Health, 2016, 8, 133-143
Published Online January 2016 in SciRes. http://www.scirp.org/journal/health
http://dx.doi.org/10.4236/health.2016.82016

A Case-Control Study on Leisure Time Physical Activity (LTPA) during the Last Three Months of Pregnancy and Foetal Outcomes in Italy

Guglielmina Fantuzzi, Elena Righi, Gabriella Aggazzotti

Department of Biomedical, Metabolic and Neural Sciences, University of Modena and Reggio Emilia, Modena, Italy
Email: guglielmina.fantuzzi@unimore.it

Received 10 December 2015; accepted 25 January 2016; published 28 January 2016

Abstract

The association between Leisure Time Physical Activity (LTPA) during pregnancy and foetal outcomes has been extensively investigated. However, epidemiological studies specifically referred to LPTA in the last months of pregnancy are scarce. We evaluated the association between LPTA and the risk of both preterm delivery and small for gestational age (SGA) during the last three months of pregnancy in Italy. A nationwide case-control study was performed in nine Italian cities. A total of 299 preterm delivery, 364 SGA and 855 controls were enrolled in the study. A self-administered questionnaire was used to assess socio-demographic variables, medical and reproductive history, life-style habits and LTPA referred to the last three months of pregnancy. Univariate and multivariate regression analyses were performed in order to estimate Odds ratios and 95% CI. LTPA during the last three months of pregnancy decreases the risk of preterm delivery (adjusted OR = 0.56; 95% CI 0.39 - 0.79). Among the different types of physical activity, walking, the most frequently referred activity, appears significantly protective against preterm delivery (adjusted OR = 0.53; 95% CI 0.36 - 0.81). Moreover, a small protective effect of walking was evidenced against SGA (adjusted OR = 0.72; 95% CI 0.51 - 1.00). In conclusion, a mild physical activity such as walking in the last three months of pregnancy seems to reduce the risk of preterm delivery and, at a lesser extent, of SGA, confirming the beneficial effects of physical activity along the whole pregnancy.

Keywords

Leisure Time Physical Activity (LTPA), Preterm Delivery, Small for Gestational Age, Last Three Months of Pregnancy, Case Control Study

How to cite this paper: Fantuzzi, G., Righi, E. and Aggazzotti, G. (2016) A Case-Control Study on Leisure Time Physical Activity (LTPA) during the Last Three Months of Pregnancy and Foetal Outcomes in Italy. *Health*, **8**, 133-143.
http://dx.doi.org/10.4236/health.2016.82016

1. Introduction

Leisure Time Physical Activity (LTPA) is an important factor to improve and maintain the best conditions of physical well-being. Despite this, pregnant women, especially in the last months of pregnancy, tend to reduce or stop practicing sports and physical exercises, thus contributing to the increase of body weight and other recognized disorders such as gestational diabetes and preeclampsia [1]-[4].

In the last years, an increasing number of epidemiological studies has evaluated the association between LTPA during pregnancy and foetal outcomes, in particular gestational length and infant size for gestational age although with conflicting results. The majority of epidemiological studies found a protective influence of LTPA during pregnancy: a reduced risk of preterm birth among women who were engaged in some kind of exercise in comparison with non-exercisers has been documented [5]-[9]. However, other epidemiological studies didn't find any significant association [10]-[13].

Small for Gestational Age (SGA) birth has been less investigated. Some epidemiological studies, focused on the association between LTPA and birthweight in general, found that LTPA during pregnancy doesn't increase the risk of low birth weight [14] [15]. On the contrary, other studies found an association between the time spent in sport activities and low birthweight [16]. Moreover, epidemiological studies suggest that LTPA may help to normalize birthweight into the healthy range by reducing overweight birth [17].

There is an evidence that women tend to modify their LTPA when they become pregnant: a decline in the intensity of physical activity during pregnancy is observed in women who are involved in vigorous sports activities while, on the contrary, women who are inactive prior to pregnancy sometimes start exercising during pregnancy taking into account the wellness of the baby [18] [19].

LTPA frequency in the last period of pregnancy and during the last three months in particular is not well investigated and epidemiological studies specifically referred to preterm delivery and SGA in late pregnancy are scarce in literature. The aim of the present study was to explore the relationship between LPTA in advanced pregnancy and fetal outcomes such as preterm birth and low birthweight and in particular SGA.

