Short-Term Effects of Ambient air Pollution on Pediatric Hospital Visits for Respiratory Diseases in Ouagadougou, Burkina Faso

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Abstract

Background: The adverse effects of air pollution on respiratory health has been documented in high-income countries, but data are scarce from low-income countries. We reported on air quality in Ouagadougou and its effects on hospital visits for respiratory diseases among children.

Methods: It was a retrospective hospital-based ecological study. All children admitted from 1 July 2019 to 30 June 2020 at two major teaching hospitals in Burkina Faso were included. We conducted a binary logistic regression to determine the health effects of PM2.5 and PM10 on hospital visits for respiratory diseases, with adjustment for covariates (weather, sociodemographic factors and medical history).

Results: Hospital visits for respiratory diseases accounted for 14.16% of all visits. Children were males in the majority (54.57%) and aged between 29 days-30 months (74.85%). PM10 was at WHO recommended levels, ranging from 0.06 µg/m³ to 18.33 µg/m³. PM2.5 concentration ranged from 0.41 to 258.82 µg/m³, above the WHO standards. Rise in PM2.5 concentration was associated with slightly more outpatients than inpatients (ORc=0.996 95% CI: 0.993-0.998; p=0.003). The weather confounded this relationship, but the sociodemographic factors and medical history did not. The increase in PM10 was not significantly associated with hospital visits for respiratory diseases (ORc=0.997 95% CI: 0.977-1.018; p=0.802). Adjusting the PM effects for all covariates, higher $PM_{2.5}$ and relative humidity levels and the female sex were associated with more outpatient cases than inpatients. Underlying conditions (severe acute malnutrition, sickle cell disease and heart disease) favoured more inpatients than outpatients.

Conclusion: At harmful levels in Ouagadougou, PM2.5 caused primarily outpatient hospital visits rather than hospitalisations for respiratory diseases.

Background

In most low- and middle-income countries (LMICs), such as Burkina Faso, there is rapid urban population growth. Ouagadougou, the capital city, is undergoing rapid urbanisation, representing 45.4% of the national urban population in 2019 [1]. The potential impact of urbanisation is the increase in ambient air pollution from traffic, industries and municipal solid waste disposal. Ambient air pollution is a major environmental health risk in the world. In 2016, 91% of the world population lived in places where WHO recommended air quality levels were not met [2]. The respiratory system is most affected by short-term exposure to air pollution, given that inhalation is the primary mechanism by which air pollutants enter the body[3]. Thus, chronic obstructive pulmonary diseases and acute lower respiratory tract infections due to outdoor air pollution were responsible for 18% of premature deaths in 2016 [2]. Children are more sensitive to the adverse health effects of air pollutants due to the immaturity of their respiratory system [4]. Childhood mortality from lower respiratory tract infections due to air pollution is higher in LMICs, especially in Asia and Africa, with a 4 to 5 years reduction in the average life expectancy in children in Sub-Saharan Africa[5].

Outdoor air quality is monitored in most high-income countries, and its impact on health outcomes has been well documented. There is a limited measurement of ambient air quality in Sub-Saharan Africa, contributing to the lack of prioritisation in public health actions [4]. In Burkina Faso, ambient Particulate Matters (PM) measured in 2007 and 2010 in Ouagadougou showed levels beyond the World Health Organization (WHO) guidelines of 25 and 50 $\mu g/m^3$, with spatiotemporal variabilities due to weather conditions [6]. Measurements in 2018 and 2019 in peripheral neighbourhoods, roadsides, schools, industrial and administrative areas of Ouagadougou reported 24-hour average concentrations of 87 ± 16 $\mu g/m^3$ of fine particles (PM2.5) and 951 ± 266 $\mu g/m^3$ of coarse particles (PM10)[7]. Both concentrations were above the WHO recommendations[8].

