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ORIGINAL

SUPERVISED PHYSICAL ACTIVITY DURING PREGNANCY IMPROVES FETAL CARDIAC RESPONSE

EL EJERCICIO FÍSICO SUPERVISADO DURANTE EL EMBARAZO MEJORA LA RESPUESTA CARDIACA FETAL

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ABSTRACT

Objective: To assess the influence of a physical activity program during pregnancy on the adaptation of the fetal heart rate (FHR). Greater adaptations and faster recovery are expected to find.

Methods: 45 pregnant women included in a randomized control trial, all with uncomplicated pregnancies for exercise were studied in their third trimester of pregnancy. Rest FHR, post-exercise FHR and recovery time were assessed.

Results: Rest FHR was similar in both groups. Post-exercise FHR were significantly higher in control group (CG) than in exercise group (EG) in both test, 40% 138,5±6,4EG vs 141±7,5CG (p=0,001), 60% 141,6±10,8EG vs 150,3±16,8CG. The same was found in recovery time, 40% 78,2±95,7EG vs 328,4±315,2CG (p=0,001), al 60% 193,3±257,8EG vs 542,6±482,9CG (p=0,003).

Conclusion: Greater adaptation in post-exercise FHR and faster recovery to rest FHR have been found as a result of a physical activity program carried out during pregnancy.

KEYWORDS: Pregnancy, exercise, fetal heart rate, recovery time.

RESUMEN

Objetivo: Valorar la influencia de un programa de ejercicio físico durante la gestación en la adaptación de la frecuencia cardiaca fetal (FCF). Se espera encontrar una mejor adaptación de la FCF especialmente en cuanto a recuperaciones más rápidas.

Método: 45 gestantes participantes en un ensayo clínico aleatorizado sin complicaciones ni contraindicaciones para el ejercicio fueron estudiadas durante el tercer trimestre de embarazo. Se midieron las siguientes variables: FCF en reposo, FCF post-ejercicio y tiempo de recuperación de la FCF a los niveles de reposo.

Resultados: La FCF en reposo fue similar en ambos grupos. La FCF post-ejercicio fue significativamente mayor en el grupo control (GC) que en el grupo ejercicio (GE) en ambas pruebas, al 40% GE=138,5±6,4GE vs 141±7,5 GC (p=0,001), al 60% 141,6±10,8 GE vs 150,3±16,8GC. Lo mismo ocurre en los tiempos de recuperación, al 40% 78,2±95,7GE vs 328,4±315,2GC (p=0,001), al 60% 193,3±257,8 GE vs 542,6±482,9GC (p=0,003).

Conclusión: El ejercicio físico desarrollado durante el embarazo tiene como consecuencia una mejor adaptación de la FCF post-ejercicio, así como recuperaciones más rápidas.

PALABRAS CLAVE: Embarazo, ejercicio, frecuencia cardiaca fetal, tiempo de recuperación.

INTRODUCTION

Nowadays physical activity during pregnancy is a common activity between women in reproductive age[1]. Importants scientists evidences maintain that physical exercise is safe for mother and fetus with no risk on pregnancy development[2-6]. Even some authors associate physical exercise with improved labor results[7-9].

Fetal heart rate (FHR) is one of the most studied parameter to confirm fetal well-being[1, 10, 11]. Few studies have search FHR response in those mothers who practice physical exercise, nevertheless there is a lack of agreement about how FHR responses to different exercise dose [12-15], and remains unknown the influence of a supervised physical exercise during pregnancy in FHR behavior. That could be due to the variety of the studies designs.

In theory, uteroplacental blood flow decreases due to muscles blood attraction during exercise, as a consequence less fetal nutrients and oxygen disposition from the mother, it means undoubtedly a serious determinant to physical exercise safety during gestation [16-18]. However the most of the studies agree on the absence of harmful effects for fetal well-being[3, 4, 13, 15, 16, 18].

A better awareness of this variable in response to maternal exercise would be useful to assess fetal adaptation capacity in unbalanced cardiodinamic situations like physical exercise.

Therefore, it would be interesting to examine if the effects of a supervised physical exercise dose that a woman can carry out during her pregnancy could also reach fetal organism and generate adaptations in its cardiac response.

