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Article

Effect of Rehydration with Mineral Water Following Exercise Induced Dehydration on Cardiorespiratory Fitness in Athletes

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Abstract: Background: the present study aimed to examine the effect of rehydration with mineral water on cardiorespiratory fitness in athletes. **Methods**: Twenty athletes (21.7±3 years) were randomly underwent a crossover design experimental trail. Three visits were arranged. The first visit was for baseline measurement. The second visit included three phases (pre-dehydration, post-dehydration, and post-rehydration), and either Zamzam (mineral water) or bottle water (control water) was used. The third visit was similar to the second visit with exchange the type of water. Cardiorespiratory fitness and blood parameters have been evaluated. Data were analyzed to compare results of Zamzam water with bottle water and to compare between the phases for each type of water. **Results**: although there was no significant difference found between Zamzam and bottle water in the cardiorespiratory fitness markers, Zamzam water maintained cardiorespiratory function including VO_{2peak}, VT1, VT2, and VE_{peak} even with rehydration equal to 100% of losing body mass following exercise-induced dehydration (>-2% body mass), where rehydration with bottle water reported significant reduction in both VO_{2peak} and VE_{peak}. **Conclusion**: rehydration with mineral water such as Zamzam water may not impair cardiorespiratory fitness even with amount equal to 100% of losing body mass.

Keywords: Dehydration; rehydration; cardiorespiratory fitness; athlete;

1. Introduction

Exercise can induce sweat loss and decrease total body water with combination of electrolytes loss [1]. Sweat consists of sodium and chloride as well as a small amount of other electrolytes such as potassium, magnesium and calcium [2]. However, sweat loss during training is effecting the fluid homeostasis, and impact on the thermoregulation which may impair the performance [3,4]. Exercise in warm condition can cause dehydration due to sweat losses which often exceed fluid intake. Average sweat rate can range from 1 to 2.5 $L.h^{-1}$ depends on some factors (e.g., intensity, duration, environment conditions, level of fitness, and clothing). Taekwondo players may lose weight (≥2% of the body mass) due to dehydration during training and competitions[5]. Losing 2-3% of the body water may result in a decline performance especially, cardiorespiratory fitness. For example, Ganio et al, 2006 found that dehydration reduced VO_{2peak} significantly ($P<0.05$) [6].

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The effects of rehydration with different types of fluid intake such as water or sport drinks on performance have been widely investigated among athletes[7-13]. However, there is a lack of studies that have investigate the effect of rehydration with Zamzam water on hydration status among athletes. Moreover, there is no study has investigated the impact of rehydration with Zamzam water on fitness components such as cardiorespiratory fitness. Zamzam water has unique characteristics including being rich in minerals compared to normal water[10], and it is an alkaline fluid (average PH=8)[14]. In addition, Zamzam water is very cheap compare to the bottle water and much cheaper than sport drinks. To our knowledge, no available studies have investigated the effect of rehydration with Zamzam water on cardiorespiratory fitness in taekwondo players. The present study aims to investigate the effect of rehydration with two types of water (Zamzam and Bottle) on cardiorespiratory fitness markers in professional taekwondo players.

2. Materials and Methods

Participants

Twenty professional taekwondo male players (at least one Dan) aged 18 - 30 years old were randomly selected from the registered players at Saudi Taekwondo Federation, Riyadh, Saudi Arabia. All participants were informed about the purpose of the study and procedure. Written consent was obtained from the participants after the familiarization session. Ethical approval was obtained from the Ethics Committee at the Institute Review Board (IRB) King Saud University (No. E-20-4667).

Design

Participants were randomized with subjects blinded in a crossover design. The period between trails was 7 to 14 days. Three visits were arranged for each participant in order to examine the effect of rehydration with Zamzam water on cardiorespiratory fitness markers including VO_{2peak}. The first visit was for baseline measurements and the second and third visits were for the two trails.

Anthropometric Measurements

Participants' height (to the nearest 0.1 cm) was measured through the use of a Deteco Electronic height rod (Model: DHRWM, USA), and body mass (to the nearest 0.1 kg) was measured via Seca-869 (Germany). Body mass index (BMI) was calculated as body mass in kilograms divided by height in meters squared (kg.m-2). Body composition parameters were assessed through the use of a bioelectric impedance analysis scale (Model BC- 980, Tanita Corporation, Tokyo, Japan).

