

# Pregnancy outcomes in contaminated areas, SP, Brazil

## *Desfechos relacionados à gravidez em áreas contaminadas, SP, Brasil*

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## **Abstract**

**Objective:** Estimate and compare prevalence of events related to pregnancy (pregnancy, low birth weight, premature delivery, spontaneous abortion, stillbirth, congenital malformation, and multiple births) in populations exposed and non-exposed to environmental contaminants in Santos and São Vicente Estuary. **Methods:** This study was part of a large project financed by CNPq, which aimed to estimate health effects associated with environmental area, contaminants exposure among individuals of the Baixada Santista region. This cross-sectional study evaluated two neighborhoods of São Vicente near a contaminated area, and one neighborhood of Bertioga, the control area. A structured and previously tested questionnaire was applied at 236 households in São Vicente and 251 households in Bertioga in order to obtain the data. The chi-square test or Fisher's exact test were used to evaluate associations between area and qualitative variables; Student's *t* test or two proportion comparison test were used to evaluate differences between variables; and a significance level of 5% adopted. **Results:** There was significant association between living in Bertioga ( $p = 0.01$ ) and number of pregnancies in the past five years. In São Vicente, 64 (28.3%) childbearing age women became pregnant whereas in Bertioga there were 109 (38.8%). There were no statistical significant associations between living in any area and others pregnancy outcomes evaluated. **Conclusion:** Although no significant association was found, prevalence of low birth weight, preterm delivery and spontaneous abortion and prevalent odds ratio were higher in contaminated area. This study's evidence of a reduced number of pregnancies in contaminated area strengthens the need for additional more in-depth studies in Santos and São Vicente Estuary.

**Keywords:** Pregnancy outcomes. Environmental pollution. Organochlorine compounds. Heavy metals. Low birth weight. Prematurity.

## Resumo

**Objetivo:** Estimar e comparar a prevalência dos eventos relacionados à gravidez (engravidar, baixo peso de nascimento, parto prematuro, aborto espontâneo, natimortalidade, malformações congênitas e gemelaridade) em populações exposta e não-exposta aos contaminantes ambientais na região do estuário de Santos e São Vicente. **Métodos:** O estudo fez parte de um amplo projeto financiado pelo CNPq, que teve como objetivo estimar os efeitos à saúde associados à exposição aos contaminantes ambientais entre os moradores da Baixada Santista. O estudo transversal avaliou dois bairros do município de São Vicente, próximos a uma área contaminada, e um bairro no município de Bertioga, área controle. Para a obtenção dos dados foi aplicado um questionário estruturado e pré-testado em 236 domicílios em São Vicente e 251 domicílios em Bertioga. Para avaliar associações entre a área e as variáveis qualitativas utilizou-se o teste qui-quadrado ou teste exato de Fisher; para avaliar as diferenças entre as variáveis, o teste *t* de Student ou o teste de comparação de duas proporções, e adotado nível de significância de 5%. **Resultados:** Houve associação significativa entre morar em Bertioga ( $p = 0,01$ ) e o número de gestações ocorridas nos últimos cinco anos. Em São Vicente, 64 (28,3%) mulheres em idade fértil engravidaram, enquanto em Bertioga foram 109 (38,8%). Não houve associações estatísticas significativas nas áreas com os demais desfechos da gravidez avaliados. **Conclusões:** As prevalências e as razões de chances prevalentes de baixo peso ao nascer, nascimentos prematuros e abortos espontâneos foram maiores nas áreas contaminadas, sem associações significativas. A evidência do estudo de diminuição do número de gestações na área contaminada reforça a necessidade de aprofundamento de estudos na região do estuário de Santos e São Vicente.

**Palavras-chave:** Gravidez. Poluição ambiental. Compostos organoclorados. Metais pesados. Baixo peso ao nascer. Prematuridade.

## Background

The industrial development provided a quality of life never reached by the human being which, associated to a distinguishing occupation of the urban space, paradoxically increased the risk of exposition to chemical substances potentially deleterious to the human health<sup>1</sup>

According to the Environmental State Agency – CETESB<sup>2</sup> in Brazil, Santos and São Vicente estuaries are examples of environmental degradation caused by the strong pressure on these fragile ecosystems, consequence of the intense occupation that coastal regions tend to present in a general way.

