduce muscle injury, as stated by (Paul et al., 2014) "dry land training includes mainly strength and conditioning (S&C) sessions that aim to help the swimmer excel and to prevent musculoskeletal injuries, which happen in other sports". Another definition of dry-land is, "dry-land training is simply activities that take place out of the pool as a form of cross training (a variety of different training methods including both cardiovascular and strength exercices), and includes strength and conditioning and flexibility exercise." (Farokie et al., 2016).

Another opinion that supports the above theory says, "Currently, incorporating a combination of training methods has been suggested to be a more effective training strategy for the optimization of both strength and power capacities compared with focusing on only 1 training target in isolation. However, to our knowledge, no studies have directly compared the effectiveness of combined training (i.e., dryland, in-water– specific strength and plyometric training) on maximal strength, power, and performance capacities in water polo players"(Sáez de Villarreal et al., 2015); (Alberton et al., 2017); (Keiner et al., 2018). It can be said that the combination of training on land and in water results in a more effective way to increase the strength, power and performance of polo athletes. Some of the dry-land exercises are ballistic and non-ballistic, drill speed training and plyometric exercises. With this exercise, the physical condition of the athletes, especially their strength, speed and power, can be maximally increased. Dry-land training has a significant effect in improving the physical condition of athletes, as stated by de Villarreal et al., (2014), "The positive effects of dry-land strength training, which target the upper limbs, on WP performance parameters have also been reported extensively". Other opinion regarding the effect of dry-land in improving the physical condition of athletes is according to Crowley et al., (2018) that, coaches proposed the inclusion of dry-land RT training programs to improve the swimmers power, strength, and physical capacity while also creating a robust and injury-free swimmer. This clearly indicates that the trainer must create an exercise program that can improve the athletes' swimming power, strength, physical capacity and injury avoidance techniques.

Meta analysis refers to a form of research using data from other existing studies (secondary data). Therefore meta analysis is a quantitative research method by analyzing quantitative data from the results of previous studies to accept or reject the hypotheses proposed in these studies. (Retnawati et al., 2018). So meta -analysis is a technique used to summarize the findings of two or more studies with the aim of combining, reviewing and summarizing previous studies. In addition, by using meta-analysis various questions can be investigated based on data found in the results of previous studies that have been published; and one of the requirements needed in conducting meta-analysis is an assessment of the results of similar research (Nieuwenstein et al., 2015), (Paldam, 2015), (Mansyur & Iskandar, 2017).

Meta analysis is a quantitative analysis and uses a considerable amount of data and applies statistical methods by practicing it in organizing a number of information from large samples whose function is to complement other purposes, to organize and extract as much information as possible from the data obtained, as well as a the technique to reanalyze the results of statistical research based on primary data collection (Glass, 1976); (Hunter et al., 2014); (Mansyur & Iskandar, 2017).

This research is aimed to determine the effect size of previous studies on dry land training in improving athlete performance. The effect size is a quantitative index used to summarize study results in a meta-analysis. That is, the effect size reflects the magnitude of the relationship between variables in each study. The choice of the effect size index depends on the type of data used in the study (Retnawati et al., 2018).

There are four types of data in research according to (Borenstein et al., 2010); (Retnawati et al., 2018), namely: dichotomy, continuous, time-to-event and survival time. Meta analysis has several functions. The function of meta analysis according to Retnawati et al., (2018) is to identify the heterogeneity of influences in various kinds of research and if possible, conclusions can be drawn, increasing statistical power and precision to detect influences, develop, improve, and test hypotheses, to reduce the subjectivity of comparative studies using systematic procedures and explicit compar isons, to identify data gaps between the basic knowledge and lead to further research, and to determine the sample size for future studies.

METHODS

This research was to provide a description of the phenomenon under study by describing the value of the independent variable, either one or more (independent) variables based on the indicators of the variables studied for exploration and classification. It was conducted by describing a number of variables without questioning associative state and comparability between existing research variables (Mansyur & Iskandar, 2017).

Population dan Sample

The population of this study were articles published in international journals indexed by a highly reputable database of Scopus, which were related to the impact of dry-land training on improving the performance of water polo athletes.

The sample in this study were 20 scientific articles published in international journals indexed by the highly reputable Scopus database in the Q1/Q2 category with the H-Index and articles published in international journals on the Elsevier homepage with Impact Factors from 2011-2020. This study had two types of research data sources, namely primary and secondary data sources.

The instrument used in this study was the coding data sheet. This data not only served as an internal audit, but was also useful in answering why certain studies were not included in the synthesis (Cooper et al., 2019).

