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**ORIGINAL ARTICLE /** *ARTIGO ORIGINAL*

# Air pollutants associated with insufficient birth weight

## *Poluentes atmosféricos associados ao peso insuficiente ao nascimento*

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**ABSTRACT:** ***Introduction:*** A growing number of studies have shown consistent evidence of the harmful effects of air pollution on human health, as well as its effects on newborn weight. The objective of this study is to evaluate the effect of air pollution on birth weight, more specifically the insufficient birth weight (identified between 2,500 and 2,999 grams). ***Methods:*** This was a cross-sectional study based on data gathered from all babies born to mothers living in São José dos Campos, São Paulo, Brazil, between the years of 2006 to 2010. The association between maternal exposure to air pollution and birth weight was examined using logistic regression (both univariate and multivariate) to consider the average concentration of each pollutant during the 1st and 3rd trimesters and the months of the 1st trimester. ***Results:*** Of the 39,453 total live births during the study period, 10,542 (26.7%) newborns had insufficient weight. In multiple logistic analysis, maternal exposure to particulate matter in the 1st and 3rd trimester of pregnancy had a greater chance for insufficient weight. There is a chance of 1.07 (95%CI 1.00 – 1.14) for an insufficient weight scenario for exposure (to the 2nd quartile) of particulate matter in the 1st trimester and 1.10 (95%CI 1.04 – 1.18) for exposure (the 3rd quartile) in the 3rd trimester. ***Conclusion:*** The survey results indicate that maternal exposure to air pollution in the 1st and 3rd trimesters of pregnancy for residents of São José dos Campos create considerable potential to cause insufficient weight.

***Keywords:*** Child health. Air pollution. Logistic models. Birth weight. Infant, newborn. Environmental science.

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**RESUMO:** ***Introdução:*** Um número crescente de estudos tem mostrado evidências consistentes dos efeitos nocivos da poluição do ar na saúde humana e afetando também o peso do recém-nascido. O objetivo deste estudo é avaliar o efeito da poluição do ar sobre o peso ao nascer, mais especificamente o peso insuficiente ao nascer (entre 2.500 e 2.999 g). ***Métodos:*** Trata-se de um estudo transversal com dados relativos a todos os nascidos de mães residentes no Município de São José dos Campos, São Paulo, nos anos de 2006 a 2010. Para examinar a associação entre exposição materna à poluição do ar e o peso ao nascer foi utilizada a regressão logística (univariada e múltipla), considerando-se a média da concentração de cada poluente do 1º e 3º trimestres e dos meses do 1º trimestre. ***Resultados:*** Do total de 39.453 nascidos vivos do período estudado, 10.542 (26,7%) recém-nascidos apresentaram peso insuficiente. Na análise logística múltipla, a exposição materna ao material particulado no 1º e 3º trimestre de gestação apresentou maior chance para o nascimento de uma criança com peso insuficiente. Há uma chance de 1,07 (IC95% 1,00 – 1,14) de ocorrência de peso insuficiente para exposição (ao 2º quartil) ao material particulado no 1º trimestre e de 1,10 (IC95% 1,04 – 1,18) para exposição (ao 3º quartil) no 3º trimestre. ***Conclusão:*** Os resultados da pesquisa indicam que a exposição materna no 1º e 3º trimestres de gestação à poluição do ar no município de São José dos Campos pode determinar o peso insuficiente de recém-nascidos.

***Palavras-chave:*** Saúde da criança. Poluição do ar. Modelos logísticos. Peso ao nascer. Recém-nascido. Ciências do ambiente.

## INTRODUCTION

A growing number of studies published around the world, especially within the last 20 years, have showed consistent evidence of the harmful effects of air pollution in human health[1]. The main pollutants are: particulate material ($PM_{10}$), ozone ($O_3$), sulfur dioxide ($SO_2$), carbon monoxide (CO), and nitrogen oxides.

Researches indicate that the fetus and the newborn (NB) are more susceptible than adults to environmental toxic substances[2].

Although the greatest concern of the researchers in studying the birth weight is mainly regarding low birth weight (LBW), their risk factors and consequences for the life of the individual in short and long terms seek the attention to the proportion of children who are born with insufficient weight (birth weight between 2,500 and 2,999 g)[3].