While evidence has linked respiratory diseases to outdoor air pollution in high-income countries, there are few studies in LMICs, and none in Burkina Faso, specifically [9]. Further, most African studies focused on the association between air pollution in schools, road traffic, industrial areas, mine dumps, industrial communities, and the occurrence of wheeze, cough, noise, or asthma [4,10]. No study has assessed the impact of air pollution on hospital admissions for respiratory diseases in Africa [4].

Short-term effects of PM2.5 and PM10 on hospitalisations, outpatient visits, or emergency for respiratory diseases, respectively, have been reported outside Africa [11–13]. A 10 $\mu g/m^3$ increase in $PM_{2.5}$ resulted in a rise of 0.13% (95% CI: 0.02%-0.24%) in children consultations in China [13]. Similarly, $PM_{2.5}$ and PM_{10} increase were associated with high emergency room visits and hospitalisations for respiratory diseases amongst children [14–17]. The effects on emergency visits or hospitalisations as compared to outpatient visits have not been evaluated.

This study evaluates the short-term effects of fine and coarse pollutants on hospitalisations for respiratory diseases compared to outpatient consultations among children in the two major teaching hospitals in Ouagadougou, Burkina Faso.

Methodology

Study area

Ouagadougou is the capital and the biggest city in Burkina Faso, with 2.5 million inhabitants [1]. Located in the middle of the country, Ouagadougou has a tropical climate with an annual average temperature of 28°C, an annual cumulative rainfall from 600 to 900 mm, and average relative humidity of 75% during the rainy season [18]. Two climatic seasons occur: a dry season from October to April and a rainy season from May to September. The Harmattan, dry and dusty wind from the North East wind, blows during the dry season, especially between November and March.

Study design

It was a retrospective hospital-based ecological study of children using individual epidemiological records and geographical air pollution data.

Study population

All children who visited the hospital between 1 July 2019 and 30 June 2020 at the pediatric units of the Centre Hospitalier Universitaire Yalgado OUEDRAOGO (CHU-YO) and the Centre Hospitalier Universitaire Pediatrique Charles de Gaulle (CHUP-CDG) of Ouagadougou were eligible.

We included 0 to 15 years old children diagnosed with any respiratory disease at the two hospitals and residing in Ouagadougou during the study period. Children whose final diagnosis was unclear or sociodemographic characteristics missing were excluded.

Sample size

In the absence of pre-existing data on the hospital frequency of respiratory diseases, we assumed a frequency of 50%. We tested the hypothesis of a respiratory disease's prevalence of 50% at a significance level of 5% and a 4% expected difference between the groups with 90% power. The calculated minimum sample size was 1639 [19]. We collected a total sample of 2102 hospital visits.

Sample selection

Consecutively children who met the inclusion criteria were recruited over the study period.

Variables

The dependent variable is hospital visits, either outpatient visits or hospitalisation for respiratory diseases. PM_{10} and $PM_{2.5}$ concentrations were the independent variables. Covariates include relative humidity, temperature, sociodemographic variables and medical history.

Data collection

Patients data were obtained from hospital and clinical records. First, daily hospital records were checked to identify patients diagnosed with a respiratory disease during the study period, either inpatients or outpatients. Then, from individual patients records, sociodemographic and clinical data were extracted. These included sex, age, residence, type of hospital visit (outpatient or hospitalisation), primary diagnosis, and hospitalisation outcome for inpatients. Children age was further categorised as a newborn (≤ 28 days), infant (29 days-30 months excluded), young child (30 months-5 years included), older child (> 5years).

Data on air quality and weather were collected during the same period using a PurpleAir® device localised at Ouagadougou (GPS coordinates: 12.308310, -1.469981) and visible at www.purpleAir.com. We retrieved data on daily concentrations of PM10, PM2.5, relative humidity, and temperature between 1 July 2019 and 30 June 2020.

Analyses

Data were analysed using Stata/IC 16 (StataCorp LLC, Tx, USA). Using Shapiro-Francia W' test, continuous variables were not normally distributed and were presented as quartiles. Categorical variables were summarised as frequency and percentage.

