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Sheng Zhen Gong in pregnancy: The effects of a traditional low intensity exercise form on maternofetal health and wellbeing

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ABSTRACT

Objective: The aim of the study was to evaluate maternal and fetal responses to Sheng Zhen Gong (SZG), a low intensity form of exercise, using multi-modal antenatal surveillance techniques.

Methods: This was a single-blinded randomized controlled trial in low risk pregnant women from a tertiary center in the Philippines. Participants were randomized into Chronic Exercise (CE), Acute Exercise (AE) and No Exercise (NE) groups. A Pregnancy Physical Activity Questionnaire (PPAQ) was given to ascertain baseline activities. Systematic periodic assessment was performed utilizing standard ultrasound and Doppler studies between 20^{+0} to 32^{+0} weeks gestation with or without sessions involving a biophysical and Warwick-Edinburgh Mental Well-being Scale (WEMWBS) evaluation before and after SZG exercise.

Results: Eighty-nine (89) women were included with average energy expenditures of light to moderate intensity. In the CE group, systolic, diastolic, mean arterial pressures and heart rates were lower while oxygen saturations increased after exercise (n=35; p: <0.01 to 0.01). There were also observable significant increases in maternal well-being scores after exercise for both CE (n=35) and AE (n=21) groups (p<0.01). Increasing the frequency of exercise was also associated with better maternal well-being (p: 0.02). Fetal Doppler studies showed no significant changes after exercise.

Conclusion: In normal pregnancy, routine low intensity physical activity in the form of SZG was seen to have positive effects on maternal cardiovascular, blood glucose and mental

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KEYWORDS

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well-being maintenance with no evidence of detrimental effects on the fetus.

INTRODUCTION

Maintaining some form of physical activity during normal pregnancy is highly recommended by healthcare providers worldwide but prevailing Asian practices and beliefs on pregnancy as a vulnerable period for women and their unborn children promote sedentary lifestyles. Various forms of exercise have been extensively studied and found to be safe and beneficial in both the antepartum and postpartum periods. These include walking, stationary cycling, aerobic exercises, dancing, stretching, resistance exercises and hydrotherapy. In this study, we evaluated the effects of a traditional low impact exercise called Sheng Zhen Gong (SZG) on the maternal-fetal dyad. [1-4]

Around 4,500 years ago, the Chinese people already practiced exercises known presently as Qigong to maintain health and contend with sickness. Prior to the mid-20th century, these work outs were called by different names, among others: *Tuna* or exhalation and inhalation, *Daoyin* or guiding and conducting exercise, *Jingzuo* or sitting meditation, and *Xingqi* or circulating the *Qi* (the vital energy or life force in the body).[5-7] The exercises were depicted in relics (e.g., potteries) dated up to 5,000 years old. Historical texts like the *Yellow Emperor's Internal Classics* written more than 2,000 years past, described movements, to activate *Qi* and blood which evolved into a variety of forms that persist today as Qigong.[8] As time passed, at least five different traditions were established each with its own theories and characteristics. These are Medical Qigong, Daoist Qigong, Buddhist Qigong, Confucian Qigong, and Martial Arts Qigong. They still exist, for the purpose of producing *Qi*, to prevent illness and deal with disharmony or imbalance in the body, mind and spirit. Qigong, the name which became official in the 1950's during the early years of the People's Republic of China (PROC), is the practice of or working with *Qi*.[9,10] A Qigong book by Liu in 2013 defined it as "the skill of mind-body exercise that integrates the three adjustments of body, breath and mind into one.[11]" There are two main types of Qigong practice. Internal Qigong is the generation of *Qi* by the practitioner. External Qigong is the projection of internally generated *Qi* by an expert practitioner with the intent of healing another person. Qigong has two body forms: dynamic and static. Dynamic forms involve bodily movements where *Qi* is cultivated as it flows in the body. In the static forms, the *Qi* is stored, and the aim is to achieve mental tranquility.

Research on *Qigong* has been conducted since the mid-20th century in the PROC. From the mid-1950's to mid-1960's, the emphasis was on the therapeutic effects and the physiological processes of Qigong. From the late 1970's to 1990's, the investigations were on external Qigong, more sophisticated technology like functional magnetic resonance imaging (fMRI) were utilized, and extensive animal studies were done. From 2000 to the present, standardization of the management of Qigong in consideration of its many forms came to the fore along with increased research funding.[5]

The physiological effects of Qigong have been well studied. Since adjustment in breathing is one hallmark of Qigong, the effects on the respiratory system were explored. Qigong brings about slower, longer, deeper, and more regular breaths among skillful practitioners. These result in decreased ventilatory capacity, higher tidal capacity, and greater oxygen uptake. Diaphragmatic movement is enhanced, leading to strengthening of visceral function.[11,12]

On the cardiovascular system, there is a decline in the heart rate and cardiac output when practitioners enter into a tranquil state.[13,14] During this state, there is also higher finger pulse amplitude, lower pulsation of the temporal artery and greater cerebral vessel resistance, resulting in lesser blood flow in the brain which indicates that blood is redistributed in the body. There is also improved microcirculation, enhanced blood elasticity and cerebral blood circulation. Blood measurements in patients with hypertension, coronary heart disease and arteriosclerosis demonstrated reduced levels of cholesterol and triglyceride with increased high-density lipoprotein.[15,16]

Neurophysiologic effects include an increase in alpha-wave frequencies during meditative states. Furthermore, there are lower evoked potentials showing reduced cerebral cortex activity with noted effects in neurotransmitters as well. There is higher 5-hydroxytryptophan (5-HTP) with the opposite effect occurring as far as dopamine and norepinephrine metabolism are concerned, strengthening the immune system as a whole. For instance, the quality of sleep is enhanced by 5-HTP and the stimulation of enkephalin production may give rise to feelings of pleasure, quieting the mind, and reducing pain.[1]

The above physiological effects may well be present in a contemporary form of Qigong known as Sheng Zhen Gong. This is a system of meditation in motion or in stillness. It draws and circulates *Qi* into the body. In the process, it brings about a feeling of well-being, harmony with one's surroundings, and contentment. The postures and movements of the different forms of SZG have messages and mental images which are contemplated as they are being practiced. In addition to the benefits of traditional Chinese Qigong such as healing, strengthening, and balancing the mind and body, SZG transforms consciousness. A central belief is that in time, a practitioner's sense of awareness is heightened and his or her instincts are sharpened bringing on an experience of love, one's original nature.[17]

This is the first study to evaluate SZG in pregnancy. Reports on other modes of exercise in pregnancy have shown that the most notable maternal physiologic changes are cardiorespiratory and glucometabolic in nature. Studies have revealed that these adaptations allow for slight differences in responses to acute exercise while chronic exercise before and during pregnancy produces more maternal and neonatal short- and long-term benefits such as decreased incidence of gestational diabetes, hypertensive disorders, operative deliveries, excessive weight gain and retention, and postpartum depression.[18] Such data has prompted the American College of Obstetrics and Gynecology to recommend moderate exercise for 20 to 30 minutes most days of the week.[19] Using a specialized program designed by its founder Master Li Junfeng and the International Sheng Zhen Society in Manila, the Philippines, along with researchers from the Department of Physiology, College of Medicine, University of the Philippines – Manila and the Section of Maternal Fetal Medicine, Department of Obstetrics and Gynecology, Philippine General Hospital, and as supported by the Philippine Institute of Traditional and Alternative Health Care (PITAHC), the general objective of the project was to evaluate maternal and fetal responses to SZG, a low intensity form of exercise, using multi-modal antenatal surveillance techniques.