During the 50's, in the metropolitan area of Baixada Santista, the local availability of a developed road infrastructure, rail and ports, water and electricity, combined with the proximity of the metropolitan area of São Paulo led to the implantation of several basic industries (steel, petrochemicals, fertilizers) throughout the extensive network of estuarine canals and extensive mangroves, confined between the Atlantic Ocean and the Serra do Mar. This potentially highly pollutant industrial activity, often not accompanied by control measures, made the estuaries of Santos and São Vicente major recipients of toxic wastes and contaminated effluents, mainly with dust, heavy metals, organochlorines, polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), dioxins and furans. Industrial pollutants, along with waste and wastewater from the Port of Santos and other cities in the region, cause a severe environmental contamination with significant impacts in the social area and public health<sup>2</sup>.

The effects of chronic exposition to industrial contaminants spread in the environment, that appear after a changeable interval of time, constitute in risks for the development of diseases with important effects in population, opposing to acute and occupational expositions, which have a major impact in the individual level<sup>3</sup>.

There is a growing concern in the scientific community about the effects from exposure to chemicals on the reproductive system of pregnant women. Several studies provide evidence that fetuses and babies are likely to be more sensitive than adults to the varieties of toxic substances in the environmental<sup>4</sup>.

In worldwide literature and especially in Brazil there are few studies evaluating the risks to health arising from the embryo-fetal environmental contamination<sup>1</sup>. Identification of potential risk factors for the pregnant and fetus is imperative for reducing morbidity and mortality, fetal and neonatal.

A recent review made by Shirangi and colleagues (2011), produced evidence that suggested an association between exposure to pesticides near homes and an increase in adverse outcomes of the reproductive system. Among the outcomes, the congenital malformations had presented a strong force of association. Other outcomes like low birth weight (LBW), prematurity and abortion, while presenting weaker associations, deserve new inquiries<sup>5</sup>.

As a contribution to a preliminary approach to the theme, this study aimed to estimate and compare the prevalence of events related to pregnancy (low birth weight, premature birth, miscarriage, stillbirth, congenital malformations, and multiple births) in neighborhoods of two cities (São Vicente and Bertioga) in the region of the estuary of Santos and São Vicente.

## Methods

This is a cross sectional study which was part of a larger project entitled "Epidemiological study on resident population in metropolitan area of Santos – Santos Estuary: Evaluation of effect and exposure indicators to environmental contaminants" whose objective was to estimate the effects on health associated with exposure to environmental contaminants among the residents of metropolitan area of Santos -

Santos and São Vicente Estuary, this project was funded by the National Research Council - CNPq.

Identification of contaminated areas used in this study was done based on the report "Santos and São Vicente Estuarine System"<sup>2</sup> of CETESB, which aimed to evaluate the contamination of water, sediments and aquatic organisms of the estuarine system of Santos and São Vicente and Santos Bay, relating it to potential contaminants sources in the region.

After the areas were identified, exposed and non-exposed population samples were calculated based on the prevalence of congenital malformations in Brazil and the 2000 Brazilian resident population census classified by the Brazilian Institute of Geography and Statistics – IBGE.

In this preliminary study three neighborhoods were selected in two distinct areas (Figure 1). Two of them, Parque das Bandeiras e Parque das Bandeiras Gleba II, located in São Vicente (Área 1) in the continental portion, in a radius up to 1.5 km away from industrial contaminants identified by CETESB (2001)<sup>2</sup>. These deposits, dating from the mid-1960, contain heavy metals (particularly mercury and zinc) and organochlorine (hexachlorobenzene)<sup>2</sup>, with the soil, water and air as possible complete routes of exposure according to ATSDR criteria<sup>6</sup>. As a region of contrast in relation to environmental contamination, but with socio-economic characteristics of the region near Santos, = Jardim Vicente de Carvalho II was chosen, located in Bertioga (Area 2), along the Rio-Santos highway. 193 families were selected in Parque das Bandeiras, 43 no Parque das Bandeiras Gleba II and 251 in Jardim Vicente de Carvalho II, a total of 487 domiciles.

In each residence a structured questionnaire was applied with reference to the morbidity questionnaire developed by researchers at the National Cancer Institute (INCA) in 2003. This questionnaire was adapted to the needs of the study and pre-tested in order to ensure consistency and applicability. The interviews were



**Figure 1** - Areas analyzed in the Estuary region of Santos and São Vicente  
**Figura 1** - Áreas avaliadas na região do Estuário de Santos e São Vicente

conducted during the weekends (between March and December 2007) and, in cases where besides the informant, the other residents were at home, they collaborated with their personal information. The study was approved by the Ethics Committee in Research. After data collecting, a descriptive analysis was made of childbearing age women, between 15 and 49 years according to the classification of the IBGE. To assess pregnancy outcomes (low birth weight - live birth weighing less than 2500g; prematurity - live births with gestational age less than 37 weeks, spontaneous abortion - pregnancy loss under 20 weeks, stillbirth - 20 weeks of pregnancy loss or more, congenital malformations and multiple births) data of women who became pregnant in the last five years was used.