The 1-year prevalence of respiratory diseases was calculated by reporting the total number of respiratory diseases to the total number of hospital visits for all conditions during the study period.

The dependent variable was hospital visits measured as dichotomic (Outpatient visits or Hospitalisations). We first estimated the association between hospital visits and particulate matters using binary logistic regression. The potential confounding effect of climate (humidity and temperature), then sociodemographic factors (age and sex) were further assessed.

For air quality, the threshold for 24-hours average (short-term effects) was set at 50 µg/m³ and 25 µg/m³ for PM10 and PM2.5, respectively, according to WHO standards [8].

Results

Out of 14,209 patients records, 10,695 had complete information and were usable. Of these, 8,490 cases (79.38%) were non-respiratory diseases. From the 2,205 records with a respiratory disease diagnosis, information on the dependent variable and the covariates was available for 2,012 people (91.25%). The hospital frequency of respiratory diseases was 14.16% (2012) over the 1-year study period.

Demographic and clinical profile of the study population

The sociodemographic and clinical characteristics of the patients are summarised in Table 1. Most participants (67.94%) were recruited at the Centre Hospitalier Universitaire Pediatrique Charles de Gaulle (CHUP-CDG). Most respiratory cases arose during the dry season (1,114/2012, 55.37%). The majority (54.57%) were males, 1506 (74.85%) were infants.

Inpatients represented 62.43% (1,256 cases) of all cases. Regarding the distribution of respiratory diseases, acute bronchitis was the most frequent (46.87%), followed by pneumonia (38.57%) and rhinitis (37.08%). Forty-three deaths (3.42%) were reported, and all occurred among hospitalised patients.

Table 1
Distribution of sociodemographic and clinical features

Variables	Frequency	Percentage
Study site		
CHUP-CDG	1367	67.94
CHU-YO	645	32.06
Consultation period		
Dry season	1114	55.37
Rainy season	898	44.63
Sex		
Male	1098	54.57
Female	914	45.43
Age		
New-born (1–28 days)	54	2.68
Infant (29 days-30 months excluded)	1506	74.85
Young child (30 months-5 years included)	265	13.17
Older child (> 5years)	187	9.29
Hospital visits		
Outpatients	756	37.57
Inpatients	1256	62.43
Diagnosis		
Rhinitis	746	37.08
Acute Bronchitis	943	46.87
Pneumonia	776	38.57
Inpatients’ outcomes		
Death	43	3.42
Discharged	1201	95.62
Left against medical advice	12	0.96

Levels of airborne PM and weather condition

The daily values of PM_{10} were under 50 µg/m³ all through the study period. It ranged from 0.06 µg/m³ to 18.33 µg/m³. Seventy percent (75%) of PM_{10} concentration was lower than 2.02 µg/m³ [0.81 (0.26, 2.02) µg/m³].

$PM_{2.5}$ ranged from 0.41 to 258.82 µg/m³ and has a median level of 15.94 (IQR 6.07–47.39) µg/m³. More than 25% of the $PM_{2.5}$ daily values were above 25 µg/m³.

With extremes of 24.49°C and 42.44°C, the median temperature was 33.51 (31.86, 35.18) °C. Over a year, median humidity was 28.68 (IQR 13.62, 48.31) %, and humidity ranged from 5.00–63.18%. Most patients with respiratory disease presented during the rainy season 898 (44.63%).

Determinants of hospital visits for respiratory diseases

The relationship between particulate matters was assessed following different steps with the weather, sociodemographic and medical history covariates. After the univariate analysis, the effect was adjusted only for particulate matters (Table 2). Then, it was adjusted for the weather as covariates to determine their interactions with the particulate matter (Table 3). Potential confounding effects of the sociodemographic variables (Table 4) and the medical history (Table 5) were also assessed.