Blood Parameters

Vein blood samples of 15 ml were taken three times by a phlebotomist: pre-dehydration, post-dehydration, and post-rehydration during the second and third visits. Blood sample was taken in order to assess the complete blood count (CBC), hemoglobin (Hb), and hematocrit (Hct) as well as electrolytes including calcium (Ca), sodium (Na), potassium (K), chloride (Cl), and magnesium (Mg). Blood samples were analyzed in specialized medical laboratory.

Cardiorespiratory Fitness

A standard Bruce protocol was utilized for determining the VO_{2peak} and ventilatory threshold (VT_1 and VT_2) values [15]. Three of the following four criteria were used to verify the attainment of VO_{2peak}: 1) oxygen uptake plateau with increased workload, 2) respiratory exchange ratio (RER) greater than 1.1, 3) HR greater than 90% of age-predicted maximal value (220 - age), and 4) perceived exertion based on the 6-20 Borg scale greater than 17 [16].

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Procedures

Each participant was instructed to complete three visits in the Cardiovascular and Exercise Physiology Laboratory, Department of Exercise Physiology at Sport Sciences and Physical Activity College, King Saud University in Riyadh, Saudi Arabia. The first visit was baseline for body composition, anthropometrics, and cardiorespiratory fitness measurements. The second and third visits were for the experimental trails one week apart. Participants were instructed not to exercise 24-hours prior to each visit and have the same meals (types, amount, and timing) on the day before the visit. In addition, they have been instructed to sleep the same duration (~7-8 hours) with most of it during the night.

First Visit

All participants visited the laboratory at 9:00 am. Following signing the consent form, body composition and anthropometrics were taken. Then, cardiorespiratory fitness tests were carried out including VO_{2peak}, VT1, and VT2, peak breath frequency (BF_{peak}), and peak minute ventilation (VE_{peak}) using Bruce protocol on treadmill (h/p Cosmos, Saturn® 300/125 r, Germany). Heart rate (HR) at rest, during exercise, and at recovery sessions were assessed through Polar H7 Bluetooth Heart Rate Sensor & Fitness Tracker (USA).

Second Visit

Pre-Dehydration Session

In the second visit, participants attended at 9:00 am. Blood sample of 15 ml was taken from the radial vein. Blood samples were taken in three occasions as follows: before dehydration, after dehydration, and after rehydration sessions. Furthermore, body composition including body mass and total body water have been measured before and after the dehydration session as well as after rehydration.

Dehydration Session

In the dehydration session, participant was instructed to exercise using bike ergometer exercise (Lode, Corival cpet., Netherlands). Intensity of the exercise was reached gradually starting from 30 Watts for 5 minutes as a warm-up at a cadence between 70 and 80 rpm. Then, exercise intensity increased until reaching 60% of the participant's reserved heart rate ($HR_{reserved}$). The exercise was performed in an environmental chamber (a customized 6m x 6m x 3m from Weiss Technik UK Ltd.) at relatively hot and humid ambient (37±1℃ and 68%±2 relative humidity). Dehydration marker was losing at least 2% of the body mass. To confirm reaching effective dehydration level, plasma volume change was calculated through previous valid formula[17,18]. The range duration of the exercise was 45–60 minutes. Body composition including body mass was measured immediately after drying body. Thereafter, the rehydration session started by sitting on a convertible chair and drinking an amount of bottled water (Bottle water) equal to the body weight loss (2-3%).

Participant was instructed to have an average of 400 ml at the beginning and about 300 ml every 20 min until reaching the target amount of water (100% of losing body mass). Temperature of the ingested water was 15±1 °C. The average duration of the rehydration session was 80±10 minutes including recovery time. The laboratory temperature was 21±1 °C, and the relative humidity was 30±2%. Following a sufficient recovery, exercise testing to evaluate maximum VO_{2peak} was carried out through the use of a portable machine (Cortex – METAMAX 3B®) [19]. Incremental exercise testing of the VO_{2peak} using Bruce protocol was conducted as described above [15]. A clinical doctor supervised all sessions of the present study. Table 1 illustrates the characteristics of Zamzam water and Bottle water [10].

Table 1. Comparison of physical and chemical parameters of Zamzam water and Bottle water (one of the most common Bottle waters selected from the market).

PH	7.7	7.4
Bicarbonates (mg/l)	173.5	25.9
Total hardness (mg/l)	309.7	40.9
Calcium (mg/l)	93.75	10.9
Magnesium (mg/l)	18.9	3.39
Sodium (mg/l)	130.5	16.9
Potassium (mg/l)	44.4	1.19
Chloride (mg/l)	164	18.9
Sulphate (mg/l)	124.3	25.9
Nitrate (mg/l)	131.52	2.9
TDS (mg/l)	798	119.9

Third Visit

All procedures of the third visit were similar to the second visit except water replacement of Bottle water with Zamzam water.