To test association between qualitative variables, chi-square test or exact Fisher's test was used. We also adopted the test to compare two proportions<sup>7</sup>. To test differences between quantitative variables we used Student's *t* test<sup>8</sup>. Prevalence rates were also calculated for each outcome of pregnancy by area and odds ratios prevalent (ORP) between areas.

Questionnaires containing errors, in blank, or when the respondent could not answer were excluded from the analysis.

SPSS (version 13.0) and significance level of 0.05 were used.

## Results

Among the 450 women living in two neighborhoods of São Vicente and the 508 women in the neighborhood of Bertioga, 226 and 281, respectively, were within the fertile-age women group.

The average age of fertile-age women was 31.70 years in São Vicente area, where 75% were 40 years or less. In Bertioga area the average age of fertile-age women was 29.39 years, where 75% of these women were 36 years or less. Statistically significant difference was showed between mean ages of the sample between the two areas based on *t* test ( $p=0.02$ ).

Table 1 shows demographic characteristics of fertile-age women in the analyzed areas. In both areas more than 50% of these women were married or living with a partner. No significant association between place of residence and women marital status was found ( $p=0.37$ ).

Considering education, there was an association with place of residence by the chi-square test ( $p=0.00$ ). In Bertioga area 53.1% of interviewed had completed basic education, while in São Vicente area 36.9%.

**Table 1** - Socio-demographic characteristics of women according to areas analyzed**Tabela 1** - Características sociodemográficas das mulheres em idade fértil segundo as áreas analisadas

	Áreas – N (%)		TOTAL
	São Vicente*	Bertioga*	
<b>Marital status</b>			
Married	141 (56.2)	157 (53.4)	298 (54.7)
Divorced	13 (5.2)	23 (7.8)	36 (6.6)
Never married	91 (36.3)	111 (37.8)	202 (37.1)
Widowed	6 (2.4)	3 (1.0)	9 (1.7)
Total	251 (100.0)	294 (100.0)	545 (100.0)
<b>School enrollment</b>			
Illiterate*2	5 (2.0)	18 (6.3)	23 (4.3)
Elementary	92 (36.9)	152 (53.1)	244 (45.6)
High School	131 (52.6)	107 (37.4)	238 (44.5)
College	21 (8.4)	9 (3.1)	30 (5.6)
Total	249 (100.0)	286 (100.0)	535 (100.0)
<b>Work</b>			
Yes	115 (45.8)	145 (49.7)	260 (47.9)
No	136 (54.2)	147 (50.3)	283 (52.1)
Total	251 (100.0)	292 (100.0)	543 (100.0)
<b>Occupational exposure</b>			
Yes	12 (10.8)	11 (7.7)	23 (9.1)
No	99 (89.2)	132 (92.3)	231 (90.9)
Total	111 (100.0)	143 (100.0)	254 (100.0)
<b>Past work</b>			
Yes	106 (45.1)	151 (53.7)	257 (49.8)
No	129 (54.9)	130 (46.3)	259 (50.2)
Total	235 (100.0)	281 (100.0)	516 (100.0)
<b>Past occupational exposure</b>			
Yes	7 (7.1)	7 (5.4)	14 (6.1)
No	92 (92.9)	122 (94.6)	214 (93.9)
Total	99 (100.0)	129 (100.0)	228 (100.0)
<b>Use of tobacco</b>			
Yes	26 (10.4)	58 (19.7)	84 (15.5)
No	223 (89.6)	236 (80.3)	459 (84.5)
Total	249 (100.0)	294 (100.0)	543 (100.0)
<b>Past use of tobacco</b>			
Yes	26 (10.5)	38 (13.0)	64 (11.9)
No	221 (89.5)	255 (87.0)	476 (88.1)
Total	247 (100.0)	293 (100.0)	540 (100.0)
<b>Alcohol consume</b>			
Yes	34 (13.7)	59 (20.1)	93 (17.2)
No	214 (86.3)	235 (79.9)	449 (82.8)
Total	248 (100.0)	294 (100.0)	542 (100.0)
<b>Past alcohol consume</b>			
Yes	6 (2.5)	20 (6.9)	26 (4.9)
No	238 (97.5)	271 (93.1)	509 (95.1)
Total	244 (100.0)	291 (100.0)	535 (100.0)

\* São Vicente = Parque das Bandeiras and Parque das Bandeiras Gleba II neighborhoods; Bertioga = Vicente de Carvalho II neighborhood.