Table 2 shows the effect of particulate matter on hospital visits. The univariate analysis found a statistically significant association between $PM_{2.5}$ and hospital visits; any 10 µg/m³ increase in $PM_{2.5}$ concentration was associated with 4% reduced odds of inpatient than outpatient (ORc = 0.996 95%CI: 0.993–0.998; p = 0.003). Thus, the PM2.5 increase results in more outpatient visits than hospitalisations. There was a 3% reduced odds of hospitalisations than outpatient when sPM10 increases, but the relationship was not statistically significant (ORc = 0.997 95%CI: 0.977–1.018; p = 0.802).

Adjusting for the $PM_{2.5}$ and PM_{10} did not confound the effects of each on hospital visits for respiratory diseases. For any unit increase of $PM_{2.5}$, the likelihood of inpatient compared to outpatient was continuously and significantly reduced by about 0.4% (ORa = 0.996 95%CI: 0.993–0.999; p = 0.002). The inpatient odds compared to outpatient was about 0.5% for any unit increase in PM10, although this was not statistically significant (ORa = 0.995 95%CI: 0.975–1.016; p = 0.659). This model explained 0.99% more of the relationship between PM and hospital visits (Pseudo R^2 = 0.0099) as compared to the model without PM.

Table 2
Particulate matters determinants of hospital visits for respiratory diseases

Factors	Crude OR		Adjusted OR	
	OR (95% CI)	P-value	OR (95% CI)	P-value
PM2.5	0.996 (0.993–0.998)	0.003*	0.996 (0.993–0.999)	0.002*
PM10	0.997 (0.977–1.018)	0.802	0.995 (0.975–1.016)	0.659
Dependent variable: hospital visits (Outpatients/Inpatients)				
The model including all particulate matters				
*Significant association at 5%				
Pseudo R^2: 0.0099; N = 2012; pvalue of the model = 0.0035				
Akaike's information criterion (AIC) = 2660.44; df = 3				

The Table 3 adjusted for all PM with the weather. Although the model better fitted the data with a lower AIC, this model still explained 0.99% of the hospital visits compared to the simple model without the PM and the weather covariates. The relative humidity and the temperature confounded the PM effects on hospital visits by modifying the extent of the association. Any 10 µg/m³ increase in $PM_{2.5}$ was significantly associated with a 9% reduced odds of inpatient than outpatient (ORa = 0.991 95% CI: 0.987–0.995; $p < 0.001$). The increase in PM10 (10 µg/m³) resulted now in a 1.3% increased odds of inpatient compared to outpatient; this was still not significant (ORa = 1.013 95% CI: 0.991–1.038; p = 0.239).

Besides, the temperature was not statistically associated with hospital visits (ORa = 0.984 95% CI: 0.954–1.016; p = 0.326), while the relative humidity was significantly associated with hospital visits, making a 1.5% reduced odds of inpatient compared to outpatient (ORa = 0.985 95% CI: 0.977–0.992; $p < 0.001$).

Table 3
Effects of particulate matters on hospital visits for respiratory diseases, adjusted for weather covariates

Factors	Crude OR		Adjusted OR	
	OR (95% CI)	P-value	OR (95% CI)	P-value
PM2.5	0.996 (0.993–0.998)	0.003*	0.991 (0.987–0.995)	< 0.001*
PM10	0.997 (0.977–1.018)	0.802	1.013 (0.991–1.038)	0.239
Temperature	-	-	0.984 (0.954–1.016)	0.326
Humidity	-	-	0.985 (0.977–0.992)	< 0.001*
Dependent variable: hospital visits (Outpatients/Inpatients)				
Model adjusted for temperature and relative humidity				
*Significant association at 5%				
Pseudo R^2: 0.0099; N = 2012; p-value of the model < 0001				
Akaike's information criterion (AIC) = 2647.37; df = 5				

To the model adjusting for the weather, the sociodemographic factors were added in Table 4. This model justified about 1.34% of the hospital visits compared to the simple model (Pseudo R^2 = 0.0134) with a slightly lower AIC. The age and sex did not modify the extent of the association between PM and hospital visits found when adjusting to the weather. These sociodemographic factors did not play any confounding role for the PM. Also, they did not confound the temperature and the relative humidity effects on hospital visits, as the extent remained similar, and the statistical significance was not influenced.

