ORIGINAL PAPER

Effect of aerobic exercise versus device-guided breathing on gestational hypertension

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Abstract

Introduction. Gestational hypertension is a prevalent condition, occurring in 10% of pregnancies. Physical exercise has a valuable effect on lowering blood pressure. Device-guided breathing is a beneficial strategy for treating high blood pressure. The purpose of this study was to compare aerobic exercise vs. device-guided breathing in gestational hypertension.
Methods. The study included 90 singleton pregnant women (at the 21st week of gestation) diagnosed with gestational hypertension. They were randomly divided into 3 groups. The aerobic exercise group ($n = 30$) received aerobic exercise until the 36th week of gestation. The device-guided breathing group ($n = 30$) received device-guided breathing until the 36th week of gestation. The third group was a control group. All groups received the same antihypertensive medications. They were assessed before and after treatment with a mercury column sphygmomanometer to measure systolic and diastolic blood pressure.
Results. All groups showed a significant reduction in their systolic and diastolic blood pressure values after the end of the training program. However, the comparison with the corresponding values measured before treatment revealed that the participants in the device-guided breathing group exhibited a greater reduction in the systolic and diastolic blood pressure values than those in the aerobic exercise and control groups.
Conclusions. Device-guided breathing is more effective than aerobic exercise in decreasing systolic and diastolic blood pressure in gestational hypertensive women.
Key words: blood pressure, hypertension, pregnancy, aerobic exercise, device-guided breathing

Introduction

The estimated hypertension prevalence is about 7.7% among women during their reproductive age [1]. Gestational hypertension constitutes a frequent complication of pregnancy and is associated with maternal/perinatal morbidity and mortality [2].

Women with gestational hypertension presented systolic blood pressure (SBP) ≥ 140 mm Hg or diastolic blood pressure (DBP) ≥ 90 mm Hg in 2 measurements with no less than 4–6 hours in-between [2]. Antihypertensive management of gestational hypertension aims to reduce maternal morbidity through limiting severe hypertension episodes [3].

Aerobic training is recommended for health promotion and prophylaxis of several cardiovascular diseases. It refers to exercises involving major muscle groups, as well as improving the body oxygen consumption. Cycling, walking, jogging, and running represent different kinds of aerobic exercise. A recent Western meta-analysis has found that aerobic exercise could produce a significant clinical decrease in blood pressure [4].

The current American and European hypertension guidelines recommend regular practice of physical exercise owing to its benefit in reducing blood pressure [5, 6]. Regular exercise lowers SBP by 3–5 mm Hg and DBP by 2–3 mm Hg in subjects with normal blood pressure. However, such an effect is more marked in hypertensive patients, with a mean reduction of 7 mm Hg for SBP and 5 mm Hg for DBP [7].

Device-guided breathing is another non-pharmacological strategy for hypertensive patients [8, 9]. It is a type of biofeedback that uses musical tones to reduce breathing fre-quency. The positive effect of device-guided breathing on lowering blood pressure could be related to its influence on pulmonary stretch receptors, baroreceptors, and the parasympathetic nervous system [10].

Therefore, the aim of this study was to compare the effect of aerobic exercise vs. device-guided breathing on blood pressure in women suffering from gestational hypertension, as well as to provide some reliable and useful observations concerning gestational hypertension treatment.

Subjects and methods

Methods

This study was conducted at the Woman's Health Outpatient Clinic, Faculty of Physical Therapy, Cairo University.

Sample size calculation was based on a comparison of hypertension prevalence rates in women with a high risk to develop the disorder (16–18%) [11]. With the consideration of a significance level of 5%, as well as a power of 80%, the sample size was estimated at $n = 87$.