Statistical Analysis

Data analysis was carried out via the SPSS 26.0 package (SPSS Inc., Chicago, IL). Shapiro-Wilk test was utilized for assessing normality of the data distribution. A paired t-test was used for comparing pre-and-post tests for parametric data and Wilcoxon test for nonparametric data. All data in the text and tables are presented as Mean±SD, with P values <0.05 indicating statistical significance.

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3. Results

The physical characteristics and cardiorespiratory fitness markers of the participants are presented in Table 2. These values were taken during the first visit. Table 2 demonstrates that participants were trained and have minor variation in most of these measurements.

Table 2. Physical characteristics and cardiorespiratory fitness markers (n=20).

Variables	Mean	SD
Age	21.70	3.21
Height (cm)	176.25	5.63
Body mass (Kg)	67.88	8.76
Body mass index (BMI)	21.88	2.90
Body fat (%)	12.69	4.54
Lean mass (%)	82.78	4.01
Total body water (Kg)	42.52	4.20
Total body water (%)	63.14	3.03
Intracellular water (ICW) (Kg)	26.24	3.20
Extracellular water (ECW) (Kg)	16.30	1.29
Extracellular water/total body water (%)	38.45	1.97
Resting heart rate (bpm)	66.50	7.05
Peak heart rate (bpm)	196	8.67
VO2peak (L/min)	3.81	0.41
VO2peak (mL/kg/min)	55.75	4.72
Ventilatory threshold VT1 (%of VO2peak)	53.31	11.6
Ventilatory threshold VT2 (%of VO2peak)	91.64	14.29
Peak oxygen pulse (ml/beat)	19.53	2.44
VEpeak (L/min)	134.62	21.55
Breath frequency (times/min)	59.37	9.09

The results of the study confirmed that all participants met the minimum criteria of dehydration status represented as negative values in plasma volume change variable and lost 2% or more of their body mass. Table 3 shows no significant difference between Zamzam water and Bottle water in most of the measured variables except in some electrolytes (sodium and potassium) and Hb ($P<0.05$). In Zamzam water trail, participants reported significant lower Hb concentrations in both pre-dehydration and post-rehydration ($P=0.002$ and $P=0.006$, respectively). However, all measured values were within healthy range and indicated that participants were well trained.

Table 3. The effect of rehydration with Zamzam versus Bottle water in measured variables represented as mean (±SD). (n=20).

Variables	Phases	Bottle water	Zamzam water	P
Body mass (Kg)	Pre (dehydration)	67.30 (±8.72)	67.36 (±8.62)	0.639
	Post(dehydration)	65.82 (±8.48)	65.84 (±8.60)	0.933
	Post(rehydration)	67.40 (±8.70)	67.35 (±8.78)	0.786
Total body water (Kg)	Pre (dehydration)	42.34 (±4.61)	42.34 (±4.43)	0.983
	Post(dehydration)	44.23 (±4.75)	44.29 (±4.77)	0.801
	Post(rehydration)	42.41 (±4.44)	42.81 (±4.32)	0.804
Plasma volume change	Post(dehydration)	-3.23 (±2.34)	-4.47 (±2.16)	0.075
	Post(rehydration)	-1.30 (±2.13)	-1.01 (±2.29)	0.703
Calcium (dl/mg)	Pre(dehydration)	9.62 (±0.21)	9.50 (±0.25)	0.050
	Post(dehydration)	10.29 (±0.38)	10.21 (±0.37)	0.379
	Post(rehydration)	10.03 (±0.31)	9.90 (±0.39)	0.186
Sodium (L/mmol)	Pre(dehydration)	140.45 (±1.00)	139.73 (±1.48)	0.016
	Post(dehydration)	141.75 (±1.13)	141.50 (±1.67)	0.494
	Post(rehydration)	137.73 (±1.28)	137.25 (±1.77)	0.226
Potassium (L/mmol)	Pre (dehydration)	4.21 (±0.31)	4.00 (±0.31)	0.015
	Post(dehydration)	4.21 (±0.24)	4.13 (±0.27)	0.305
	Post(rehydration)	4.53 (±0.47)	4.37 (±0.40)	0.218
Chloride (L/mmol)	Pre (dehydration)	100.56 (±1.59)	100.37 (±2.05	0.527
	Post(dehydration)	101.54 (±1.35)	101.29 (±2.02)	0.535
	Post(rehydration)	97.43 (±1.35)	97.19 (±2.18)	0.628
Magnesium (dl/mg)	Pre(dehydration)	1.96 (±0.13)	1.95 (±0.15)	0.641
	Post(dehydration)	1.89 (±0.15)	1.93 (±0.17)	0.305
	Post(rehydration)	1.94 (±0.13)	1.99 (±0.28)	1.000
Hemoglobin (dl/mg)	Pre(dehydration)	14.91 (±0.61)	14.51 (±0.71)	0.002
	Post(dehydration)	15.60 (±0.71)	15.40 (±0.76)	0.206
	Post(rehydration)	15.18 (±0.64)	14.71 (±0.75)	0.006
Hematocrit (%)	Pre(dehydration)	45.81 (±2.25)	44.89 (±3.38)	0.225
	Post(dehydration)	47.09 (±2.19)	46.90 (±3.34)	0.820
	Post(rehydration)	46.01 (±2.06)	44.92 (±3.34)	0.224
Peak heart rate (bpm)	Pre (dehydration)	195.10 (±8.67)	195.10 (±8.67)	**1.000**
	Post(rehydration)	195.01 (±7.97)	193.95 (±8.62)	0.160
VO2peak (L/min)	Pre (dehydration)	3.81 (±0.41)	3.81 (±0.41)	**1.000**

