Effect of Exercise Training Program on the Maternal Blood Lead Level in Normal Pregnant Women

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ABSTRACT

Background: *Lead exposure and its deleterious effects continue to be a problem in many countries. The lack of effective and safe treatment for low level intoxication has promoted environmental interventions to control different sources of lead.* ***Objective:*** *This study was conducted to determine the effect of exercise training program in conjunction with consumption of foods with high calcium contents and calcium supplementation on the maternal blood lead (PbB).* ***Study design****: Thirty-five healthy pregnant women at the second trimester of pregnancy from Nasser General Hospital at Shobra El Keima were represented as industrial governments in Cairo. They were divided randomly into two groups (A&B). Group (A) study was 15 women participated in an exercise training program plus consumption of foods rich in calcium and 1000mg/day of calcium carbonate supplementation and group (B) control was 20 women were followed the same regimen of calcium intake only as in group (A). Assessment of the maternal PbB was carried before and after two months of the exercise training program.* ***Results:*** *The collected data revealed a significant reduction in the mean values of maternal PbB in group (A) but the decrease in group (B) was non significant between before and after two months of the exercise training program. A detectable significant difference of maternal PbB between both groups was found after the end of the program.* ***Conclusion:*** *So, this study suggested that exercise training program is a simple intervention measures which can reduce lead burden among pregnant women thus resulted in decreasing its hazard on the fetuses. Further studies will be recommended for determining the effect of maternal exercise on the fetal PbB and maternal bone mineral density.*

Key words: *Lead, pregnancy, exercise, calcium.*

INTRODUCTION

In Cairo as in many other countries, environmental lead exposure with its concomitant risk of neurotoxicity remains a major health hazard for population[8, 22]. Exposure to lead is of special concern during pregnancy; lead absorbed by the pregnant mother is readily transferred to the developing fetus, through the placenta at mid pregnancy[9].

There is evidence from animal studies that intrauterine exposure to lead may disrupt endocrine balance during pregnancy and may lead to abnormalities of renal structure and function[20], abnormalities of the reproductive system and neurodevelopmental toxicity in offspring[7]. Human evidence corroborates these findings, linking prenatal exposure to lead with increased incidence of abortions, reduced birth weight, pre term delivery[1] and neurological abnormalities in offspring[3]. Also,

maternal blood pressure is believed to increase among residents exposed to lead such as that omitted from house paint, gasoline and other sources[26]. These concerns are especially salient for women and children in developing nations. Not only exposure to lead common, but the toxicity of lead for pregnant women and their offspring may be amplified by nutritional deficiency and concomitant toxic exposures which often occur in poor nations which has emphasized the urgent need to control lead exposure[6].

Some authors have reported bone loss during pregnancy and lactation that allow easy mobilization of lead from bone stores to blood[27].

The interrelation between dietary calcium and lead has been widely documented in animals and human studies[14,15]. Results from these studies suggested that dietary calcium may have a protective role against lead, essentially through two mechanisms by decreasing absorption of lead in the gastrointestinal tract and by decreasing the mobilization of lead from bone store to blood, particularly during periods of high metabolic activity of bone, such as pregnancy, lactation and menopause.

Artal and O'Toole, (2001)[2] reported that moderate exercise of limited duration has no harmful effects to the healthy pregnant women and their fetuses. In addition, exercise has the potential to play an important role in the maintenance of and increase in bone density[16,28]. The mechanical stresses that are putted through bone during exercise are thought to affect directly the structure and geometrical characteristics of bone[18].

Due to the absence of safe and cost effective treatment against low level lead poisoning, preventive actions must focus primarily on reducing environmental sources and modifying behaviors or lifestyles that may increase the risk of exposure. So, this study is an attempt to evaluate the effect of an exercise training program on the maternal blood lead level in a sample of normal pregnant women.

SUBJECTS, MATERIALS AND METHODS

Subjects

Thirty five pregnant women in the second trimester of pregnancy with a history of one or more normal spontaneous vaginal deliveries of mature babies from Nasser General Hospital at Shobra El Keima which represented an industrial communities in Cairo.

