Relationship between Maternal Physical Activities and Preterm Birth

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Abstract

A cross-sectional study was conducted in three Municipal Health Centers located in Aichi prefecture, central Japan. The main purpose of this study was to verify the interaction between maternal leisure-time physical activities prior to and/or during pregnancy and preterm birth and also, to determine the risk factors related to preterm birth. In this study of the 2,682 questionnaires delivered within one year to mothers or relatives at the Municipal Health Centers, 1,714 questionnaires were analyzed. In a univariate analysis the results showed that mothers who had a previous low birthweight or a premature baby, or who were hospitalized during pregnancy before the 37th week of gestation, or had an occupational activity, or carried out their household chores, or were sick, or received much medical advice and did not exercise were more likely to have a preterm baby. In multivariable logistic regression analyses, maternal hospitalization before the 37th week of gestation and occupational activities were significant determinants associated with preterm birth. Thus, it was verified that maternal leisure-time physical activities prior to and/or during pregnancy were not related to preterm birth.

Key words: maternal leisure-time physical activities, preterm birth, maternal occupational activities, maternal history of physical activities, maternal household chores

Introduction

Preterm birth, defined as a birth that occurs at a gestational age of less than 37 completed weeks regardless of birthweight⁽¹⁾, has been recognized as the most important cause of perinatal and neonatal mortality^(2–4). Likewise, neonatal and infant morbidity is high in premature birth babies^(2,3).

The rate of preterm births in the United States in 1981 was 9.4 percent and it has increased over the years to 10.6 percent in 1991⁽⁵⁾. In Japan the rate is lower compared with that of the United States. However, it has increased slightly from 4.1 percent in 1980 to 5.1 percent in 1998^(6,7), as shown in Figure 1. In France the rate declined from 8.2 percent in 1972 to 5.6 percent in 1981⁽²⁾, however, in 1986 the rate increased to 7.7 percent⁽³⁾.

The etiology of preterm births is still not well understood. Many studies have been conducted with the purpose of clarify which factors are associated with preterm births. Preterm birth has been associated with many characteristics of the mother, such as age^(3,4,8–12), stature^(4,10,13), weight^(2–4,10–12,14), race^(2,4,11), the history of previous preterm birth^(2,3,9,11,12,14), low birthweight^(2,4,9,10), and/or abortion^(4,12), parity^(4,10), medical complications^(2,3,10,12), maternal diseases^(2–4,10,12), multiple gestation^(2–4,12), maternal habits

during pregnancy, e.g. cigarette smoking^(2–4,9–11,14–16) and alcohol consumption⁽⁴⁾. Preterm birth has also been related to such social and environmental factors as stress^(3,17–24), marital status^(2,11,12), maternal occupational activity and the situation at work^(3,4,12,25–27), socioeconomic status^(2,4,12), and educational level^(9–11,18).

In addition, there is a lack of consensus regarding the effect of maternal leisure-time physical activities during pregnancy with the shortening of gestational length. In a meta-analysis conducted by Lokey et al.⁽²⁸⁾, the length of gestation between mothers who exercised during pregnancy and those who were sedentary did not differ. This evidence is ascertained by a number of studies^(29–33) that reported similar findings. In a study conducted by Berkowitz et al.⁽³⁴⁾ and Misra et al.⁽³⁵⁾, it was found that maternal exercise during pregnancy actually decreased the risk of preterm delivery. However, in a study conducted by Clapp & Dickstein⁽³⁶⁾ it was asserted

Fig. 1 Trend in preterm live births in Japan, 1980 through 1998.

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that mothers who performed endurance exercise, into the third trimester delivered earlier than those who stopped exercising prior to the 28th week of gestation did.

The purpose of this cross-sectional study was to provide additional evidence regarding the relationship between maternal leisure-time physical activities prior to and/or during pregnancy and the risk of delivering preterm newborns, and also, to determine the risk factors related to preterm birth, attempting to enlarge the assessment of mothers at risk of developing preterm labor.