Data Collection

The data collection techniques in this study were as follows: first, grouping the research results that have been collected based on the experimental class. Second, the statistical data used in calculating the effect size obtained from each article. Table 1 were the results of article grouping.

Material and Instrument

The instrument used in this study was the coding data sheet. Identification of the search and retrieval process of coding according to the criteria that meet the explicit requirements, checking each study against the eligible criteria and recording the information on the screening form or database were important things in the scientific publication of the research synthesis. With this information, the coding synthesis could report on the number of studies and the reasons for specialization. This data not only served as an internal audit, but was also useful in answering why certain studies were not included in the synthesis (Cooper et al., 2019).

Table 1. Articles Qualification

Data Collection Criteria	Data Group	Number of Article Findings
Publication Year	2011	1
	2012	2
	2013	1
	2014	2
	2015	4
	2016	2
	2017	2
	2018	2
	2019	2
	2020	2
Highly Reputable Database Indexation	Scopus Q1	9
	Scopus Q2	7
	Homapage Elsevier	1
	Other	3
Sample	Swimmer	12
	Water Polo Athlete	6
	Platform Diving Athlete	1
	Student	1

A coding procedure for meta-analysis around a coding protocol specifying that information were extracted from each eligible study. A coder will read the study report and fill in the coding protocol with the appropriate response to the study. First, one had to distinguish between two slightly different parts of the coding protocol: that was, the section that encoded information about the characteristics of the study (study descriptors) and the section that encoded information about the empirical findings of the study (effect size). Conceptually, this difference was similar to the independent and dependent variables.

The findings were represented in the form of effect size values, where the dependent variable from the meta -analysis was the "output" of the empirical research study. The characteristics of the study such as method, steps, sample, abstract, treatment, and context were the independent variables from the meta-analysis representing factors that could influence the nature and substance of the findings. Among the characteristics of the study, namely representing the phenomenon under study, the type of treatment whose effect was on the constructs between particular population, and those representing the research method, for example, the specific design, size, procedure, researcher, research context, etc. (Lipsey & Wilson, 2001).

The variables used in coding the data to capture information about the effect size of research on the meta-analysis study of the impact of dry-land training on improving the performance of water polo athletes were: name of the researcher, year of study, research subject, independent and dependent variables, time, and sample size.

Procedure

The research procedure employed in this study were as follows: first, deciding the problems, namely the impact of dry-land training on the water polo athletes' performance, second was searching for and collecting research reports in the form of international journals indexed by high reputable databases related to the topic unde-rstudy and determining the period of the research findings, published in 2014-2020, which were used as source data. The third was reading the research report to check the suitability of the content with the research problems, focusing the research on problems related to the methodological aspects and categorizing each research or, in other words, recording as much information as possible in the research report. The fourth was determining the effect size on each research report from each data obtained. The last was analyzing the research reports published based on the methods and data analysis used, so that the conclusions of the meta-analysis research could be drawn.

Data Analysis

In the analytical study, the effect size refered to the quantitative index used to summarize the results. Thr effect size reflected the substance of the relationship between variables in each study (Borenstein et al., 2010). The basis of the effect size used in this study was the standardized mean difference, which was the most common form of effect size when research was focused between two independent groups such as the treatment and control groups (Piggot, 2012).

Referring to the research method in the articles on the primary data source list, namely the experimental research which only involved two groups of experimental and control, the study used comparative analysis with t-test analysis technique. The criteria used to construct interpretation of the effect size results was according to Gravetter and Wallnau (2009).

Table 2. Effect Size Interpretation Criteria

Criteria	
Small effect	0.01 ≤ 0.09
Medium effect	0.09 ≤ 0.25
Large effect	>0.25

RESULT

This study was classified into three levels of effect size categories, namely large, medium and small. Details can be seen in the table below.

Table 3. Effect Size Interpretation Criteria

Study	Description	Effect Size
(de Villarreal et al., 2014)	Large	0,63
(Sáez de Villarreal et al., 2015)	Large	0,53
(Keiner et al., 2018)	Large	0,54
(McGowan et al., 2016)	Large	0,5
(Cuenca-Fernández et al., 2020)	Large	0,56
(Alberton et al., 2017)	Large	0,81
(P. G. Morouço et al., 2012)	Large	0,64
(P. Morouço et al., 2011)	Large	0,68
(Xu & Xu, 2020)	Large	1,0
(Dalamitros et al., 2015)	Large	0,74
(Morais et al., 2016)	Large	0,32
(Crowley et al., 2018)	Large	0,34
(Ingley et al., 2015)	Large	0,43
(Dalamitros et al., 2015)	Large	0,47
(Morais et al., 2019)	Medium	0,21
(Alberton et al., 2015)	Medium	0,1
(Sandhu, 2017)	Medium	0,16
(Barris et al., 2013)	Medium	0,18
(Girold et al., 2007)	Small	0,08
(Botonis et al., 2019)	Small	0,04

Table 3 revealed 12 articles with large effect sizes, 4 articles with medium effect sizes and 2 articles with small effect sizes.