All women were healthy with uncomplicated singleton fetuses, they had no contraindications for participating in an exercise training program, such as obstetrical conditions e.g. previous abortion, vaginal bleeding and pre term delivery and a history of non obstetrical condition e.g. cardiorespiratory diseases, uncontrolled hypertension or diabetes type I or II, chronic liver and/or renal diseases.

Also, they must lived near industrial sources with heavy stop and go vehicler traffic, worked at factories produced lead and on the basis of income were the same.

They were divided randomly into two groups (A&B). Study group (A) consisted of 15 pregnant women who participated in an exercise training program, in addition to consumption of foods rich in calcium and 1000mg/day of calcium carbonate supplementation[23] and control group (B) was 20 women were followed the same regimen of calcium intake only as in group (A) for two months. Informed consent form was signed from each pregnant woman before participation in this study.

Evaluations were carried individually for each woman in both groups (A&B) before and

after the end of the suggested program (two months) for measuring the maternal PbB.

Procedures

I. Evaluative procedures

Each woman was rolled in a personal interview to collect data about age, reproductive history and date of last menstrual period.

For measurement of the maternal PbB, 5ml of maternal venous blood was withdrawn in a heparinized syringe after carefully cleaning the skin at the venepuncture site. Samples were kept at 4°C and analyzed by UNICAN 929 & 939 Qz Atomic Absorption Spectrometers with Gf 90 and Gf 90z Graphite Furnace and Fs90 Furnace autosamplers in Atomic Energy Institute in Naser City, Cairo.

II. Treatment procedures

All through the study period (two months), the participant women in both groups (A&B) were instructed to take food rich in calcium which includes the following amounts daily: one glass of milk (250ml), one egg and cheese (100gm). Also, they were taken 1000mg/day of calcium carbonate supplementation (2 capsules/day).

For group (A), each woman was participated in a moderate intensity of an exercise training program via pedaling on an electronic bicycle ergometer, which adjusted at a constant speed of 30Km/hour for 25 minutes. The exercise session was started by 5 minutes of warm up and ended by 5 minutes of cool down at the constant speed of the bicycle without load. And in between them the active stage (15 minutes) of the pedaling exercise at the constant speed with adjusted load to achieve 60% of the estimated maximal heart rate for each woman[2] (Maximum heart rate=220-age of woman in years)[17] was performed. The exercise training program was performed for two months, 3 sessions per week (one every other day).

Data were collected and statistically analyzed using arithmetic mean, standard deviation, percentage and paired T test at $P<0.05$ as a level of significance.

RESULTS

The results of this study are presented under the following headings:

- Physical characteristics in relation to the maternal PbB concentration before starting the suggested exercise program:

Table (1) showed the physical characteristics of both groups (A&B), in which the concentration of maternal PbB didn't vary with age, weight and height, whereas the higher concentration was found in women whose parity $\geq$ 2 times and also when gestational age >20 weeks in both groups.

Comparison between both groups (A&B) showed non significant difference ($P>0.05$) at all physical characteristics in relation to the maternal PbB concentration before starting the exercise training program.

Table (1): Physical characteristics in relation to the maternal PbB concentration before starting the suggested program in both groups.

Variables	Maternal PbB concentration (µg/dl)					
	Group (A) (Study)			Group (B) (Control)		
	<10	10-14	>14	<10	10-14	>14
Number of pregnant women	5	6	4	7	7	6
Age (years)	26.3	27.1	28.4	26.8	27.7	27.9
Weight (Kg)	70.5	72.4	71.2	71.8	74.4	73.5
Gestation (weeks)	18	20	22	17	21	22
Height(Cm)	150.4	152.9	158.2	154.6	157.2	156.8
Parity						
1 time	3	1	-	4	2	-
2 times	2	3	2	3	3	4
> 3 times	-	2	2	-	2	2

- Maternal blood PbB concentration:

In both groups (A&B), the maternal PbB concentration was<10µg/dl in 5 & 7 women (33.33 & 35%), while 6 & 7 women (40 & 35%) had maternal PbB concentration 10-14µg/dl and the highest concentration >14µg/dl was found in 4 & 6 women (26.66& 30%) respectively before starting the suggested program, figure (1).