\*\* Functional Illiteracy: Those who declared themselves illiterate and those with up to 2nd year of elementary school schooling.

\* São Vicente = bairros Parque das Bandeiras e Parque das Bandeiras Gleba II; Bertioga = bairro Vicente de Carvalho II.

\*\*Analfabeto funcional: Os declarados analfabetos e aqueles que cursaram até a 2ª série do ensino fundamental.



With more studies years (between high school and college) there was a greater percentage in São Vicente area (61%) over Bertioga area (40.4%) (Table 1).

There was no statistical association between area and working status of fertile age women who were working at the time of the study (45.8% in São Vicente and 49.7% in Bertioga) by Fischer's exact test ( $p=0.46$ ). Women who were currently working had little contact with chemicals at the workplace, only 10.8% in São Vicente area and 7.7% Bertioga area (Table 1). No significant association between living areas and contact with chemicals at the workplace was found. (Fisher's exact test with  $p=0.66$ ).

In São Vicente, 45.1% of fertile-age women reported previous employment and in Bertioga this percentage was 53.7% (test for comparing two proportions with  $p=0.44$ ). Out of those women, only 7.1% in São Vicente area and 5.4% in Bertioga area that reported previous employment had contact with chemicals at work (Table 1). No significant association between living areas and previous chemical contact at the workplace was found (Fisher's exact test with  $p=0.08$ ).

The proportion of fertile-age women that reported smoking in Bertioga (19.7%) was higher than those in São Vicente (10.4%) (test for comparing two proportions with  $p=0.01$ ). In relation to previous smoking habits, there was no statistical difference (test for comparing two proportions with  $p=0.39$ ) between São Vicente (10.5%) and Bertioga (13%).

Few women reported drinking alcohol in both areas and there was no statistical difference between those from São Vicente (13.7%) and from Bertioga (20.1%). There was statistically significant difference between the percentage of fertile-age women from São Vicente (2,5%) and from Bertioga (6.9%) that reported previous alcohol consumption by the comparing two proportions test ( $p=0.03$ ) (Table 1).

In São Vicente area almost 30% of the fertile-age women conceived in the last 5 years while in Bertioga this percentage was

1/3 higher (Table 2). There was an statistically significant difference between these two groups (test for comparing two proportions  $p=0.01$ ).

In addition to a greater number of pregnant women in the last five years, Bertioga area also presented a greater number of pregnancies when compared to São Vicente area. The 64 women that conceived in São Vicente area had 82 pregnancies in the last five years, while the 109 fertile-age women in Bertioga area had 155 pregnancies in the period. The pregnancy average per woman over the past five years in São Vicente area was 1.28 (SD=0.57) and in Bertioga area 1.42 (SD=0.72) without statistically significant difference (t test  $p=0.06$ ) (Table 2).

There was no statistically significant association between living area and receiving prenatal care (Fisher's exact test  $p=0.65$ ) (Table 3).

Table 3 also shows adverse pregnancy outcomes among women that conceived in the last five years in the studied areas. São Vicente area had a higher percentage of miscarriages than Bertioga area, but without statistically significant difference (test for comparing two proportions  $p=0.24$ ).

São Vicente area had a higher percentage of premature babies (8.1%) than Bertioga area (5.7%). ORP showed 1.42 times more occurrence of premature births in São Vicente area than Bertioga area, but the difference was not statistically significant (test for comparing two proportions  $p=0.78$ ). In São Vicente area 4 women (6.9%) had low birth weight newborns while in Bertioga area there were 5 women (4.7%) (Table 3). ORP showed 1.47 times more likely to occur low birth weight in São Vicente area than Bertioga area but the difference was not statistically significant (test for comparing two proportions  $p=0.82$ ).