OBJECTIVES

The objective of the present study was to assess the influence of a moderate aerobic physical exercise program performed during pregnancy on FHR response. The hypothesis consisted in a moderate aerobic physical exercise program three times per week would be associated with improved FHR response and faster recovery time.

METHODS

The study was carried out via collaboration between Gynaecology and Obstetrics Service of Universitary Hospital of Fuenlabrada (Madrid) and the Faculty of Physical Activity and Sport Science (INEF) of the Technical University of Madrid (UPM). The Ethics Committee of Clinical Research approved the protocol.

Size

45 Pregnant women (Age= 31,9±3,2) were studied between February 2011 and March 2012. The test was part of a Randomized Control Trial (RCT) whose main objective was to examine the influence of exercise on pregnancy outcomes. The draw in was made at obstetrics examination room at Universitary Fuenlabrada Hospital, the women were randomized in Exercise Group (EG) and Control Group (CG). The randomization procedure was based on Armitage and Berry (randomized numbers tables) [19].

Written informed consent was sign for all participants. All women had neither contraindications nor complication for exercise, either multiple gestation. A questionnaire was completed with size demographic data (Pre-pregnancy BMI, smoking, level of education, pregnancy history, etc).

Intervention

Physical exercise program

Physical exercise program design was based on the Guidelines of American College of Obstetricians and Gynecologist [20], since they are basic and safe lines of actuation supported by several researches [4, 9, 18, 21, 22]. That reassures fetal and maternal well-being during and after physical activity.

The program was performed at Universitary Hospital of Fuenlabrada (Madrid), at a ventilated room, with natural light, with music and with positive environmental conditions (600m altitude, 19-21º temperature, 50-60% humidity).

Practice sessions development was conducted by a Physical Exercise and Sports graduate.

Exercise program: 80 sessions made up the program, three times per week, 55-60 minutes duration. Training intensity was moderate between 55-65% based on Karvonen formula, it was assured using Polar heart rate monitor (FT7).

The women began the program between 10-15 week of gestation, the end was around 38-39, unless they develop any contraindication for exercise. Minimum required adherence to the program was 80% (64 sessions).

Program designs: the sessions started with a 7-8 minutes walking warm-up, sometimes games. Following the main part of the session, 35-40 minutes in which three different parts were included.

Aerobic exercise during 20-25 minutes with simple choreographies adapted for pregnancy women. High impact steps as running, skipping and turning were avoided.

General strength training, working the main damaged muscles during pregnancy like abdominals, lower back muscles, gluteus, quadriceps and pectoral. Mild load was recommended (0,5-1 kg), two series of eight, fifteen or twenty repetitions were performed depending on worked muscles.

Pelvic floor muscles training based on Kegel exercises with slow and fast contractions [1, 24].

At the end a 7-8 minutes cool-down period, in which the intensity decreased gradually trough stretching and relaxation exercises. Stretching exercises were maintained during 30 seconds. Relaxation exercises comprised slow and controlled breath and visualizations. Sometimes relaxant massage was performed.

Fetal Heart Rate evaluation protocol

All the women were studied between 34-36 week of gestation. The evaluations were carried out in the afternoon between 17-19 hours and the women were asked for a 90 minutes fasting before the test. The specific test protocol for FHR evaluation consisted on two exercise series of three minutes walking at two different intensity (40%-60%) following Karvonen formula [21, 23].

Previous to the first walking session (40%), the expectant woman stayed 15 minutes standing up in order to obtain FHR and maternal heart rate (MHR) at rest. When those parameters were obtained the first test began at 40% intensity. After three minutes walking, FHR was immediately registered posterior to maternal effort, also recovery time to rest were recorded. This protocol was repeated at 60% intensity.

Wireless telemetry T800 (Hispania Hospital S.L Spain) to assess FHR and uterine activity was used to register FHR. All subjects wore a heart rate (HR) monitor (FT7, Polar Electro Oy, Finland) during the training session to register MHR.

Assessed parameters during the protocol:

- Rest fetal heart rate.
- Rest maternal heart rate.

- Fetal heart rate after maternal effort.
- Recovery time of fetal heart rate to rest.

Statistical analysis: Student´s *t* test and X^2 test were used to data analyze in all variables, both main variables and descriptive. Significance level was set at $p<0,05$.