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Variables	Phases	Bottle water	Zamzam water	P
	Post(rehydration)	3.67 (±0.40)	3.66 (±0.48)	0.864
VO2peak (ml/kg/min)	Pre (dehydration)	55.75 (±4.72)	55.75 (±4.72)	**1.000**
	Post(rehydration)	53.25 (±8.30)	54.70 (±5.13)	0.424
VT1 (%of VO2peak)	Pre (dehydration)	53.31 (±11.6)	53.31 (±11.6)	**1.000**
	Post(rehydration)	50.56 (±8.37)	53.06 (±11.54)	0.320
VT2 (%of VO2peak)	Pre (dehydration)	91.64 (±14.29)	91.64 (±14.29)	**1.000**
	Post(rehydration)	84.71 (±12.57)	90.36 (±16.30)	0.339
Peak oxygen pulse (ml/beat)	Pre (dehydration)	19.53 (±2.44)	19.53 (±2.44)	**1.000**
	Post(rehydration)	19.42 (±2.52)	19.16 (±2.69)	0.715
VEpeak (L/min)	Pre(dehydration)	134.26 (±21.55)	134.26 (±21.55)	**1.000**
	Post(rehydration)	128.57 (±18.32)	128.06 (±21.42)	0.931
Breath frequency (times/min)	Pre(dehydration)	59.37 (±9.09)	59.37 (±9.09)	**1.000**
	Post(rehydration)	57.38 (±7.93)	57.47 (±8.55)	0.968

Furthermore, most of the plasma electrolytes concentration values reported significant elevation in post-dehydration in comparison with pre-dehydration stage ($P<0.05$) using both water types (Bottle water and Zamzam water). Likewise, most of the electrolytes' values persisted significantly higher in post-rehydration with both water types, except for sodium and chloride as their values significantly decreased compared to the pre-dehydration stage. Magnesium concentration decreased in post-dehydration compared to pre-dehydration stage with Bottle water only. Plasma Hb concentration and Hct ratio elevated significantly in post-dehydration and post-rehydration stages with both water types in comparison with pre-dehydration values ($P<0.05$), except with Zamzam water as Hct ratio elevated significantly in post-dehydration stage only ($P=0.001$).

However, heart rate was only significantly decreased in post-rehydration compared to pre-dehydration with Zamzam water ($P=0.014$). Remarkably, VO2peak (ml/kg/min) and VEpeak were significantly lower in post-rehydration compared to pre-measurement with Bottle water ($P=0.029$ and $P=0.038$, respectively), but not with Zamzam water ($P=0.183$). There was no significant change between trails in VT1, VT2, peak oxygen pulse, and BFpeak with both water types (Zamzam and Bottle water).

Table 4. Comparison between trails (pre-dehydration, post-dehydration, and post-rehydration) for each water type (Zamzam and Bottle water), represented as mean (±SD) (n=20).