METHODOLOGY

This was a single-blinded randomized controlled trial among low risk pregnant Filipino women approved by the University of the Philippines Manila Research Ethics Board (UPMREB Code 2017–429–01) and registered in the Philippine Health Research Registry (PHRR181008–001968). The study was performed in

accordance with the Declaration of Helsinki. Only individuals who met the following inclusion criteria were asked to participate: at least 18 years old, with singleton pregnancies, and with no maternal co-morbidities or fetal congenital anomalies. Patients who had mental disabilities, who were unable to give informed verbal or written consent, or who previously practiced SZG were excluded. All patients were recruited after a full physical examination, a medical history interview, and a first trimester scan. The latter was performed between 11^{+0} to 13^{+6} weeks age of gestation according to a standard protocol to properly establish fetal age and assess maternofetal conditions.[20] After obtaining their consent, the patients completed a Pregnancy Physical Activity Questionnaire (PPAQ)[21] to ascertain baseline activities and were randomized into three (3) groups: Chronic Exercise (CE), Acute Exercise (AE) and No Exercise (NE). Both CE and NE participants were subsequently monitored with periodic ultrasound evaluation: biometry, maternofetal Doppler flow studies and congenital anomaly screening between 20^{+0} to 24^{+0} weeks, and biometry, maternofetal Doppler flow studies and biophysical profile scoring between 26^{+0} to 32^{+0} weeks. Participants from the AE group only had biometry, maternofetal Doppler flow studies and biophysical profile scoring between 26^{+0} to 32^{+0} weeks (Supplementary Table 1). Both delivery and neonatal outcomes were collected.

For the CE group, participants were encouraged to attend SZG exercise sessions in-person at the study site twice weekly, and practice SZG routinely at home throughout pregnancy and until delivery. During an exercise session at the study site, a participant would undergo the following activities: first, a pre-exercise assessment which involved measurements of maternal capillary blood glucose (CBG), maternal blood pressure, maternal oxygen saturation, and the Warwick-Edinburgh Mental Well-being Scale[22] (WEMWBS); second, a 30-minute program of SZG exercises (movement and meditation) with a certified instructor; and finally, a post-exercise assessment involving the same parameters measured before. Participants were instructed not to eat or drink anything starting 1 hour prior to an exercise session. The SZG program performed in each exercise session was a specially designed routine for pregnant women and had eight (8) movements: four (4) standing and four (4) sitting forms (Figure 1), followed by meditation. Moreover, in one scheduled exercise session between 26^{+0} to 32^{+0} weeks age of gestation, CE patients would undergo *extended testing* which included additional ultrasonography (biometry and biophysical profile scoring), Doppler flow studies of the middle cerebral artery, umbilical artery, and uterine artery, and maternal and fetal electrocardiographic (ECG) evaluation in both pre- and post-exercise assessments.

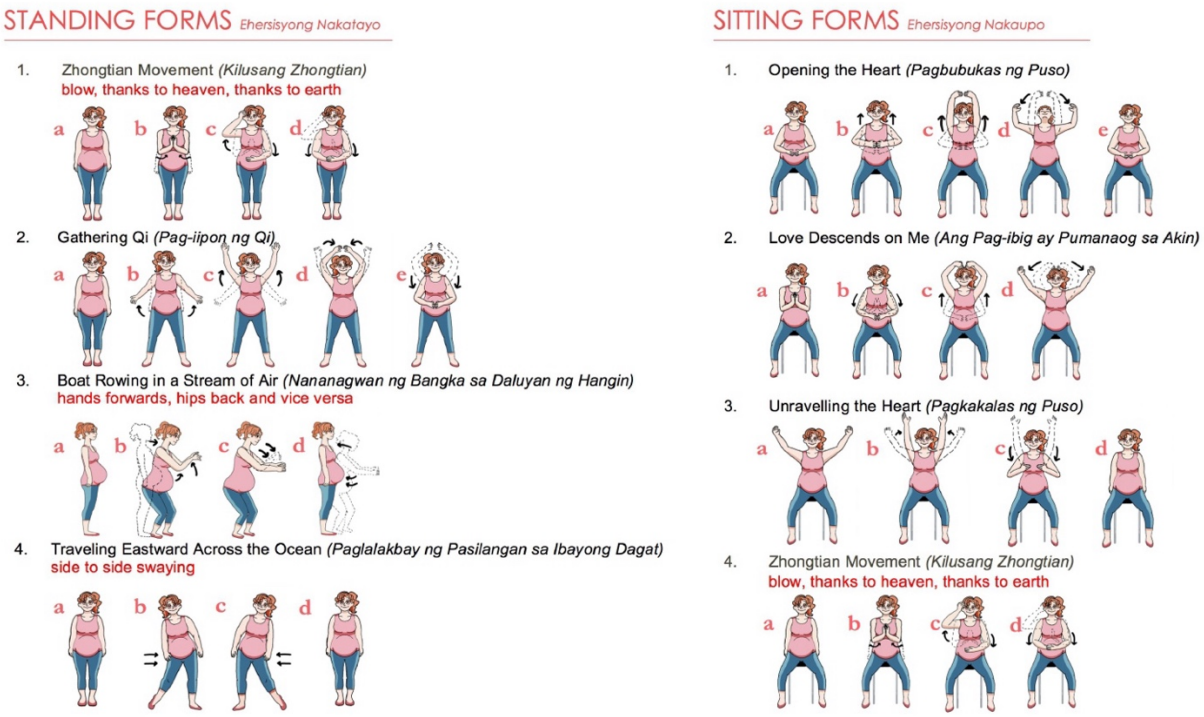

Figure 1: Sheng Zhen Gong in pregnancy routine

For the AE group, participants were only required a single SZG exercise session between 26^{+0} to 32^{+0} weeks age of gestation with pre- and post-exercise *extended testing.* While for the NE or control group, participants were only required a single 30-minute session of no exercise (patients were simply seated comfortably in a waiting room) between 26^{+0} to 32^{+0} weeks age of gestation with pre- and post- no exercise session *extended testing.*

Data collected from the accomplished data reports were manually entered into an electronic spreadsheet file, and subsequent data processing and analysis were then carried out using the statistical software, Stata 13. Descriptive statistics such as the mean, median, standard deviation and range were used for numerical variables such as age in years, anthropometric and cardio-pulmonary measurements. Otherwise, frequency and percentage were used for categorical variables such as marital status, presence of risk factors, and occurrence of select outcomes. A series of chi-square tests of association, repeated one-way analysis of variance (means), and Kruskal-Wallis tests (median) were used to compare the distribution of socio-clinico-demographic characteristics and examination findings between the comparison groups. Stratified paired t-tests were performed to compare the cardio-pulmonary responses of the women in the two study groups before and after the intervention. Repeated measures analysis of variance was performed to compare the Doppler scan results between the groups, and their two different measurements in the study. A series of Fisher's exact tests were

performed to compare the ratings of the women in the study regarding their physical activity during pregnancy – across their group allocation. Finally, the level of significance for all sets of analyses was set at a p-value less than 0.05 using two-tailed comparisons. Contrasts were used as a multiple comparisons procedure for the study.

