Edema of Pregnancy: A Comparison of Water Aerobics and Static Immersion

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***Objective*: To compare the edema-relieving effects of static immersion with water aerobics.**

***Methods*: Eighteen healthy women between 20 and 33 weeks' gestation were studied standing on land, immersed to the axilla, and participating in a water aerobics class, each for 30 minutes.**

***Results*: Water aerobics and the static immersion led to a similar diuresis, 187 and 180 mL, respectively. Both were significantly greater than standing 30 minutes on land, 65 mL ($P < .01$). The dilutional effect as measured by a decline in urine specific gravity was also similar between static immersion and water aerobics and greater than standing on land ($P < .01$). Standing on land led to a small increase in leg volume compared with water aerobics or static immersion ($P < .01$).**

***Conclusion*: Water aerobics had diuretic and edema-relieving effects similar to static immersion. When women develop edema of pregnancy, water aerobics classes may be used as a potential treatment. (Obstet Gynecol 1999;94:726–9. © 1999 by The American College of Obstetricians and Gynecologists.)**

Edema is a common problem associated with pregnancy. Bedrest with leg elevation is often suggested as a possible treatment. Recent studies have shown that immersion initiates a diuresis faster than bedrest and is more effective hour per hour as a treatment for the edema of pregnancy.[1–3] The diuresis that occurs with immersion is secondary to the hydrostatic force of water. The hydrostatic force is proportional to the depth of immersion, acting on the fluid in the extravascular spaces. Edema fluid is pushed from the extravascular space into the venous system, bypassing the lymphatics.[4–7] The resultant increase in central blood volume leads to an increase in glomerular filtration and subsequently to water excretion.[4–7] Because the hydrostatic force is proportional to the depth of water, the diuretic effects of immersion occur to a greater extent when standing in several feet of water compared with swimming in it or lying in a bathtub. Unfortunately, to stand in water for as long as 45 minutes can be tedious and sometimes cold. In contrast, water aerobic exercise, which has become quite popular in recent years, offers the ability for the pregnant woman to be upright in the water at the same time that she performs an activity.

In previous studies, we compared water exercise with land exercise and found a significant diuretic effect with exercise in water.[8–11] In this study, we were interested in comparing the diuretic effects of static immersion with water exercise. Exercise produces a hemoconcentrating effect, as fluid moves out of the vascular space, which may partially counteract the hydrostatic forces. However, if static immersion and water aerobics demonstrated similar diuretic effects, then the benefits of water aerobics would be greater than that of exercise alone. Additionally, we chose to compare static immersion with water aerobics because the combined physiologic effects of exercise and immersion are not well understood.

Methods

Eighteen healthy women with uncomplicated singleton pregnancies were recruited from prenatal water aerobics classes to participate in the study. All were white; 17 were primiparous. All subjects had attended at least two previous sessions in a water aerobics class. Exclusion criteria included the following: smoking, history of exercise restrictions, medical or obstetric complications such as diabetes, hypertension, or heart disease. Subjects had to have approval from their obstetricians to participate in water aerobics classes. The mean age of the subjects was 30.3 years, range 21–36 years. Three patients who applied to participate were excluded because of age over 36 years. The gestational age at the time of the study ranged between 20 and 33 weeks. No

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subject had clinical problems with edema, nor had any had a clinical assessment of edema before the study. This study was approved by the institutional review board.

Each subject was evaluated on three occasions at least 48 hours apart. All evaluations were conducted at the exercise swimming pool of Portland Providence Medical Center. The mean air and water temperatures in the pool area and pool were 30.6 ± 0.6C and 31.5 ± 0.2C, respectively. On the day before testing, subjects were asked to avoid immersion or exercise. They were asked also to avoid beverages with caffeine and chocolate and to eat similar foods each testing day. Fluid was not restricted until data collection began. The subjects were tested at the same time each day.

Each subject performed each of the three conditions. The order in which a subject performed the three conditions was assigned randomly by rolling a die. The three 30-minute study conditions included the following: standing on land, standing in water to the axilla (static immersion), or a low-intensity water aerobics class also with immersion to the axilla. We randomized the order of the three trials so that the order would be distributed evenly to minimize interactions or gestational age effects. Dependent variables included body weight, volumetric measurement of the left lower leg, urine output, urine specific gravity, maternal heart rate, blood pressure, and temperature.