Methods

The method used in this study is described briefly here and in detail in a previous study³⁷⁾. Information was collected at three Municipal Health Centers, located in the cities of Kariya, Hekinan and Takahama, in Aichi prefecture, central Japan.

In Japan all babies three or four months old must be brought by their mothers or relatives to the Municipal Health Center to have their health and physical conditions checked. At the time they came to the Health Center, we delivered our questionnaire to all mothers who had a single birth; multiple births were excluded from this study. The average rate of mothers who actually showed up for their babies' medical checkup was 97.4 percent in 1997 and 96.8 percent in 1998 among all three cities mentioned above.

Questionnaires were handed out between July, 1997 and June, 1998 in Kariya and between October, 1997 and September, 1998 in Hekinan and Takahama. A total of 2,682 questionnaires were handed out. Of these, 1,732 (64.6 percent) were returned to us at Chukyo University. However, as 18 questionnaires had not been properly filled out, data from 1,714 questionnaires were utilized in this study.

The questionnaire consisted basically of the following: mother's and baby's physical and demographic characteristics such as mother's height, weight and age, and baby's weight, height, head circumference and gender; gestational factors of the index pregnancy such as length of gestation, mother's smoking and drinking habits, passive smoking, mother's occupational activities outside the home and execution of household chores, mother's leisure-time physical activities, mother's health condition and also an evaluation of mother's psychological stress; mother's previous pregnancies' characteristics and habits such as in her medical histories and as a result of previous delivery experiences, and mother's leisure-time physical activities during elementary, junior high and after junior high school.

In the questionnaire we included questions about maternal occupational activities during pregnancy regarding occupational category, work posture, and the nature of the job. In addition, we included some questions about environmental and/or mental stress, physical effort, and fatigue. We utilized the evaluation method of occupational fatigue structured by Mamelle et al.³⁸⁾. We also sought information if mothers had any reason for stopping their working activities during pregnancy. Those who gave positive answers were asked to be explicit about what reasons made them stop working. Some reasons are as follows: the mother felt unfit for the work activities, she had relationship problems with co-workers, difficulty in performing both household chores and work activities, and problems during the course of pregnancy.

We used SPSS 8.0 for the statistical analysis. Firstly, using the chi-square test, we conducted a univariate analysis to identify the independent variables significantly related to preterm births.

Secondly, we carried out a logistic regression analysis, including all variables we had used in the univariate analysis. We intended to evaluate each variable adjusted by the other variables in the model including all cases. Odds ratios (OR) and 95 percent confidence intervals (CI) were then calculated for all variables. Finally, using a logistic regression analysis we calculated the OR and 95 percent CI for all nulliparous mothers and, in a separate analysis, for all multiparous mothers. We attempted to verify whether there was any significant difference in risk factors regarding preterm birth between nulliparous and multiparous mothers. In this study, we did not include race variables since 99.3 percent of the mothers who answered the questionnaires were Japanese.

This study has been conducted under the approval of "The Human Subjects Committee at Chukyo University Graduate School of Physical Education".

Results

This study indicated that the risk factors with a strong relationship to preterm birth in a univariate analysis, as is shown in Table 1, include previous delivery of a premature baby or low birthweight baby, maternal hospitalization before the 37th week of gestation, and maternal sickness during pregnancy, especially in the case of those mothers who had many illnesses. There were significant trends towards an increasing risk of delivering preterm babies with the increase in the number of maternal illnesses and medical advice. Mothers who had some occupational activity, performed half or less of their household chores and did not exercise during pregnancy were at risk of delivering preterm babies. Mothers who were engaged in leisure-time physical activities during elementary, junior high and after high school presented a similar risk of delivering a preterm baby as mothers who did not exercise. Regarding the performance of household chores and maternal illnesses during pregnancy, 82 percent of mothers who completed half or less of their household chores were ill at least once during pregnancy while mothers who could complete all of their household chores the rate dropped to 69.9 percent. When comparing these two groups on the basis of the number of illnesses, we verified that 29.8 percent of the mothers who did half or less of their household chores were very sick (3 or more illnesses), while of mothers who completed all chores only 15.7 percent were very sick, to a statistically significant degree ($P < 0.01$).