RESULTS

Baseline clinical characteristics and physical activity levels of the sample population

A total of 89 women were included in the study and randomized as follows: CE group (35, 39.32%), AE group (21, 23.60%) and NE group (33, 37.08%). Considering the socio-clinico-demographic characteristics of the study population, there were more unemployed pregnant women in the CE group ($\chi2$: 8.57, p: 0.05) while women in the NE group had a higher median number of pregnancies ($\chi2$: 10.08, df: 2, p: 0.01), and live births ($\chi2$: 10.19, df: 2, p: 0.01). The AE group was noted to have older pregnancies (gestational ages) during recruitment than the other groups ($\chi2$: 39.51, df: 2, p<0.01) with a higher number of women taking multivitamins ($\chi2$: 6.70, p: 0.04), and Calcium carbonate ($\chi2$: 11.68, p: 0.01). Otherwise, there were no other significant differences between the groups with respect to the remaining socio-clinico-demographic characteristics (Table 1).

Table 1: Socio-clinico-demographic Characteristics of the Study Participants

Characteristics	Overall	NE	AE	CE	p-val
Age in years	25.99 ± 4.84	26.09 ± 4.92	25.62 ± 5.77	26.11 ± 4.27	0.92
Marital status					
Married/Widow	25 (28.09%)	11 (33.33%)	3 (14.29%)	11 (31.43%)	0.27
Single	64 (71.91%)	22 (66.67%)	18 (85.71%)	24 (68.57%)	
Educational Level					
Elementary	5 (5.62%)	-	2 (9.52%)	3 (8.57%)	
High school	46 (51.69%)	18 (54.55%)	9 (42.86%)	19 (54.29%)	
Vocational	2 (2.25%)	-	1 (4.76%)	1 (2.86%)	0.13
College	33 (37.08%)	15 (45.45%)	9 (42.86%)	9 (25.71%)	
Post-Graduate	3 (3.37%)	-	-	3 (8.57%)	
Occupation					
Unemployed	61 (68.54%)	18 (54.55%)	14 (66.67%)	29 (82.86%)	
Unskilled work	5 (5.62%)	3 (9.09%)	-	2 (5.71%)	0.05*
Skilled work	23 (25.84%)	12 (36.36%)	7 (33.33%)	4 (11.43%)	
Religion					
Roman Catholic	80 (89.89%)	30 (90.91%)	18 (85.71%)	32 (91.43%)	
Islam	1 (1.12%)	-	-	1 (2.86%)	0.65
Protestant	8 (8.99%)	3 (9.09%)	3 (14.29%)	2 (5.71%)	
Social history					
Alcohol drinking	22 (24.72%)	12 (36.36%)	2 (9.52%)	8 (22.86%)	0.08
Smoking	4 (4.49%)	3 (9.09%)	-	1 (2.86%)	0.36
Age at first coitus	18 (13-28)	18 (15-25)	18 (15-25)	18 (13-28)	0.85
Number of partners	1 (1-5)	1 (1-5)	2 (1-5)	2 (1-5)	0.20
Contraceptive use	47 (52.81%)	19 (57.58%)	12 (57.14%)	16 (45.71%)	0.56
History of STD	1 (1.12%)	1 (3.03%)	-	-	0.61
Familial History					
Breast cancer	4 (4.49%)	3 (9.09%)	-	1 (2.86%)	0.36
Colon cancer	1 (1.12%)	-	1 (4.76%)	-	0.24
Ovarian cancer	1 (1.12%)	-	-	1 (2.86%)	0.99
Co-morbidities	25 (28.09%)	12 (36.36%)	7 (33.33%)	6 (17.14%)	0.17
Supplementation					
Iron/Folic acid	58 (65.17%)	21 (63.64%)	17 (80.95%)	20 (57.14%)	0.19
Multivitamins	32 (35.96%)	12 (36.36%)	12 (57.14%)	8 (22.86%)	0.04*
Calcium tablets	16 (17.98%)	4 (12.12%)	9 (42.86%)	3 (8.57%)	0.01*
Ascorbic acid	4 (4.49%)	-	2 (9.52%)	2 (5.71%)	0.22
Menstrual History					
Menarche	13 (9-20)	13 (11-20)	13 (9-16)	12 (9-16)	0.08
Dysmenorrhea	36 (40.45%)	11 (33.33%)	10 (47.62%)	15 (42.86%)	0.55
Irregular MI	14 (14.61%)	2 (6.06%)	4 (19.05%)	7 (20%)	0.22
Days of menses	4 (2-7)	4 (3-7)	4 (2-7)	4 (3-7)	0.68
Pads per day	3 (2-5)	3 (2-4)	3 (2-5)	3 (2-5)	0.20
Obstetric History					
Gravidity	2 (1-6)	3 (1-6)	2 (1-5)	2 (1-5)	0.01*
Parity	1 (0-4)	2 (0-3)	1 (0-4)	1 (0-4)	0.01*
Age of gestation	12 6/7 (11 1/7-31 4/7)	12 4/7 (11 2/7-14 1/7)	28 2/7 (11 6/7-31 4/7)	12 5/7 (11 1/7-13 6/7)	<0.01*
Pre-term labor	66 (74.16%)	27 (81.82%)	12 (57.14%)	27 (77.14%)	0.14
Abortion	4 (4.49%)	2 (6.06%)	1 (4.76%)	1 (2.86%)	0.71
Abdominal delivery	10 (11.24%)	4 (12.12%)	1 (4.76%)	5 (14.29%)	0.56
Obstetric complication	65 (73.03%)	26 (78.79%)	13 (61.90%)	26 (74.29%)	0.33
Height (cm)	154.67 ± 7.68	153.09 ± 6.55	155.99 ± 5.05	155.36 ± 9.66	0.32

Characteristics	Overall	NE	AE	CE	p-val
Weight (Kg)	57.50 ± 10.89	56.45 ± 10.60	61 ± 9.82	56.39 ± 11.61	0.24
Body mass index (Kg/m^2)	24.07 ± 4.39	24.11 ± 4.40	25.03 ± 3.55	23.46 ± 4.82	0.44

Legend: NE – No Exercise; AE – Acute Exercise; CE – Chronic Exercise; STD – Sexually Transmitted Disease

A summary of Pregnancy Physical Activity Questionnaires (PPAQ) at recruitment showed no significant differences in baseline levels of physical activity among the women across all of the study groups (Table 2). Computed average energy expenditure and different activity intensities across study groups are presented in Tables 3 and 4.

Effect of SZG on maternal and fetal Doppler characteristics

Monitoring of ultrasonographic findings from all participants on testing day between 26^{+0} to 32^{+0} weeks age of gestation showed that fetuses of women across all study groups were comparable (Table 5). In terms of Doppler studies before and after exercise, there were no noted effects due to the presence or absence of exercise on both maternal and fetal parameters using a repeated measures analysis of variance (Table 6).