2. Methods

2.1. Study Design and Population

A nationwide case-control study focused on maternal LTPA was carried out as a part of a national study primarily designed to investigate in adverse pregnancy outcomes and life style habits. Data were collected in nine Italian cities as described elsewhere [20]. In five cities the participating obstetric clinics covered nearly 100% of total births that occurred in the municipal areas, while in the four largest cities the coverage ranged from 40% to 60% of total births. Participation rate was 96%.

Preterm birth cases (No. 299) were singleton babiesborn before the end of the 37th week of pregnancy, while SGA cases (No. 364) were births with weight below the 10th percentile for the gestational age, according to Italian standards [21]. Controls (No. 855) were placed on singleton births that occurred in the same hospitals 1 - 2 days after the delivery of the case, with a gestational age > 37th completed week of pregnancy and a birthweight over 2500 g. Only babies born from mothers who were Caucasian, born in Italy and resident in the investigated cities were considered eligible for inclusion in the study. Multiple pregnancies or newborns with congenital malformations were excluded.

2.2. Data Collection and Assessment of LTPA

Mothers of cases and controls were recruited during their hospital stay just after delivery by trained interviewers. After informed consent and before hospital discharge, mothers were asked to complete a structured, self-administrated questionnaire, previously validated regarding some style-life variables [22].

The questionnaire collected information about socio-demographic variables (mother's age, educational level, etc.), reproductive and medical history (parity, miscarriages, stillbirth, hypertension, diabetes, etc.) and life-style habits such as smoking habits, environmental tobacco smoke(ETS) exposure and drinking habits (coffee, beer and alcohol consumption). Maternal and infant medical records were reviewed to obtain clinical data about mother's health and birth outcomes (infant sex, gestational age and infant birthweight).

Information on physical activity, both as working activity and LTPA, was referred to the last three months of pregnancy and based on maternal self-reporting. Working activity was defined as yes (occupational activity with

movement) or no (either none or sedentary occupation).

LTPA was referred as follows: "have you played any sport in the last three months (other than that included in the antenatal course)? If yes, which activity have you performed for at least >30 min/day? Gymnastics (times/week), cycling (times/week), swimming in indoor or outdoor pool (times/week), walking >1/2 hour (times/week), other sports, specify (times/week)". The questionnaire also gathered information about domestic physical activity such as house-work and gardening (times/week).

The information about the attendance to antenatal classes was also collected, asking about physical activity performed during the courses, frequency and time length.

2.3. Statistical Analyses

Bivariate and multivariate regression procedures were applied to estimate the associations between LTPA and preterm birth and SGA. Odds ratios (ORs) and 95% Confidence Intervals (95% CI) were calculated.

The following variables were considered as confounders: infant gender, maternal age (years), partner, education, employment during the last three months, parity, previous preterm deliveries, previous SGA, miscarriage, stillbirth, gestational diabetes and hypertension, antenatal class attendance. Among style-life habits, active smoking, alcohol and coffee intake, ETS exposure were taken into account. Confounding variables were assessed both by questionnaire and clinical records, when possible.

The regression models were adjusted for variables significantly associated with case status ($p < 0.05$): statistical analyses were performed with SPSS Statistical Software 18.0 for Windows.

Since no invasive procedures were applied in the study, no Ethics Committee approval was required at the time of enrolment of subjects. However, a positive consensus was subsequently asked and obtained.

3. Results

In **Table 1**, the distribution of socio-demographic variables, medical and reproductive history and life-style habits for preterm births and controls is reported. Among maternal characteristics, only age >40 ys was significantly associated with preterm delivery, while no association was found with marital status, education and working activity during the last three months of pregnancy. Mothers of preterm new borns have had previous preterm deliveries, SGA babies, miscarriages and stillbirth when multipara. Moreover, a history of hypertension and diabetes was shown. Active smoking before and during the last three months but not ETS exposure was more frequent in mothers of preterm babies compared with control subjects. Alcohol and coffee intake were not associated, while antenatal classes attendance was positively associated with a low risk of preterm delivery.

Mothers of SGA babies were more likely to have females and to be primipara (**Table 2**). No association was found with age, marital status, education and employment during the last three months of pregnancy. When multipara, previous preterm deliveries, previous SGA babies and miscarriages were more frequent in mothers of SGA cases, while no difference was observed in stillbirth. Regarding to maternal life-style habits, smoking habits, ETS exposure and coffee intake were more frequent in SGA mothers compared with control subjects, while no association was evidenced in alcohol intake and antenatal classes attendance. Regarding to LTPA within the whole sample (1518 subjects), 26% (400 subjects) declared to practice some kind of physical activity during the last three months of pregnancy.