On testing days, subjects emptied their bladders approximately 1 hour before coming to the pool. When subjects came to the pool, the following variables were measured: urine volume, specific gravity of urine, maternal heart rate and blood pressure, and weight and leg volume. Subjects were asked to drink 8 ounces of water immediately before beginning their assigned test condition. After the 30-minute study period was completed, the same data were recollected. Primary outcomes were changes in urine volume, specific gravity, leg volume, maternal heart rate, and blood pressure. Subjects were asked to drink 8 ounces of water immediately before beginning their assigned test condition. After the 30-minute study period was completed, the same data were collected.

Leg volume was measured by a water displacement technique. The measuring device was a rigid 22-quart container with water filled up to an overflow spout located 13 inches above ground level. Subjects placed their left foot into the water and shifted the majority of weight onto that leg. They then stood as still as possible while the overflow spout collected the fluid displaced. The fluid was then transferred to graduated cylinders and measured.

Subjects standing on land were asked to stand relatively still for 30 minutes. They were instructed that they could shift weight as desired. Subjects in the immersion condition stood relatively still in water at the level of the axilla for 30 minutes. They could take a few steps or shift their weight lightly if they were cold or felt uncomfortable. Exercising women were in axilla-deep water and were led in the water aerobics regimen by a trained aerobics instructor.

The water aerobic session included a 5-minute warm-up with water walking (at axilla depth). This was followed by 10 minutes of water jogging and upper extremity workout with hand buoys. There were then 10 minutes of a deep water workout using a foam cylinder between the legs to float and 5 minutes of toning and cooling down (at axilla depth). Exercise intensity was evaluated using the Borg perceived exertion scale at 13 minutes into the session and again at 23 minutes.[12] Any subject who seemed short of breath or reported a perceived exertion score greater or equal to 15 was instructed to reduce the intensity of her workout to a more comfortable level. A score of 15 is equivalent to "hard" work on the part of a subject. The same instructor, music, exercises, and routine were used during each aerobic session, and all subjects had been familiarized with the procedure before the water aerobics study session.

Statistic evaluation was designed to compare the changes before and after a condition but also between the conditions (static immersion, water aerobics, and standing on land) with each subject serving as her own comparison. For example, we were interested not only in the change in urine specific gravity from before water aerobics compared with after water aerobics, but also how that change compared with the change after standing on land. Thus, we used a 3×2 repeated-measures and a blocked analysis of variance. The significant interactions were then analyzed using Tukey post hoc analysis.

Subject number for this study was modeled upon other studies of physiologic changes in pregnancy. Typically, eight to 20 subjects are studied depending on the number and length of various conditions. Subject number was affected by availability as well.

One subject completed only 27 of her 30-minute standing session because of reported dizziness but fully completed all of her other sessions. All other subjects finished the study without any difficulties, and there were no pregnancy complications among the subjects. During the study, one subject had a single systolic blood pressure measurement of 146 mmHg, and another subject had a diastolic measurement of 87 mmHg. Neither of these women had any other abnormal values before or after.

Table 1. Outcome Variables From the Three Trials: Standing on Land, Static Immersion, and Water Aerobics

Variable		Static land		Static immersion		Water aerobics	
		Pretrial	Post-trial	Pretrial	Post-trial	Pretrial	Post-trial
Urine volume (mL)*	Mean	126	65	115	180	179	187
	SD	160	46	105	120	177	108
	Range	32–745	15–193	25–383	35–465	28–788	46–375
Urine specific gravity†	Mean	1.015	1.015	1.015	1.009	1.011	1.008
	SD	0.007	0.007	0.008	0.006	0.007	0.006
	Range	1.003–1.027	1.004–1.028	1.000–1.028	1.002–1.026	1.000–1.026	1.001–1.024
Leg volume† (mL displacement)	Mean	2344	2390	2335	2330	2321	2332
	SD	294	285	283	278	288	275
	Range	1825–3041	1953–3120	1905–3012	1870–2990	1888–3021	1920–3021
Weight (lb)	Mean	156	156	156	156	155	155
	SD	22.3	22.2	21.8	21.9	21.9	21.8
	Range	114–195	114–195	113–197	113–197	114–197	114–196
Heart rate (bpm)†	Mean	87	80	86	75	88	86
	SD	11	12	11	8	10	11
	Range	72–110	68–114	67–107	59–94	68–106	73–115
Systolic BP (mmHg)	Mean	105	105	105	110	106	109
	SD	13	12	15	13	13	14
	Range	80–132	82–125	76–137	86–146	86–137	77–134
Diastolic BP (mmHg)	Mean	65	67	66	67	65	65
	SD	6	7	7	9	8	9
	Range	52–74	54–80	49–77	53–87	48–77	46–84
MAP (mmHg)	Mean	78	79	79	81	79	79
	SD	7	8	9	10	9	10
	Range	61–88	63–93	58–95	65–107	61–97	56–98

SD = standard deviation; BP = blood pressure; MAP = mean arterial pressure.
* $P < .05$ between land, static immersion, and water aerobics.
† $P < .01$.