Effect of SZG on maternal cardiorespiratory parameters

Clinical parameters for individual study groups before and after testing showed the following significant *intra-group* findings: among those assigned to the CE group, it was noted that systolic (t: 5.51, df: 34, p<0.01), diastolic (t: 2.77, df: 34, p: 0.01), and mean arterial pressures (t: 4.44, df: 34, p<0.01) were lower after exercise. Their heart rates (t: 9.22, df: 34, p<0.01), and blood glucose (t: 7.80, df: 34, p<0.01) were also significantly lower post-exercise; while oxygen saturation (t: -4.66, df: 34, p<0.01) improved after exposure to the regimen. For the AE and NE groups, there were no significant changes, but to a certain extent, women in the AE group appeared to have lower heart rates (t: 1.85, df: 20, p: 0.08) after exercise.

On the other hand, inter-group analysis between exercise groups (CE and AE) was performed by running repeated measures analysis of variance. There were no significant differences between the exercise groups in terms of systolic blood pressure (F[1,54]: 0.19, p: 0.67), diastolic blood pressure (F[1,54]: 0.59, p: 0.45), mean arterial pressure (F[1,54]: 0.07, p: 0.80), and oxygen saturation (F[1,54]: 1.64, p: 0.21). However, there was a significant improvement in the CE group than in the AE group for the parameter of capillary blood glucose (F[,54]: 4.47, p: 0.04), and to some extent, in heart rate (F[1,54]: 3.46, p: 0.07) as well (Table 7). Further evaluating the latter findings, the effects of repeated or routine exercise in pregnancy based on the number of exercise sessions attended was evaluated. Measures of simple effects were estimated for the significant parameters of capillary blood glucose and heart rate while further stratifying the sessions into: 1, 2 to 5, 6 to 10, 11 to 15, and more than 15 sessions. It was noted that there was no significant reduction in the blood glucose levels among those who only had one session (F [1, 51]: 3.07, p: 0.09) - but there were significant decreases among those who had 2 to 5 (F[1,51]: 3.91, p: 0.05), 6 to 10 (F[1,51]: 11.06, p<0.01), 11 to 15 (F[1,51]: 9.10, p<0.01), and more than 15 sessions (F[1,51]: 8.34, p: 0.01) after exercise.

It was noted that there was a significant reduction in the heart rate after exercise only among those who had 2 to 5 (F[1,51]: 4.64, p: 0.03), 6 to 10 (F[1,51]: 7.20, p: 0.01), 11 to 15 F[1,51]: 4.34, p: 0.04) sessions, but these were not noted among those who had only a single (F[1,51]: 2.94, p: 0.09), and more than 15 sessions F[1,51]: 2.41, p: 0.12).

Table 2: Distribution of the PPAQ Responses across Study Groups

Questions	Overall	NE	AE	CE	p-value
Sitting at work or in class					
None	7 (25%)	1 (6.67+)	3 (42.86+)	3 (50+)	0.17
Less than 1/2 hour	4 (14.29%)	4 (26.67+)	-	-	
1/2 to 2 hours	2 (7.14%)	1 (6.67+)	1 (14.29+)	-	
2 to 4 hours	4 (14.29%)	1 (6.67+)	1 (14.29+)	2 (33.33+)	
4 to 6 hours	3 (10.71%)	2 (13.33+)	1 (14.29+)	-	
6 or more hours	8 (28.57%)	6 (40+)	1 (14.29+)	1 (16.67+)	
Standing or slowly walking at work while carrying things like heavier than 3.8 liters or 1 gallon					
None	16 (57.14+)	9 (60+)	3 (42.86+)	4 (66.66+)	0.32
Less than 1/2 hour	5 (17.86+)	3 (20+)	1 (14.29+)	1 (16.67+)	
1/2 to 2 hours	4 (14.29+)	3 (20+)	-	1 (16.67+)	
2 to 4 hours	-	-	-	-	
4 to 6 hours	2 (7.14+)	-	2 (28.57+)	-	
6 or more hours	1 (3.57+)	-	1 (14.29+)	-	
Standing or slowly walking at work while not carrying anything					
None	5 (17.86+)	3 (20+)	-	2 (33.33+)	0.14
Less than 1/2 hour	9 (32.14+)	5 (33.33+)	1 (14.29+)	3 (50+)	
1/2 to 2 hours	4 (14.29+)	4 (26.67+)	-	-	
2 to 4 hours	4 (14.29+)	1 (6.67+)	2 (28.57+)	1 (16.67+)	
4 to 6 hours	1 (3.57+)	-	1 (14.29+)	-	
6 or more hours	5 (17.86+)	2 (13.33+)	3 (42.86+)	-	
Walking quickly at work while carrying things like heavier than 3.8 liters or 1 gallon					
None	21 (75+)	12 (80+)	4 (57.13+)	5 (83.33+)	0.46
Less than 1/2 hour	5 (17.86+)	3 (20+)	1 (14.29+)	1 (16.67+)	
1/2 to 2 hours	1 (3.57+)	-	1 (14.29+)	-	
2 to 4 hours	1 (3.57+)	-	1 (14.29+)	-	
4 to 6 hours	-	-	-	-	
6 or more hours	-	-	-	-	
Walking quickly at work while not carrying anything					
None	12 (42.86+)	7 (46.63+)	2 (28.57+)	3 (50+)	0.82
Less than 1/2 hour	9 (32.14+)	3 (20+)	3 (42.86+)	3 (50+)	

Questions	Overall	NE	AE	CE	p-value
1/2 to 2 hours	4 (14.29+)	3 (20+)	1 (14.29+)	-	
2 to 4 hours	2 (7.14+)	1 (6.67+)	1 (14.29+)	-	
4 to 6 hours	1 (3.57+)	1 (6.67+)	-	-	
6 or more hours	-	-	-	-	

Legend: PPAQ – Pregnancy Physical Activity Questionnaire; NE – No Exercise; AE – Acute Exercise; CE – Chronic Exercise

Table 3: Description of physical activity energy expenditure in MET-h/wk during pregnancy based on the modified PPAQ.