Variables	Trails	Pre(dehydration)	Post(dehydration)	Post(rehydration)	p
Weight mass (Kg)	Bottle	67.30 (±8.72)	65.82 (±8.48)	67.40 (±8.70)	a & b
	ZmW	67.36 (±8.62)	65.84 (±8.60)	67.35 (±8.78)	a
Total body water (Kg)	Bottle	42.34 (±4.61)	44.23 (±4.75)	42.41 (±4.44)	a
	Zamzam	42.34 (±4.43)	44.29 (±4.77)	42.81 (±4.32)	a
Plasma volume change	Bottle	-3.23 (±2.34)	-	-1.30 (±2.13)	b
	Zamzam	-4.47 (±2.16)	-	-1.01 (±2.29)	b
Calcium (dL/mg)	Bottle	9.62 (±0.21)	10.29 (±0.38)	10.03 (±0.31)	a & b
	Zamzam	9.50 (±0.25)	10.21 (±0.37)	9.90 (±0.39)	a & b
Sodium (L/mmol)	Bottle	140.45 (±1.00)	141.75 (±1.13)	137.73 (±1.28)	a & b
	Zamzam	139.73 (±1.48)	141.50 (±1.67)	137.25 (±1.77)	a & b
Potassium (L/mmol)	Bottle	4.21 (±0.31)	4.21 (±0.24)	4.53 (±0.47)	b
	Zamzam	4.00 (±0.31)	4.13 (±0.27)	4.37 (±0.40)	a & b
Chloride (L/mmol)	Bottle	100.56 (±1.59)	101.54 (±1.35)	97.43 (±1.35)	a & b
	Zamzam	100.37 (±2.05)	101.29 (±2.02)	97.19 (±2.18)	a & b
Magnesium (dL/mg)	Bottle	1.96 (±0.13)	1.89 (±0.15)	1.94 (±0.13)	a
	Zamzam	1.95 (±0.15)	1.93 (±0.17)	1.99 (±0.28)	-
Hemoglobin (dL/mg)	Bottle	14.91 (±0.61)	15.60 (±0.71)	15.18 (±0.64)	a & b
	Zamzam	14.51 (±0.71)	15.40 (±0.76)	14.71 (±0.75)	a & b
Hematocrit (%)	Bottle	45.81 (±2.25)	47.09 (±2.19)	46.01 (±2.06)	a & b
	Zamzam	44.89 (±3.38)	46.90 (±3.34)	44.92 (±3.34)	a
Peak heart rate (bpm)	Bottle	195.10 (±8.67)	-	195.01 (±7.97)	-
	Zamzam	195.10 (±8.67)	-	193.95 (±8.62)	b
VO2peak (L/min)	Bottle	3.81 (±0.41)	-	3.67 (±0.40)	b
	Zamzam	3.81 (±0.41)	-	3.66 (±0.48)	-

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Variables	Trails	Pre(dehydration)	Post(dehydration)	Post(rehydration)	p
VO2peak (ml/kg/min)	Bottle	55.75 (±4.72)	-	53.25 (±8.30)	b
	Zamzam	55.75 (±4.72)	-	54.70 (±5.13)	-
VT1 (%of VO2peak)	Bottle	53.31 (±11.6)	-	50.56 (±8.37)	-
	Zamzam	53.31 (±11.6)	-	53.06 (±11.54)	-
VT2 (%of VO2peak)	Bottle	91.64 (±14.29)	-	84.71 (±12.57)	-
	Zamzam	91.64 (±14.29)	-	90.36 (±16.30)	-
Peak oxygen pulse (ml/beat)	Bottle	19.53 (±2.44)	-	19.42 (±2.52)	-
	Zamzam	19.53 (±2.44)	-	19.16 (±2.69)	-
VEpeak (L/min)	Bottle	134.26 (±21.55)	-	128.57 (±18.32)	b
	Zamzam	134.26 (±21.55)	-	128.06 (±21.42)	-
Peak breath frequency (times/min)	Bottle	59.37 (±9.09)	-	57.38 (±7.93)	-
	Zamzam	59.37 (±9.09)	-	57.47 (±8.55)	-

a: significance between Pre(dehydration) and Post(dehydration); b: significance between Pre(dehydration) and Post(rehydration) (P=<0.05).

4. Discussion

The present study aims to investigate the effect of rehydration with two types of water (Zamzam and Bottle) on cardiorespiratory fitness markers in professional taekwondo players. In general, the results of the study demonstrated that rehydrating with Zamzam water following significant dehydration may help to maintain or even improve cardiorespiratory fitness. Rehydration with fluid following 2% or more of losing weight could help to maintain or eliminate the decline of sports performance[7,20-23]. A number of studies examined the effect of exercise-induced dehydration on cardiorespiratory fitness[24,25]. For instance, Adams (2017) concluded that full fluid replacement, even in a blinded manner, could enhance physical performance advantage[25,26].

