Systemic Review of Swim Bench Training During Last 5 Years

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ARTICLE DETAILS

ABSTRACT

Purpose: There are numerous advantages to training swimmers on a swim-bench, which is why this systematic review critically evaluates the published data for this practise. The current review’s purpose is to evaluate the efficacy of swim bench training in light of recent research conducted over the past five years.

Methodology / Evidence Acquisition: Published articles that examined the benefits and uses of swim bench training for an athlete were reviewed using the PRISMA guidelines. An electronic database search based on three databases that include PubMed, Google Scholar, and Taylor & Francis was done using the keywords "Swim bench" and "Swim bench training". The database search was limited to articles between January 2016 and the date to include data from 5 years. The researcher omitted articles that were originally published in a language other than English or did not have a translated version in English from the study.

Conclusions: Jaime and Maria (2017) and González Ravé J et al. (2018) studies of isokinetic force production There was no significant result found related to isokinetic force. Whereas, Popovici & Suciu (2017) proved the strength and velocity gain in young female swimmers after swim bench training and also enhanced muscle synchronisation as well as improved propulsive force generation and considered it as a source of improvement and immediate instruction for better training purposes. However, it is further suggested that further experimental studies are needed to observe the swim-bench effect on training as well as rehabilitation purposes scientifically with the principal of
Introduction

The swim benches provide a mechanical ergogenic aid to dryland swimming training. Neuromuscular activation and the unique joint actions are no doubt specific to each type of swimming stroke, but swim bench training focuses on correcting body position and movements that are the same for each stroke. A study stated that the most important among the ergometers that are used on land is the swim bench that will help to imitate the movements of the front crawl when the subject lies on it in the prone position (Gatta et al., 2017). This type of training helps the swimmers that are new to effectively imitate the actual swimming techniques in the training. A research study revealed that the isokinetic swim was described as a generator producing isokinetic resistance for swim-specific dryland training (Jaime & Maria, 2017).

Swim benches are being used as ergometers as well as others for isokinetic training. Some swim benches are ideal triathlon trainers in rehabilitation centers, gyms, and clubs as well as in the home. The swim benches range from leisure sports to surfing purposes and from rehabilitation centres to performance swimmers.

Detecting and correcting technical errors has always been a pivotal aim in the training with the Biometer swim bench as well as in the water. This study mentioned that many of the swimmers use the swim benches in their dryland training to help them gauge their performance (Popovici & Suciu, 2017). Even recent research proved and recommended the use of a swim bench for imitating arm movements even in blind people (Hartono et al., 2020).

Power gains are achieved by this artificial training form on the swim bench. The isokinetic swim bench test is the mainstay to determine the IFP, that is, the isokinetic force production, as well as IP, that is, isokinetic power, as mentioned in the study (González Ravé et al., 2018). The Bio Meter swim bench yielded the most effective result as mentioned in Sharp et al., (1982). Some studies suggest and state that there exists a very close relationship between performance on the swim bench and the power outputs obtained from swim bench ergometer testing (Loveless & Minahan, 2010), (Morton & Gastin, 1997), (Sharp et al., 1982), and (Sharp et al., 2012).

A study proved the effects of swim bench training on hormone levels, showing a decrease in testosterone in boys and men (Adebero et al., 2019). The researchers studied the effect of the time of the day on the benefits of the exercises done at that time and mentioned that there is evidence that shows there was no effect of time of the day while using a 30s Wingate test (Reilly & Down, 1992) or while performing an arm isokinetic test on a swim bench (Reilly & Marshall, 1991).

A study mentioned that there is a lack of an isokinetic phase in the swim stroke till date, so that is why there is a lack of effect of in-water training on the variables that were studied while using the biokinetic swim bench (Jaime & Maria, 2017). However, there is always a suggestion of using a swim bench in regular training, but it still lacks the biomechanical aspects that cannot be reproduced, like what a swimmer feels in the water. Similarly, as Tanaka H et al. (1998);
González Ravé J et al. (2018) mentioned, there is no proof of an effect of water resistance training that swim bench can bring about in terms of the factors studied. On the other hand, the positive results were seen and successfully transferred to the water by the swim bench in another study (Popovici & Suciu, 2017). They showed that strength and power evaluated on an isokinetic bench correlate very well with the swimmer's performance in a 25-meter sprint swim, as reported by Counsilman (1994) and Maglischo et al. (1985). A recent study aimed at finding aid for the blind and helping them gain training (Hartono et al., 2020). If the disability is to use vision to determine proper head position as well as in the inability to see demonstrations and reluctance to move hands and arms away from the torso, then these disabilities are going to pose serious problems like when the horizontal alignment is too poor (head too high or low) as well as when the lateral alignment is too poor (head not returned to a neutral position after breathing). These problems will lead to an inefficient stroke technique. It is the best recommendation of this research to reach arm movements on a swim bench (Hartono et al., 2020).