In **Table 3**, unadjusted and adjusted odds ratios (95% CI) of the association between LTPA in the last three months of pregnancy and preterm delivery are reported. Adjusted odds ratios (95% CI) were calculated after controlling for maternal age, previous preterm deliveries, hypertension, diabetes and active tobacco smoking. Both unadjusted and adjusted analyses showed a protective association of LTPA in general and of walking in particular, on preterm delivery. Other activities such as swimming, sports/exercise, biking, housework and gardening are not associated; however the low number of subjects involved in these activities induces caution. In order to avoid misclassification due to the presence of mothers with previous preterm deliveries, the sensitivity analysis was performed taken into account pregnant women without previous preterm deliveries (No. 251): the same association with LTPA was confirmed.

Regarding to SGA, in **Table 4** unadjusted and adjusted odds ratios (95% CI) of the association between LTPA in the last three months of pregnancy and SGA are reported. After controlling for confounding variables,

Table 1. Distribution of preterm delivery cases and controls according to maternal characteristics, reproductive history and maternal life-style habits in Italy.

	Controls n = 855		Preterm delivery cases n = 299		
	n	%^	n	%^	Unadjusted OR [95% CI]
Maternal characteristics					
Maternal age (years)					
≤20	13	1	7	2	1.52 [0.59 - 3.90]
21 - 30	333	39	118	39	1.00 [Reference]
31 - 40	495	58	162	54	0.92 [0.70 - 1.22]
>40	13	1	12	4	2.60 [1.16 - 5.87]
Partner					
Yes	816	96	279	94	1.00 [Reference]
No	34	4	19	6	1.63 [0.92 - 2.91]
Education					
Primary/middle school	246	29	87	29	1.00 [Reference]
High school	417	49	142	47	0.96 [0.71 - 1.31]
University	191	22	69	23	1.02 [0.71 - 1.50]
Working activity during the last three months					
No	240	29	86	29	1.00 [Reference]
Yes	587	71	204	70	0.97 [0.72 - 1.30]
Reproductive history					
Newborn sex					
Males	413	48	160	54	1.00 [Reference]
Females	442	52	135	46	0.79 [0.60 - 1.03]
Parity					
Primiparae	424	50	153	51	1.00 [Reference]
Multiparae	428	50	145	49	0.94 [0.72 - 1.22]
Previous preterm deliveries[§]					
No	386	91	99	68	1.00 [Reference]
Yes	38	9	46	32	4.72 [2.91 - 7.65]
Previous SGA[§]					
No	343	96	73	74	1.00 [Reference]
Yes	15	4	26	26	8.14 [4.11 - 16.14]
Miscarriages[§]					
No	285	67	76	52	1.00 [Reference]
Yes	140	33	69	48	1.85 [1.26 - 2.71]

Continued

Stillbirth[§]					
No	418	99	137	95	1.00 [Reference]
Yes	5	1	8	5	4.88 [1.57 - 15.17]
Diabetes					
No	838	99	277	94	1.00 [Reference]
Yes	10	1	18	6	5.44 [2.48 - 11.94]
Hypertension					
No	820	96	246	84	1.00 [Reference]
Yes	32	4	45	15	4.69 [2.91 - 7.54]
Maternal life-style habits					
Active smoking before pregnancy					
No	595	70	187	63	1.00 [Reference]
Yes	259	30	110	37	1.35 [1.02 - 1.78]
Active smoking in the last three months of pregnancy					
No	721	85	237	80	1.00 [Reference]
Yes	125	15	60	20	1.46 [1.04 - 2.05]
Environmental tobacco smoke exposure					
No	555	65	186	63	1.00 [Reference]
Yes	295	35	111	37	1.12 [0.85 - 1.48]
Coffee intake					
No	357	42	133	45	1.00 [Reference]
Yes	492	58	160	55	0.87 [0.67 - 1.14]
Alcohol intake					
No	468	56	173	59	1.00 [Reference]
Yes	373	44	119	41	0.86 [0.66 - 1.13]
Antenatal classes attendance					
No	436	51	195	66	1.00 [Reference]
Yes	417	49	102	34	0.55 [0.42 - 0.72]

^Percentage may not add to 100 because of rounding or missing information for some subjects; [§]Only in multiparae.

no significant association was observed between LTPA and SGA: however, a small association between SGA and walking was observed in multivariate analysis.