The next step was the testing for normality and homogeneity of variants between sample groups. The normality test administered the Kolmogorov-Smirnov test with the help of SPSS 21 software. The test was carried out by comparing the probability (sig.) With the alpha (α) value. The test criterion was if (sig.)>Alpha (α), then the test results were said to be normally distributed. After carrying out the normality test, the next step was conducting a homogeneity test. This homogeneity test was intended to determine the distribution of data, whether homogeneous or inhomogeneous. The homogeneity test criteria using SPSS version 21 was performed by comparing the significant number (sig.) with the alpha value (α). As long as the significant number (sig.) was greater than α (0.05), then the data was homogeneous, but if it was significantly more smaller than α (0.05), then the data was not homogeneous. This test used the ANOVA test.

Because the results of normality and homogeneity test results were normal and homogeneous, the t-test was conducted later. The results of the mean difference in effect sizes with the full t-test can be seen in table 4 .

Table 4. The Mean Difference of the Effect Size

t	df	Sig.(2-tailed)	Mean difference
3.990	18	0.000	32.200

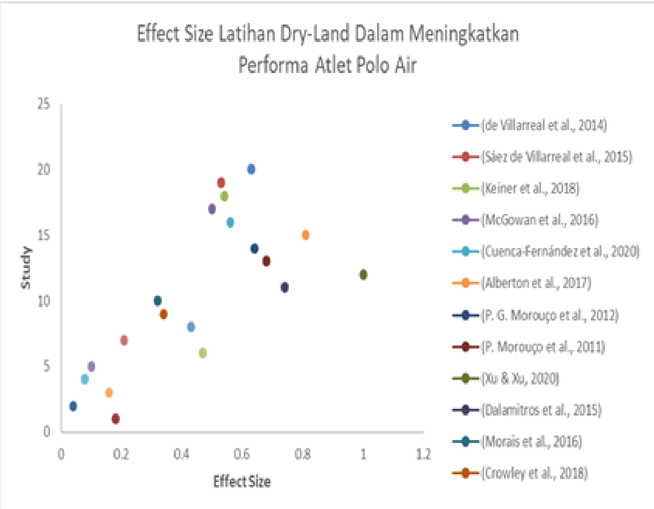
From the table 4 it can be seen that the effect size difference test was at the 0.05 significance level obtained p (sig.2-tailed) = 0.000. T table was found with the t distribution table at the 95% confidence level (α = 5%, because the t test was two-sided, then the value of α / 2 = 5% = 0.025) and degrees of freedom (df) = n-2 = 20- 2 = 18, so that t table = 1.734. Because p <0.005, then H1 was accepted and Ho was rejected, or it could be said that the two means were different. Thus it can be concluded that there was a significant impact of effect size from the dry-land training on the performance of water polo athletes at the 95% confidence level.

This effect size validity test was conducted to determine the impact of dry-land training on the performance of water polo athletes. This test used the Paired Sample t Test to compare the difference between the two means of two paired samples assuming the data was normally distributed. The results of the effect size test on the impact of dry-land training on the performance of water polo athletes are presented in detail in table 5

Table 5. The Effect Size Validity Test Results of Dry-Land Training Impact on Water Polo Athlete Performance

Mean	SD	t	df	Sig.(2-tailed)
34.368	24.350	6.152	18	0.000

From the table above, it can be seen that the effect size validity test was at the 0.05 significance level obtained p (sig.2-tailed) = 0.000. T table was found with the t distribution table at the 95% confidence level (α = 5%, because the t test was two-sided, then the value of α / 2 = 5% = 0.025) and degrees of freedom (df) = n-2 = 18- 2 = 16, so t table = 2.119. Because p <0.005, then was accepted and was rejected, or it could be said that the two means were different. Thus it can be concluded that there was a significant impact of effect size from the dry-land training on the performance of water polo athletes at the 95% confidence level. The Forest Plot below depicts the distribution of the effect size.



