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Cardiorespiratory Responses to Underwater Treadmill Running Versus Land-Based Treadmill Running

Courtney M. Schaal, Larry Collins, and Candi Ashley

Underwater (UW) running provides a low load-bearing form of supplementary training that can be used for recovery and rehabilitation while maintaining cardiovascular fitness. Whether it elicits a cardiorespiratory training stimulus comparable to that of land-based running is seemingly unclear. The purpose of this study was to compare cardiorespiratory responses between underwater treadmill running and land-based running. Fourteen male triathletes completed trials at maximal and submaximal workloads for each of three conditions: running on an underwater treadmill with AQx® water running shoes, running on an underwater treadmill barefoot, and running on a land-based treadmill. No differences between groups were found for measures of oxygen consumption (VO_2), rating of perceived exertion (RPE), or respiratory exchange ratio (RER) across modalities for maximal trials; however, heart rate (HR) was greater during land-based running than underwater treadmill running. No group differences were found for HR, RPE, and RER across modalities during submaximal trials; however, VO_2 was significantly greater during land-based running than underwater treadmill running. We concluded that the cardiorespiratory training stimulus during underwater treadmill running was comparable to that of land-based running at maximal exertion levels, with the exception of HR, and therefore could be an effective form of supplemental training during rehabilitation. At submaximal levels, underwater treadmill running elicited a less rigorous training stimulus than land-based running in terms of VO_2 and therefore is a less effective form of supplemental training.

Keywords: aquatic exercise, underwater running, underwater treadmill

Underwater running has emerged as a low load-bearing form of supplementary training for cardiovascular fitness, as a way to promote recovery from strenuous exercise while maintaining aerobic fitness and as a way to prevent or recuperate from injuries (Reilly & Dowzer, 2003). It provides an excellent form of cross training by decreasing the running impact forces and the negative effects of excessive mileage. Underwater running has been reported to decrease the likelihood of

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incurring running-related musculoskeletal injuries such as plantar fasciitis, tendonitis, and stress fractures (Silvers, Rutledge, & Dolny, 2007). It has traditionally been used for aerobic conditioning during rehabilitation, but whether it elicits a cardiovascular and metabolic training stimulus comparable to that of land-based running is seemingly unclear. Previous literature has reported conflicting results possibly due to differences in the nature and protocol of each study, methods used for water running, and training status/running style of the participants. This study aims to further investigate whether underwater treadmill running elicits similar cardiorespiratory responses to land-based treadmill running.

In the past, underwater running has been performed primarily through deep water running (DWR), utilizing a buoyancy device that attempts to reproduce the pattern of limb movement used during land-based running without the ground support phase, which eliminates the impact. The majority of prior studies utilizing buoyancy vests in DWR seem to have noted a decrease in maximal oxygen consumption (VO_2 max) as well as a decrease in heart rate (HR) during underwater running compared to land-based running. These results were reported in studies done by Butts, Tucker, and Greening (1991), Frangolias and Rhodes (1995), Dowzer, Reilly, Cable, and Nevill (1999), and Svedenberg and Seger (1992). Conflicting results were reported by Frangolias, Belcastro, Coutts, Rhodes, and Taunton (2000) as well as DeMaere and Ruby (1997) who found oxygen consumption (VO_2) and HR to be similar between underwater and land-based running. Although DWR has been the most common form of underwater running used in the past, it is shown to be quite different from land-based running in terms of muscle recruitment and kinematics of the lower extremities (Silvers et al., 2007).

Shallow water running (SWR) where the individual runs in the shallow end of a swimming pool typically at a waist deep water level has emerged to more closely mimic land-based running. Prior studies utilizing SWR have reported lower VO_2 and HR during underwater running than during land-based running, similar to DWR with buoyancy devices (Dowzer et al., 1999; Pohl & McNaughton, 2003). SWR adds a ground reaction force component while still allowing for reduced impact to the lower extremities. Raising the water level presumably increases the cardiorespiratory demand for a given workload, while at the same time increasing the frontal resistance of forward movement in water, which may degrade overall running mechanics due to upward buoyancy forces (Silvers et al., 2007).