Studies show that children born with insufficient weight (IW) have higher risk than the ones born with appropriate weight, with greater probability of death, higher chance of respiratory infections, and delayed growth and development, in addition to greater possibility of occurrence of chronic diseases in the future[4-6].

The adverse consequence of the IW acquires great magnitude when considering that an expressive fraction of NBs has weight in that range. In Brazil, the prevalence of low birth weight in 2011 was 8.5%[7]. Some studies show that the number of children with IW is two to three times higher than in the ones with LBW[8,9].

Puffer et al.[10] carried out a study in which the importance of birth with favorable weight (> 3,000 g) for survival, growth, and health development were already stressed. This study demonstrates the characteristics of birth weight in several countries. In India, for example,

from 1969 to 1972, 45.8% had IW at birth. In 1977, 24.9% of the children in Chile and 24.2% in Uruguay were born in that weight range.

In Brazil, there are regional differences in the distribution of LBW and IW. However, most studies are restricted to hospitals or partial populational data and are not representative of the population[11].

Although several studies regarding the effects of air pollution on pregnancy outcomes have been developed worldwide, the knowledge of these effects about the population is still quite restricted. The IW range, more frequent than the LBW, deserves greater attention, not only due to its mortality but also due to its risk of morbidity[3-6].

The objective of this study was to evaluate the effects of air pollution on birthweight, more specifically insufficient weight at birth when being Born at São José dos Campos, São Paulo, within the years from 2006 to 2010.

## METHODS

It is a cross-sectional data obtained in the Live Birth Information System (*Sistema de Informações sobre Nascidos Vivos* – SINASC) through the Declaration of Live Birth (DB). In this document, there are information as for as the characteristics related to NB, to pregnancy, to the birth, and to the mother.

The selection criteria of the sample for the study were: NB of mothers living in the municipality of São José dos Campos, born in the years from 2006 to 2010, at term of a single gestation, and with birth weight between 2,500 and 4,500 g. The dependent variable was insufficient weight (weighing between 2,500 and 2,999 g) or satisfactory weight (weighing between 3,000 and 3,999 g). There were selected variables which were shown in the literature as possible factors for IW, fit for this study, then, as independent variables; namely: gender of the NB, maternal marital status, maternal school education, number of prenatal consultations, birth route, age, and maternal parity. Among these variables, maternal marital status, maternal school education, number of prenatal consultations, and gender of the NB remained in the final model of the multiple logistic analysis as possible modifiers of the effects of air pollution.

São José dos Campos is situated approximately 90 km from São Paulo and has a population of approximately 700,000 inhabitants. Its participation in the gross domestic product of the state is 1.93%, standing out in the economy by the industry and services[12].

The pollutants studies were the $PM_{10}$, $SO_2$, and $O_3$, which are quantified by the measuring station of the Environmental Sanitation Technology company (*Companhia de Tecnologia de Saneamento Ambiental* – CETESB) of São José dos Campos, São Paulo. The concentration of pollutants (first and third quarters, in addition to the months of the first quarter) was recorded in quartiles, representing the values of concentration of the pollutants in ascending order (first, second, third, and fourth quartile).

Only the NBs at term were selected and the trimesters of pregnancy were calculated from the date of birth (retrospectively). The daily mean concentration of each pollutant was placed in the respective periods. For example, a child born, at term 37 to 41 weeks,

in 30th November, was considered as having 39 weeks that day, and from this date on we calculated the mean pollutant concentration of the 9 months before birth, that is, the period between March and November. Thus, we obtained the mean pollutant concentration in the first (March–May) and third (September–November) trimesters of pregnancy for that child. In the case of the first trimester, the mean pollutant concentration was determined for each month (i.e. March, April, and May).

To analyze the IW at birth, the logistic regression was used (both univariate and multivariate one). The univariate logistic analysis examined, first, the relation of IW at birth with the maternal exposure to several pollutants with the objective of estimating the gross effect, that is, with no adjustments, of this exposure in the weight of the child. Besides, this model was used to verify the relation of the outcome with each independent variable previously mentioned. In this case, the statistical analysis was based on the calculation of the *odds ratio* (OR) to estimate the chance of the NB with IW at birth associated to each variable. In all the analyses confidence intervals of 95% (95%CI) and significance level of 5% (a = 5%) were used.