RESULTS

Sample characteristics are shown in Table I.

Tabla I: Size characteristics.

Parameter	Group		p
	Exercise Group n=25	Control Group n=20	
Age	31,84 ±3,4	31,95 ±2,9	> *0,05*
Pre-pregnancy BMI	23,53 ± 4,1	22,75 ± 3,3	> *0,05*
MHR (bpm) at rest at test.	91,6 ± 15,3	90,7 ± 12,4	> *0,05*
Gestational Age at test	33,6 ± 3	34,9 ±1,2	*>0,05*
Studies level (n/%)			*>0,05*
Primary level ended.	2 / 8%	5 / 25%	
Secondary level ended	16 / 64%	12 / 60%	
Tertiary level ended	7 / 28%	3 / 15%	
Smoking (n/%)			*>0,05*
No	20 / 80%	15 / 75%	
Yes	2 / 8%	2 / 10%	
Sometimes	1 / 4%	0 /0%	
Yes before, not now	2 / 8%	3 / 15%	
Miscarriage (n/%)			*>0,05*
No	17 / 68%	17 / 85%	
One	7 / 28%	2 / 10%	
Two or more	1 / 4%	1 / 5%	
Underweight birth			*>0,05*
No	25 / 100%	20 / 100%	
One newborn underweight	0 / 0%	0 / 0%	
Two or more newborn underweight	0 / 0%	0 / 0%	
Preterm pregnancy (n/%)			*>0,05*
No	25 / 100%	19 / 95%	
One	0 / 0%	1 / 5%	
Two or more	0 / 0%	0 / 0%	

Table II shows results of FHR assessed in beats per minute (bpm) at rest, post-exercise FHR (bpm) at 40% and 60%, and FHR recovery time in seconds (s) at 40% and 60%.

Table II: FHR at rest, post-exercise FHR and FHR recovery time at 40% and 60%.

Parameter	Group		*p*	Cohen *d*
	Exercise Group n=25	Control Group n=20		
Rest FHR (bpm)	140,1 ± 6,4	141,5 ±7,5	=0,496	
Post-exercise FHR (bpm) 40%	138,5 ±11,3	149,8 ± 10,3	=0,001	1,06
FHR recovery time (s) 40%	75,2 ±95,7	328,4 ±315,2	=0,001	1,17
Post-exercise FHR (bpm) 60%	141,6 ± 10,8	150,3 ± 16,8	=0,043	0,65
FHR recovery time (s) 60%	193,3 ±257,8	542,6 ±482,9	=0,003	0,95

Significant differences were found in FHR after 40% test (p=0,001) and at 60% (p=0,043). Also significant differences were found in FHR recovery time at 40% (p=0,001) and 60% (p=0,003).

After maternal effort at 40% all the fetuses in EG recovered their rest FHR within the time set for recovery (20 minutes), and 95% of the fetuses in CG. These fetuses carried out the test at 60% because their FHR was within the safe target (120-160 bpm) [25, 26].

After maternal effort at 60% all the fetuses in EG recovered its FHR facing 75% of the fetuses in CG, significant differences were found in this case (p=0,008).

DISCUSSION

The objective of the current study was to evaluate FHR response after maternal exercise, the main variable in this study was recovery time of FHR after maternal effort.

Our findings show a fast recovery to rest levels on FHR in fetuses whose mothers exercise during pregnancy. FHR after exercise in trained mothers keeps almost unchanged, in CG FHR after maternal exercise increases significantly.

Due to that faster recovery to rest levels in EG, a “training effect” could be thought in fetus whose mothers exercise during pregnancy, decreasing the time to reach rest levels[27-29].

These short variations in FHR after exercise could be considered as a fetal heart physiologic adaptation to uterine blood-flow restriction during exercise [16, 30], which is more effective in fetus of active pregnant mothers.

Several authors studied FHR response to maternal exercise[21, 22, 31-38]; nevertheless, the controversy about the adaptation of this parameter is still maintained [16].

Szymanski and Satin carried out a study to assess FHR in expectant mothers divided in different groups depending on their fitness level. Their test consisted on 30 minutes treadmill at 40-59% intensity. Doppler echocardiography was used to measure FHR. The results showed a non-significant increase of FHR post-exercise in sedentary expectants, it was significant in regularly active mothers[34].