With DWR and SWR posing certain limitations in their ability to resemble land-based running, underwater treadmills have gained popularity. Underwater treadmills eliminate forward movement through water that allows for a more natural gait pattern and incorporates a reduced impact ground support phase that may enhance the specificity of underwater training (Silvers et al., 2007). With this being possible, underwater running should more effectively produce metabolic responses similar to those seen during land-based running. Previous literature has investigated whether underwater treadmill running actually does elicit similar metabolic responses to those seen on land in order to provide a foundation for the value and effectiveness of underwater running as a training modality. The results that were found still seem to be conflicting. Pohl and McNaughton (2003) reported VO_2 and HR to be higher during underwater running on a treadmill compared to land-based treadmill running. In contrast, Silvers et al. (2007) reported VO_2 and HR to be similar between modalities.

In recent years, AQx® Sports Deep Water Running Shoes have been designed with the specific intention of enhancing DWR. They are designed to simulate running on land without the associated impact and are thought to be more similar to land-based running than running in the water barefoot. Research has not been conducted to evaluate the physiological effects of the use of the AQx® shoes during underwater treadmill walking or running. Further establishing or refuting the effectiveness of AQx® water running shoes as a mechanism to enhance underwater treadmill running will lend additional research information to what is already known regarding both water treadmill running as well as the effectiveness of these shoes. Based on the evidence previously presented, underwater treadmill running with AQx® shoes should elicit similar results to those seen during land-based running. The goal of the present study was to investigate whether this claim was true through comparison of cardiorespiratory response to underwater treadmill running both with and without AQx® shoes to that of land-based running.

Method

Participants

Fifteen volunteers defined as "experienced triathletes" were recruited from local triathlon training groups, primarily through word of mouth. Due to participant attrition, the final sample consisted of 14 experienced male triathletes, ages 20–46. Table 1 provides demographic data for the participants. "Experienced triathlete" was defined as having completed at least two triathlons in the last year or having completed more than five triathlons in their lifetime. Participants were also required to be currently training a minimum of 10 hours per week. No monetary compensation was offered to the participants; however, their incentive for participating was

Table 1 Participant Demographics (n = 14)

	Mean (SD)	Minimum	Maximum
Age (yrs)	35.1 (9.8)	20	46
Height (cm)	182.1 (6.1)	170.2	190.5
Weight (kg)	78.7 (11.3)	56.8	94.5
Body Mass Index (kg/m^2)	23.9 (2.9)	17.96	28.26
Years Training	8.9 (6.9)	2	25
Sprint Triathlons			
(per lifetime)	14.6 (21.3)	0	75
Olympic Triathlons			
(per lifetime)	4.3 (5.0)	0	15
Half Iron Man (per lifetime)	1.6 (2.9)	0	10
Full Iron Man (per lifetime)	1.1 (2.0)	0	7
Miles Ran (per wk.)	22.9 (10.6)	10	40
Hrs Biked (per wk.)	6.5 (4.7)	2	15
Hrs Swam (per wk.)	2.5 (1.7)	1	6

to gain the knowledge of their VO_2max, which can be used for training purposes. Prior to including any participant in the study they were required to complete an informed consent approved by the University's Institutional Review Board (IRB) as well as a medical and training history questionnaire administered by a licensed physician.

Measures

HR was monitored continuously using a Polar Heart Rate Monitor® (Polar, USA) that the participants wore strapped to their chests. Rating of perceived exertion (RPE) was assessed every 2 minutes during VO_2max tests and every 5 minutes during submaximal oxygen consumption (VO_2 submax) tests using the Borg 15 point (6–20) scale. This scale was explained to the participants at the start of the study prior to beginning their first trial to ensure they knew how to read and use it accurately. Exertion was indicated by participants using hand signal responses to the numerical chart held in front of them while they ran. Metabolic measurements, including oxygen consumption ($VO_{2)}$ and respiratory exchange ratio (RER), were assessed continuously via expired gas collection analyzed by a Vacumed® metabolic measurement system, which was appropriately calibrated prior to each trial. For maximal tests, the highest VO_2 value measured was the value used. For the VO_2 submaximal tests, the average VO_2 value measured from minute 2 through minute 30 of the trials was the value used. Minute 1 values were not used in the average because participants had not yet reached 70% of their VO_2 max after the first minute.