From the results of this univariate model the variables for the models of multiple analysis were selected. The independent variables entered one by one, using the highest OR value observed in the univariate logistic analysis as an entrance criteria, showing a statistically significant association ($p < 0.001$). And also to verify the importance of which variable for the model and its permanence, the likelihood-ratio test was used, remaining at the end of the analysis only the variables with $p < 0.05$. After obtaining the complete models, the pollutants were included, individually and in group, and their association with weight at birth and IW at birth were tested.

The statistical analysis was performed in the Excel and STATA v.7 softwares.

This research was submitted to and approved by the Research Ethics Committee of the Universidade de Taubaté (approval number: 687.272).

## RESULTS

Initially, 45,671 live births were selected in the period between 2006 and 2010 in the city of São José dos Campos, São Paulo. After applying the selection criteria, 39,453 NBs were kept in the study. From the total live births analyzed, 10,542 (26.7%) NBs presented IW. Besides, approximately half of them were males and children of mothers with a partner, considering that more than 50% were born by cesarean (Table 1). The mean weight of NBs and the mean maternal age in this study are 3,253 g, standard deviation (SD) of 375.3 and 27 years of age (SD = 6.3).

For air pollutants, mean values of $SO_2$, $PM_{10}$, and $O_3$ in $\mu g/m^3$ ($3.24 \pm 2.39$, $24.68 \pm 12.84$, and $72.78 \pm 36.77$, respectively) were observed. The means of the pollutants are within the acceptable standards of air quality, established in the last update of the recommendations of the World Health Organization (WHO), of 2005[13].

This study found statistically significant results for the occurrence of children with IW for the variables regarding maternal characteristics, pregnancy, birth, and NB. The chance

of a child being born with IW was higher among female NB and among mother without a partner. As for maternal education with 8 years or more of complete studies, from 1 to 7 prenatal consultations and cesarean delivery feature as a protection factor. The maternal education has been inversely associated to IW, meaning, the higher the education, the lower the chances of IW at birth. The same profile was observed in relation to the number of prenatal consultations (Table 2).

In the univariate logistic analysis, the maternal exposure to $PM_{10}$ and $SO_2$ in the first trimester of pregnancy represented a higher chance of a child being born with IW. For example, there is a chance of 1.07 (95%CI 1.01 – 1.14) of occurrence of IW at birth for exposure at the second quartile of concentration of $PM_{10}$ and 1.04 (95%CI 0.97 – 1.10) for exposure to the third

Table 1. Distribution of live births of mother living in São José dos Campos, SP, in the period between 2006 and 2010, according to weight and gender of the newborn, marital status and maternal education, number of prenatal consultations, and kind of delivery.

| Variables | n (n = 39,453) | % |
|---|---|---|
| Weight | | |
| Favorable | 28,911 | 73.3 |
| Insufficient | 10,542 | 26.7 |
| Gender of the newborn | | |
| Male | 20,273 | 51.4 |
| Female | 19,178 | 48.6 |
| Maternal marital status | | |
| With a partner | 19,611 | 50.2 |
| Without a partner | 19,439 | 49.8 |
| Maternal education (years of complete studies) | | |
| None | 103 | 0.3 |
| 1 to 7 | 6,605 | 16.9 |
| 8 to 11 | 24,152 | 61.6 |
| 12 or more | 8,325 | 21.2 |
| Number of prenatal consultations | | |
| None | 296 | 0.8 |
| 1 to 3 | 762 | 1.9 |
| 4 to 6 | 4,573 | 11.7 |
| 7 or more | 33,420 | 85.6 |
| Delivery | | |
| Vaginal | 15,480 | 39.3 |
| Cesarean | 23,950 | 60.7 |

Note: 403; 23; 2; 402 and 268 cases without records, respectively, for the variables of maternal marital status, delivery, gender of the newborn, number of prenatal consultations, and maternal education.

quartile of concentration of $SO_2$. In the third trimester, the pollutants pointed out as possible risk factors were $PM_{10}$ and $O_3$ (Table 3). In the final model (multiple logistic analysis), adjusted for all pollutants, the gender of the NB, maternal marital status, maternal education, number of prenatal consultations, and birth labor; the exposure to $PM_{10}$ and $SO_2$ was kept with an increased chance (except for the fourth quartile of exposure to the $PM_{10}$) for IW in the first trimester. In the third trimester, the $PM_{10}$ and the $O_3$ were kept as possible risk factors (Table 4).