In **Table 5**, adjusted odds ratios [95% CI] of preterm delivery and SGA related to the frequency of LTPA and walking in particular during the last three months of pregnancy were reported. Preterm deliveries were significantly less frequent in women practicing LTPA, both 1 - 2 times/week and ≥3 times/week. Regarding to walking, a protective relationship against preterm delivery was confirmed, above all in women practicing walking 3 times/week.

After controlling for confounding variables (low birth weight, active smoking, coffee) no significant adjusted ORs were evidenced between LTPA and SGA when the frequency of LTPA and walking (1 - 2 times/week and ≥3 times/week) was taken into account.

Table 2. Distribution of SGA cases and controls according to maternal characteristics, reproductive history and maternal life-style habits in Italy.

	Controls n = 855		SGA cases n = 364		
	n	%^	n	%^	Unadjusted OR [95% CI]
Maternal characteristics					
Maternal age (years)					
≤20	13	1	10	3	1.73 [0.74 - 4.04]
21- 30	333	39	148	41	1.00 [Reference]
31- 40	495	58	198	54	0.90 [0.70 - 1.16]
>40	13	1	7	2	1.21 [0.47 - 3.10]
Partner					
Yes	816	96	342	94	1.00 [Reference]
No	34	4	20	5	1.40 [0.80 - 2.47]
Education					
Primary/middle school	246	29	114	38	1.00 [Reference]
High school	417	49	176	59	0.91 [0.69 - 1.21]
University	191	22	68	23	0.77 [0.54 - 1.10]
Employment during the last three months					
No	240	29	105	30	1.00 [Reference]
Yes	587	71	244	70	0.95 [0.72 - 1.25]
Reproductive history					
Newborn sex					
Males	413	48	157	43	1.00 [Reference]
Females	442	52	207	57	1.29 [1.00 - 1.66]
Parity					
Primiparae	424	50	220	61	1.00 [Reference]
Multiparae	428	50	138	38	0.62[0.48 - 0.80]
Previous preterm deliveries[§]					
No	386	91	108	79	1.00 [Reference]
Yes	38	9	29	21	2.73 [1.61 - 4.63]
Previous SGA[§]					
No	343	96	79	81	1.00 [Reference]
Yes	15	4	19	19	5.50 [2.68 - 11.30]
Miscarriages[§]					
No	285	67	75	55	1.00 [Reference]
Yes	140	33	62	45	1.68 [1.14 - 2.49]
Stillbirth[§]					
No	418	99	134	98	1.00 [Reference]
Yes	5	1	3	2	1.87 [0.44 - 7.93]
Diabetes					
No	838	99	348	99	1.00 [Reference]
Yes	10	1	4	1	0.96 [0.30 - 3.09]
Hypertension					
No	820	96	345	95	1.00 [Reference]
Yes	32	4	19	5	1.41 [0.79 - 2.52]

Continued

Maternal life-style habits					
Active smoking before pregnancy					
No	595	70	228	63	1.00 [Reference]
Yes	259	30	131	36	1.32 [1.02 - 1.71]
Active smoking in the last three months of pregnancy					
No	721	85	256	71	1.00 [Reference]
Yes	125	15	102	28	2.30 [1.71 - 3.10]
Environmental tobacco smoke exposure					
No	555	65	199	58	1.00 [Reference]
Yes	295	35	141	41	1.33 [1.03 - 1.72]
Coffee intake					
No	357	42	116	35	1.00 [Reference]
Yes	492	58	219	65	1.37 [1.05 - 1.78]
Alcohol intake					
No	468	56	203	61	1.00 [Reference]
Yes	373	44	130	39	0.80 [0.62 - 1.08]
Antenatal classes attendance					
No	436	51	181	51	1.00 [Reference]
Yes	417	49	175	49	1.01 [0.79 - 1.29]

^Percentage may not add to 100 because of rounding or missing information for some subjects. §Only in multiparae.

Table 3. Unadjusted and adjusted odds ratios (OR) [95% confidence intervals] of preterm delivery related to LTPA during the last three months of pregnancy.