Results from a multivariable analysis for all cases are given in Table 2. In this table, we included only the OR and 95 percent CI for maternal leisure-time physical activities and for variables significantly associated with preterm birth. Mothers who were hospitalized before the 37th week of gestation and worked during pregnancy were at a greater risk of delivering preterm babies. Maternal pre-pregnant weight is partially associated with preterm birth, but there is not a linear trend on this matter. Maternal leisure-time physical activities prior to and/or during pregnancy were not significantly associated with preterm birth.

In Table 3 we can see the results through a logistic regression analysis for the determinant risk factors of preterm birth among nulliparous mothers. Maternal hospitalization and occupational activities during pregnancy were conducive to preterm birth. Maternal pre-pregnancy weight is no longer associated with preterm birth. Once again, maternal leisure-time physical activities prior to and/or during pregnancy were not significantly associated with preterm birth.

Table 1 Univariate analysis of the risk factors of preterm babies

Variable	n	Preterm (+) (%)	Preterm (-)	X ²
Baby gender				
Male	838	45 (5.4)	793	0.626
Female	846	41 (4.8)	805	
Maternal age (years)				
<20	13	0 (0)	13	0.818
20≤	136	6 (4.4)	130	
24≤	667	36 (5.4)	631	
29≤	684	36 (5.3)	648	
≥34	158	6 (3.8)	152	
Maternal height (cm)				
<150	78	5 (6.4)	73	0.861
150≤	408	20 (4.9)	388	
155≤	590	29 (4.9)	561	
160≤	467	22 (4.7)	445	
≥165	149	10 (6.7)	139	
Maternal pre-pregnancy weight (kg)				
<45	247	17 (6.9)	230	0.261
45≤	501	19 (3.8)	482	
50≤	502	24 (4.8)	478	
≥55	446	26 (5.8)	420	
Birth order				
First	871	46 (5.3)	825	0.696
Second	619	28 (4.5)	591	
Third or more	205	12 (5.9)	193	
History of preterm baby				
No	902	36 (4.0)	866	0.002
Yes	43	6 (14.0)	37	
History of low birthweight				
No	886	36 (4.1)	850	0.004
Yes	57	7 (12.3)	50	
Maternal smoking during pregnancy				
Did not smoke ^a	1,519	78 (5.1)	1,441	0.701
Smoked	179	8 (4.5)	171	
Maternal alcohol habits during pregnancy				
Did not drink	800	46 (5.8)	754	0.228
Seldom drank	558	21 (3.8)	537	
Sometimes or more times	338	19 (5.6)	319	
Passive smoking				
No	590	30 (5.1)	560	0.981
Yes	1,107	56 (5.1)	1,051	
Maternal psychological stress during pregnancy				
No	885	37 (4.2)	848	0.070
Yes	800	49 (6.1)	751	
Maternal hospitalization before the 37 th week of gestation				
No	1,456	47 (3.2)	1,409	0.000
Yes	213	38 (17.8)	175	
Maternal sickness during pregnancy				
No	444	13 (2.9)	431	0.014
Yes	1,231	73 (5.9)	1,158	
Number of maternal sickness episodes during pregnancy				
None	444	13 (2.9)	431	0.000
1	541	18 (3.3)	523	
2	359	16 (4.5)	343	
3	182	21 (11.5)	161	
4 or more	147	18 (12.2)	129	
Medical advice during pregnancy				
No	282	10 (3.5)	272	0.207
Yes	1,402	75 (5.3)	1,327	
Number of medical advice episodes during pregnancy				
None	281	10 (3.6)	271	0.028
1	570	22 (3.9)	548	
2	439	22 (5.0)	417	
3	259	18 (6.9)	241	
4 or more	135	13 (9.6)	122	
Maternal occupational activity during pregnancy				
No	891	35 (3.9)	856	0.024
Yes	804	51 (6.3)	753	
Maternal activity at home (household chores) during pregnancy				
Did all of them	832	41 (4.9)	791	0.015
Did more than half of them	683	28 (4.1)	655	
Did half or less of them	181	17 (9.4)	164	
Maternal leisure-time physical activity during pregnancy				
No exercise	1,025	61 (6.0)	964	0.044
Exercised	667	25 (3.7)	642	
Physical activity during elementary school				
No exercise	899	41 (4.6)	858	0.286
Exercised	752	43 (5.7)	709	
Physical activity during junior high school				
No exercise	462	16 (3.5)	446	0.069
Exercised	1,225	69 (5.6)	1,156	
Physical activity after high school				
No exercise	727	36 (5.0)	691	0.898
Exercised	943	48 (5.1)	895	