Although cardiorespiratory fitness is a key fitness component for taekwondo players, few studies investigated the effect of rehydration following exercise-induced dehydration on cardiorespiratory fitness that may reduce performance especially in short-term manner [27]. Data obtained from Zamzam water trail were compared with Bottle water trail. The results showed no significant differences in most of the measured variables except in plasma Hb concentration. Comparing with Bottle water trail, participants in Zamzam water trail reported significant lower Hb concentrations in both pre-dehydration and post-rehydration (P=0.002 and P=0.006, respectively). Nevertheless, the observed difference in Hb did not impact VO2peak (post-rehydration) significantly between trails (Zamzam water vs. Bottle water). There was no significant difference between post-rehydration trials (Zamzam water vs. Bottle water) in VO2peak.

It has been evidenced that significant increase in HR, VE, and breath rate in the control group compared with rehydrated group indicated that dehydration (−2% of body mass) was enough to elicit significant decrease in cardiorespiratory function [28]. However, short term (~80 min±10) of rehydration with water equivalent to 100% of losing body mass may help to maintain cardiorespiratory function. Similar results have been reported in a previous study [28,29]. Shillington (2017) found that there were no significant differences observed in some of the cardiorespiratory functions such as VE (72.1±8.4 vs. 69.4±7.5 L•min^{-1}; P=0.5) and VO2peak (2.4±0.1 vs. 2.4±0.2 L•min^{-1}; P=0.3) in two types of commercial beverages post-rehydration following exercise test trail (~90 min) [30].

Table 4 presents the comparison performed between trails (pre-dehydration, post-dehydration, and post-rehydration) for each examined water type (Zamzam water and Bottle water). Hb and Hct values elevated significantly in post-dehydration and post-rehydration with both Zamzam water and Bottle water in comparison with pre-dehydration values (P<0.05), except with Zamzam water as Hct elevated significantly only in post-dehydration stage (P=0.001). The elevation of Hb and Hct occurred as a nature of losing plasma volume[18]. Moreover, the elevation values of Hb and Hct may negatively affect blood viscosity. Alterations of such blood parameters were associated with a reduction in performance capacity as a result of increased viscosity and in turn reduced peripheral blood flow and cardiac output[31-33].

However, short term of rehydration (~80 min) with Zamzam water did not impair most of the cardiorespiratory parameters. For instance, HRpeak decreased significantly only in post-rehydration compared with per-dehydration stage with Zamzam water (P=0.014). Remarkably, both measured values of the VO2peak (relative (ml/kg/min) and absolute (L/min)) were significantly lower in post-rehydration in comparison with similar values measured in pre-dehydration trail with Bottle water (P=0.002 and P=0.029, respectively), but not in Zamzam water (P=0.094 and P=0.183, respectively). Dehydration (> -2% body mass) may impair endurance performance even during relatively short duration such as taekwondo games[5,34].

Nevertheless, dehydration during exercise in the heat impaired greater performance decrement than similar exercise in cooler conditions. This has been explained by greater cardiovascular and thermoregulatory strain associated with heat exposure [34]. In the present study, exercise testing was relatively performed in cool conditions (21±1 °C). Furthermore, that may explain the absence of significant change between trails in VT1, VT2, peak oxygen pulse, and BFpeak with both Zamzam water and Bottle water (all P>0.05). The promising findings of the present study concluded that rehydration with Zamzam water did not impair key parameters of the cardiorespiratory fitness including VO2peak. The effect of rehydration with Zamzam water on different sports may need to be investigated in different conditions.

5. Conclusions

Generally, the effect of rehydration with water may not influence most of the cardiorespiratory fitness markers. The present study demonstrated that there was no significant difference between Zamzam water and Bottle water in most examined variables including cardiorespiratory fitness markers. However, the effect of rehydration with Zamzam water tends to maintain cardiorespiratory fitness markers such as VO2peak even as short as 80±10 minutes following exercise-induced dehydration (> -2% body mass). Although rehydration was not as recommended with 150% of losing body mass, rehydration with Zamzam water by 100% of losing body mass did not impair key cardiorespiratory fitness markers. Further studies are warranted to insure the effect of similar reachable liquid such as Zamzam water on different sports and conditions.

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