For a better evaluation of the results, a detailed analysis of the first trimester of pregnancy was made, with the objective of identifying the month with greater influence of air pollutants during pregnancy. The results found are shown in Table 5. The second month of pregnancy was highlighted, once the exposure to all pollutants was pointed out as a risk factor for the occurrence of IW at birth.

Table 2. *Odds ratio* with the respective confidence interval of 95% of insufficient weight of live births in the municipality of São José dos Campos, SP, of mothers living in this city in the period between 2006 and 2010, according to the gender of the newborn, maternal marital status and education, number of prenatal consultations, and kind of delivery.

| Variables | Prevalence of insufficient weight | OR | 95%CI |
|---|---|---|---|
| Gender of the newborn* | | | |
| Male | 22.41% | 1.00 | – |
| Female | 31.28% | 1.57 | 1.50 – 1.64 |
| Maternal marital status* | | | |
| With a partner | 25.60% | 1.00 | – |
| Without a partner | 27.84% | 1.12 | 1.07 – 1.17 |
| Maternal education* (years of complete studies) | | | |
| None | 28.16% | 1.00 | – |
| 1 to 7 | 28.37% | 1.01 | 0.66 – 1.56 |
| 8 to 11 | 26.75% | 0.93 | 0.61 – 1.43 |
| 12 or more | 26.71% | 0.86 | 0.56 – 1.33 |
| Number of prenatal consultations* | | | |
| None | 46.62% | 1.00 | – |
| 1 to 3 | 34.51% | 0.60 | 0.46 – 0.80 |
| 4 to 6 | 31.16% | 0.52 | 0.41 – 0.66 |
| 7 or more | 25.74% | 0.40 | 0.32 – 0.50 |
| Delivery* | | | |
| Vaginal | 28.36% | 1.00 | – |
| Cesarean | 25.66% | 0.87 | 0.83 – 0.91 |

OR: *odds ratio*; 95% CI: confidence interval of 95%; *p < 0.001.

Table 3. *Odds ratio* and confidence intervals of 95% for insufficient weight according to the quartiles of concentration of the air pollutants for the first and third pregnancy trimesters, in the municipality of São José dos Campos, SP, between 2006 and 2010 (univariate logistic analysis).

| Quartile | First trimester | Third trimester |
|---|---|---|
| | OR (95%CI) | OR (95%CI) |
| $SO_2$ | | |
| 1st | 1 | 1 |
| 2nd | 1.01 (0.95 – 1.08) | 0.97 (0.91 – 1.03) |
| 3rd | 1.04 (0.97 – 1.10) | 0.95 (0.90 – 1.02) |
| 4th | 1.00 (0.94 – 1.07) | 0.98 (0.92 - 1.05) |
| $PM_{10}$ | | |
| 1st | 1 | 1 |
| 2nd | 1.07 (1.01 – 1.14) | 1.03 (0.97 – 1.10) |
| 3rd | 1.02 (0.96 – 1.09) | 1.09 (1.03 – 1.17) |
| 4th | 1.00 (0.94 – 1.07) | 1.03 (0.97 – 1.10) |
| $O_3$ | | |
| 1st | 1 | 1 |
| 2nd | 0.98 (0.92 – 1.04) | 1.03 (0.97 – 1.10) |
| 3rd | 1.00 (0.94 – 1.07) | 1.04 (0.98 – 1.11) |
| 4th | 0.98 (0.92 – 1.05) | 1.01 (0.95 – 1.08) |

OR: *odds ratio*; 95%CI: confidence interval of 95%; $SO_3$: sulfur dioxide; $PM_{10}$: particulate material; $O_3$: ozone.

Table 4. *Odds ratio* and confidence interval s of 95% for insufficient weight according to the quartiles of concentration of the air pollutants for the first and third trimesters of pregnancy, in the municipality of São José dos Campos, SP, between 2006 and 2010 (multiple logistic regression).