^a294 mothers were ex-smokers.

Table 2 Logistic regression analysis of the risk factors of preterm babies among all subjects

Variable	Category	Odds Ratio	95% Confidence Interval
Maternal hospitalization before the 37 th week of gestation	No	1.00	
	Yes	4.70	2.67~8.26
Maternal occupational activity during pregnancy	No	1.00	
	Yes	1.94	1.13~3.35
Maternal pre-pregnancy weight (kg)	<45	1.00	
	45≤	0.45	0.21~0.98
	50≤	0.54	0.25~1.17
	≥55	0.64	0.28~1.43
Maternal leisure-time physical activity during pregnancy	No exercise	1.00	
	Exercised	0.68	0.39~1.17
Physical activity during elementary school	No exercise	1.00	
	Exercised	1.17	0.70~1.93
Physical activity during junior high school	No exercise	1.00	
	Exercised	1.58	0.85~2.96
Physical activity after junior high	No exercise	1.00	
	Exercised	0.82	0.49~1.37

Table 3 Logistic regression analysis of the risk factors of preterm babies among nulliparous mothers

Variable	Category	Odds Ratio	95% Confidence Interval
Maternal hospitalization before the 37 th week of gestation	No	1.00	
	Yes	6.07	2.69~13.69
Maternal occupational activity during pregnancy	No	1.00	
	Yes	4.16	1.59~10.83
Maternal leisure-time physical activity during pregnancy	No exercise	1.00	
	Exercised	0.52	0.25~1.08
Physical activity during elementary school	No exercise	1.00	
	Exercised	1.29	0.63~2.63
Physical activity during junior high school	No exercise	1.00	
	Exercised	2.56	0.95~6.88
Physical activity after junior high	No exercise	1.00	
	Exercised	0.77	0.36~1.63

Table 4 Logistic regression analysis of the risk factors of preterm babies among multiparous mothers

Variable	Category	Odds Ratio	95% Confidence Interval
Maternal hospitalization before the 37 th week of gestation	No	1.00	
	Yes	3.27	1.23~8.73
Maternal activity at home (household chores) during pregnancy	Did half or less of them	1.00	
	Did more than half of them	0.31	0.11~0.88
	Did all of them	0.23	0.07~0.74
Maternal pre-pregnancy weight (kg)	<45	1.00	
	≤45~	0.18	0.05~0.71
	≤50~	0.48	0.14~1.63
	≥55	0.58	0.17~1.92
Maternal leisure-time physical activity during pregnancy	No exercise	1.00	
	Exercised	0.65	0.25~1.67
Physical activity during elementary school	No exercise	1.00	
	Exercised	1.08	0.49~2.41
Physical activity during junior high school	No exercise	1.00	
	Exercised	1.25	0.49~3.15
Physical activity after junior high	No exercise	1.00	
	Exercised	0.81	0.36~1.81