Regarding frequency of stillbirths, there was only one case in the past five years among interviewed households and it occurred in São Vicente area. There was also only one case of twin birth in the last five years in Bertioga area. There were few cases where babies had congenital malforma-

**Table 2** - Number of pregnant women and pregnancies in the past five years according to areas analyzed

**Tabela 2** - Distribuição das mulheres que engravidaram e do número de gestações nos últimos cinco anos segundo as áreas analisadas

	Areas - N (%)	
	São Vicente*	Bertioga*
<b>Pregnant</b>		
Yes	64 (28.3)	109 (38.8)
No	162 (71.7)	172 (61.2)
Total	226 (100.0)	281 (100.0)
Pregnancies mean	1.28	1.42
Standard deviation	0.57	0.72
Minimum	1	1
Maximum	4	5
25%	1.00	1.00
50%	1.00	1.00
75%	1.00	2.00

\* São Vicente: Parque das Bandeiras and Parque das Bandeiras Gleba II neighborhoods; Bertioga: Vicente de Carvalho II neighborhood.

\* São Vicente: bairros Parque das Bandeiras e Parque das Bandeiras Gleba II; Bertioga: bairro Vicente de Carvalho II.

tions, a case in São Vicente area (1.6%) and three cases in Bertioga area (2.8%).

## Discussion

Bertioga area presented a higher percentage of fertile-age women who were pregnant in the last five years in relation to São Vicente area, with a significant statistical difference. In relation to pregnancy average per woman that conceived in the last five years, no statistically significant difference was found. Brazil has a tendency to fertility decline in recent demographic census. In the country, fertility transition is close to population replacement level. However, there are internal differences in fertility rates, once they are negatively correlated with socioeconomic factors such as income and education status<sup>9</sup>. These factors had a worse level in Bertioga area than in São Vicente area in this study.

Male and female reproductive systems

are susceptible to environmental factors, impacting tissue development and also adults' reproductive functions resulting in men and women fertility decrease<sup>10,11</sup>. Evidence between exposure to environmental pollutants and human fertility is controversial and the results have little consistency<sup>12</sup>. However, experimental studies have shown that association<sup>13</sup>. Guillette & Edwards (2008) reported that environmental contaminants, including pesticides, pharmaceuticals and industrial pollutants play roles as endocrine disruptors, altering reproductive performance of wild populations of fish, amphibians, reptiles and birds<sup>13</sup>.

Association between environmental contaminants and pregnancy outcomes such as miscarriages, premature birth and low birth weight has been investigated by several authors. A review done by Windham & Fenster<sup>14</sup> was associated with increased risk for air pollution, heavy metals, pesticides and others. For organochlorine pesti-

**Table 3** - Prenatal care and pregnancy outcomes among women who became pregnant in the past five years according to areas analyzed

**Tabela 3** - Acompanhamento pré-natal e desfechos da gravidez entre as mulheres que ficaram grávidas nos últimos cinco anos segundo as áreas analisadas

	Areas (N (%))		TOTAL
	São Vicente*	Bertioga*	
<b>Prenatal care</b>			
Yes	62 (96.9)	103 (95.4)	165 (95.9)
No	2 (3.1)	5 (4.6)	7 (4.1)
Total	64 (100.0)	108 (100.0)	172 (100.0)
<b>Miscarriage</b>			
Yes	14 (23.3)	15 (14.7)	29 (17.9)
No	46 (76.7)	87 (85.3)	133 (82.1)
Total	60 (100.0)	102 (100.0)	162 (100.0)
<b>Prematurity</b>			
Yes	5 (8.1)	6 (5.7)	11 (6.6)
No	57 (91.9)	99 (94.3)	156 (93.4)
Total	62 (100.0)	105 (100.0)	167 (100.0)
<b>Low birth weight</b>			
Yes	4 (6.9)	5 (4.7)	9 (5.5)
No	54 (93.1)	101 (95.3)	155 (94.5)
Total	58 (100.0)	106 (100.0)	164 (100.0)

\* São Vicente: Parque das Bandeiras and Parque das Bandeiras Gleba II neighborhoods; Bertioga: Vicente de Carvalho II neighborhood.

\* São Vicente: bairros Parque das Bandeiras e Parque das Bandeiras Gleba II; Bertioga: bairro Vicente de Carvalho II.

cides, the authors reported a dose-response relationship between increasing levels of dichloroethylene (DDE) and prematurity.

Knowledge about organochlorines effects on human health is limited and results are usually conflicting<sup>10</sup>. Authors reported an extensive review of epidemiological studies where populations exposed to higher concentrations of PCBs or DDE exhibited reproductive abnormalities, including spontaneous abortions and reduced birth weight. They also reported that other studies, with exposure to medium and low concentrations of PCBs or DDE, found no associations with these same adverse pregnancy outcomes.