	Controls n = 853		Cases n = 299		Unadjusted ORs [95% CI]	Adjusted ORs* [95% CI]
	n	%^	n	%^		
LTPA						
No	604	71	244	82	1.00 [Reference]	1.00 [Reference]
Yes	249	29	54	18	0.54 [0.39 - 0.75]	0.56 [0.39 - 0.79]
Swimming						
No	763	89	279	94	1.00 [Reference]	1.00 [Reference]
Yes	90	11	19	6	0.58 [0.35 - 0.96]	0.71 [0.42 - 1.21]
Walking						
No	678	79	261	88	1.00 [Reference]	1.00 [Reference]
Yes	175	21	37	12	0.55 [0.37 - 0.80]	0.53 [0.36 - 0.81]
Sports/exercise						
No	833	98	296	99	1.00 [Reference]	1.00 [Reference]
Yes	20	2	2	1	0.28 [0.06 - 1.21]	0.28 [0.06 - 1.16]
Biking						
No	839	98	293	98	1.00 [Reference]	1.00 [Reference]
Yes	14	2	5	2	1.02 [0.36 - 2.86]	1.32 [0.46 - 3.82]
House-work and gardening						
No	791	93	276	93	1.00 [Reference]	1.00 [Reference]
Yes	57	7	20	7	1.00 [0.59 - 1.70]	0.96 [0.54 - 1.70]

*adjusted for maternal age, previous preterm deliveries, hypertension, diabetes and active tobacco smoke during pregnancy.

Table 4. Unadjusted and adjusted odds ratios (OR) [95% confidence intervals] of SGA related to LTPA during the last three months of pregnancy.

	Controls n = 853		Cases n = 364		Unadjusted ORs [95% CI]	Adjusted ORs* [95% CI]
	n	%^	n	%^		
LTPA						
No	604	71	261	73	1.00 [Reference]	1.00 [Reference]
Yes	249	29	97	27	0.90 [0.68 - 1.19]	0.87 [0.65 - 1.16]
Swimming						
No	763	89	314	88	1.00 [Reference]	1.00 [Reference]
Yes	90	11	44	12	1.19 [0.81 - 1.74]	1.17 [0.78 - 1.75]
Walking						
No	678	80	299	83	1.00 [Reference]	1.00 [Reference]
Yes	175	20	59	17	0.76 [0.55 - 1.06]	0.72 [0.51 - 1.00]
Sports/exercise						
No	833	98	349	97	1.00 [Reference]	1.00 [Reference]
Yes	20	2	9	3	1.07 [0.48 - 2.38]	1.05 [0.47 - 2.38]
Biking						
No	839	98	354	99	1.00 [Reference]	1.00 [Reference]
Yes	14	2	4	1	0.68 [0.22 - 2.07]	0.78 [0.25 - 2.44]
House-work and gardening						
No	791	93	331	93	1.00 [Reference]	1.00 [Reference]
Yes	57	7	25	7	1.05 [0.64 - 1.71]	1.11 [0.67 - 1.84]

*adjusted for maternal age, previous preterm deliveries, hypertension, diabetes and active tobacco smoke during pregnancy.

Table 5. Adjusted odds ratios [95% CI] of preterm delivery and SGA related to the frequency of LTPA and walking in particular during the last three months of pregnancy.

	Controls		Preterm delivery			SGA		
LTPA (times/week)	n	%	n	%	Adjusted ORs° [95% CI]	n	%	Adjusted ORs* [95% CI]
No	604	71	244	82	1.00 [Reference]	261	73	1.00 [Reference]
1, 2 times/week	83	10	16	5	0.50 [0.27 - 0.90]	32	9	0.96 [0.61 - 1.51]
≥3 times/week	166	19	38	13	0.59 [0.39 - 0.88]	65	18	0.82 [0.59 - 1.16]
Walking (times/week]								
No	678	72	261	88	1.00 [Reference]	299	83	1.00 [Reference]
1, 2 times/week	43	5	14	5	0.85 [0.44 - 1.67]	12	3	0.65 [0.33 - 1.26]
≥3 times/week	132	15	23	8	0.44 [0.27 - 0.71]	47	13	0.74 [0.51 - 1.07]

°adjusted for age, active smoking, other preterm delivery, hypertension, diabetes; *adjusted for other low birth weight, active smoking, coffee.

4. Discussion

The present study shows that women who have performed physical activity as LTPA mainly walking in the late period of pregnancy are at substantially lower risk of preterm delivery compared to women who are less active.

The results of our study are in agreement with some large prospective cohorts when comparing the same period of pregnancy. Findings from a study performed in Brazil on preterm delivery showed that LTPA during the third trimester was associated with a lower chance of preterm birth [6]. Moreover, mild physical activity during the second trimester of pregnancy such as walking shows an independent protective effect on low birth weight, preterm birth, and intrauterine growth restriction [9].