Analyzing the risk factors among multiparous mothers, where results are shown in Table 4, we found that mothers who were hospitalized before the 37th week of gestation were at risk of having a preterm baby. In addition, mothers who performed half or, less than half of their household chores were at higher risk of having preterm babies. Maternal pre-pregnant weight is partially associated with preterm birth, however the trend is not linear. In this analysis, maternal leisure-time physical activities prior to and/or during pregnancy were not significantly associated with the risk of delivering preterm babies.

Since maternal occupational activities were related to an increased risk of delivering preterm babies, we conducted a univariate logistic analysis estimating the OR and 95 percent CI for all variables related to occupational activities during pregnancy. These are given in Table 5. Mothers who worked during pregnancy presented a higher percentage of preterm deliveries than

those who did not work, to a statistically significant degree ($P<0.05$). The other variables under analysis, that is, occupational category, working posture, nature of job, environmental and/or mental stress, occupational fatigue and if mothers had any reason for stopping working did not show a significant relationship to preterm birth.

To clarify the selection bias, we have analyzed the relationship between maternal leisure-time physical activities and preterm delivery according to maternal medical and obstetrical histories, as shown in Table 6. We found that among mothers who had no history of illnesses or of delivering a low birthweight baby or preterm baby, those who exercised during pregnancy showed less incidence of delivering preterm babies than those who did not exercise (2.1 vs. 4.7, respectively). Among mothers who had one illness, those who exercised had 5.2 percent of preterm births while the percentage was slightly higher among those mothers who did

Table 5 Univariate logistic analysis of maternal occupational activities during pregnancy among all subjects and preterm

Variable	n	Preterm babies n	(%)	Odds Ratio (95% Confidence Interval)	
Maternal Occupational situation during pregnancy					
Non-worker	891	35	3.9	1.00	
Worker	804	51	6.3	1.66 (1.07~2.58)	P<0.05
Occupational category					
Office workers	338	21	6.2	1.00	
Manufactory workers	86	2	2.3	0.36 (0.08~1.56)	
Service workers	99	10	10.1	1.70 (0.77~3.73)	
Educational workers	51	2	3.9	0.62 (0.14~2.71)	
Medical care workers	77	7	9.1	1.51 (0.62~3.69)	
Others	146	8	5.5	0.88 (0.38~2.02)	NS
Work posture					
Sitting	403	24	6.0	1.00	
Standing	213	12	5.6	0.94 (0.46~1.92)	
Others	187	15	8.0	1.38 (0.70~2.69)	NS
Nature of employment					
Part-time job	207	15	7.2	1.00	
Full-time job	538	32	5.9	0.80 (0.43~1.53)	
Others	50	4	8.0	1.11 (0.35~3.51)	NS
Environmental and/or mental stress, physical effort situation					
Did not occur	264	22	8.3	1.00	
Occurred to some extent	519	27	5.2	0.60 (0.34~1.08)	NS
Number of environmental and/or mental stress events and physical effort situations that occurred					
Just one situation	217	9	4.1	1.00	
Two situations	128	8	6.3	1.54 (0.58~4.10)	
Three or more situations	167	9	5.4	1.32 (0.51~3.40)	NS
Occupational fatigue situation					
Did not occur	249	14	5.6	1.00	
Occurred to some extent	548	37	6.8	1.22 (0.64~2.29)	NS
Number of fatigue situations that occur					
Just one situation	187	14	7.5	1.00	
Two situations	172	13	7.6	1.01 (0.46~2.21)	
Three or more situations	188	10	5.3	0.69 (0.30~1.60)	NS
Mothers reasons for ceasing working					
Have none	409	24	5.9	1.00	
Had to some extent	389	27	6.9	1.20 (0.68~2.11)	NS
Number of reasons for ceasing work activities					
One reason	265	21	7.9	1.00	
Two or more reasons	120	6	5.0	0.61 (0.24~1.56)	NS