| Quartile | First trimester | Third trimester |
|---|---|---|
| | OR (95%CI) | OR (95%CI) |
| $SO_2$ | | |
| 1st | 1 | 1 |
| 2nd | 1.01 (0.94 – 1.07) | 0.97 (0.91 – 1.03) |
| 3rd | 1.03 (0.96 – 1.10) | 0.96 (0.89 – 1.02) |
| 4th | 1.00 (0.94 – 1.07) | 0.99 (0.93 – 1.06) |
| $PM_{10}$ | | |
| 1st | 1 | 1 |
| 2nd | 1.07 (1.00 – 1.14) | 1.02 (0.96 – 1.09) |
| 3rd | 1.01 (0.94 – 1.07) | 1.10 (1.04 – 1.18) |
| 4th | 0.99 (0.93 – 1.05) | 1.04 (0.97 – 1.11) |
| $O_3$ | | |
| 1st | 1 | 1 |
| 2nd | 0.98 (0.91 – 1.04) | 1.04 (0.97 – 1.11) |
| 3rd | 0.99 (0.93 – 1.06) | 1.05 (0.99 – 1.12) |
| 4th | 0.99 (0.93 – 1.05) | 1.01 (0.95 – 1.08) |

OR: *odds ratio*; 95% CI: confidence interval of 95%; $SO_3$: sulfur dioxide $PM_{10}$: particulate material; $O_3$: ozone.
Note: Adjusted model for the variables: maternal marital status, maternal education, number of prenatal consultations, and gender of the newborn.

## DISCUSSION

According to the recommendation by WHO, the proportion of children born with appropriate weight, that is, heavier or equal to 3,000 g, should be at least 85%[10,14]. However, this did not occur in São José dos Campos in the period between 2006 and 2010, where a significant proportion of children were born with IW (26.7%).

Air pollution as a determinant of harm to fetal development has already been evaluated in many studies[15-17]. Some authors describe the relation between oxidative stress, systemic inflammation, and autoimmunity[18].

Fetuses, in particular, are considered highly susceptible to a variety of toxics due to their pattern of exposure and physiological immaturity[19]. Their organ systems, still in development, may be more vulnerable to environmental toxic substances during critical gaps (sensitive period of development) due to their high rates of cell proliferation or due to changes in their metabolic capacity[20].

The choice of the period of 3 months for the estimate of maternal exposure to air pollutants is based on the fact that many studies evaluating pregnancy outcomes use the pregnancy trimester as a measuring unit, as in the studies by Reis[21], Medeiros et al.[22], and Junger et al.[23].

Table 5. *Odds ratio* and confidence interval s of 95% for insufficient weight according to the quartiles of concentration of the air pollutants for the first and third trimesters of pregnancy, in the municipality of São José dos Campos, SP, between 2006 and 2010 (multiple logistic regression).

| Quartile | First month | Second month | Third month |
|---|---|---|---|
| | OR (95%CI) | OR (95%CI) | OR (95%CI) |
| $SO_2$ | | | |
| 1st | 1 | 1 | 1 |
| 2nd | 1.02 (0.96 – 1.09) | 1.05 (0.99 – 1.12) | 0.95 (0.89 – 1.01) |
| 3rd | 1.04 (0.97 – 1.11) | 1.07 (1.00 – 1.14) | 0.99 (0.93 – 1.05) |
| 4th | 1.00 (0.94 – 1.07) | 1.03 (0.96 – 1.09) | 0.96 (0.90 – 1.02) |
| $PM_{10}$ | | | |
| 1st | 1 | 1 | 1 |
| 2nd | 1.03 (0.96 – 1.10) | 1.07 (1.00 – 1.14) | 0.96 (0.90 – 1.03) |
| 3rd | 1.05 (0.99 – 1.12) | 1.02 (0.96 – 1.09) | 0.98 (0.92 – 1.05) |
| 4th | 1.03 (0.96 – 1.10) | 1.03 (0.96 – 1.10) | 1.01 (0.95 – 1.08) |
| $O_3$ | | | |
| 1st | 1 | 1 | 1 |
| 2nd | 0.95 (0.89 – 1.01) | 1.01 (0.95 – 1.08) | 1.00 (0.93 – 1.06) |
| 3rd | 0.97 (0.91 – 1.04) | 1.06 (0.99 – 1.13) | 0.94 (0.88 – 1.01) |
| 4th | 0.93 (0.88 – 1.00) | 1.00 (0.94 – 1.07) | 0.97 (0.91 – 1.04) |

OR: *odds ratio*; 95%CI: confidence interval of 95%; $SO_2$: sulfur dioxide $PM_{10}$: particulate material; $O_3$: ozone.
Note: Adjusted model for the variables: maternal marital status, maternal education, number of prenatal consultations and gender of the newborn.