May et al performed a study to assess FHR at rest by biomagnetometer in pregnant women organized in different fitness levels by a questionnaire. Their results show less FHR at rest in active women during pregnancy with significant differences[35].

In the study carried out by Silveira et al, a sedentary pregnant women group before pregnancy performed sessions of water aerobics at a swimming pool with moderate intensity. In the third trimester FHR behaviour was measured by cardiotocography before and after exercise. A slightly increase of FHR 1,41 bpm was found in post-exercise time, without significant differences[36].

In the study of Kenelly, pregnant women at their third trimester were tested on cycle ergometer, intensity was set on 15 of perceived exertion Borg scale. Their findings obtained by cardiotocography reveal an increase of FHR post-exercise, no statistically significant[37].

In the RCT performed by Brenner et al, pregnant women were divided in supervised physical activity group and sedentary group. FHR was assessed in the third trimester during a cycle ergometer session until the pregnant woman reached 170bpm. Their results show no significant differences in FHR at rest between groups, nor in recovery time (10-20 minutes). They indicate a decrease of FHR immediately after exercise, but without significant differences from the statistical viewpoint[22].

The study of Barakat et al, assess FHR in expectants in their third trimester during a 20 minutes cycle ergometer test, intensity was set between 50-60% of maximal HR. A cardiotocography was used. Recovery time to rest levels was around 5-7 minutes[21].

In Melzer et al review, the findings reveal a post-exercise FHR increase in the most of the studies. This increase is correlated with exercise duration and intensity[38].

The present study is similar to Brenner study in the method, because it is also a RCT with a supervised intervention in EG. The founded results in post-exercise FHR in the EG are similar to Silveira[36] and Kenelly[37] results.

Differences have been found in recovery time with Barakat study[21].

Few scientists data have been found about recovery time to rest levels, this makes more difficult to find similitudes or differences with other studies. However, in the review carried out by Wolfe[25], the average of recovery time is 20 minutes, different to the results found in this work.

The main novelty in this study is the use of the telemetry to assess FHR. This equipment gives us the possibility to record FHR immediately after exercise in a really normal activity in pregnant women as walking. The expectant must not be doing exercise over a machine or next to the equipment during the variable recording.

In this way the supervised intervention during pregnancy has let to find different results in EG tan in other relevant studies[21, 22, 34, 35].

CONCLUSION

The results in the present study encourage us to think in a possible adaptation of FHR as a consequence of supervised exercise during pregnancy. These cardiovascular adaptations could be responsible of the little variation on FHR when the exercise ends and the uterine blood-flow is restored, in association with a significant less time to recovery to rest levels in fetus of EG.