Questions	Average weekly energy expenditure (MET- h/wk)			
	Overall	NE	AE	CE
Preparing meals like cooking, setting the table, and washing dishes	16.47	17.23	22.29	12.25
Dressing, bathing, and feeding children while you are sitting	9.71	11.67	8.83	8.40
Dressing, bathing, and feeding children while you are standing	10.56	11.30	11.25	9.45
Playing with your children while you are sitting or standing	16.09	19.62	15.30	13.23
Playing with your children while you are walking or running	13.61	15.27	13.00	16.00
Carrying children…	5.54	6.68	5.00	4.80
Taking care of an older adult…	5.35	5.73	4.33	5.60
Sitting and using a computer or writing while not at work…	5.63	4.77	7.05	5.58
Watching TV or a video…	14.75	14.95	13.42	15.35
Sitting and reading, talking or on the phone, while not at work	9.11	10.56	9.44	7.54
Playing with pets…	5.29	6.11	3.73	5.44
Light cleaning like making beds, laundry, ironing, putting things away…	18.72	21.47	17.25	17.02
Shopping for food, clothes, or other items…	16.24	14.88	18.21	16.33
Heavier cleaning like vacuuming, mopping, sweeping, or washing windows	1.49	2.12	1.33	1.00
Mowing lawn while on a riding mower	0.10	0.13	0.03	0.12
Mowing lawn while using a walking mower, raking, or gardening	0.10	0.03	0.21	0.09
Walking slowly to go to places such as walking to the bus or to work or visiting. Not for fun or exercise	13.08	10.08	15.00	14.75
Walking quickly to go to places such as walking to the bus or to work or to school. Not for fun or exercise	16.12	13.36	21.00	15.80
Driving or riding in a car or bus	4.90	5.49	4.38	4.65
Walking slowly for fun or exercise	1.75	1.62	2.29	1.55
Walking quickly for fun or exercise	2.24	2.02	3.23	1.84
Walking quickly uphill for fun or exercise	2.19	1.82	3.64	1.67
Jogging	0.85	0.95	1.08	0.60
Prenatal exercise class	0.35	0.00	0.33	0.70
Swimming	0.44	0.59	0.07	0.51
Dancing	0.47	0.51	0.27	0.55
Sitting at work or in class	14.57	20.70	10.00	11.52
Standing or slowly walking at work while carrying things like heavier than 3.8 liters or 1 gallon	10.91	5.25	17.50	12.30
Standing or slowly walking at work while not carrying anything	17.69	15.52	27.13	14.08
Walking quickly at work while carrying things like heavier than 3.8 liters or 1 gallon	8.89	5.94	13.00	9.20
Walking quickly at work while not carrying anything	12.20	15.58	7.43	11.88

Legend: PPAQ – Pregnancy Physical Activity Questionnaire; MET-h/wk – metabolic equivalent hours per week; NE – No Exercise; AE – Acute Exercise; CE – Chronic Exercise

Table 4: Description of physical activity energy expenditure in MET-h/wk during pregnancy, according to intensity and type of activity based on the modified PPAQ.

Physical Activities (MET-h/wk)	Overall (n=89)	NE (n=33)	AE (n=21)	CE (n=35)
Total Activity	255.39	261.95	277.03	239.81
Intensity				
Sedentary Activity	48.94	56.48	44.28	44.64
Light-intensity Activity	109.59	112.71	125.38	97.18

Moderate-intensity Activity	93.81	90.00	102.64	95.72
Vigorous-intensity Activity	3.04	2.78	4.72	2.27
Type of Activity				
Household/caregiving Activity	113.98	126.12	117.04	104.29
Occupational Activity	64.26	62.98	75.06	58.98
Sports/exercise	8.28	7.52	10.91	7.43

Legend: PPAQ – Pregnancy Physical Activity Questionnaire; MET-h/wk – metabolic equivalent hours per week; NE – No Exercise; AE – Acute Exercise; CE – Chronic Exercise

Table 5: Ultrasonographic findings among the study participants on testing day between 26^{+0} to 32^{+0} weeks age of gestation

Findings	Overall	NE	AE	CE	p-val
Third Trimester					
Fetal Presentation					
Cephalic	55 (61.80%)	21 (63.63%)	14 (66.67%)	20 (57.14%)	
Breech	10 (11.24%)	1 (3.03%)	5 (23.81%)	4 (11.43%)	0.33
Transverse	6 (6.74%)	1 (3.03%)	2 (9.52%)	3 (8.57%)	
Fetal heart rate	146 (123-168)	144 (123-167)	153 (131-168)	146 (123-157)	0.38
BPD					
Centimeters	7.8 (7.1-8.7)	7.9 (7.1-8.5)	7.8 (7.1-8.7)	7.8 (7.3-8.7)	0.52
Weeks	31.43 (28.43-35.29)	31.86 (28.43-34.29)	31.14 (28.57-35.29)	31.28 (29.29-35.14)	0.51
OFD in cm	9.8 (8.6-11.1)	9.7 (8.8-10.9)	9.9 (8.6-10.5)	9.9 (8.9-11.1)	0.99
CI in %	80 (73-85)	80 (75-85)	78.1 (74-85)	79 (73-85)	0.33
Head circumference					
Centimeters	28.2 (25-31)	28.1 (25-31)	27.9 (25.2-30.3)	28.4 (25.5-30.8)	0.90
Weeks	30.71 (27.14-34.71)	30.71 (27.14-34.71)	30.57 (27.29-33.71)	31.14 (27.71-34.43)	0.94
Fetal length					
Centimeters	5.8 (4.8-6.8)	5.8 (5.4-6.8)	5.7 (4.8-6.3)	5.74 (5.1-6.3)	0.44
Weeks	30.14 (25.86-34.86)	30.14 (28.57-34.86)	30 (25.86-32.71)	30.14 (27.43-32.43)	0.27
AC					
Centimeters	25.8 (22.7-30.5)	26.1 (23.4-30.5)	25.7 (22.7-29.1)	25.7 (23-29.5)	0.23
Weeks	30 (27.14-34.43)	30.29 (27.71-34.43)	29.86 (27.14-33)	29.86 (27.29-33.43)	0.18
EFW in grams	1567 (1012-2425)	1597 (1270-2425)	1543 (1012-1966)	1567 (1089-1953)	0.29
Weeks by EFW	30.14 (27.29-34.29)	30.14 (28.29-34.29)	30.14 (27.43-32)	30.29 (27.29-32)	0.56
Weeks by EDD	31 (28-33.71)	31.14 (28.71-33.71)	31 (28-32.71)	30.86 (28.86-33.43)	0.34
Placental Location					
Posterior	40 (56.34%)	12 (52.17%)	13 (61.90%)	15 (55.56%)	0.79
Anterior	31 (43.66%)	11 (47.83%)	8 (38.10%)	12 (44.44%)	
Amniotic fluid index	12.9 (8-21.9)	13.1 (9.3-21.9)	13.5 (9.1-17.6)	12.3 (8-17)	0.24

Legend: NE – No Exercise; AE – Acute Exercise; CE – Chronic Exercise; BPD – Biparietal diameter; OFD – Occipitofrontal diameter; CI – Cephalic index; AC – Abdominal circumference; EFW – Estimated fetal weight; EDD – Estimated date of delivery