Protocol and Instrumentation

All water-based trials took place on a Hydroworx 1000® treadmill consisting of a variable speed treadmill with an integrated underwater treadmill surface at the bottom of an adjustable pool. The speed range of this treadmill is 0 to 7.5 mph, which could be increased by 0.1 mph. The pool containing the treadmill was 7'6" wide, 14' long, and 5'4" deep, with a 2,100 gallon capacity. Water level in the pool could be raised or lowered to a person's xiphoid process for trials by utilizing a control panel, which allowed the water to drain into reserve tanks or to be pumped back into the pool. Water jets were inset at the front of the pool to provide water flow resistance that could be increased or decreased from 0 to 100% resistance using the control panel. Water trials were completed both barefoot and wearing AQx® brand water running shoes. These shoes provide additional weight and have "gills" on the sides, which create additional water resistance. The additional grip on the bottom of the shoes allows for greater traction when running that in turn allows for a larger range of motion at hips, knees, and ankles that more closely resembles running on land. Shoe design is shown in Figure 1. The land-based trials took place on a Trackmaster RS-232® treadmill and were performed wearing traditional running shoes designed for land.

Each participant completed six experimental trials: three VO_2 max and three submaximal treadmill bouts performed at 70% of VO_2 max. One maximal and one submaximal trial were completed for each of the three modalities, which included (a) running on a Hydroworx® underwater treadmill barefoot, (b) running on a Hydroworx® underwater treadmill with AQx® brand water running shoes, and

Figure 1 — AQx brand underwater running shoes.

(c) running on a land-based treadmill. The order of trials was randomized, but VO_2 max tests were completed prior to the corresponding submaximal treadmill bout in each case.

Participants were requested to refrain from doing any exercise 12 hours prior to each trial, to refrain from doing any strenuous exercise 24 hours prior to each trial, and to refrain from eating 4 hours prior to each trial. They were instructed to come to each trial fully hydrated, which we allowed to be interpreted by each individual participant. Each trial was separated by at least 48 hours and was not supposed to be separated by more than 1 week; however, due to some unforeseeable events, there were some trials that were separated by more than a week.

At the beginning of each participant's first trial on the Hydroworx® underwater treadmill, they completed a 5-minute familiarization bout with and without AQx® shoes to acclimate them to the underwater treadmill. Upon completion of the familiarization bout, participants rested for approximately 2 minutes and then began the experimental trial. Since maximal trials had to be completed prior to submaximal trials, the familiarization bout was performed prior to each participants' maximal underwater treadmill trial only. No participants had experienced running on an underwater treadmill prior to this study.

Maximal Trials. Maximal trials were conducted using an incremental protocol to volitional exhaustion. The land-based treadmill tests were started at a self-selected, moderately vigorous pace that was held constant for the duration of the test. This pace was determined just prior to beginning the test during a brief warm-up period lasting 1 to 5 minutes. The treadmill grade was increased by 2% every 2 minutes until exhaustion occurred. The maximal underwater treadmill tests were done using a modified Astrand ramp protocol, similar to that used in an underwater treadmill study utilizing a Hydroworx 2000® treadmill by Silvers et al. (2007). Prior to beginning the trial, the water level in the Hydroworx® pool was adjusted to just below the participant's xiphoid process while standing in the pool. The jets in the front of the pool were set at 40% resistance to promote normal running gait and minimize float time over the treadmill belt (Silvers et al, 2007). The participants began the trial at a self-selected, moderately vigorous pace determined during the warm-up period. For the first 4 minutes, treadmill speed was increased 0.5 mph every minute while maintaining 40% jet resistance. At the end of minute 4, jets were increased 10% every minute until volitional exhaustion was reached. In some cases, the maximum (100%) jet resistance possible was reached prior to the participant reaching volitional exhaustion. In these cases, speed was increased 0.5 mph per minute until the participant then reached exhaustion, or the Hydroworx® treadmill's maximum speed of 7.5 mph was reached and maintained for a full minute. It should be noted that no flotation devices or tethering systems were used for the water trials. Table 2 provides further data and protocols.

Prior to each VO_2 max test, resting HR was measured. Participants were allowed to warm up for 1 to 5 minutes at their discretion. During the final minutes of the trials, verbal encouragement was employed to help ensure that a maximal effort was reached. After reaching exhaustion, participants were allowed to cool down at their discretion. During each maximal trial, HR, oxygen consumption, and RER were measured continuously. HR was recorded every minute and RPE was assessed every 2 minutes.