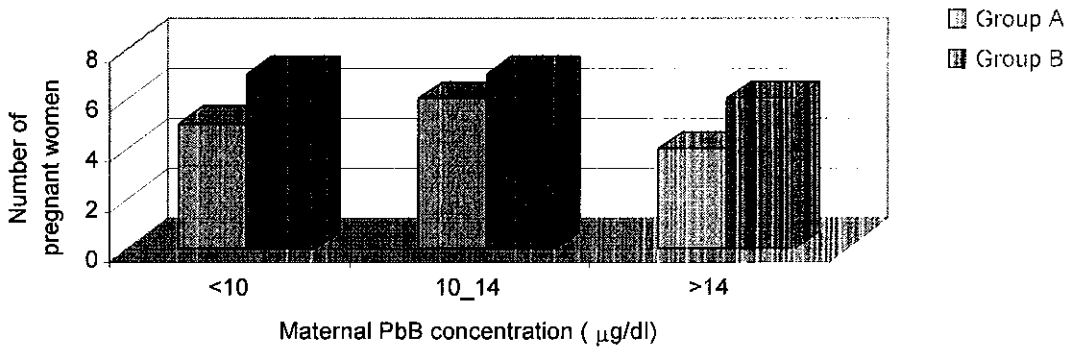

Fig. (1): Concentration of maternal PbB in both groups (A&B) before starting exercise training program.

The mean values of maternal PbB at the starting of the study was 13.09± 1.57 µg/dl and 12.45±2.20µg/dl respectively, while after two months of the suggested program, the mean values was 9.90±1.22µg/dl and 11.81±2.04µg/dl in group (A) and (B) respectively, table (2).

Maternal PbB showed a significant decrease (t=2.94, P<0.04) after two months of treatment in group (A), while in group (B) the decrease was non significant (t= 1.64, P<0.13). Also, comparison between both groups (A&B) revealed a significant difference (t=2.37, P<0.05) after completion of the suggested program, figure (2).

Table (2): Mean values of maternal PbB in both groups.

Groups	Date of evaluation	Maternal PbB (µg/dl)	Pvalue
Group (A)	Pre exercise	13.09± 1.57	0.04
	Post exercise	9.90±1.22	
Group (B)	Pre exercise	12.45±2.20	0.13
	Post exercise	11.81±2.04	

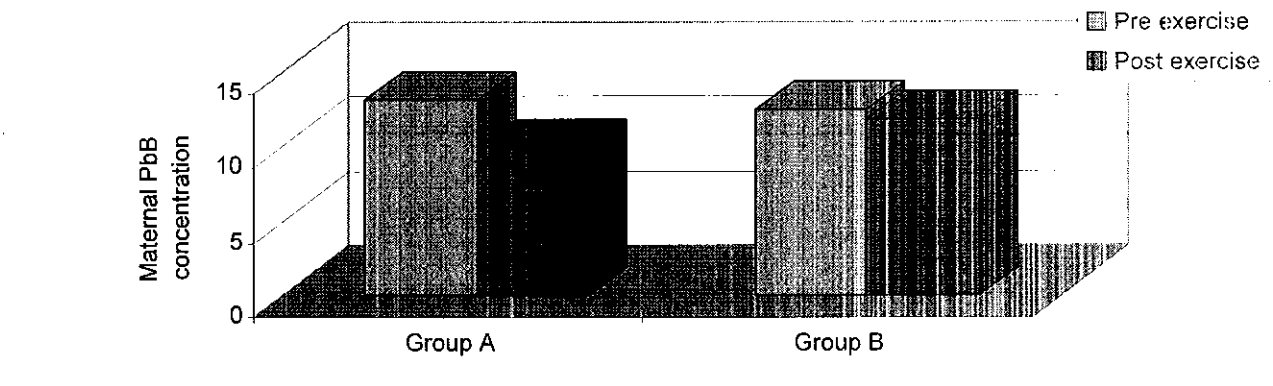

Fig. (2): Mean values of maternal PbB in both groups.