In Europe, the Norwegian Mother and Child Cohort Study showed that women exercising three to five times per week at 30th week of gestation had significantly reduced risk of preterm birth (adjusted OR = 0.74, 95% CI = 0.65 - 0.83) compared to non-exercisers [8]. Very similar results have been observed also in the Danish National Birth Cohort where a reduced risk of preterm birth among women who engaged in some kind of exercise during pregnancy, even at the lowest level, in comparison with non-exercisers was evidenced (hazard ratio: 0.82, 95% C.I.: 0.76 - 0.88) [5].

In our study, the slight but not significant protective effect against the risk of SGA is in agreement with the results from the Danish National Birth Cohort where in the exercising women a slightly decreased risk of having a child small for gestational age (hazard ratio = 0.87, 95% CI 0.83 - 0.92) was observed [23]. Other studies suggest that recreational physical activity is associated with a protective effect against SGA when practiced at a medium range of frequency (for instance 3 - 4 times a week) while either a high or low frequency of physical activity may be at risk of SGA [16]. A recent cohort study among predominantly Puerto Rican women evidenced that a high total physical activity in mid-pregnancy was associated with a decreased risk of SGA (RR = 0.42; 95% CI 0.21 - 0.82) as compared to those with low total activity: however, high levels of sports/exercise were associated with an increased SGA risk (RR = 2.14, 95% CI 1.04 - 4.39) [23]. No association between sports and LTPA and low-birthweight was recently found in a large population based study in Sweden where 4458 healthy women who delivered after 37th completed gestational weeks were involved [14].

Our study has some strengths. First of all, it has been carried out nationwide involving Italian subjects from North to South and Sicily, resident in Italy. Moreover, the enrolment of cases and controls has reached a high coverage (100% of births in 5 cities and from 40 to 60% in the remaining 4) and the participation rate was high as well (96%), with no difference between cases and controls. In this way, selection bias was controlled.

Within our sample, LTPA was practiced in 29% of control subjects: this value is in agreement with the data reported in the Danish cohort by Juhl *et al*. [5] while higher than those reported by Haastad *et al*. in Norway, where less than 11% were defined as regular exercisers in the third trimester [24]. A very low prevalence value (4%) of LTPA during the 3 trimester was reported in a Brazil cohort study [6]. However, women characteristics such as race, income and style-life habits could explain the observed differences. Information bias in the classification of cases could be excluded as preterm delivery and SGA cases were confirmed by medical records. Moreover this kind of data may suffer from reporting bias because of social desirability and/or poor recall: however, the interlapsed time is short and misclassification may be not significant.

In the present study a variety of potential confounding factors was taken into account; however, residual confounding may still be present. First of all the assessment of LTPA is based on self-reported questionnaire. It is well known that it may be an important source of potential bias: however, our results are similar to those provided by other investigators. They suggest that the relation between physical activity and pregnancy outcomes is robust, and can be detected even when physical activity is measured using relatively imprecise techniques. Of particular concern, we cannot exclude that the observed association between LTPA and pregnancy outcomes is confounded by maternal weight gain during pregnancy, variable which we were not able to control for in the analysis.

A limitation of any study on physical activity during pregnancy is that women whose previous pregnancies resulted in preterm birth or other negative outcomes are more likely to avoid physical efforts. In our study when the sensitivity analysis was performed taken into account women without previous preterm deliveries only, the results of the study were confirmed: however residual confounding could exist and not controlled for.

Moreover, women who are active during the third trimester may represent a very specific group of women who are willing to exercise and likely to adopt several other healthy habits. Unfortunately, these aspects cannot be controlled for in this study. Regarding to biological plausibility, LTPA during pregnancy could decrease the risk of preterm delivery by improving placentation and vascularization while reducing oxidative stress [25] [26].

5. Conclusion

In conclusion, because no harm or risk increase was detected among women who exercised, and physical activ-

ity throughout life is considered a healthy behaviour, LTPA during the whole pregnancy, the last period included, should be encouraged during prenatal care visits. This is in agreement with the American College of Obstetricians and Gynaecologists guidelines (2002) that recommend that women with no contraindications should be advised to practice physical activity during the whole pregnancy [27].

Acknowledgements

This study was partially supported by the Italian Ministry of University, Technology and Research (grant No. 9806171176/98).

Conflict of Interest

The authors declare that they have no conflict of interest.