Submaximal Tests. Each submaximal trial was performed for 30 minutes at a workload that was calculated to be 70% of the participant's VO_2 max determined during each corresponding maximal trial. Since it was difficult to set a workload that was precisely 70% of an individual's VO_2 max, there was a variation from 70% noted in Table 3. Previous related studies have set VO_2 submax tests at 60-80% of VO_2 max or at ventilatory threshold, and the participants used in the present study were triathletes and therefore highly trained (DeMaere & Ruby, 1997; Frangolias et al., 1995; Frangolias et al., 2000; Pohl & McNaughton, 2003). This supported 70% of VO_2 max to be an acceptable intensity for the submaximal tests performed during this study.

Table 2 Maximal VO_2 Trial Protocols

	Incremental Protocol	Speed Mean (SD)	Workload Mean (SD)
Water Treadmill (barefoot)	40% jet resistance; moderately vigorous pace. Increase speed .5mph/min for 4 min. then increase jets 10%/min. until exhaustion.	7.2mph (0.38)	96% jets (7.4)
Water Treadmill (with AQx shoes)	40% jet resistance; moderately vigorous pace. Increase speed .5mph/min for 4 min then increase jets 10% /min until exhaustion.	7.2mph (0.42)	95% jets (6.5)
Land Treadmill	Moderately vigorous pace constant speed increase grade 2%/min. until exhaustion.	7.03mph (0.4)	10.5% grade (2.2)

Table 3 Submaximal VO_2 Trial Values

	Avg. VO_2 for Trial (SD)	% of VO_2max (SD)	Speed Mean (SD)	Workload Mean (SD)
Water Treadmill (barefoot)	36.4ml/kg/min (7.9)	70.3% (8.5)	6.4mph (0.43)	46% jets (8.4)
Water Treadmill (with AQx shoes)	39.1ml/kg/min (5.6)	73.4% (7.0)	6.2mph (0.44)	44% jets (7.1)
Land Treadmill	40.8ml/kg/min (4.6)	76.9% (25.5)	6.9mph (1.0)	.6% grade (1.0)

Prior to commencing each trial, resting HR and weight were measured. Participants were then allowed a 1 to 5 minute warm up period, followed by 30 minutes of running at 70% VO_2 max with no change in pace, grade, or jet resistance throughout. Oxygen consumption and RER were measured continuously. HR was recorded every minute. Water temperature was monitored using the pool thermometer and ranged from 20.6 to 35.6 degrees Celsius even though the aim was to maintain the temperature within 2–4 degrees. On average the water temperature was 25.8 degrees Celsius.

Statistical Analysis

Descriptive statistics, repeated measures analysis of variance (ANOVA), and paired t-tests were performed using SPSS 17.0 software to analyze the effects of the three modalities being investigated (i.e., water treadmill barefoot, water treadmill with AQx® shoes, and land treadmill). If statistical significance was found for a variable on the repeated measures ANOVA, follow-up pairwise comparisons were conducted between modalities using Bonferroni adjustments. Significance levels for all tests were set at $p < 0.05$ and effect size was determined using the formula *d = t *(2 * (1-r)/n) ^1/2*, shown to be effective for repeated measures analysis (Dunlap, Cortina, Vaslow, & Burke, 1996). The variables used in this formula *d, t, r*, and *n* are defined as effect size, t-score, correlation value, and sample size, respectively.

Results

For the maximal tests, differences in VO_2, RPE, and RER were found to be nonsignificant across all 3 modalities. There was a significant difference in maximal HR between water treadmill running and land-based treadmill running (see Table 4). For the submaximal tests, differences in average HR, average RPE, and average RER were found to be nonsignificant. VO_2 submax was significantly greater during land-based treadmill running than during either underwater treadmill running condition (see Table 5).

For the significant variables (i.e., maximal HR and VO_2 submax), pairwise comparisons were performed. Interestingly, after completing pairwise comparisons, both variables were found to be significantly different between the barefoot underwater treadmill trials and land-based treadmill trials. Tables 4 and 5 present descriptive statistics, main significance indications, as well as data for the pairwise comparisons.