DISCUSSION

Lead pollution carries a definite hazard to the pregnant women and new borns. The relationship between environmental risk factors and exposure to lead toxicity has been a matter of concern in many studies[4,11]. Thus, the higher lead levels (>14µg/dl) measured in the tested industrial area in this study might be attributed to improper application of control measures in lead industries in our communities.

In the present study, maternal PbB decreased after two months of exercise training program, in addition to consumption of foods rich in calcium and 1000mg/day of calcium carbonate supplementation and also, in group (B) who followed the same regimen of high calcium intake only as in group (A), which come in agreement with experimental studies, which have shown that consumption of calcium could decrease the absorption of lead through the digestive tract because of competition at the level of the gastrointestinal receptors[13-15].

Thus, changes taking place during pregnancy pose an increase demand for calcium that is satisfied either by dietary calcium or by bone reserved[10]. So, the maternal bone may serve as a source of calcium, as reflected by changes in bone formation rate and loss of bone mineral as a function of the number of pregnancies[27]. Since lead has found to be incorporated into bone in a way similar to calcium[30], it would appear that pregnancy release accumulated lead as well as calcium from bone. Therefore, adequate intake of calcium could reduce the mobilization of calcium and accumulated lead from bone.

Also in accordance with the present findings, several authors have reported an inverse association between increasing dietary calcium consumption and decreasing blood lead levels[13-15]. Similar data suggesting a protective effect of milk consumption as

observed by Hernandez-Avila et al., (1997)[13]. These authors evaluated the effect of calcium in post partum women and observed inverse correlation between PbB levels and milk consumption. However, there are no reports of a protective effect of calcium supplementation in the general population.

Other explanation for the significant decrease in maternal PbB after two months of exercise training in group (A) could be attributed to the effect of the exercise which reported in several studies to increase BMD in post menopausal osteoporotic women[21,29]. However, there are no reports of its effect on bone during pregnancy. Thus, exercise directly may protect and maintain maternal BMD that indirectly resulted in reducing maternal PbB in this study.

Exercise induced moderate degree of mechanical strain that is required to stimulate an increase in bone mass and that this strain is best generated by intermittent compressive forces[5]. So that, stationary bicycle when used in human subjects, it imposes mechanical strain on the lumbar vertebrae via action of the psoas muscles during hip flexion or indirectly via the activity of the lower back musculature as mentioned by Rubin and Lanyon (1985)[24].

This presumptive link between muscle activity and bone mass is supported by the data reported by many authors[18,25].

Also, exercise can increase bone mass through the piezo electric force in which the exercise make compression on the bone that causes a negative potential at the compression site and a positive potential else where in the bone, so, minute quantities of current flowing in bone causes an increase of the osteoblastic activity at the negative site of the current flow, which explained the increase in bone deposition at the compression site[12].

Thus, lead remains a major problem in particular because of still high prevalence of risk factors related to cultural and technological factors. So, behavioral and dietary interventions should be developed and evaluated in terms of their ability to reduce lead levels in pregnant women because adverse effects on neuro psychological development have been observed in newborns with lead lower than 10μg/dl [19].

CONCLUSION

The present results, can concluded that exercise with diet rich in calcium and calcium supplementation may be therapeutically effective in reducing maternal PbB and can be considered for inclusion in future intervention protocols. But larger numbers, randomized trails will be required to determine specifically the amount of calcium as well as the exercise intensity and duration of treatment necessary to produce this salutary effect on maternal as well as fetal PbB and maternal bone mineral density.

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REFERENCES

1- Andrews, K., Savitz, D. and Hertz-Picciotto, I.: "Prenatal lead exposure in relation to gestational age and birth weight: a review of epidemiologic studies", Am. J. Ind. Med., 26: 13-32, 1994.

2- Artal, R. and O'Toole, M.: "Guidelines of the American College of Obstetricians and Gynecologists for exercise during pregnancy and post partum period", Br. J. Sports Med., 37: 6-12, 2001.