There is a limited literature available on the effects of the use of swim benches, and the knowledge has yet to be able to satisfy the needs. That is why the review aimed to critically evaluate the already present through insufficient knowledge. Therefore, the main objective of this review is to perform a systematic review to critically assess the evidence related to the uses of swim benches that may benefit swimmers and their performance.

**Purpose**
The main objective of this study is to determine the usefulness of the swim bench in training in terms of the recently completed work in the last 5 years.

**Methodology/Evidence Acquisition**
Published articles that examined the benefits and uses of swim bench training for an athlete were reviewed using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. An electronic database search based on three databases that include PubMed, Google Scholar, and Taylor & Francis was done using the keywords "Swim bench" and "Swim bench training". The database search was limited to articles between January 2016 to December 2020 to include the data of five years. It retrieved 1289 articles on sight.

**Data Abstraction**
During the first round of article identification, all content on swim benches was considered. The titles have been screened, which leads to a short listing of 108 unique articles. Then the abstracts were undergone detailed analysis and 17 of them were found to be reviews. While 2 were reported in a language other than English, those did not stand up to the inclusion criteria of this review and were thus excluded. The full text of 3 articles was unavailable and the author was contacted. On account of no positive response within a week, those three articles were also excluded. Five of the 108 were books, and six were theses; thus, they were excluded on the basis of the exclusion criteria of this review study. On further examination of the selected 108, 7 were found to be duplicates and hence excluded from the study. One article was found to have information on a swim bench that was unpublished and referring to exclusion criteria. That too was not included in this study. After this detailed scrutiny of the abstracts, 67 of the 108 were included, and the full-text analysis was done on them.

The detailed analysis resulted in 3 articles that are included in this review. Then, the articles that had been found were evaluated based on the inclusion criteria listed in Table 1.
Table 1. A summary of inclusion criteria applied to identify relevant articles.

<table>
<thead>
<tr>
<th>Serial</th>
<th>Inclusion Criteria</th>
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<tbody>
<tr>
<td>1</td>
<td>The article must include original data and should be a published one</td>
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<tr>
<td>2</td>
<td>The article must be published in English</td>
</tr>
<tr>
<td>3</td>
<td>Provide use of swim bench in swimmers only</td>
</tr>
<tr>
<td>4</td>
<td>The article must include a minimum of one potential effect of swim bench training</td>
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</table>

Articles were excluded if they were unrelated to the topic or met the exclusion criteria outlined in table 2.

Table 2. Summary of exclusion criteria applied to identify relevant articles.

<table>
<thead>
<tr>
<th>Serial</th>
<th>Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Commentaries, book chapters, letters, thesis work, editorials, conference proceedings, case reports, conference, abstracts, or non-peer-reviewed articles</td>
</tr>
<tr>
<td>2</td>
<td>Studies conducted without swim benches</td>
</tr>
<tr>
<td>3</td>
<td>Studies other than the English language</td>
</tr>
<tr>
<td>4</td>
<td>Studies mentioning swim bench only as apparatus for calculation of their other results.</td>
</tr>
<tr>
<td>5</td>
<td>Animal or cadaver studies</td>
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<tr>
<td>6</td>
<td>Studies done on Paralympics</td>
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</tbody>
</table>

Two rounds of literature review were done, by applying the three-step method in every round. The 1st round yielded the articles from the search results of the keywords from the mentioned databases, and the second round was carried out by reviewing the bibliography lists of the remaining articles from the 1st round. Thus, they also added more references for the study, and valuable pieces of information were collected from them.