1) NS denotes not significant; 2) n denotes number of cases

Table 6 Relationship between maternal leisure-time physical activities and preterm delivery

	Mothers who had no medical or obstetrical history of LBWB and/or PTB	Mothers who had one illness	Mothers who had two or more illnesses and/or previous LBWB and/or PTB
Maternal leisure-time physical activity during pregnancy			
No exercise, preterm cases/total cases (%)	15/318 (4.7)	8/147 (5.4)	9/100 (9.0)
Exercised, preterm cases/total cases (%)	3/143 (2.1)	4/77 (5.2)	1/36 (2.8)

LBWB denotes low birthweight babies; PTB = preterm babies.

not exercise i.e. 5.4 percent. Among mothers who had two or more illnesses and/or previous low birthweight babies and/or preterm births, those who exercised had 2.8 percent of preterm births while among those mothers who did not exercise 9.0 percent had preterm babies. In this analysis, mothers who exercised showed fewer incidences of preterm births than those who did not exercise in all subgroups.

Discussion

In the present investigation maternal leisure-time physical activity during pregnancy did not raise the risk of preterm delivery. It was suggested that exercise induces significant increases in the levels of norepinephrine concentrations and, subsequently, these catecholamines decrease uterine blood flow^{21,39}. As a consequence, premature labor could theoretically be triggered by an increase in the frequency and amplitude of uterine contractions², caused by a decrease in uterine blood flow. Artal et al.³⁹ observed that mild exercising produced changes in the levels of catecholamines but these changes were transitory and reversed within 30 minutes after exercising. Furthermore, there are another experimental studies that show no uterine activity during exercise⁴⁰ and after exercise⁴¹ in pregnant women. The recommendation of the American College of Obstetricians and Gynecologists which advises that mothers without obstetric or medical complications exercise during pregnancy to maintain and/or improve maternal fitness and their sense of well-being⁴² appears to be reasonable.

In the study by Clapp & Dickstein³⁶ it was shown that mothers who exercised into the third trimester had delivered earlier than those who stopped exercising by the 28th week of gestation, that is, a mean of minus eight days. However, the distribution of births of the overall populace prior to the 38th week i.e. prior to the 266th day of gestation, was similar among the non-exercising group and exercising group (non-exercising group accounted for 3.9 percent of the births vs. exercising groups who accounted for 4.3 percent of the births). We tried to examine our findings using the same criteria; however, the number of mothers who stopped exercising prior to the 28th week of gestation was too few to indicate a meaningful result.

In this study some factors related to previous pregnancies were determinants of the increasing risk of a preterm delivery. Mothers with a history of preterm birth or low birthweight babies were more susceptible to having another preterm baby in a univariate analysis. We could not determine the same findings in a multivariate analysis and that is probably due to the few cases of multiparous mothers who had previously delivered a preterm or a low birthweight baby in this study.

The performing of household chores was related to preterm birth. Mothers who did half or less of their household chores delivered 9.4 percent of the preterm babies compared with the 4.9 percent delivered by the mothers who completed all chores. In

addition, mothers morbidity appeared to be related to the performance of household chores and consequently with preterm birth. We verified that 29.8 percent of the mothers who did half or less of their household chores were very sick (3 or more illnesses), while of mothers who completed all chores only 15.7 percent were very sick, to a statistically significant degree ($P < 0.01$). Launer et al.²⁷ also found that women in families where members help with the household chores to some degree have high rates of morbidity during pregnancy and have significantly higher OR for preterm birth. In the present study some part of the relation must be explained by the morbidity during pregnancy. Although after the adjustment of illness during pregnancy it remained significant among multiparous mothers.