Table 4 Maximal Test Results

	Water Treadmill Barefoot Mean (SD)	Water Treadmill with Aqx Shoes Mean (SD)	Land Treadmill Mean (SD)	P Value	ES
VO_2 Max (ml · kg^1 · min^{-1})	51.77 (8.7)	53.2 (6.8)	53.01 (6.9)	0.584	0.45
HR Max (bpm)	172.8 (9.7)	172.5 (12.8)	185.1 (13.4)	0.004*	0.99
RPE Max	18.5 (1.1)	19.3 (.77)	18.7 (1.4)	0.698	0.84
RER Max	1.12 (0.09)	1.13 (0.10)	1.18 (0.06)	0.073	0.84

*Indicates significance was found for $p < 0.05$.

Table 5 Submaximal Test Results

	Water Treadmill Barefoot Mean (SD)	Water Treadmill with Aqx Shoes Mean (SD)	Land Treadmill Mean (SD)	P Value	ES
VO_2 avg. (ml.kg-1min-1)	36.4 (7.9)	39.1 (5.6)	40.8 (4.6)	0.14*	0.45
HR avg. (bpm)	140.3 (11.0)	148.0 (16.7)	150.0 (9.2)	0.074	0.9
RPE avg.	13.5 (1.2)	14.0 (2.0)	12.7 (.50)	0.141	0.81
RER avg.	0.93 (0.05)	0.92 (0.04)	0.92 (0.04)	0.559	0.51

*Indicates significance was found for $p < 0.05$.

Discussion

The present study indicated that underwater treadmill running both barefoot and with the AQx® brand underwater training shoes may elicit similar cardiorespiratory responses to land-based running during maximal intensity trials, but during submaximal intensity trials both forms of underwater treadmill running elicit results that vary from land-based running. Silvers et al. (2007) found no significant differences for VO_2, HR, RER, or RPE when comparing water treadmill running to land-based treadmill running at maximal exertions. This supports the findings of the present study, which indicated no significant differences in VO_2, RER, and RPE for land-based running in comparison to underwater treadmill running with the exception of HR, which was found to be greater during land-based treadmill running. A number of previous studies utilizing underwater running without an underwater treadmill had noted a greater HR on land than in the water, which is likely due to the hydrostatic effect caused by water immersion (Butts et al., 1991; Dowzer et al., 1999; Frangolias et al., 1995, 2000; Svedenhag & Seger, 1992). The results of the present study may be due to the temperature of the water during underwater treadmill trials being cooler than the ambient air temperature during land-based trials, as HR is affected by temperature. Interestingly, the difference in HR was only seen between running on a water treadmill barefoot and running on a land-based treadmill, but not between running on a water treadmill with the AQx® brand shoes and running on a land treadmill. This suggests that for maximal exertion performance, the AQx® shoes may elicit HR responses similar to that of land-based treadmill running. Since all other variables were found to be similar for all three modalities during maximal trials with the exception of HR, water treadmill running seemingly elicited similar cardiorespiratory responses at maximal exertions.

At submaximal exertion levels, HR, RPE, and RER were all found to be similar for water treadmill running in comparison to land-based treadmill; however, VO_2 was found to be significantly lower during water treadmill running. When reviewing the results of this study, it is important to take into the consideration the average work load of the submaximal trials, which were based on the VO_2 max found during the maximal trials. While the goal for all submaximal trials was for their workloads to be set at 70% of the VO_2 max, they were actually performed at 70%, 73%, and 77% of VO_2 max for the underwater barefoot, underwater with shoes, and land-based trials, respectively. This indicates that the land-based submaximal trials were performed at a higher percent of maximum and therefore at a higher intensity than either of the water trials. If the land-based trials were performed at a higher intensity, then we would expect them to elicit a higher average VO_2 as the results of this study demonstrated. If all submaximal trials had been able to have been held closer to a consistent 70% of the max, there may not have been a difference noted in the average VO_2 for the 30 minute submaximal trials (Table 3).

It was expected that water- and land-based treadmill running would have elicited similar results for all variables at submaximal levels, but this was not shown in the results. It is interesting to note that the difference in HR was found between the barefoot underwater treadmill running in comparison to land-based treadmill running, but not for the water treadmill running with AQx® shoes. This lends credence to the concept that running on underwater treadmills with the AQx® shoes may elicit results that are more similar to land-based treadmill running than simply running on an underwater treadmill barefoot.