Search Results/Evidence Synthesis

The search strategy presents the state of the art at the time and usually gives a narrative summary of articles and their inclusion as well as exclusion criteria. Focused on one theme, 3 studies included in the review are classified categorically and presented in the discussion in a detailed manner (Jaime & Maria, 2017), (González Ravé et al., 2018), and (Popovici & Suciu, 2017). These studies focused on at least one effect of swim bench effectively. These 3 articles will be discussed topic and variable-wise in this review. These have been divided into categories based on their purpose of study, which will be discussed in detail in the discussion below. Jaime & Maria (2017) mentioned the isokinetic force. González-Rave et al. (2018) also studied isokinetic force and power. Popovici & Suciu (2017) used female young swimmers to know the benefits of swim bench training. The 5-year data of the study on effects and benefits of swim bench training incorporation into the dryland training programmes is the potential pretext for this review, which is aimed at finding a comprehensive review of 5 years of swim bench research. Moreover, the assessment of the quality of each publication was also done. To summarise as well as analyse the results, each paper was compared for its population and equipment used. In this way, the gaps in research that are still existing in this field can be pointed out in an effective way.

Results and Discussion

This review presents an overview of all published articles on swim bench training and assesses the quality of the articles with possible comparison of results of studies that confirm or contradict
one another. Several publications on swim bench training were of poor quality. In the last few years, the number of peer-reviewed articles has increased and the quality has been enhanced. Essential amendments were made to allow a more detailed analysis of the participants and training protocol, as well as information on the effects of the training and their comparisons with others.

Table 3. Summary of Systematic Review identify relevant articles.

<table>
<thead>
<tr>
<th>S.No.</th>
<th>Authors &amp; year</th>
<th>Title &amp; objective of study</th>
<th>Population</th>
<th>Type of Swim bench used</th>
<th>Variables</th>
<th>Number of participants</th>
<th>Gender</th>
<th>Age</th>
<th>Years</th>
<th>Type of training</th>
<th>Power and mechanical work</th>
<th>other</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Jane &amp; Mari, 2017</td>
<td>Effect of Specific Strength and Pyramidal Set of Training on Swim Bench Performance</td>
<td>Swimmers 16</td>
<td>Swim bench</td>
<td>Stroke force, swimming performance and swimming related to external load</td>
<td>Power and device</td>
<td>16</td>
<td>F</td>
<td>16.2±2.63</td>
<td>Swim bench and Isometric Trainer</td>
<td>Average strength, mechanical work, average power, average speed, length of function, time of arm stroke, frequency of arm stroke, number of cycles</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Revi et al., 2018</td>
<td>The Effect of Two Different Approaches of Resisted Training on the Swimming Strength and Performance</td>
<td>Swimmers 16</td>
<td>Swim bench</td>
<td></td>
<td>Power and device</td>
<td>16</td>
<td>M</td>
<td>16.2±2.63</td>
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<td>Average strength, mechanical work, average power, average speed, length of function, time of arm stroke, frequency of arm stroke, number of cycles</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Popovic &amp; Soci, 2017</td>
<td>To highlight the Importance of Strength and Power Training in Young Swimmers</td>
<td>Swimmers 24</td>
<td>Swim bench</td>
<td></td>
<td>Power and device</td>
<td>24</td>
<td>F</td>
<td>15-14</td>
<td>Swim bench and Isometric Trainer</td>
<td>Average strength, mechanical work, average power, average speed, length of function, time of arm stroke, frequency of arm stroke, number of cycles</td>
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</tbody>
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Isokinetic Force and Power by Swim Bench
Greater power gains are achieved by this artificial training form on the swim benches. However, in a study, it was mentioned that breathing pure oxygen during the 6-min recovery period between arm strokes on a swim bench leads to an improvement in the peak and mean power outputs during the third, fourth, and fifth intervals (Sperlich et al., 2011). Also, another study testing the power gain on swim bench training mentioned the research studies that presented a
close relationship between the performance of swimming with the power outputs that were recorded and gained from swim bench ergometer testing (Geber et al., 2018); (Loveless & Minahan, 2010), (Morton & Gastin, 1997); (Sharp et al., 1982); and (Sharp et al., 2012). That embossed their finding by supporting the theory that swim bench power output is a potentially useful indicator of performance.

In our first study, Jaime & Maria (2017), the stroke force of arms was calculated by using an isokinetic swim bench. This tool was used as a generator for the production of an isokinetic resistance for swim-specific dryland training and its use to do it in acceleration (9 levels) that is in proportion to the force applied by the user. Another study also mentioned the exact same thing after using an isokinetic swim bench in their study (Arroyo-Toledo et al., 2016).