Table 6: Distribution of Doppler Characteristics across Study Groups

Findings	No Exercise		Acute Exercise		Chronic Exercise		p-value
	First Scan	*Second Scan*	*Before*	*After*	*Before*	*After*	
UMB A S/D	3.07 ± 0.78	2.99 ± 0.65	3.06 ± 0.64	2.90 ± 0.57	2.94 ± 0.76	2.90 ± 0.46	0.87
UMB A PI	1.04 ± 0.20	1.02 ± 0.18	1.08 ± 0.22	0.97 ± 0.16	1.00 ± 0.18	0.99 ± 0.15	0.26
UMB A RI	0.65 ± 0.08	0.65 ± 0.08	0.65 ± 0.07	0.64 ± 0.07	0.64 ± 0.07	0.64 ± 0.06	0.91
RT UT A S/D	1.88 ± 0.21	1.99 ± 0.31	2.03 ± 0.59	2.06 ± 0.53	2.03 ± 0.39	2.08 ± 0.47	0.80
LT UT A S/D	1.99 ± 0.41	1.98 ± 0.24	2.10 ± 0.50	1.97 ± 0.34	2.17 ± 0.60	2.23 ± 0.79	0.38
RT UT RI	0.47 ± 0.08	0.50 ± 0.12	0.59 ± 0.35	0.81 ± 0.96	0.49 ± 0.08	0.70 ± 1.07	0.69
LT UT RI	0.49 ± 0.08	0.49 ± 0.05	0.51 ± 0.09	0.51 ± 0.18	0.52 ± 0.09	0.54 ± 0.12	0.88
MCA PI	1.65 ± 0.25	1.67 ± 0.23	1.85 ± 0.44	1.90 ± 0.52	1.85 ± 0.39	1.70 ± 0.32	0.26
CP Ratio	1.63 ± 0.34	1.68 ± 0.44	1.76 ± 0.48	1.95 ± 0.67	1.91 ± 0.51	1.73 ± 0.36	0.10

Legend: UMB A – Umbilical artery; RT UT A – Right uterine artery; LT UT A – Left uterine artery; MCA – Middle cerebral artery; S/D – Systolic peak / End diastolic flow; RI – Resistance index; PI – Pulsatility index; CP – Cerebroplacental

Table 7: Effects of Exercise on Clinical Cardiorespiratory Parameters across Study Groups

Characteristics	Acute Exercise		Chronic Exercise		p-value
	Before	*After*	*Before*	*After*	
Number of Sessions	-		11 ± 4.70 (2-24)		-
Clinical Parameters					
Systolic blood pressure	107.08 ± 12.10	104.19 ± 7.29	105.78 ± 11.54	102.19 ± 12.20	0.67
Diastolic blood pressure	69.23 ± 10.60	67.43 ± 7.30	67.26 ± 9.51	66.28 ± 9.69	0.45
Mean arterial pressure	81.85 ± 10.76	79.68 ± 6.95	80.10 ± 9.92	78.25 ± 10.29	0.80

Oxygen saturation	98.52 ± 0.51	98.81 ± 0.75	98.07 ± 0.80	98.65 ± 0.47	0.21
Heart rate	92.62 ± 9.62	88.19 ± 9.51	92.83 ± 8.46	84.32 ± 6.58	0.07
Capillary blood glucose	120.95 ± 18.64	114.57 ± 14.55	130.18 ± 13.94	114.29 ± 8.10	0.04*

Effect of SZG on maternal well-being

Using the Warwick-Edinburgh Mental Well-being Scale (WEMWBS), there were observable significant increases in the mean (F[1, 267]: 8.45, p<0.01) and median (z: -12.81, p<0.01) WEMWBS scores before and after exercise for both CE and AE groups (Table 8). It can also be noted that when considering the sessions as continuous covariates, increasing the number of sessions was associated with even greater scores or better well-being post-exercise (F[1, 267]: 5.18, p: 0.02), particularly among those who had more than 15 sessions (Table 8).

Table 8: Distribution of Warwick-Edinburgh Mental Well-being Scale Scores (WEMWBS) across Study Groups

Statistics	Overall		Acute Exercise		Chronic Exercise		p-value
	Before	*After*	*Before*	*After*	*Before*	*After*	
Mean ± SD	55.81 ± 8.09	64.63 ± 6.80	59.75 ± 8.22	64.30 ± 5.69	55.49 ± 8.01	64.66 ± 6.89	<0.01*
Median	56 (35-70)	68 (40-70)	59 (46-70)	65 (51-70)	56 (35-70)	68 (40-70)	<0.01*

For the study participants in the exercise groups (AE and CE), a total of 53 out of 56 birth outcomes were collected. Data from three (3) participants were not obtained due to nationwide lockdowns during the COVID-19 pandemic (2020-2022) even after several attempts to contact them or trace their whereabouts. Table 9 shows that there were no significant differences across study groups although the influence of institutional policies and other ongoing events during the pandemic were not accounted for.

Table 9: Distribution of the Outcomes across Study Groups

Outcomes	Overall	No Exercise	Acute	Chronic	p-value
Mode of Delivery					
Vaginal	43 (48.31%)	14 (42.42%)	10 (47.62%)	19 (54.29%)	0.30
Abdominal	10 (11.24%)	4 (12.12%)	-	6 (17.14%)	
Anthropometrics					
Actual birth weight (Kg)	2.9 (1.7-4.5)	2.9 (1.7-3.5)	2.85 (2.1-4.5)	2.8 (2.2-4.0)	0.66
Low birth weight	6 (6.74%)	1 (3.03%)	2 (9.52%)	3 (8.57%)	0.75
Fetal length (cm)	50 (31-54)	50 (46-52)	52 (51-52)	50 (31-54)	0.35
Head circumference (cm)	33 (30-48)	33 (31-35)	35 (35-36)	33 (30-48)	0.30
Chest circumference (cm)	32 (24-36)	32 (31-35)	32 (32-33)	32 (24-36)	0.66
Abdominal circumference (cm)	30 (27-31)	30 (29-31)	29 (29-30)	30 (27-31)	0.95
Need for intensive care	1 (1.12%)	-	-	1 (2.86%)	0.13
Exclusive Breastfeeding	19 (21.35%)	8 (24.24%)	1 (4.76%)	10 (28.57%)	0.10
Type of anesthesia					
Local	12 (13.48%)	5 (1515%)	-	7 (20%)	
Epidural	2 (2.25%)	1 (3.03%)	1 (4.76%)	-	0.32
Spinal	4 (4.49%)	2 (6.06%)	-	2 (5.71%)	
General	1 (1.12%)	-	-	1 (2.86%)	
Blood transfusion	1 (1.12%)	-	-	1 (2.86%)	0.62
Duration of labor (hours)	4 (1-17)	6 (3-9.5)	17 (17-17)	3 (1-12)	0.09

DISCUSSION

Routine exercise strengthens, shapes and tones the human body to perform more efficiently.[23] It conditions bodily systems to adequately respond to multiple stimuli, and whether homeostatic balance is maintained depends on the individual's concurrent level of fitness or the presence of any illness. As pregnancy is a diabetogenic state where all maternal systems are altered to accommodate the growth of the fetus[24], exercise during this period may be viewed as an additional strain to the intensifying adaptations ongoing in the mother. Although exercise is not contraindicated in pregnancy, addressing opposing views on its safety during the gestational period will require understanding the intimate and intricate physiological connections between the maternofetal dyad.

Our results showed that the population investigated was homogeneous in terms of baseline levels of physical activity before study engagement. Overall, participant average energy expenditure was at an intensity between light to moderate and with most of this involving household work or caregiving. The latter was similar to reports from comparable populations in Asia.[25,26] Given a population with a tendency towards less intense activity, the addition of low impact exercise such as Shen Zhen Gong was not seen as too strenuous for this group of women.