REFERENCES

1. Barakat R. El ejercicio físico durante el embarazo. Madrid: Pearson Educación; 2006.
2. Barakat R, Alonso, G. Rodriguez, M. Rojo, J. El ejercicio físico y los resultados del embarazo. Progresos en Ginecologia y Obstetricia. 2006;49(11):630-8. http://dx.doi.org/10.1016/S0304-5013(06)72664-4
3. Baciuk EP, Pereira RI, Cecatti JG, Braga AF, Cavalcante SR. Water aerobics in pregnancy: Cardiovascular Response, Labor and Neonatal Outcomes. Reproductive Health. 2008;5:10. http://dx.doi.org/10.1186/1742-4755-5-10
4. Cavalcante SR, Cecatti JG, Pereira RI, Baciuk EP, Bernardo AL, Silveira C. Water aerobics II: maternal body composition and perinatal outcomes after a program for low risk pregnant women. Reproductive Health. 2009;6:1. http://dx.doi.org/10.1186/1742-4755-6-1
5. Gavard JA, Artal R. Effect of exercise on pregnancy outcome. Clinical Obstetrics and Gynecology. 2008;51(2):467-80. http://dx.doi.org/10.1097/GRF.0b013e31816feb1d
6. Juhl M, Olsen J, Andersen PK, Nohr EA, Andersen AM. Physical exercise during pregnancy and fetal growth measures: a study within the Danish National Birth Cohort. American Journal of Obstetrics and Gynecology. 2010;202(1):63 e1-8.
7. Ferraro ZM, Gaudet L, Adamo KB. The potential impact of physical activity during pregnancy on maternal and neonatal outcomes. Obstetrical & Gynecological Survey. 2012;67(2):99-110. http://dx.doi.org/10.1097/OGX.0b013e318242030e
8. Kalisiak B, Spitznagle T. What effect does an exercise program for healthy pregnant women have on the mother, fetus, and child? PM & R : The journal of Injury, Function, and Rehabilitation. 2009;1(3):261-6. http://dx.doi.org/10.1016/j.pmrj.2008.12.006
9. Peláez M. El ejercicio físico durante el embarazo sobre la ganancia excesiva de peso y sus consecuencias. Tesis Doctoral. Universidad Politécnica de Madrid; 2011.
10. Lotgering FK, Gilbert RD, Longo LD. Maternal and fetal responses to exercise during pregnancy. Physiological Reviews. 1985;65(1):1-36.
11. Nijhuis IJ, ten Hof J. Development of fetal heart rate and behavior: indirect measures to assess the fetal nervous system. European Journal of Obstetrics, Gynecology, and Reproductive Biology. 1999;87(1):1-2. http://dx.doi.org/10.1016/S0301-2115(99)00143-8
12. May LE, Suminski RR, Langaker MD, Yeh HW, Gustafson KM. Regular Maternal Exercise Dose and Fetal Heart Outcome. Medicine and Science in Sports and Exercise. 2012. Epub 2012/01/06.PubMed PMID: 22217566. http://dx.doi.org/10.1249/MSS.0b013e318247b324
13. Spinnewijn WE, Lotgering FK, Struijk PC, Wallenburg HC. Fetal heart rate and uterine contractility during maternal exercise at term. American Journal of Obstetrics and Gynecology. 1996;174(1 Pt 1):43-8. http://dx.doi.org/10.1016/S0002-9378(96)70371-X

14. Gustafson KM, May LE, Yeh HW, Million SK, Allen JJ. Fetal cardiac autonomic control during breathing and non-breathing epochs: The effect of maternal exercise. Early Human Development. 2012. Epub 2012/01/24.PubMed PMID: 22264436. http://dx.doi.org/10.1016/j.earlhumdev.2011.12.017
15. Manders MA, Sonder GJ, Mulder EJ, Visser GH. The effects of maternal exercise on fetal heart rate and movement patterns. Early Human Development. 1997;48(3):237-47. http://dx.doi.org/10.1016/S0378-3782(96)01858-0
16. Barakat R, Ruiz, J R., Rodriguez, G., Montejo, R., Lucía, A. Does exercise training during pregnancy influence fetal cardiovascular responses to an exercise stimulus? Insights from a randomized control trial. British Journal of Sports Medicine. 2010;44(10):762-4. http://dx.doi.org/10.1136/bjsm.2009.062547
17. Veille JC. Maternal and fetal cardiovascular response to exercise during pregnancy. Seminars in Perinatology. 1996;20(4):250-62. http://dx.doi.org/10.1016/S0146-0005(96)80018-8
18. Barakat R, López, C., Montejo, R. Influencia del ejercicio físico en el tercer trimestre de embarazo sobre el comportamiento circulatorio de la unidad materno-fetal. Revista Andaluza de Medicina del Deporte. 2010;3(2):47-51.
19. Armitage & Berry. Estadística para la investigación biomédica. (3ª Edición). Madrid: Ed. Harcourt Brace. 1997.
20. Artal R, O'Toole M. Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and the postpartum period. British Journal of Sports Medicine. 2003;37(1):6-12. http://dx.doi.org/10.1136/bjsm.37.1.6
21. Barakat R, Stirling, J R., Zakynthinaki, M. Acute maternal exercise during the third trimester of pregnancy, influence on foetal heart rate. Revista Internacional de Ciencias del Deporte. 2008;4(13):33-43. http://dx.doi.org/10.5232/ricyde2008.01303
22. Brenner IK, Wolfe LA, Monga M, McGrath MJ. Physical conditioning effects on fetal heart rate responses to graded maternal exercise. Medicine and Science in Sports and Exercise. 1999;31(6):792-9. http://dx.doi.org/10.1097/00005768-199906000-00006
23. Colberg S. Diabetes y ejercicio físico. Madrid: Tutor; 2003.
24. Bo K, Sherburn M. Evaluation of female pelvic-floor muscle function and strength. Physical Therapy. 2005;85(3):269-82.
25. Wolfe LA, Charlesworth SA, Glenn NM, Heenan AP, Davies GA. Effects of pregnancy on maternal work tolerance. Canadian Journal of Applied Physiology = Revue Canadienne de Physiologie Appliquee. 2005;30(2):212-32. http://dx.doi.org/10.1139/h05-116
26. Riemann MK, Kanstrup Hansen IL. Effects on the foetus of exercise in pregnancy. Scandinavian Journal of Medicine & Science in Sports. 2000;10(1):12-9. http://dx.doi.org/10.1034/j.1600-0838.2000.010001012.x
27. Heffernan KS, Fahs CA, Shinsako KK, Jae SY, Fernhall B. Heart rate recovery and heart rate complexity following resistance exercise training and detraining in young men. American Journal of Physiology Heart and Circulatory Physiology. 2007;293(5):H3180-6. http://dx.doi.org/10.1152/ajpheart.00648.2007