References

[1] Borodulin, K., Evenson, K.R., Wen, F., Herring, A. and Benson, A. (2008) Physical Activity Patterns during Pregnancy. *Medicine & Science in Sports & Exercis*, **40**, 1901-1908. http://dx.doi.org/10.1249/MSS.0b013e31817f1957

[2] Hegaard, H.K., Pedersen, B.K., Nielsen, B.B. and Damm, P. (2007) Leisure Time Physical Activity during Pregnancy and Impact on Gestational Diabetes Mellitus, Pre-Eclampsia, Preterm Delivery and Birth Weight: A Review. *Acta Obstetricia et Gynecologica Scandinavica*, **86**, 1290-1296. http://dx.doi.org/10.1080/00016340701647341

[3] Downs, D.S., Chasan-Taber, L., Evenson, K.R., Leiferman, J. and Yeo, S. (2012) Physical Activity and Pregnancy: Past and Present Evidence and Future Recommendations. *Research Quarterly for Exercise & Sport*, **83**, 485-502. http://dx.doi.org/10.1080/02701367.2012.10599138

[4] Mudd, L.M., Owe, K.M., Mottola, M.F. and Pivarnik, J.M. (2013) Health Benefits of Physical Activity during Pregnancy: An International Perspective. *Medicine & Science in Sports & Exercise*, **45**, 268-277. http://dx.doi.org/10.1249/MSS.0b013e31826cebcb

[5] Juhl, M., Andersen, P.K., Olsen, J., Madsen, M., Jorgensen, T., Nohr, E.A. and Nybo Andersen, A. (2008) Physical Exercise during Pregnancy and the Risk of Preterm Birth: A Study within the Danish National Birth Cohort. *American Journal of Epidemiology*, **167**, 859-866. http://dx.doi.org/10.1093/aje/kwm364

[6] Domingues, M.R. and Barros, A.J. (2007) Leisure-Time Physical Activity during Pregnancy in the 2004 Pelotas Birth Cohort Study. *Revista de Saude Publica*, **41**, 173-180. http://dx.doi.org/10.1590/S0034-89102007000200002

[7] Hegaard, H.K., Hedegaard, M., Damm, P., Ottesen, B., Petersson, K. and Henriksen, T.B. (2008) Leisure Time Physical Activity Is Associated with a Reduced Risk of Preterm Delivery. *American Journal of Obstetrics and Gynecology*, **198**, 180-185. http://dx.doi.org/10.1016/j.ajog.2007.08.038

[8] Owe, K.M, Nystad, W., Skjaerven, R., Stigum, H. and Bø, K. (2012) Exercise during Pregnancy and the Gestational Age Distribution: A Cohort Study. *Medicine & Science in Sports & Exercise*, **44**, 1067-1074. http://dx.doi.org/10.1249/MSS.0b013e3182442fc9

[9] Takito, M.Y. and Benício, M.H. (2010) Physical Activity during Pregnancy and Fetal Outcomes: A Case-Control Study. *Revista de Saúde Públic*, **44**, 90-101. http://dx.doi.org/10.1590/s0034-89102010000100010

[10] Leiferman, J.A. and Evenson, K.R. (2003) The Effect of Regular Leisure Physical Activity on Birth Outcomes. *Maternal and Child Health Journal*, **7**, 59-64. http://dx.doi.org/10.1023/A:1022545718786

[11] Barakat, R., Stirling, J.R. and Lucia, A. (2008) Does Exercise Training during Pregnancy Affect Gestational Age? A Randomised Controlled Trial. *British Journal Sports Medicine*, **42**, 674-678. http://dx.doi.org/10.1136/bjsm.2008.047837

[12] Barakat, R., Pelaez, M., Montejo, R., Refoyo, I. and Coteron, J. (2014) Exercise throughout Pregnancy Does Not Cause Preterm Delivery. A Randomized, Controlled Trial. *Journal of Physical Activity & Health*, **11**, 1012-1017. http://dx.doi.org/10.1123/jpah.2012-0344

[13] Currie, L.M., Woolcott, C.G., Fell, D.B., Armson, B.A. and Dodds, L. (2014) The Association between Physical Activity and Maternal and Neonatal Outcomes: A Prospective Cohort. *Maternal and Child Health Journal*, **18**, 1823-1833. http://dx.doi.org/10.1007/s10995-013-1426-3

[14] Hegaard, H.K., Petersson, K., Hedegaard, M., Ottesen, B., Dykes, A.K., Henriksen, T.B. and Damm, P. (2010) Sports and Leisure-Time Physical Activity in Pregnancy and Birth Weight: A Population-Based Study. *Scandinavian Journal of Medicine & Science in Sports*, **20**, e96-e102. http://dx.doi.org/10.1111/j.1600-0838.2009.00918.x