3- Bellinger, D., Leviton, A., waternaux, C., Needleman, H. and Rabinowitz, M.: "Longitudinal analysis of prenatal and post natal lead exposure and early cognitive development", N. Engl. J. Med., 316: 1037-1043, 1987.

4- Bentur, Y. and Koron, G.: "The three most common occupational exposure reported by pregnant women: An update", Am. J. Obstet. Gynecol., 165: 429-437, 1991.

5- Bloomfield, S., Williams, N., Lamb, D. and Jackson, R.: "Non-weight bearing exercise may increase lumbar spine bone mineral density in healthy postmenopausal women", Am. J. Phys. Med. Rehabil., 72: 204-209, 1993.

6- Bogden, J., Kemp, F., Ham, S., Murphy, M., Fraiman, M. and Czerniach, D.: "Dietary calcium and lead interact to modify maternal blood pressure, erythropoiesis and fetal and neonatal growth in rats during pregnancy and lactation", J. Nutr., 125: 990-1002, 1995.

7- Coffigny, H., Thoreux-Maniav, A., Pinon-Bataillade, G., Monchaux, G., Masse, R. and Soutir, J.: "Effects of lead poisoning of rats during pregnancy on the reproductive system and fertility of their offspring", Hum. Exp. Toxicol., 43: 244-246, 1994.

8- Environmental Health Project (EHP): Activity report (No.32), Lead exposure abatement plan for Egypt. Results of environmental sampling for lead, 78-105, 1997.

9- Ernhart, C.: "A critical review of low level prenatal lead exposure in the human.1- Effect on the fetus and newborn", Reprod. Toxicol., 6: 9-19, 1992.

10-Garel, J.: "Hormonal control of calcium metabolism during the reproductive cycle in mammals", Physiol. Rev., 67: 51-66, 1987.

11-Grobler, S., Maresky, L. and Kotze, T.: "Lead reduction of petrol and blood lead concentrations of athletes", Arch. Environm. Health, 47(2): 19-32, 1992.

12-Guyton, A.: Human physiology and mechanisms of disease, 7th ed., WB. Saunders Company, Tokyo, PP. 610, 1994.

13-Hernandez-Avila, M., Sanin, L., Romieu, I., Palazuelos, E., Tapia-Conyer, R., Olaiz, G., Rojas, R. and Navarrete, J.: "Higher milk intake during pregnancy is associated with lower maternal and umbilical cord level in postpartum women", Environmental Research, 74: 116-121, 1997.

14-Mahaffey, K.: "Nutritional factors in lead poisoning", Nutr. Rev., 39(10): 353- 362, 1981.

15-Mahaffey, K.: "Environmental lead toxicity: Nutrition as a component of intervention", Environ. Health Prespect, 89: 75-78, 1990.

16-Marcus, R.: "Role of exercise in preventing and treating osteoporosis", Rheum. Dis. Clin. North Am., 27(1): 131-141, 2001.

17-Mesquita, A., Trabulo, M., Mendes, M., Viana, J. and Seabra, G.: "The maximum heart rate in the exercise test: the 220-age formula or Shffeield's table", Rev. Prot. Cardiol., 15(2): 139-144, 1996(Abst).

18-Mitchell, S., Grant, S. and Aitchison, T.: "Physiological effects of exercise on post menopausal osteoporotic women", Physiotherapy, 84(4): 157-163, 1998.

19-Needleman, H., Schell, A. and Bellinger, D.: "The long term effects of exposure to low doses of lead in childhood: An 11 years follow up report", N. Engl. J. Med., 306: 367-372, 1990.

20-Oberley, T., Friedman, A., Moser, R. and Siegel, F.: "Effects of lead administration on developing rat kidneys functional. morphologic and immunohistochemical studies", Toxicol. Appl. Pharmacol, 131: 85-93, 1995.

21-O'Brien, M.: "Exercise and osteoporosis", Inter. J. Med. Sci., 170(1): 58-62, 2001.

22-Olama, A., Sayed, I. and Ashraf, N.: "Umbilical cord blood lead levels in Cairo", J. Legal Med. And Forensic Sciences, 9(4): 201-210, 1997.