Despite the difficulty in isolating the effects of each pollutant, due to their high correlation among each other, it may be observed that the $SO_2$ and $PM_{10}$ showed association with the weight of the NB, indicating a higher chance of presenting IW when the mother is exposed to those during the first and third trimesters of pregnancy, however, there was no statistical significance.

Many studies found associations between pollution and birth weight[24-28]. Medeiros et al.[22] observed in their study that the maternal exposure in the first pregnancy trimester to air pollution may contribute to lower gain of weight of the child at birth. Junger[23] carried out a study in the city if Rio de Janeiro and found a positive association between $PM_{10}$, $SO_2$, and IW and the lower gain of weight at birth in the first and third pregnancy trimester and a paradoxical effect of the $O_3$ for the same periods. Romão et al.[29] also identified a risk of LBW with the maternal exposure to $PM_{10}$ (fourth quartile) in the third pregnancy trimester. Ha et al.[26] examined the births at term in the period from 1996 to 1997, in Seoul, South Korea, to determine the association between LBW and exposure to CO, $SO_2$, $NO_2$, total suspended particles (TSP), and $O_3$ in the first and third trimesters. They found an association between CO, $SO_2$, $NO_2$, and TSP during the first pregnancy trimester with LBW.

Effects of exposure to $O_3$ about the health of population have been identified from epidemiological studies of time series. These studies have demonstrated the association of this pollutant and the occurrence of deaths[13]. However, in our study it was not possible to demonstrate evidence on the effects of pregnancy.

In this study some variables regarding the NB, the maternal characteristics, and the kind of birth labor were also identified as risk factors for the occurrence of IW to birth. Azenha et al.[25] found similar results, that is, factors such as female gender, mother without a partner, low maternal education, low number of prenatal consultations, and vaginal labor are presented as high risks for the lower gain of weight at birth.

The influence of the gender of the NB on birthweight has already been demonstrated in many studies and may be explained, in parts, by the growth of male fetuses being greater from the 32$^{nd}$ to the 34$^{th}$ week of pregnancy on[30]. Despite this conclusion and the findings of many studies, the gender of the NB is a variable which has no possibility of intervention.

As for the prenatal, Antonio et al.[31] found similar results to this study, meaning, mother who went to less than seven prenatal consultations have 1.42 more chances of having children with IW. These results reinforce the importance of having prenatal consultations, once that they allow greater opportunities for orientation and quality procedures, providing better chance of a NB being born with appropriate weight.

The proportion of NB with IW was greater among mother who had vaginal delivery. Many studies indicate that there is a higher occurrence of cesarean among groups of low obstetric risk and among women of higher social status, suggesting that the indications for this medical procedure are not exclusively technical[32,33].

Some limitation of this study should be mentioned. Unlike the data regarding exposure and NB, the mother, the kind of delivery and the prenatal, which are obtained from each individual, that is, in a direct way, the data regarding the exposure to air pollutants are obtained in an indirect way through the concentration of air pollutants in the environment, which

may difficult the collection of more expressive data, such as the ones found individually. However, as may be seen in the several literature presented, none of them used a direct and individual measure, whether by the high methodological cost or by operational difficulty. In addition to that, many of the results from the studies, which use indirect measures of exposure, have presented very consistent results, which support their use in future studies.

The relevance of this study is that it was still possible to find the effects of air pollution on the birthweight after adjustment of the variables such as maternal marital status, maternal education, number of prenatal consultations, and gender of the NB; and determinants of IW at birth are discussed in the literature.

Despite the less severe outcomes, this group represent one-fourth of births and the identification and investments of differentiated attention for these children could minimize further disadvantages. This work related risk factors connected to the IW outcome. Thus, measures to control factors such as air pollutions, quality of education of the population, and access to prenatal would have, most likely, a positive impact in the health and quality of life of the population of children in the city of São José dos Campos.

It is important to highlight that even in lower levels of pollution, it was still possible to observe an association between the exposure of the pregnant woman to air pollution with IW at birth. These results indicate the need for new policies focused on greater reduction of the levels of pollution in the city of São José dos Campos.

## CONCLUSION

The results of the research indicate that the maternal exposure in the first and third trimesters of pregnancy to the air pollution of the municipality of São José dos Campos, São Paulo, may determine the insufficient weight of NBs in the period between 2006 and 2010.

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