Isokinetic Force The study evaluated in Jaime & Maria (2017) was done on 16 female swimmers from a regional competitive programme who were aged 16.22 ± 2.63 years. There was a control group that performed training, tethered to a linear set of loads, and an experimental group on a pyramidal set. The research was based on 8 weeks of training and conducted 3 tests. Each test had stroke force, swimming performance, and swimming tethered to external loads as its variables.

On a swim bench, it showed a reduction on the intermediate test, but there was an observed increase afterwards. So there are no significant differences in (GeForce) or in (IPower). The linear group showed a 14.47% decrease while the pyramidal group showed a 4.62% increase, which was insignificant. Lack of enhancement was attributed to the specificity of the training type applied to both groups. The study mentioned that swim stroke has no isokinetic phase. That is why, there is no proof of the fact that there are effects of in-water training on the variables being studied on this biokinetic swim bench. The swim bench is good to be incorporated into the routine sessions of training, but it is unable to replicate the biomechanical aspects that a swimmer feels while being in the water (Tanaka H et al., 1998).

These results were not essentially contrary to the findings that were deduced from the strength and power outcomes data collected from the training on the isokinetic bench as well as the performance in swimming a distance of 25 m (Maglischo et al., 1985). The difference between the mentioned articles and our research paper was that in an official competition calendar, the minimum documented distance was 50 m and not 25 m. According to the fact, swim bench can be well correlated with the 25 m freestyle swimming in the laboratory, but can not be correlated with official distances such as 50cm that are used in competitions. There are also some other factors that are responsible for the difference as well as have an influence on the less correlation of the isokinetic swim bench with the competition swimming that are also mentioned in this study. Some of the important things to be mentioned are: the beginning of the races from the block-start; the propelling function of the legs; the under-water diving of 15 m that is allowed on the official grounds; and the body rotation that is to be in coordination with the active motions of the stroke thrust. (Arellano et al., 1992) and (Thomas et al., 2008).

The results obtained from this research showed that the SST pyramidal programme demonstrated better results by providing enhanced improvements in all variables, including the isokinetic force in the competitive performance of the 50 m above the SST linear program. The limitation of the study was the scarcity of access to the adaptations of the study that resulted after the period of intervention, where the effects can be observed in terms of overcompensation due to different reactions of each program, relating to the time span of transformation of available strength-power at a specific speed needed for the competition (Tanaka et al., 1993).
On the other hand, these results, because of the comparison with the other research documenting the positive results obtained on the swim bench in Popovici & Suciu (2017), were successfully transferred into the water. The evolution took place due to the use of machines on a constant basis, which resulted in the formation of correct movements. Popovici & Suciu (2017) mentioned that while training using the swim bench, a great part of the muscle mass that is used regularly in swimming becomes activated so that the aerobic demand of the muscle increases to the extent that it is transferred directly into the water (Gergely et al., 1984). The swimmers in the study by Macaro et al. (2018) simulated the in-pool front crawl swimming stroke with the swim bench ergometer as closely as possible in their study span. Another research study by Lubkowska et al. (2017) also measured the thrust on land by using a swim bench testing.

The second study, which was conducted by González Ravé et al. (2018), was based on a training programme that lasted for six weeks and included 16 male national-level swimmers who were 16.22–2.63 years old. They were divided into standard groups GS and flat pyramidal loading pattern groups GP. In this study, 3 tests were conducted. In the study by González Ravé et al., the isokinetic swim bench test was used to determine the values of (IFP) and (IP) (2018). It was reported that the best results were obtained by using the BioMeter swim bench (Sharp et al., 1982). The values that were obtained for the IFP and IP variables by using an isokinetic swim bench in the study by González Ravé et al. (2018) stated that there were no remarkable changes in IP. But, there were significant variations observed in IFP in the GS, with a mean decrease of 14.47%. On the other hand, the GP increased their IFP by 4.62% and showed a large effect size (d = 0.80), although the change was not statistically significant. Both groups were seen for their specificity of training so that it could give a clue and explanation for the lack of improvements in IP found in this very study. Till now, there has been a lack of evidence regarding the benefits obtained from swim bench training in terms of the variables studied.