Results

Descriptive statistics for group means, standard deviations, and ranges of the outcome variables are expressed in Table 1. In general, static immersion and water aerobics produced a significant diuresis. After blocked analysis, significant changes were seen between pretrial and post-trial measurements as well as for changes between the three study conditions. The post hoc analysis demonstrated that the changes between conditions and trials were significant for leg volume $P = .01$, urine specific gravity $P = .005$, and maternal heart rate $P = .017$. Specifically, urine volumes were found to be significantly greater with water aerobics and immersion at 187 mL and 180 mL, respectively, compared with standing on land, 65 mL ($P < .01$). Similarly, specific gravities of the urine after water aerobics and immersion were significantly less than those after standing ($P < .01$). Leg volume showed similar trends between the study conditions ($P = .01$), often greater standing on land than after bath static immersion and water aerobics, although we found it to be of only slight clinical significance. Additionally, and most importantly, there was no difference in the urine output of the urine specific gravity after water aerobics compared with static water immersion.

Power analysis for changes in outcome based on an α of .05 was 0.79 for leg volume, 0.43 for weight, 0.91 for urine specific gravity, and 0.73 for urine volume.

Discussion

This study was initiated because of the growing popularity of prenatal water aerobic programs. We sought to better evaluate the effects of static water immersion and water aerobics. Water exercise is beneficial for several reasons: it reduces the effects of gravity, facilitates heat dissipation, and provides support for the gravid uterus. Because immersion has been shown to be an effective treatment for edema associated with pregnancy, we were hopeful that water aerobics might show a similar effect.[1,2] As opposed to various forms of land exercise, water aerobic exercise does not seem to significantly change plasma volumes and thus should not affect uterine blood flow.[8] Extrapolations about uterine blood flow are only assumptions because uterine blood has not been measured directly. Previous studies have shown that exercise produces a net decrease in plasma volume with a direct relation to exercise intensity.[13] In this study, however, we have shown that the hemodiluting effects of immersion may counteract the hemoconcentrating effects of exercise.

Immersion is not a treatment for pathologic edema or for elevated blood pressure. Evaluation of excess edema should be undertaken to rule out underlying causes. We studied women who were healthy and had participated in water aerobics previously. We chose subjects from such a population to avoid interactions from the exercise itself. Our hypothesis was an increased diuresis with static immersion compared with water aerobics. We were pleased to find no difference between the diuretic effects resulting from static immersion compared with water aerobics. Water aerobics and static immersion had similar effects on urine specific gravity. This result implies that a water aerobics class will offer the same diuretic and edema-reducing benefits as simple immersion in the same depth of water. Urine volume and specific gravity are more sensitive measures for evaluating fluid shifts than leg volume or weight. Our subjects were healthy; none had pathologic or significant edema. Because the effects of immersion are proportional to the degree of edema, it is not surprising that weight and leg volume changes were minimal.

Our findings are consistent with previous studies in which we found significant diuresis and natriuresis with immersed cycle ergometer exercise without a net change in plasma volume.[8,11] In contrast, other investigators have found that the hemodiluting effects of immersion are inhibited by water exercise in male subjects.[14] It is possible that the increased intervascular and extravascular volumes associated with pregnancy may compensate for the hemoconcentrating effects of exercise.

Interestingly, 30 minutes of standing led to a significant increase in dependent edema. Subjects repeatedly stated that their ankles felt swollen after standing for 30 minutes even though they could move around to a limited degree. This study supports the premise that when possible static standing should be avoided during pregnancy, as even 30 minutes produced an increase in dependent edema.

Additional differences between land and the two water conditions were noted. The decrease in specific gravity in water compared with standing on land is similar to what has been seen previously. The drop in heart rate with immersion also has been noted and is most likely due to the physiologic response of increased central blood volume and increased stroke volume.[5,8,14,15]

Edema is a widespread problem during pregnancy, and immersion has gained acceptance as a treatment for this condition. Our study results suggest that water aerobics is as beneficial as static immersion in terms of relieving edema in healthy women without obstetric complications.

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