Besides, sex and age were not statistically associated with respiratory diseases visits.

Table 4
Effects of particulate matters on hospital visits for respiratory diseases, adjusted for weather and sociodemographic factors

Factors	Crude OR		Adjusted OR	
	OR (95% CI)	P-value	OR (95% CI)	P-value
PM2.5	0.996 (0.993–0.998)	0.003*	0.991 (0.987–0.995)	< 0.001*
PM10	0.997 (0.977–1.018)	0.802	1.013 (0.990–1.037)	0.270
Temperature	-	-	0.985 (0.954–1.017)	0.346
Humidity	-	-	0.985 (0.978–0.992)	< 0.001*
Sex				
Male	-	-	1	
Female	-	-	0.855 (0.712–1.026)	0.093
Age				
Infant	-	-	1	
Newborn	-	-	1.705 (0.916–3.174)	0.093
Small child	-	-	0.846 (0.647–1.107)	0.223
Older child	-	-	1.207 (0.872–1.672)	0.257
Dependent variable: hospital visits (Outpatients/Inpatients)				
Adjusted for temperature, relative humidity, and sociodemographic factors				
*Significant association at 5%				
Pseudo R^2: 0.0134; N = 2012; pvalue of the model < 0.0001				
Akaike's information criterion (AIC) = 2646.06; df = 9				

The model, including the PM, the weather, the sociodemographic characteristics and children medical history, performed the best, based on the AIC (2598.19), and explained up to 3.43% of hospital visits compared to the simple model. Medical history did not confound the PM effects on hospital visits.

Medical history confounded the weather by modifying the relationship extent. Although it was not statistically significant, any 10°C increase in temperature was associated with a 1.9% reduced odds of inpatient than outpatient (ORa = 0.981 95% CI: 0.951–1.013; p = 0.247).

Medical history confounded the sex by modifying the statistical significance. Previously not significantly associated with hospital visits, sex was now significantly associated with hospital visits. Compared to males, females had a 18.4% reduced chance to be inpatient than outpatient ORa = 0.816 95% CI: 0.678–0.982; $p = 0.031$).

Further, severe acute malnutrition (ORa = 7.417 95% CI: 2.254–24.412; $p = 0.001$), sickle cell disease (ORa = 8.239 95% CI: 1.917–35.414; $p = 0.005$), heart disease (ORa = 12.150 95% CI: 2.911–50.709; $p = 0.001$) were associated with hospital visits for respiratory diseases, with an increase odds.

Table 5
Effects of particulate matters on hospital visits for respiratory diseases, adjusted for weather, sociodemographic factors and medical history

Factors	**Crude OR**		**Adjusted OR**	
	OR (95% CI)	**P-value**	**OR (95% CI)**	**P-value**
PM2.5	0.996 (0.993–0.998)	0.003*	0.991 (0.987–0.995)	< 0.001*
PM10	0.997 (0.977–1.018)	0.802	1.014 (0.990–1.038)	0.248
Temperature	-	-	0.981 (0.951–1.013)	0.247
Humidity	-	-	0.984 (0.977–0.992)	< 0.001*
Sex				
Male	-	-	1	
Female	-	-	0.816 (0.678–0.982)	0.031*
Age				
Infant	-	-	1	
Newborn	-	-	1.786 (0.957–3.333)	0.069
Small child	-	-	0.832 (0.634–1.093)	0.186
Older child	-	-	1.153 (0.827–1.607)	0.401
Medical history				
Severe acute malnutrition				
No	-	-	1	
Yes	-	-	7.417 (2.254–24.412)	0.001*
Sickle cell disease				
No	-	-	1	
Yes	-	-	8.239 (1.917–35.414)	0.005*
Heart disease				

Dependent variable: hospital visits (Outpatients/Inpatients)