Picture 1. Forest Plot of Effect Size of Scientific Articles Related to Dry-Land Training to Improve Water Polo Athlete Performance

DISCUSSION

Several articles showing the large effect size aim to compare two different treatments of specific strength training on dry land and in water to increase muscle strength and other parts which are important qualities for the performance of water polo athletes. The hypothesis was that dryland training and water training performed during pre-season results will increase upper and lower body strength and power. These performance includes increasing swimming agility and maximum strength dynamics (Veliz et al., 2014).

Water polo is a high-intensity intermittent sport, often involving sprint swimming and wrestling that require high lower and upper body strength and power (Aziz et al., 2002), (Tsekouras et al., 2005), (Platanou, 2005). The results of this study were are consistent with previous research which showed that the combined program can significantly improve strength performance (Veliz et al., 2014). Interestingly, the current studies showed that the amount of maximal strength performance improvement was almost the same for the upper body (9.5%) and lower body (11.2%). These findings have replicated the research results of Veliz et al., (2014) who reported that specific resistance training increased the strength of both the upper (10.5%) and lower limb (14.2%) muscles in the water polo players.

Some researchers and experts in water polo sport tried to compare the impact of six week exercise on dry -land and in water. There were various training methods used to develop the physical abilities of water polo athletes and swimmers described in the literature (Bloomfield et al., 1990), (Tanaka et al., 1993), (Pichon et al., 1995).

The effectiveness of the method depends on the specificity of the training and the intensity of the training sessions used as the studied performance parameters. In water polo, both dry-land and water training methods are used to prepare these athletes for competition.

Water polo is a sport that is in full contact with water and is a competitive sport. Water polo depends not only on strength, but also on the ability to exert force at speed. In addition to technical and tactical skills, muscle strength is the most important factor giving clear advantages in professional water polo competition (Smith, 1998).

Using strength and conditioning methodologies that target power capacity optimization and strength performance is beneficial for enhancing the performance of competitive water polo athletes and is considered a critical success determinant in this sport. Strength and power enhancement can be developed through a variety of training methods including traditional weight resistance training program (Veliz et al., 2014), ballistic and nonballistic training program, speed training and sprint training, combined resistance and speed training as well as plyometric training (Girold et al., 2007).

In the other research, it was explained that dry-land training could strengthen upper and lower body as well as improve trunk strength, throwing techniques and vertical jumping abilities that affect throwing speed (ThS) (Fatouros et al., 2000). Collectively, these studies show that combined strength and high-intensity programs appear to significantly improve throwing speed performance (McCluskey et al., 2010). Research results from Bloomfield et al., (1990) revealed that the performance of the ThS overhead increased but not significantly (ES = 0.24) through the combined training program. Similar to the findings of Behm & Sale (1993) which explained that there was no change in ThS ability after 8 weeks of pyramid resistance training in elite water polo players. Possible explanations for the relatively minor changes in this study were the level of experience of the training group or the length of training stimulus that was only 6-weeks prior to pre-season.

Water polo players often conduct repetitive battles in max swimming and rapid changes in direction and acceleration, most of which are on very short duration attempts. Strength and speed are the two main factors that determine the performance of sprint swimming (Hawley et al., 1992). Further, several studies have reported that muscle strength is significantly correlated with swimming speed (Aspenes & Karlsen, 2012) and upper body muscle strength output is highly correlated with speed in short distance swimming (r =; 0.87) (Hawley et al., 1992),(Platanou, 2005), (Veliz et al., 2014). Another study showed swimming speed was more in correlation (r = 20.55 to 20.66) to the specific strength generated in the aquatic environment, becoming a much more specific test (Tanaka et al., 1993). A possible explanation for the differences in results between experimental groups could be the specificity of the exercise. Specific strength training was chosen for these water polo athletes because they must have the complex ability of activating the same muscle groups used when accelerating, changing direction, or running.

Therefore, specialized strength multi-joint exercises in water should be advantageous when exploring associations with dynamic movements such as sprint or alternating swimming. The research limitation was perhaps the small sample size, but that often could not be overcome by studying samples of professional athletes.

It can be said that greater improvement coud be achieved by increasing the number of players, training, and the duration. The other factors that can contribute to the differing results between previous investigations related to the association between sprint swimming performance was training and the athlete background.

CONCLUSION

Based on the analysis of the reserach results and the discussion carried out, it can be concluded that, overall, the dry-land training model has a significant effect size on the performance of water polo athletes. It is based on the mean test results of the pretest and posttest from all relevant studies. The dry-land training model has a valid effect size in improving the general performance and muscle strength of water polo athletes. The dry land training has a large effect size especially on the general performance including the improvement in swimming agility and maximum strength dynamics.

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