Earlier studies investigating underwater running without the use of underwater treadmills proposed that a decreased VO_2 seen in the water may be due to the buoyancy effect and decreased limb loading, which would reduce cardiorespiratory responses in the water as a result of an overall reduced workload (Silvers et al., 2007). The water jet propulsions exerted in front of the runner in the underwater treadmill pool were thought to oppose the effects of buoyancy to elicit a training response similar to that of land. The results of the present study found this to hold true at maximal levels, but not at submaximal levels. This may indicate that at stronger jet resistances reached during maximal exertions, the effects of buoyancy are opposed, but at the weaker jet resistances maintained during submaximal exertions, the effects are not enough to counteract buoyancy and so workload is less.

RER was found to be similar for underwater treadmill running in comparison to land-based treadmill running at both maximal and submaximal levels, which is consistent with the majority of the prior literature (Butts et al., 1991; Dowzer & Reilly, 1999; Silvers et al., 2007). Two previous studies (Reilly et al., 2003; Svedenhag et al., 1997) reported a higher RER, but both of these studies utilized buoyancy devices during water running rather than water running alone or on an underwater treadmill.

The AQx® underwater running shoes utilized in this study are designed to enhance underwater running and elicit responses to simulate land-based running. They have rubber bottoms, which provide traction as well as "gills" that protrude slightly off of the side of the shoe to increase resistance during locomotion through the water. There were mixed responses from the participants pertaining to the AQx® shoes. Some participants noted that the shoes caused sharp pains in their anterior tibialis when running on the underwater treadmill in comparison to being barefoot, even to the point where one participant chose to terminate his submaximal trial wearing the AQx® shoes 7 minutes early. Other participants, however, noted that they preferred running on the underwater treadmill using the shoes in comparison to being barefoot. This was because without the shoes, they felt like they were slipping off of the treadmill, specifically at higher exertions, and the shoes provided traction to avoid this. The participants who noted that they preferred the shoes to being barefoot during underwater treadmill running also stated that they did not experience any pain in their anterior tibialis. No formal data on preference of shoes vs. no shoes were collected, but verbal questions were asked regarding the participants' preferences.

There were some limitations of the study that were seemingly unavoidable. One aspect that was intended to be controlled for was the time separation among the trials. The original intent was to separate trials by no more than a week in order to minimize changes in training status; however, due to unforeseeable events there were approximately six trials separated by more than a week. Another limitation included the pool temperature during water trials, which averaged 25.8 (3.63) degrees Celsius. It was intended to maintain the temperature within a 4 degree range; however, due to location of the water treadmill and pool being located in the University's Athletic Training facility, individuals outside of the study were free to alter the temperature when research was not being conducted. One other limitation of the study that should be noted for future research was that approximately 5 of the 14 participants reached the underwater treadmill's maximal workload capacity before they had reached their VO_2 max. Of these participants, all five met the criteria for reaching a maximal effort for the variable of HR (greater than 90% of age predicted maximal) and four met the criteria for RPE (score of 19 or 20 on Borg 6–20 scale). Only two participants stated that they felt they could have continued after reaching the treadmill's maximal workload, but it would have been beneficial to have been able to increase treadmill speed and/or jet resistance further to ensure true maximal exertion levels were achieved.

The study utilized only healthy triathletes as participants, so the results found may not be generalizable to a normal or rehabilitation population. Utilizing triathletes was a good indicator for trained athletes such, as runners who may be interested in underwater treadmill running as an alternate or supplementary means of training to avoid the stress placed on their musculoskeletal system on land.

The findings of this study indicate that at maximal exertions underwater treadmill running was as effective as land-based treadmill running in terms of VO_2 because no significant differences were shown between modalities with the exception of HR. At submaximal exertions, underwater treadmill running was shown to be less effective than land-based treadmill running, as land-based submaximal running elicited a greater VO_2; however, results were similar across all other dependent variables. In all cases, running underwater with the AQx® shoes was shown to be

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more similar to land-based running than running underwater barefoot. This suggested that AQx® water shoes optimize underwater treadmill running in order to simulate results of land-based running more closely. It is acknowledged that little is known regarding the reliability of water exercise testing (Silvers et al., 2007). Further research should be done to determine reliability of underwater exercise testing and to further investigate the cardiorespiratory responses of underwater treadmill running in comparison to land treadmill running using different levels of exertion and fluid jet resistance.

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