Adjusted for weather, sociodemographic factors and medical history

*Significant association at 5%

Pseudo R^2: 0.0343; N = 2012; pvalue of the model < 0.0001

Akaike's information criterion (AIC) = 2598.19; df = 13

Factors	Crude OR		Adjusted OR	
	OR (95% CI)	P-value	OR (95% CI)	P-value
No	-	-	1	
Yes	-	-	12.150 (2.911–50.709)	0.001*
Family asthma				
No	-	-	1	
Yes	-	-	0.991 (0.357–2.747)	0.986
Dependent variable: hospital visits (Outpatients/Inpatients)				
Adjusted for weather, sociodemographic factors and medical history				
*Significant association at 5%				
Pseudo R^2: 0.0343; N = 2012; pvalue of the model < 0.0001				
Akaike's information criterion (AIC) = 2598.19; df = 13				

Discussion

The health outcomes of poor air quality have not been extensively studied in Burkina Faso, although evidence of poor quality has been reported [6,7]. This study aimed to describe air quality in the major city of Burkina Faso, Ouagadougou and compare the differential effects of particulate matters on the pattern of respiratory diseases visits among children. PM10 measurement (highest value of 18.33 µg/m³) was not high enough to be considered a health risk during the study period. More than 25% of the PM2.5 daily values were above 25 µg/ m³, i.e. beyond the WHO recommended threshold. Higher PM2.5 was associated with slightly and significantly more outpatients than inpatients, a relationship confounded by the weather but not sociodemographic factors and medical history. In the same line, the non-significant effect of PM_{10} on hospital visits was confounded by the weather and not by the sociodemographic characteristics and medical history. In the final model adjusting the PM effects for all covariates, the increase in $PM_{2.5}$ and relative humidity and the female sex were associated with more outpatients cases than inpatients. At the same time, underlying conditions (severe acute malnutrition, sickle cell disease and, heart disease) favoured more inpatients than outpatients.

Air quality data are scarce from most parts of Africa, particularly West Africa. Available data reports widespread poor air quality near industries, factories or dumps [10,20,21]. Previous studies in Ouagadougou reported PM2.5 and PM10 concentrations above the WHO guidelines for air quality, with spatial and temporal variations across the city [6,7]. Recent data from many sites in Ouagadougou showed an average 24-hour concentration of 87 ± 16 µg/m³ and 951 ± 266 µg/m³ for PM2.5 and PM10, respectively [7]. This was true for PM2.5 concentrations during at least 25% of the recording days from a fixed site in our study. PM10 concentrations in the present study did not exceed the 50 µg/m³ WHO standard [8]. Still, it is noteworthy that these measurements may not represent the entire city, as shown by the variability reported in previous studies [6].

PM2.5 can go deep into the respiratory system and cause airway inflammation, inducing defensive responses, even in apparently healthy individuals. Respiratory tract inflammation could reduce pulmonary function by bronchoconstriction, damage cells and impair the integrity of the alveolar-capillary barrier[22,23]. When mixed with ozone, fine particulates can also cause arterial vasoconstriction and lead to cardiovascular diseases[24]. Because of the higher risk of air pollution adverse effects, children are usually advised to reduce the time spent outside or avoid going out during peak periods.

Short-term effects of PM2.5 increased slightly more outpatients than inpatients. These effects depended on the relative humidity and sex. More outpatient consultations rather than hospitalisations are expected when humidity increases and among females. This information is essential for health policymakers and policy implementers who can channel resources for more outpatient consultations during periods of high humidity. Evidence of PM effects on outpatient visits, emergency or hospitalisation have been reported primarily from other parts of the world. In Europe, America and Asia, an excess risk of total hospital admissions was associated with air pollution, with PM2.5 increasing respiratory hospitalisations by 1.1 to 1.8 [11]. In China, there was a 1.09 to 8.46 % excess risk of emergency visits related to PM2.5 [12]. Similarly to our study, exposure to ambient air pollution increased by 0.13% (95% CI: 0.02%-0.24%) daily outpatient visits in China [13]. Most studies in Africa explored PM adverse effects on respiratory diseases among children in schools, near industrial areas, or mine dumps. This is the first study to our knowledge that has assessed the effect on hospital visits [4,21].