Eligible participants in accordance with the pre-established criteria were selected and invited to participate in the study. The study flowchart is presented in Figure 1.
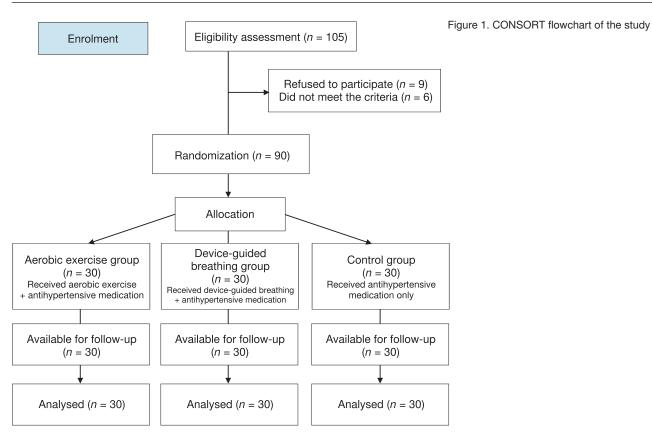
Subjects

Overall, 105 individuals were screened at the beginning. After the screening process, 90 women were found to be eligible to participate in the study. All the 90 (100%) patients completed the treatment program.

Figure 1. CONSORT flowchart of the study

A total of 90 singleton pregnant women diagnosed with gestational hypertension, at the 21st week of gestation, aged 25–35 years, with a body mass index of < 30 kg/m², were randomized. The general baseline characteristics of the participants in all groups are shown in Table 1.

Table 1. Demographic features of the participants before the intervention

Characteristics	AE group (n = 30)	DGB group (n = 30)	C group (n = 30)	p
Age (years)	30.10 ± 1.84	30.43 ± 1.58	30.94 ± 1.55	0.149
BMI (kg/m²)	26.61 ± 1.41	27.09 ± 1.44	27.35 ± 1.62	0.169

AE – aerobic exercise, DGB – device-guided breathing,
C – control, BMI – body mass index
Data are expressed as mean ± *SD*
p > 0.05, not significant

Gestational hypertension is defined as a blood pressure of above 140/90 mm Hg assessed 2 times separated by no less than 6 hours, in the absence of proteinuria, and detected after 20 weeks of pregnancy.

The exclusion criteria were multiple pregnancies, vaginal bleeding, preterm labour, cervical insufficiency, cardiac disease, renal failure, neurologic disorders, and systemic lupus erythematosus. Additionally, the participants should not have participated in any supervised physical exercise at the time of selection and after providing their informed consent.

Randomization was performed by a blinded, independent examiner who opened opaque sealed envelopes containing computer-generated randomization cards. The envelopes provided information about the random group allocation. The aerobic exercise (AE) group received aerobic exercise till the 36th week of gestation in addition to antihypertensive medication (for 15 weeks), while the device-guided breathing (DGB) group received device-guided breathing till the 36th week of gestation in addition to antihypertensive medication

(for 15 weeks). The control (C) group received antihypertensive medication only (for 15 weeks).

Exercise program for the AE group

Before and after each exercise session, the participants were advised to drink a lot of water to avoid increased body water loss during the session. Also, they were given instructions about having a light meal 1 hour before the session and wearing comfortable clothes.

A treadmill (Track Star, Incheon, Korea) was used for aerobic exercise. Each aerobic exercise session was 40-minute long (warm-up: 5 minutes; intervention: 30 minutes; and cool-down: 5 minutes). A stretching program for both upper and lower limbs with 2 repetitions and 30 seconds of stretch maintenance in each segment for a total of 10 minutes was applied as a warm-up and cool-down. The proper phase consisted of walking on the treadmill for 30 minutes at a low intensity (40% of the maximum heart rate). Maximum heart rate was calculated in accordance with the equation: 210 – age in years. The frequency of exercise was 2 times per week for 15 weeks. During the training session, the physical therapist was standing beside the participant for observation and detection of exercise stopping signs. The participant was continuously asked about feelings of pain, dizziness, or shortness of breathing.

There were no complications (e.g. hypertensive crisis, musculoskeletal lesions, hyperthermia) that demanded exercise interruption during the sessions.

Device-guided breathing for the DGB group

The RESPeRATE device (InterCure Ltd., Lod, Israel) was approved by the Food and Drug Administration as an adjunct anti-hypertensive therapy that delivers instructed signals, guiding home users to change their breathing rate [12–14].