Determining the possible differences in effects due to chronic exercise, acute exercise, and no exercise was of key interest. Maternal responses are known to differ in individuals with different levels of physical conditioning. Among those assigned to the CE group, systolic (t: 5.51, df: 34, p<0.01), diastolic (t: 2.77, df: 34, p: 0.01), mean arterial pressures (t: 4.44, df: 34, p<0.01), and heart rates (t: 9.22, df: 34, p<0.01) were lower after exercise. Their oxygen saturations (t: -4.66, df: 34, p<0.01) were also noted to be improved after exposure to the regimen. Earlier studies on routine physical activity have already shown the same lowering effects on heart rate and blood pressure. Improvements in cardiovascular performance are reportedly due to cardiovascular remodeling which increases physiologic reserves that address rising systemic vascular resistance or pressure from cardiac volume overload during exercise. These were due to subsequent strengthening of heart muscle and lessening of vascular stiffness which notably differed from effects seen in chronic pathologic conditions such as hypertension. Moreover, exercise-associated cardiovascular and pulmonary responses

increase oxygen saturation through higher stroke volume and through enhanced respiratory efforts.[27-29]

There were no significant changes for the AE and NE groups, but to a certain extent, women in the AE group appeared to have lower heart rates (t: 1.85, df: 20, p: 0.08) after exercise. Changes in cardiac autonomic function in acute exercise are similar to changes in chronic exercise. Shifts in autonomic function toward increased parasympathetic nervous system activity and decreased sympathetic nervous system activity, provide a more stable autonomic environment for the heart. All these confirm the cardioprotective effects of both acute and chronic exercise.[30,31]

With regards to blood glucose, this was significantly lower in the CE group after exercise (t: 7.80, df: 34, $p<0.01$) and especially among those who had 2 to 5 ($F[1,51]$: 3.91, p: 0.05), 6 to 10 ($F[1,51]$: 11.06, $p<0.01$), 11 to 15 ($F[1,51]$: 9.10, $p<0.01$), and more than 15 sessions ($F[1,51]$: 8.34, p: 0.01). In normal pregnancy, appropriate changes in insulin sensitivity occur as an important metabolic adaptation. As pregnancy progresses, both maternal and placental hormones promote insulin resistance, slightly increasing glucose levels that pass the placenta to fuel fetal growth. During exercise, there is an increase in glucose consumption as well as an increase in insulin sensitivity in muscle cells which allows for the continuous uptake of glucose into these cells even after exercise. Thus, routine exercise is known to lower blood glucose through improvements of blood glucose control and insulin use. Various guidelines recommend routine exercise in pregnancy to reduce the risk of excessive maternal weight gain and gestational diabetes.[24, 32,33]

Another aspect evaluated in this study was the effect of low impact exercise on mental well-being. There were observable significant increases in well-being scores after exercise for both CE and AE groups (mean: $F[1, 267]$: 8.45, $p<0.01$). Also, increasing the frequency of exercise was associated with even greater scores or better well-being post-exercise ($F[1, 267]$: 5.18, p: 0.02). Previous studies showed that physical activity significantly improves mental health and reduces the symptoms of depression in pregnant women.[34,35] Routine exercise is a form of physical activity which has been promoted by many studies as one of the lifestyle habits that ensure a healthy pregnancy.[4] Aside from good nutrition and micronutrient supplementation, high sleep quality, smoking cessation, and stress reduction, physical activity in pregnancy reduces the risk of adverse pregnancy outcomes.[36] According to the World Health Organization, it is among the key preventive strategies to achieve a successful pregnancy by safeguarding physical, mental and psychosocial health.[37] Positive contributions to the latter most likely occurred in the study due to communal exercise sessions with the instructors and participants.

Finally, our Doppler studies of the fetus showed no significant changes after SZG exercise, thus, supporting other earlier reports wherein no decrease in fetal Doppler parameters was also observed after regular supervised moderate exercise or resistance training.[38,39] Although these Doppler flow findings are limited observations, the absence of alteration in blood flow can be viewed as beneficial in terms of maintenance of cardiovascular balance. In the future, studies on fetal heart rate variability may give a more accurate account of these underlying effects. The actual maternofetal electrocardiographic studies performed in this population shall involve a different scope from the current discussion and was deemed to merit a separate report.

CONCLUSION

In normal pregnancy, the practice of Sheng Zhen Gong, a routine exercise with low intensity, was seen to have beneficial effects on maternal cardiovascular, blood glucose and mental well-being maintenance with no evidence of detrimental effects on the fetus. In high-risk pregnancy conditions, where exercise is contraindicated, patients may still benefit from meditation, the non-strenuous component of Sheng Zhen Gong to improve mental health. In general, further research on exercise in combination with other prenatal preventive strategies and with more intensive fetal studies is warranted. Studies using 24-hour data extraction modalities that will allow real-time evaluation of physiologic parameters during exercise and at rest would give a closer picture of the underlying adaptations in the maternofetal dyad.

CONFLICT OF INTEREST

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

CONTRIBUTIONS OF INDIVIDUAL AUTHORS

CLV - conception and design, data acquisition and interpretation, drafted the article; SALS - data acquisition and interpretation; ADRS - conception and design, data interpretation, statistical analysis; OAGT - data acquisition and interpretation, statistical analysis, proofreading; RNC - drafted the article; MTZ - conception and design.

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SUPPLEMENTARY INFORMATION

Supplementary Table 1: Ultrasonographic findings during monitoring of NE and CE participants in the first and second trimester.