28. Singh TP, Rhodes J, Gauvreau K. Determinants of heart rate recovery following exercise in children. Medicine and Science in Sports and Exercise. 2008;40(4):601-5. http://dx.doi.org/10.1249/MSS.0b013e3181621ec4
29. Ostojic SM, Stojanovic MD, Calleja-Gonzalez J. Ultra short-term heart rate recovery after maximal exercise: relations to aerobic power in sportsmen. The Chinese Journal of Physiology. 2011;54(2):105-10. http://dx.doi.org/10.4077/CJP.2011.AMM018
30. Clapp JF, 3rd. The effects of maternal exercise on fetal oxygenation and feto-placental growth. European Journal of Obstetrics, Gynecology, and Reproductive Biology. 2003;110 Suppl 1:S80-5. http://dx.doi.org/10.1016/S0301-2115(03)00176-3
31. Collings C, Curet LB. Fetal heart rate response to maternal exercise. American Journal of Obstetrics and Gynecology. 1985;151(4):498-501. http://dx.doi.org/10.1016/0002-9378(85)90277-7
32. Sorensen KE, Borlum KG. Fetal heart function in response to short-term maternal exercise. British Journal of Obstetrics and Gynaecology. 1986;93(4):310-3.
33. Rafla NM, Cook JR. The effect of maternal exercise on fetal heart rate. Journal of Obstetrics and Gynaecology : The Journal of the Institute of Obstetrics and Gynaecology. 1999;19(4):381-4. http://dx.doi.org/10.1080/01443619964698
34. Szymanski LM, Satin AJ. Exercise during pregnancy: fetal responses to current public health guidelines. Obstetrics and Gynecology. 2012;119(3):603-10. http://dx.doi.org/10.1097/AOG.0b013e31824760b5
35. May LE, Glaros A, Yeh HW, Clapp JF, 3rd, Gustafson KM. Aerobic exercise during pregnancy influences fetal cardiac autonomic control of heart rate and heart rate variability. Early Human Development. 2010;86(4):213-7. http://dx.doi.org/10.1016/j.earlhumdev.2010.03.002
36. Silveira C, Pereira BG, Cecatti JG, Cavalcante SR, Pereira RI. Fetal cardiotocography before and after water aerobics during pregnancy. Reproductive Health. 2010;7:23. http://dx.doi.org/10.1186/1742-4755-7-23
37. Kennelly MM, McCaffrey N, McLoughlin P, Lyons S, McKenna P. Fetal heart rate response to strenuous maternal exercise: not a predictor of fetal distress. American Journal of Obstetrics and Gynecology. 2002;187(3):811-6. http://dx.doi.org/10.1067/mob.2002.125892
38. Melzer K, Schutz Y, Boulvain M, Kayser B. Physical activity and pregnancy: cardiovascular adaptations, recommendations and pregnancy outcomes. Sports Medicine. 2010;40(6):493-507. http://dx.doi.org/10.2165/11532290-000000000-00000

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