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Short Communication

Role of the Neighbourhood Deprivation in the Adverse Effect of Air Pollution on Congenital Abnormalities

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Abstract

Congenital abnormalities (CAs) remain a major cause of stillbirth and neonatal mortality. The literature has shown that congenital malformations are suggested to have multifactorial determinants, including environmental exposures and socioeconomic patterns. Moreover, since a decade, combined effects of environmental and socioeconomic characteristics are suspected to have an impact on the risk of congenital anomalies. Three mechanisms have been proposed in the literature suggesting the possible combined effect of the social health inequalities and the environmental exposures. This commentary presents the role of the neighbourhood deprivation in the adverse effect of air pollution on congenital anomalies. Both air pollution and neighbourhood deprivation have been reported in the literature to increase the risk of congenital abnormalities.

PUBLIC HEALTH ISSUE

Congenital anomalies are recognized to be a major risk factor of stillbirth and neonatal mortality [1]. According to the WHO, about 10% of deaths under five-years-old children is reported to be related to congenital anomalies [1] European Surveillance of Congenital Anomalies (EUROCAT), an organization of population-based registries for the surveillance of congenital anomalies in Europe, recorded 9.3% of perinatal death associated with congenital anomaly between 2007 and 2011 [2]. Among them, 24% were due to congenital heart defects, 21% to chromosomal anomalies, and 18% to nervous system anomalies [2]. They commonly require medical treatments, which usually is expensive and frequently lifelong [3].

ADVERSE HEALTH EFFECT OF EXPOSURE TO ENVIRONMENTAL NUISANCES

About half of all major congenital malformations are of unknown etiology and are suggested to have multifactorial determinants, including environmental nuisances [4]. Environmental exposures of mothers during pregnancy are related with fetal growth retardation, low birth weight, preterm birth foetal and neonatal mortality [5-7].

More precisely, maternal exposure to air pollution may also be related to congenital anomalies, but the evidence is still weak, because of the paucity of studies. In a recent meta-analysis, we found that nitrogen dioxide (NO_2) concentrations were significantly associated with coarctation of the aorta: (OR = 1.20 per 10 ppb, 95%CI =[1.02;1.41]) [8]. In addition, a previous meta-analysis from Vrijheid *et al.* revealed a significantly increased risk between exposure to NO_2, sulfur dioxide (SO_2) and the tetralogy of fallot (OR per 10 ppb NO_2=1.25, 95%CI =[1.02;1.51]; and OR per 1 ppb SO_2=1.04, 95%CI =[1.00;1.08], respectively) and coarctation of aorta (OR per 10 ppb NO_2 =1.20, 95%CI =[1.00;1.44]; OR per 1 ppb SO_2=1.04; 95%CI =[1.00;1.08]).

Epidemiological evidences have been also revealed with polluted sites: the risk of congenital malformation increase among pregnant women living close to landfill (RR=1.0, 95%CI =[1.04-1,09]) [9], to hazardous waste (OR=1.33, 95%CI =[1.11–1.59]) [10] or industrial site (RR=1.9; 0, 95%CI =[1.23 -2.95]) [11], for instance.

SOCIAL HEALTH INEQUALITIES REGARDING CONGENITAL MALFORMATIONS RISK

Previous epidemiological studies showed that socioeconomic neighbourhoods were linked with general health status and with several birth outcomes, in particular [12]. An increasing number

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of studies to date have investigated the relationship between individual socioeconomic status and congenital anomalies [13-16]. The most studies concluded that deprived populations were at greater risk of congenital malformations than the most privileged [13-17]. In the United States, women with less than 10 years of education have a threefold increased risk of giving birth to a child with congenital abnormalities compared with women who completed more than 4 years of higher education [16]. Parent's education levels and household income are associated with an increasing risk of giving birth to a child with Neural Tube Defect (NTD) (15;16). Moreover, Agha *et al*. observed that children born in low socioeconomic areas had a more than 29% higher risk of having a Neural Tube Defect [13]. Recently, Yu D and al. conducted a meta-analysis to investigate association between maternal socioeconomic status and Congenital Heart Defects (CHDs). They found an increased incidence of CHDs among the lowest SES classifications in maternal education (RR = 1.11, 95% CI: 1.03, 1.21), family income (RR = 1.05, 95% CI: 1.01, 1.09) and maternal occupation (RR =1.51, 95% CI: 1.09–2.24) compared with the highest classification of the corresponding SES. Other studies didn't report a social pattern among babies born to lower social class mother [18-19]. There is a knowledge gap on the impact of both individual and contextual socioeconomic factors along the pathway from antenatal diagnosis to the delivery. Over the last years, advances in prenatal diagnosis techniques, such as newborn screening, treatment, early recognition, development of new surgical techniques, terminations and clinical management have been revealed to reduce significantly neonatal mortality rates [20-23]. Uses of folic acid and supplements during pregnancy have been reported to be an efficient preventive factor for NTDs [23-25]. However, the influence of those preventive measures might vary as socioeconomic status knowing that access to antenatal services would decrease among deprived population. In Paris, early prenatal diagnosis and maternal socioeconomic characteristics were highly associated with the likelihood of TOPFA (Termination of Pregnancy for Fetal Anomaly) for Congenital Heart Disease (CHDs) [26].