First, the therapist described the device and the procedures of the study to each participant in the DGB group. The device includes a belt-type respiration sensor connected to a computerized box that generates musical patterns through earphones. Each participant was instructed to relax in a sitting position with her back fully supported and both feet on the ground. Then, she was asked to modify her breathing pattern and voluntarily follow the sound pattern with her breathing movements. This process continued until a steady state was reached at the lowest breathing rate comfortable for the patient, aiming for up to 12 breaths per minute, in response to the melody played. The intervention was applied for 10 minutes per day, until the 36th week of gestation [15].

All participants in all groups (AE, DGB, and C) were asked to continue their dietary habits during the study. They were instructed to maintain their normal drug-use routine and sleep and meal hours; they did not consume alcohol, tea, coffee, soda, or any food/drink containing caffeine. In addition, on the experiment day, they were asked to ingest a light meal 2 hours before initiating the protocol.

Assessments

All measurements of blood pressure were taken in the morning hours. The participants were instructed to rest in a sitting position for at least 5 minutes. Then, a standard mercury sphygmomanometer (model TXJ-10, Japan) with a proper cuff size was used. The rubber cuff of the sphygmomanometer was wrapped around the upper arm and a stethoscope was placed over the brachial artery. The rubber cuff was inflated with air. As the air in the cuff was released, the first sound heard marked SBP. As the release of air from the cuff persisted, the point where the sound disappeared marked DBP. Overall, 2 measurements were obtained with a resting period of 2 minutes in-between, and their average was calculated for statistical analysis. Each woman's SBP and DBP were determined before and after training in the 36th week of gestation.

Statistical analysis

Statistical analysis was carried out with the SPSS for Windows software, version 22 (SPSS Inc., Chicago, USA). A test of normality, the Kolmogorov–Smirnov test, was used to verify the distribution of data measured before treatment. The data were compared between the groups with the use of the ANOVA test, while the comparison after treatment was performed with a 3×2 ANOVA model followed by a post-hoc test if significant results were recorded. A comparison of data measured before and after treatment within the same group was conducted with a paired t-test. The mean values of different measures within the groups were compared with a paired t-test. The value of $p \leq 0.05$ was considered significant.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Research Ethics Committee of the Faculty of Physical Therapy, Cairo University (reference No: P.T.REC/012-5/2018).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

Systolic blood pressure before and after treatment

There was a statistically significant decrease in the mean values of SBP (mm Hg) in all groups (AE, DGB, and C) after 15 weeks of treatment compared with the corresponding values before treatment. Between-group comparison showed a statistically significant decrease in SBP after the treatment in favour of the DGB group ($p = 0.001$), as presented in Table 2.

Diastolic blood pressure before and after treatment

DBP (mm Hg) exhibited statistically significant decreases in all groups (AE, DGB, and C) after treatment compared with the corresponding values before treatment. Between-group comparison showed a statistically significant decrease in DBP after the treatment in favour of the DGB group ($p = 0.001$), as presented in Table 3.

Table 2. Mean values of systolic blood pressure (mm Hg) in the 3 groups before and after the intervention

Variable	AE group (n = 30)	DGB group (n = 30)	C group (n = 30)	$p^\$$	AE group vs. DGB group	AE group vs. C group	DGB group vs. C group
Before intervention	153.83 ± 5.45	154.13 ± 4.95	155.20 ± 5.60	0.583	–	–	–
After intervention	129.93 ± 4.13	123.43 ± 4.88	135.57 ± 5.39	0.001	0.001**	0.001**	0.001**
p^*	0.001	0.001	0.001				

AE – aerobic exercise, DGB – device-guided breathing, C – control
Data are expressed as mean ± *SD*
$ ANOVA test,* paired *t*-test, ** post-hoc test; $p \leq 0.05$, significant

Table 3. Mean values of diastolic blood pressure (mm Hg) in the 3 groups before and after the intervention

Variable	AE group (n = 30)	DGB group (n = 30)	C group (n = 30)	$p^\$$	AE group vs. DGB group	AE group vs. C group	DGB group vs. C group
Before intervention	94.77 ± 2.36	93.43 ± 3.26	93.97 ± 2.82	0.192	–	–	–
After intervention	85.50 ± 2.74	83.33 ± 2.40	87.17 ± 2.38	0.001	0.003**	0.009**	0.001**
p^*	0.001	0.001	0.001				