[15] Juhl, M., Olsen, J., Andersen, P.K., Nøhr, E.A. and Andersen, A.M. (2010) Physical Exercise during Pregnancy and Fetal Growth Measures: A Study within the Danish National Birth Cohort. *American Journal of Obstetrics & Gyne-*

cology, **202**, 63.e1-63.e8. http://dx.doi.org/10.1016/j.ajog.2009.07.033

[16] Campbell, M.K. and Mottola, M.F. (2001) Recreational Exercise and Occupational Activity during Pregnancy and Birth Weight: A Case-Control Study. *American Journal of Obstetrics and Gynecology*, **184**, 403-408. http://dx.doi.org/10.1067/mob.2001.109392

[17] Alderman, B.W., Zhao, H., Holt, V.L., Watts, D.H. and Beresford, S.A. (1998) Maternal Physical Activity in Pregnancy and Infant Size for Gestational Age. *Annals of Epidemiology*, **8**, 513-519. http://dx.doi.org/10.1016/S1047-2797(98)00020-9

[18] Petersen, A.M., Leet, T.L. and Brownson, R.C. (2005) Correlates of Physical Activity among Pregnant Women in the United States. *Medicine & Science in Sports & Exercise*, **37**, 1748-1753. http://dx.doi.org/10.1249/01.mss.0000181302.97948.90

[19] Haakstad, L.A., Voldner, N., Henriksen, T. and Bo, K. (2007) Physical Activity Level and Weight Gain in a Cohort of Pregnant Norwegian Women. *Acta Obstetricia et Gynecologica Scandinavica*, **86**, 559-564. http://dx.doi.org/10.1080/00016340601185301

[20] Aggazzotti, G., Righi, E., Fantuzzi, G., Biasotti, B., Ravera, G., Kanitz, S., Barbone, F., Sansebastiano, G., Battaglia, M., Leoni, V., Fabiani, L., Triassi, M. and Sciacca, S. (2004) Chlorination By-Products (CBPs) in Drinking Water and Adverse Pregnancy Outcomes in Italy. *Journal of Water and Health*, **2**, 233-247.

[21] Parazzini, F., Cortinovis, I., Bortolus, R., Fedele, L. and Decarli, A. (1995) Weight at Birth by Gestational Age in Italy. *Human Reproduction*, **10**, 1862-1963.

[22] Barbone, F., Valent, F., Brussi, V., Tomasella, L., Triassi, M., Di Lieto, A., Scognamiglio, G., Righi, E., Fantuzzi, G., Casolari, L. and Aggazzotti, G. (2002) Assessing the Exposure of Pregnant Women to Drinking Water Disinfection By-Products. *Epidemiology*, **13**, 540-544. http://dx.doi.org/10.1097/00001648-200209000-00009

[23] Gollenberg, A.L., Pekow, P., Bertone-Johnson, E.R., Freedson, P.S., Markenson, G. and Chasan-Taber, L. (2011) Physical Activity and Risk of Small-for-Gestational-Age Birth among Predominantly Puerto Rican Women. *Maternal and Child Health Journal*, **15**, 49-59. http://dx.doi.org/10.1007/s10995-009-0563-1

[24] Haakstad, L.A., Voldner, N., Henriksen, T. and Bø, K. (2009) Why Do Pregnant Women Stop Exercising in the Third Trimester? *Acta Obstetricia et Gynecologica Scandinavica*, **88**, 1267-1275. http://dx.doi.org/10.3109/00016340903284901

[25] Clapp, F., Kim, H., Burciu, B. and Lopez, B. (2000) Beginning Regular Exercise in Early Pregnancy: Effect on Feto-Placental Growth. *American Journal of Obstetrics and Gynecology*, **183**, 1484-1488. http://dx.doi.org/10.1067/mob.2000.107096

[26] Clapp, J.F., Stephanchak, W., Tomaselli, J., Kortan, M. and Faneslow, S. (2000) Portal Vein Blood Flow—Effects of Pregnancy, Gravity, and Exercise. *American Journal of Obstetrics and Gynecology*, **183**, 167-172.

[27] American College of Obstetricians and Gynecologists (ACOG Committee) (2002) Opinion No. 267: Exercise during Pregnancy and the Postpartum Period. *Obstetrics & Gynecology*, **99**, 171-173. http://dx.doi.org/10.1016/S0029-7844(01)01749-5