Few studies evaluated the influence of both individual and neighborhood characteristics on the outcome of pregnancy [14,16,27,28]. Grewal *et al*. did not reveal any significant effects associated with the individual and contextual socioeconomic characteristics, whereas Wasserman *et al.* found that lower income, employment in manual occupations and residence in a deprived neighborhood were associated with the increased risk of a NTDs related pregnancies.

COMBINED EFFECT OF ENVIRONMENTAL EXPOSURE AND SOCIOECONOMIC CHARACTERISTIC ON THE RISK OF CONGENITAL ANOMALIES

Over the last decade, socioeconomic characteristics have been advanced to modify the health effect of environmental exposure; the most documented being with air pollution. Three mechanisms have been advanced in the literature explaining the possible combined effect of the socioeconomic position and the environmental exposure: i) the differential exposure; ii) the differential of vulnerability; iii) Combine differential of vulnerability with the differential of exposure. The first mechanism explores the possibility that the environmental nuisances are not equally distributed among group of population with different socioeconomic characteristics (see Mechanism I (Figure 1)). The second mechanism states that, at the same level of exposure, socially disadvantaged groups could show more severe health effects (see Mechanism II (Figure 1)). This concept of vulnerability is central in public health policy. For a long time, in 1993, two authors [29,30] hypothesized that disadvantaged groups might be more sensitive to certain exposures due to their health being already damaged or mechanisms of frailty. Such populations, because of their limited economic and educational resources, may accumulate certain risk factors recognised as leading to the development of chronic diseases [31], for example. By this process, these populations would present "a predisposition" to the development of health outcomes as a result of any additional environmental insult. The third mechanism suggests that some subpopulations are exposed to higher environmental nuisances than other subjects and are also particular vulnerable (see Mechanism III (Figure 1)).

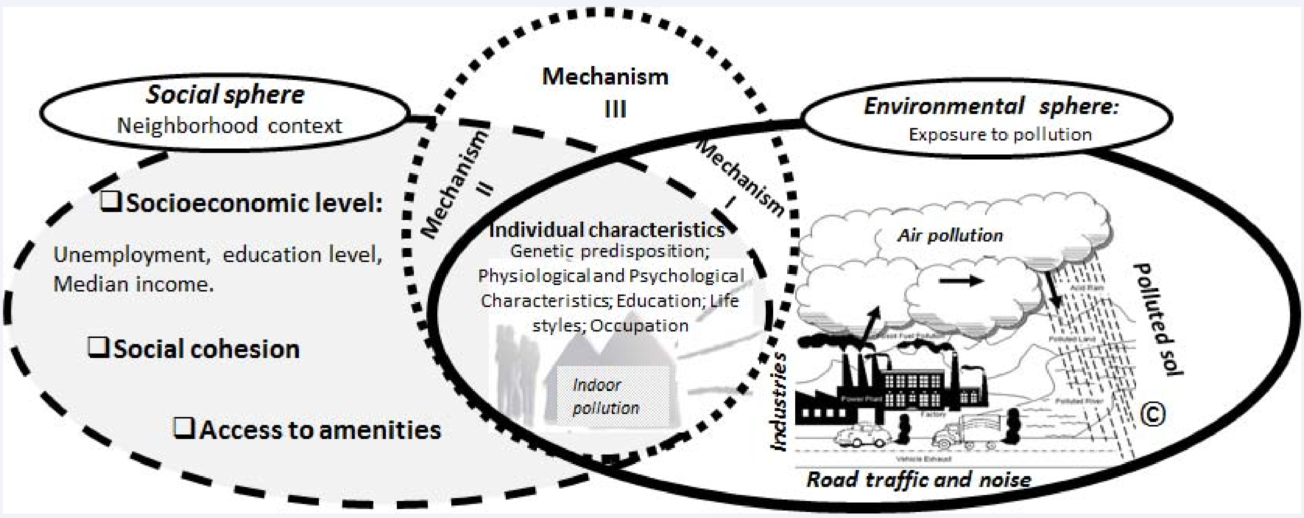

Figure 1 A conceptual model to explain the three hypothetical's mechanism advanced to explain social health inequalities.

In this context, we have developed the Equit'Area project in France in order to explore the role of environmental nuisances in the social health inequalities regarding infant and neonatal death in four major metropolitan areas (Lille, Lyon, Paris and Marseille). Based on spatial approaches (Generalized Additive model and SaScan spatial statistic), several findings have been revealed. Firstly, concerning the mechanism I, we demonstrated that there is clear evidence of city-specific spatial environmental inequalities that relate to the historical socioeconomic make-up of the cities and its evolution [32]. Secondly, concerning the mechanism II, from a spatial approach, we demonstrated the existence of a combined effect of noise exposure and socioeconomic deprivation level on the increased risk of infant mortality in Lyon Metropolitan area [33].

CONCLUSION

Disadvantaged communities could suffer disproportionately from the impact of environmental nuisances. Hence, general statements about environmental and social inequalities cannot be made separately. While the study of social inequalities in health or environmental risk factors on health is now common in the public health literature, further examination of the role of socioeconomic characteristics in air pollution epidemiology and risk assessment must be made. While knowledge gaps may be decreased and filled, public health stakeholders and policy makers should contribute to the development of management implementation that help minimize health inequalities.

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