AE – aerobic exercise, DGB – device-guided breathing, C – control
Data are expressed as mean ± *SD*
$ ANOVA test, * paired *t*-test, ** post-hoc test; $p \leq 0.05$, significant

Discussion

Gestational hypertension, or pregnancy-induced hypertension, means new hypertension developed during pregnancy after the 20th week of gestation in the absence of proteinuria or other preeclampsia signs [15].

This study showed that the AE group, who received aerobic exercise, exhibited significant reductions in SBP and DBP. This is supported by Muktabhant et al. [16], who stated that aerobic exercise practised for about 30–60 minutes 2–7 times per week during pregnancy, as compared with being more sedentary, was associated with a significantly reduced risk of gestational hypertensive disorders overall, gestational hypertension, and caesarean delivery. Our findings corroborate a recent Cochrane review that evaluated the effect of exercise during pregnancy on the risk of hypertensive disorders. The authors observed a reduction of maternal hypertension in women receiving diet or exercise, or both interventions, compared with the control group [17]. Regular exercise should therefore be recommended for all individuals, including normotensives, pre-hypertensives, and hypertensives [18].

The largest systematic review and meta-analysis to date on gestational hypertension (22 randomized controlled trials, $n = 5316$) showed that exercise during pregnancy significantly lowered the risk for gestational hypertension (OR = 0.61, 95% CI: 0.43–0.85). Moreover, moderate-intensity exercise was accompanied by a 25% reduction in the odds of developing gestational hypertension, with a clear dose-dependent effect [19]. This is in line with findings from 3 other large meta-analyses in which reductions in gestational hypertension were observed [17, 20, 21].

The results of the present study are supported by Santos et al. [22], who reported that an acute session of aerobic exercise (45 minutes at 50% of the maximum heart rate) reduced SBP ($\Delta = -4.7$ mm Hg) and DBP ($\Delta = -4.0$ mm Hg) in resistant hypertension patients. Regular physical exercise, mainly aerobic training, is a highly recommended non-pharmacological method for preventing and controlling hypertension. Endurance training causes blood pressure reduction not only in normotensives but also in hypertensive individuals, with a more obvious influence among the latter [7].

In the present study, we investigated the potential beneficial effects of device-guided breathing, a non-pharmacological and non-invasive intervention, on gestational hypertension. Our finding is in alignment with observations by Adler et al. [23], who stated that device-guided breathing was able to induce acute reductions in blood pressure even in young, healthy, normotensive individuals. Harada et al. [24] implied that device-guided breathing acutely lowered blood pressure and sympathetic nerve activity in humans with hypertension, as well as led to baseline improvements after 8 weeks of daily use [25]. Oneda et al. [26] demonstrated a similar acute reduction in SBP of ca. 6–8 mm Hg in patients with hypertension. In contrast, others [27, 28] reported no change in blood pressure with device-guided breathing after 8–9 weeks of daily at-home slow breathing.

The subsequent acute reduction in blood pressure induces augmentation of the baroreflex sensitivity and resets the disturbed autonomic balance in subjects with hypertension. Accordingly, it has been hypothesized that regular systemic instructions regarding slow voluntary breathing could reduce blood pressure and provide an additional management option for hypertensive patients [29]. Thus, pre-programmed clinical devices may deliver more controlled breathing instructions that may have a positive effect on lowering blood pressure [12].

Limitations

The study was limited by the psychological condition of the patients at the time of the intervention, which might have affected the results.

Conclusions

Aerobic exercise and device-guided breathing may be potential non-pharmacological interventions for blood pressure improvement in gestational hypertensive patients. From the findings of this study, one can conclude that device-guided breathing is more effective than aerobic exercise in decreasing SBP and DBP in gestational hypertensive women.

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Disclosure statement
No author has any financial interest or received any financial benefit from this research.

Conflict of interest
The authors state no conflict of interest.

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