Another review analyzed studies between exposure to Dichloro-Diphenyl-Trichloroethane (DDT) and/or DDE and adverse pregnancy outcomes and also found conflicting results<sup>14</sup>. The authors reported that some studies have shown associations between organochlorine pesticides with increased preterm delivery and reduced birth weight and also studies that showed no association with the same adverse pregnancy outcomes.

Abortions, premature births and low birth weight showed greater prevalence and ORP in São Vicente area than in Bertioga area, although no significant differences were found.



These results can be considered relevant since in the contaminated area there were no associations with other factors that may interfere with pregnancy, such as prenatal care, occupational exposure, alcohol consumption and smoking.

The main goal of prenatal care is to look after the well-being of the women and the fetus since the beginning of the pregnancy, ensuring the birth of a healthy child, maternal well-being and neonatal care, in ways that integrate all levels of health attention<sup>15</sup>. Poor prenatal care is an important risk factor for perinatal mortality<sup>16</sup>, premature birth and low birth weight<sup>17</sup>. Laurenti & Buchalla<sup>18</sup> have shown that mothers who received seven or more prenatal visits had a lower perinatal mortality. SEADE Foundation data showed a large percentage difference between the cities, São Vicente (70.86%) and Bertioga (34.05%) when comparing the number of mothers who had seven or more prenatal consultations. Almost all women that conceived in the last five years in both areas had prenatal care, but the questionnaire used in this study did not evaluate the number of queries, where the treatments were performed or quality of care.

In contrast to non-occupational environmental contamination in pregnant women, occupational exposure is an important factor that should be controlled<sup>1</sup>. Occupational exposure to chemicals has been reported as an important risk factor in pregnancy, interfering in perinatal morbidity and mortality<sup>12</sup>. In the present study few women were exposed to chemicals at work in both investigated areas thus were not a relevant factor in association between outcomes and analyzed areas.

Bertioga area presented a higher percentage of fertile-age women with current and past exposure to alcohol with a significant difference to São Vicente area, although it was not possible to investigate whether consumption occurred during pregnancy. Alcohol is a substance with a significant teratogenic effect, which interferes in fetal development. Freire and co-authors<sup>19</sup> found that alcohol use during pregnancy was as-

sociated with fetal growth restriction and females appear more susceptible to its effects. The authors reported that 10% of children born with restricted intrauterine growth in the U.S. had fetal alcohol exposure, and also that 11% of patients with mental disabilities suffered alcohol teratogenic effects.

Pregnant woman who smoke cause harm to their own health and to the health of the fetus. Effects of smoking during pregnancy include: low birth weight, premature births and miscarriage<sup>20</sup>. Passive exposure to tobacco smoke should also be considered, since studies have showed a small but consistent effect in birth weight reduction and the occurrence of preterm delivery<sup>14</sup>. Bertioga area presented a higher percentage of fertile age women with current and past smoking habits, although it was not possible to establish whether consumption occurred during pregnancy.

Studies have shown association between environmental contaminants exposure and miscarriage<sup>21</sup>, natimortality<sup>22</sup>, congenital malformations<sup>23</sup> and multiple births<sup>24</sup>, however in this work it was not possible to assess these outcomes because of lack of data during the studied period.

In all related pregnancy outcomes, information loss never surpassed 20%. Information loss, by variable, was considered of little significance: prenatal care analysis (0.58%), pregnancy number per woman (5.20%), twin (2.31%), miscarriage (6.36%), low birth weight and stillbirth (5.20%), premature births (3.47%), and congenital malformations (2.89%).

Retrospective studies are more susceptible to memory bias<sup>25</sup>, although in the present study, pregnancy outcomes had been investigated in a short period, less than five years. In addition, more than 63% of households women interviewed answered about themselves, which reduced recall bias.

The neighborhoods studied in São Vicente are located close to deposits of industrial waste, mainly contaminated with hexachlorobenzene - HCB, hexachlorobutadiene - HCBd, tetrachlorobenzene, pentachlorobenzene, chloroform, carbon

tetrachloride and perchlorethylene<sup>2</sup>.

However, contaminant presence in the environment is not sufficient to characterize contamination or exposure of a given population. The contact is crucial in order to define the presence of a contamination route. Moreover, concentration in environmental compartments and duration of contact with these substances are essential to determine the risk of adverse manifestations in exposed individuals.

## Conclusions

Prevalence and ORP of low birth weight, premature births and miscarriages were higher in contaminated areas although no significant associations were found. Although study design did not allow causal inferences, there are sufficient evidence of pregnancy decline in contaminated areas, reinforcing the necessity for further studies in the region of Santos and São Vicente Estuary.

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