23-Repke, J.T.: "Calcium homeostasis in pregnancy", Clinical Obstet. and Gynecol., 37: 59-65, 1994.
24-Rubin, C. and Lanyon, L.: "Regulation of bone mass by mechanical strain magnitude", Calcif. Tissue Int., 37: 411-417, 1985.
25-Sinaki, M., McPhee, M. and Hodgson, S.: "Relationship between bone mineral density of spine and strength of back extensors in healthy post menopausal women", Mayo Clinics, 61: 116-122, 1986.
26-Sowers, M., Jannausch, M., Scholl, T., Li, W., Kemp, F. and Bogden, J.: "Blood lead concentrations and pregnancy outcomes", Arch. Environmental Health, 57(5): 489-495, 2002 (Abstract).
27-Tojo, Y., Kurabayashi, T., Honda, A., Yamamoto, Y., Yahato, T., Takakuwa, K. and Tanaka, K.: "Bone structural and metabolic changes at the end of pregnancy and lactation in rats", Am. J. Obstet. Gynecol., 178: 180-185, 1998.
28-Walker, M., Klentroa, P., Chow, R. and Plyley, M.: "Longitudinal evaluation of supervised versus unsupervised exercise program for treatment of osteoporosis", Eurp. J. Appl. Physiol., 83(4-5): 349-355, 2000.
29-Warren, A. and Carl, S.: "Exercise for osteoporosis", Sports Med., 26: 23-28, 1998.
30- Wittmers, L., Wallgren, J., A ufderheido, A. and Rapp, G.: "Lead in bone distribution in the human skeleton", Arch. Environ. Health, 43: 381-391, 1988.

الملخص العربي

تأثير برنامج التمرينات على مستوى عنصر الرصاص في دم الأم الحامل طبيعيا

التعرض للرصاص وآثاره الضارة مازالت مشكلة في العديد من الدول و ذلك لنقص وسائل العلاج له و هو ما دعى هذه الدول لاتخاذ العديد من الإجراءات البيئية الطبيعية للسيطرة على مصادره .

هدف الدراسة : تهدف هذه الدراسة إلى تقييم تأثير برنامج التمرينات بالإضافة إلى الكالسيوم على مستوى عنصر الرصاص في دم الأمهات الحوامل .

خطوات الدراسة : أجريت هذه الدراسة على ٣٥ سيدة حامل في الفترة الثانية من الحمل من مستشفى ناصر العام في منطقة شبرا الخيمة كمثال للمنطقة الصناعية. وتم تقسيم الحالات إلى مجموعتين (أ , ب) عشوائيا. مجموعة (أ) دراسية تضم ١٥ سيدة حامل شاركن في برنامج التمرينات بالإضافة إلى تناول غذاء به نسبة عالية من الكالسيوم و ١٠٠٠ جم من كربونات الكالسيوم يوميا و المجموعة (ب) ضابطة وتضم ٢٠ سيدة حامل أخذن نفس الغذاء و الكالسيوم الإضافي كما في المجموعة (أ). وتم التقييم للمجموعتين عن طريق قياس مستوى عنصر الرصاص في دم الأم الحامل قبل وبعد شهرين من برنامج التمرينات .

نتائج الدراسة : وقد أظهرت النتائج نقص فعال في مستوى عنصر الرصاص بالدم في المجموعة (أ) و لم يظهر في المجموعة (ب) فيما بين قبل و بعد شهرين من برنامج التمرينات . وقد وجدت فروق فعالة في مستوى عنصر الرصاص فيما بين المجموعتين بعد نهاية برنامج التمرينات .

الخلاصة : وعليه يمكن اقتراح برنامج التمرينات مع تناول غذاء به نسبة عالية من الكالسيوم كوسيلة بسيطة يمكنها تقليل خطر تأثير عنصر الرصاص على السيدات الحوامل وأجنتهن . وأيضا إجراء دراسات أخرى لمعرفة تأثير التمرينات للأم الحامل على نسبة الرصاص في دم جنينها وكثافة عظام الأم .

الكلمات الدالة : الرصاص ، الحمل ، التمرينات ، الكالسيوم .