However, the swim bench has only been able to replicate a few parts of a typical swimming workout. It is unable to model all of the biomechanical factors that are necessary to establish how a swimmer experiences the water (Aspenes & Karlsen, 2012). According to the results of this study, due to a lack of an isokinetic phase in a swimmer's technique, isokinetic bench training may have had an undesirable effect on the swimmer's ability to execute at a high level. These results are different from what Councilman and Counsilman (1994) and Maglischo et al. (1985) found. They said that there is a remarkable relationship between strength and power as measured on an isokinetic bench and performance in a 25-metre sprint swim. A consistent conclusion in both investigations was that IP and IFP values were lower at the beginning of a competitive season than during the preparatory phase. During the preparation phase, competitive swimmers did a lot of endurance training. This made it harder for them to use their full muscle power, either because their muscles were tired or because their neural pathways were blocked or because of some properties of their muscles.

The results were comparable with the above study by Jaime & Maria (2017) that found the pyramidal group has more effect on improving time as well as isokinetic force and power. However, in contrast to the study by Jaime & Maria (2017), the results were insignificant. However, this study recommended a pyramidal organisation of training for young people during their preparatory period.

Swim Bench Training In Young
Another study by Popovic & Suciu (2017) was based on knowing the value of dry-land strength as well as power training in order to achieve an improved performance in swimming in children with the help of the Biometer Isokinetic Trainer-swim bench. This study was based on twenty-
four-year-old female swimmers, aged 13 to 14 years, making it one of its kind. Average strength, mechanical work, average power, average speed, length of traction, time of active phase, frequency of arms, and number of cycles were the variables studied. The results showed clearly that specific training using the biometer isokinetic swim bench improved the athletic performance of young swimmers. It was concluded that dry-land strength and power training using the swim bench is essential for young swimmers as they may enhance the ability to produce propulsive force in the water, mainly in short-distance events.

Swim benches are the ideal product that is used in training on the dryland as well as in the water. Swim benches are also being developed. The research study by Popovici & Suciu (2017) mentioned that the swim bench (one used in this study was the Biometer Isokinetic Trainer) not only developed the strength at a speed that is nearly equal to the one observed in the event, or even more than that, and resulted in the improvement of the inter-muscular synchronization, suggesting the fact that each group of muscles that take part in any movement has to act in a certain order and at a specific time. Every swim stroke can be simulated perfectly using a relevant swim bench. Swim benches are perfect for performing unrestricted movement sequences that are particular to a specific technique. Detecting as well as correcting any technical errors is an important process that is aimed at during the training with the Biometer swim bench as well as in the water (Popovici & Suciu, 2017). There are swim benches that display time, distance, as well as speed parameters on the screen of the computer to have a well-organized and well-informed training procedure. Eddy wheels are there for the production of resistance. Most of them have airflow wheels that can easily adjust resistance, hence leading to a required level of training.

Another important benefit is the immediate instruction that a coach can give to the swimmer while observing the pattern of swimming. This immediate feedback loop will lead to an enhanced improvement in the swimming technique. According to the findings of the study carried out by Popovici and Suciu (2017), the vast majority of swimmers use swim benches throughout their dryland training sessions so that they may better evaluate their progress. Individual mechanical power is produced over a period of time that coincides with competition times so that they can assist themselves in becoming more competitive (Edelmann-Nusser et al., 2004).

Conclusions/ Originality Value
Jaime & Maria (2017) studied isokinetic force production; though it was reduced at the intermediate test and increased at the end, there was no significant result found related to isokinetic force and isokinetic power, so this study was again a drawback. González Ravé J et al., (2018) showed no significant effect of swim bench training on isokinetic power yet a decrease was observed in that of isokinetic force and the results were conflicting with the previous studies. However, Popovici & Suciu (2017) proved the strength and velocity gain in young female swimmers after swim bench training and also enhanced muscle synchronisation as well as improved propulsive force generation and considered it as a source of improvement and immediate instruction for better training purposes. As a result, the literature also indicated that dryland training has a significant impact on swimming performance, and further research in the area of swim-bench inclusion in training, specifically in rehabilitation and performance enhancing, is expected to be beneficial.

Conflicts of Interests
There are no conflicts of interest among the authors.
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According to the authors, the sponsor did not have any role in the research itself, which is something that could have influenced the results of this investigation.

Author Contributions
There is an equal contribution from all authors to the study's conception, design, statistical analysis and data interpretation, manuscript drafting and critical revision.

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