Maternal hospitalization before the 37th week of gestation was a great determinant risk of preterm birth in this study. Among mothers who were hospitalized, 17.8 percent had preterm babies against 3.2 percent among mothers without any hospitalization. In addition, maternal sickness during pregnancy was a determinant risk factor in the delivery of a preterm baby. Mothers who had not been sick had 2.9 percent of preterm deliveries, but mothers who had been seriously sick (four or more illnesses) had a high percentage of preterm births, accounting for 12.2 percent of the whole. The present findings are in agreement with those of the study conducted by Ferraz et al.¹⁰ where maternal illness during pregnancy was also a risk factor for preterm birth. Medical advice was also related to preterm birth. That is, mothers who received more advice had a higher percentage of preterm births. The majority of the medical advice given to mothers who had delivered preterm babies emphasized the ceasing of exercising and working, and recommended longer rest periods. However, among those mothers, 42 percent did not receive any advice. In addition, among mothers who had two or more illnesses and/or previous low birthweight babies and/or preterm babies, 35.7 percent did not receive any kind of medical advice. Responsible physicians should give more attention and care to those mothers who have histories of low birthweight and/or a preterm baby, are sick or are hospitalized during pregnancy, since they are liable to have a preterm delivery.

Maternal occupational activities bore a significant relationship to preterm birth in the present study. We could not define any significant association between occupational categories and preterm birth; however, service and medical care workers present a higher OR of preterm births than do the other categories. Working posture, the standing position, were denominated as risk factors in preterm delivery in some studies^{25-27,38} but that could not be confirmed by the evidence presented by the present analysis. Nevertheless, service and medical care workers showed a higher percentage of preterm babies and those workers usually have jobs involving lengthy standing. Mothers suffering from working related stress had a higher percentage of preterm births according to Homer et al.²³, however, in our study it was not statistically significant. Nulliparous mothers who worked during pregnancy showed

a considerably high odds ratio for preterm birth in this study. According to Creasy³⁾, the symptoms of the development of early preterm labor are frequently so subtle that is difficult to make a value prediction. However, those mothers should be advised that they are more likely to have a preterm birth and should receive special education in the recognition of any symptoms related to an early delivery.

Pregnant women who have medical or obstetrical histories, or feel unfit to exercise are more likely to hesitate in exercising or withdraw from their physical activities. If this kind of selection bias happened in the present subjects, it would have distorted the findings. In the analysis for the selection bias the findings showed that the incidence of preterm birth was fewer among exercisers than non-exercisers irrespective of maternal medical and/or obstetrical histories. Therefore, the selection bias is unlikely to exert influences on the findings of the present study.

It is suggested that some limitations may have occurred to affect the findings of the present study. Since our survey was conducted based on the medical check of babies during their first three or four months of life, we may well have omitted findings concerning those babies who due to severe complications postpartum were still hospitalized at the time we delivered our questionnaires. In addition, as in Japan both ultrasonography and/or the last menstrual period are commonly used to ascertain the gestational age, we were unable to confirm which method was used to calculate the gestational age for each case.

Finally, in this retrospective study it was concluded that maternal leisure-time physical activities prior to and/or during pregnancy do not jeopardize pregnancy outcome, that is, preterm birth²⁸⁻³⁵⁾.

Multiparous mothers who have delivered previously premature or low birthweight babies require special care since they are at a greater risk of having subsequent poor pregnancy outcomes^{4,14,43)}. If mothers intend to have more children, then it is most pertinent to focus on their health to prevent the recurrence of preterm⁵⁾. The important risk factors with regard to preterm birth are maternal hospitalization before the 37th week of gestation, maternal occupational activity during pregnancy and maternal illness during gestation. Mothers who were not in good health had a higher tendency to deliver preterm babies. Physicians should carefully advise pregnant women in such conditions on how to carry on their pregnancies, how to adapt their lifestyles and behavior and how to avoid a premature birth. Physicians should be prompt in identifying at an early stage those mothers at high risk of delivering premature babies.

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