Findings	Overall	NE	AE	CE	p-value
First Trimester					
Fetal heart rate	162.74 ± 8.76	163.56 ± 7.54	-	161.97 ± 9.82	0.46
Crown Rump Length					
Millimeters	6.17 ± 1.12	6.08 ± 1.10	-	6.26 ± 1.15	0.54
Weeks	12.62 ± 0.84	12.55 ± 0.82	-	12.68 ± 0.86	0.53
TR Normal	63 (70.79%)	30 (90.91%)	-	33 (94.29%)	0.48
DV Normal	64 (71.91%)	31 (93.94%)	-	33 (94.29%)	0.95
Present Nasal bone	52 (58.43%)	27 (81.82%)	-	25 (71.43%)	0.35
NT (mm)	1.44 ± 0.45	1.36 ± 0.47	-	1.51 ± 0.42	0.18
Other Findings					
Anterior placenta	1 (1.12%)	-	-	1 (2.86%)	-
Fetal tachycardia	4 (4.49%)	-	-	4 (11.43%)	-
Second Trimester					
Fetal Presentation					
Cephalic	27 (30.34%)	13 (39.39%)	-	14 (40%)	
Breech	20 (22.47%)	9 (27.27%)	-	11 (31.43%)	0.91
Transverse	10 (11.24%)	4 (12.12%)	-	6 (17.14%)	
Fetal heart rate	151 (120-174)	150 (120-174)	-	151 (127-165)	0.59
BPD					
Centimeters	5.3 (4.3-6.5)	5.27 (4.3-6.5)	-	5.3 (4.4-6)	0.88
Weeks	22 (19-26.29)	21.93 (19-26.29)	-	22 (19.29-24.29)	0.87
OFD (cm)	6.9 (5.83-8.9)	6.8 (5.8-8.9)	-	7.1 (6.1-7.7)	0.37
CI in %	76 (56.4-83)	77.9 (63-83)	-	76 (56.4-83)	0.01*
HC					
Centimeters	19.4 (3.50-23.1)	19.4 (7.39-23.1)	-	19.4 (3.50-21.9)	0.88
Weeks	21.57 (19.57-25.14)	21.57 (19.85-25.14)	-	22 (19.57-24)	0.68
FL					
Centimeters	3.66 (2.93-4.50)	3.65 (2.93-4.50)	-	3.66 (3-4.3)	0.77
Weeks	21.71 (19-26.29)	21.5 (19-24.71)	-	21.86 (19.86-26.29)	0.21
AC					
Centimeters	17.1 (7.0-21)	16.65 (13.17-21)	-	17.6 (7.0-20.2)	0.26
Weeks	22 (18.71-25.57)	21.71 (18.71-25.57)	-	22.29 (19.29-24.71)	0.32
EFW in grams	448 (164-755)	419 (164-755)	-	468 (283-659)	0.23
Weeks by EFW	21.71 (19.14-24.86)	21.57 (19.29-24.86)	-	21.86 (19.14-23.57)	0.27
Weeks by EDD	21.86 (20.14-24.71)	21.79 (20.14-24.71)	-	22 (20.29-24.71)	0.51
Placental Location					
Posterior	28 (31.46%)	13 (39.39%)	-	15 (42.86%)	0.90
Anterior	29 (32.58%)	13 (39.39%)	-	16 (45.71%)	
Placental Grade					
1	53 (59.55%)	23 (69.70%)	-	30 (85.71%)	0.32
2	4 (4.49%)	3 (9.09%)	-	1 (2.86%)	
Amniotic fluid index	3.94 (1.7-10.6)	3.9 (1.7-10.6)	-	4 (2.6-6.4)	0.50
Congenital Anomaly Scan					
HR	2.5 (0.11-3.1)	2.5 (0.11-3.1)	-	2.5 (0.8-2.9)	0.92
TCD	2.3 (1.36-3.2)	2.3 (1.36-3.2)	-	2.3 (1.5-2.9)	0.68
LV	0.6 (0.36-0.8)	0.6 (0.38-0.8)	-	0.6 (0.36-0.8)	0.56
CM	0.5 (0.3-0.9)	0.5 (0.33-0.8)	-	0.5 (0.3-0.9)	0.46
BOD	3.5 (0.8-4.5)	3.45 (1.8-4.5)	-	3.5 (0.8-4.5)	0.90
IO	1.4 (0.6-4.6)	1.3 (0.6-1.9)	-	1.4 (0.76-4.6)	0.27
LO	1 (0.6-1.3)	1 (0.6-1.2)	-	1 (0.79-1.3)	0.97
RO	1 (0.6-1.3)	1 (0.6-1.3)	-	1 (0.8-1.3)	0.63
CC	6.4 (5.33-8.6)	6.45 (5.36-8.6)	-	6.4 (5.33-8.2)	0.92
TC	13.8 (10.6-16.9)	13.9 (11.54-16.9)	-	13.8 (10.6-16.7)	0.58
TC/AC	0.82 (0.72-1.77)	0.84 (0.73-0.92)	-	0.80 (0.72-1.77)	0.02*
CC/TC	0.46 (0.39-0.53)	0.46 (0.39-0.52)	-	0.46 (0.41-0.53)	0.29
RK (Length 1)	1.4 (0.73-1.8)	1.31 (0.73-1.8)	-	1.4 (0.89-1.7)	0.43
RK (Length 2)	1.4 (0.2-2.2)	1.3 (0.2-2.0)	-	1.4 (0.9-2.2)	0.10
RK (PELVIS)	0.2 (0.1-0.4)	0.25 (0.1-0.4)	-	0.2 (0.1-0.4)	0.90
LK (Length 1)	1.5 (0.8-1.9)	1.31 (1.01-1.80)	-	1.5 (0.8-1.9)	0.32
LK (Length 2)	1.3 (0.66-2.3)	1.21 (0.66-2.3)	-	1.4 (1.0-2.2)	0.15
LK (PELVIS)	0.3 (0.1-1.3)	0.3 (0.1-1.3)	-	0.2 (0.1-0.9)	0.24
Humerus	3.5 (2.82-4.30)	3.5 (2.93-4.3)	-	3.5 (2.82-4.2)	0.75
Radius	2.9 (2.28-3.6)	2.9 (2.28-3.6)	-	3 (2.3-3.6)	0.39
Ulna	3.2 (0.68-3.9)	3.15 (0.68-3.9)	-	3.23 (2.7-3.9)	0.56

Findings	Overall	NE	AE	CE	p-value
Tibia	3.3 (2.66-4.1)	3.2 (2.66-4.1)	-	3.3 (2.7-3.9)	0.69
Fibual	3.2 (2.35-3.8)	3.1 (2.6-3.8)	-	3.2 (2.35-3.7)	0.88
Sex of the fetus					
Male	30 (33.71%)	15 (45.45%)	-	15 (42.86%)	
Female	24 (26.97%)	9 (27.27%)	-	15 (42.86%)	0.50
Repeat scan	3 (3.37%)	2 (6.06%)	-	1 (2.86%)	
Doppler Scan					
UMB A S/D	3.74 (2.08-8.67)	3.71 (2.43-8.67)	-	3.74 (2.08-5.11)	0.80
UMB A PI	1.23 (0.88-1.78)	1.2 (0.88-1.78)	-	1.24 (1.02-1.54)	0.54
UMB A RI	0.73 (0.59-0.88)	0.73 (0.59-0.88)	-	0.73 (0.59-0.80)	0.60
RT UT A S/D	2.29 (1.04-7.79)	2.25 (1.04-4.69)	-	2.35 (1.71-7.79)	0.55
LT UT A S/D	2.33 (1.35-5.10)	2.24 (1.35-5.10)	-	2.41 (1.66-4.54)	0.13
RT UT RI	0.57 (0.29-1.47)	0.57 (0.29-1.47)	-	0.57 (0.42-0.87)	0.87
LT UT RI	0.57 (0.26-0.88)	0.55 (0.26-0.88)	-	0.59 (0.40-0.78)	0.17
MCA PI	1.53 (1.04-4.30)	1.50 (1.04-2.18)	-	1.55 (1.13-4.30)	0.40
CP Ratio	1.21 (0.81-3.20)	1.21 (0.81-1.76)	-	1.20 (0.88-3.20)	0.94

Legend: NE – No Exercise; AE – Acute Exercise; CE – Chronic Exercise; BPD – Biparietal diameter; OFD – Occipitofrontal diameter; CI – Cephalic index; AC – Abdominal circumference; EFW – Estimated fetal weight; EDD – Estimated date of delivery; HR – Heart rate; TCD – Transcerebellar diameter; LV – Lateral ventricle; CM – Cisterna magna; BOD – Binocular diameter; IO – Interocular diameter; LO – Left ocular; RO – Right ocular; CC – Cardiac circumference; TC – Thoracic circumference; RK – Right kidney; LK – Left kidney; UMB A – Umbilical artery; RT UT A – Right uterine artery; LT UT A – Left uterine artery; MCA – Middle cerebral artery; S/D – Systolic peak / End diastolic flow; RI – Resistance index; PI – Pulsatility index; CP - Cerebroplacental