Because PM10 concentration remained normal over the study period, it was not associated with more respiratory hospital visits, even though these particles were linked to a higher risk of admission in settings where PM10 was abnormally high [21,25,26].

Air pollution adverse effects go beyond the impact of PM 2.5 and include other pollutants such as ozone, nitrogen dioxide, or sulfur dioxide. For instance, these pollutants have been associated with increased emergency room visits and hospitalisations for asthma, with strong evidence for 8-hour or 24-hour ozone and 24-hour nitrogen dioxide, and moderate for 24-hour sulfur dioxide [27]. But pollutants effects must be evaluated in a multipollutant approach, closer to the reality on the ground. There is, therefore, a need for broad-based monitoring of air pollutants to fully assess the health effects of air pollution, which has implications for policy on emission reduction. Meteorological factors could also confound the effects of pollutants. In effect, climatic elements interacted with particulate matters in Ouagadougou, but respiratory visits increased concurrently with a rise in PM2.5 and decreased with relative humidity[6,14].

In this study, females seem more prone to experience PM effects compared to males, particularly with PM10 [16,17], but this association has not been consistently reported[15]. Moreover, this study revealed that females had more chances to be outpatients than hospitalised, compared to males. Regarding age, this study did not find any association with respiratory vists[4,16]. However, evidence suggests that young children could be more sensitive to outdoor air pollutants [4,16]. Amongst outpatient children, older children (7 to 14 years) experienced more respiratory adverse effects of PM2.5 than younger ones (less than 7 years) [13].

Beyond the weather and sociodemographic factors, medical history was analysed in this study. Severe acute malnutrition, sickle cell disease and heart disease increased the likelihood of hospitalisations compared to consultations. These underlying conditions make children vulnerable to infections and more severe diseases, which may explain this association. Malnutrition has been described to have synergistic and antagonistic interactions with infections, as malnutrition and infections could influence each other in a vicious cycle, or exceptionally the malnutrition could reduce the multiplication of the infectious agent[28,29]. Sickle cell disease, heart disease and malnutrition would lower immunity and increase children susceptibility to infections, leading to hospitalisations for respiratory diseases and other causes.

Study Limitations

This retrospective ecological study analysed the relationship between geographical air pollution and individual hospital-based data. As a result, it could be subject to ecological fallacy, with associations that do not exist. The study was limited to two tertiary hospitals in Ouagadougou, and our results may not represent the situation across other facilities. Further, air pollution data were collected from a single fixed position, while air quality varies by area in Ouagadougou city. Despite these limitations, the study confirmed poor air quality in Ouagadougou and has provided preliminary evidence of its potential effect on the pattern of hospital visits among children for respiratory diseases in Ouagadougou.

Conclusion

The air quality based on the level of PM2.5 measurements was poor in Ouagadougou. It calls for continuous monitoring of air quality related to particulate matters and other pollutants from different stations in the city. A high concentration of PM2.5 was associated with increased outpatient consultations among children, a finding that could help prepare for such situations. Monitoring air pollution levels and analysing the health-related conditions is crucial for policymakers to enable them to appreciate the health impacts of poor air quality and hopefully institute measures that could reduce the levels of emission.

Abbreviations

CI
Confidence Interval
PM
Particulate matters
STH

Soil-transmitted helminthiasis

WHO

World Health Organization

Declarations

Ethics approval and Consent to Participate

The National Ethics Committee for Health Research (Comité d'Ethique National pour la Recherche en Santé, CERS) in Burkina Faso, approved the study and waived for collecting the individual informed consent, as it involved a secondary data collection (Approval number 2020-8-166). Patients data were anonymously collected from hospital and clinical records under confidentiality assurance.

All methods were carried out following relevant guidelines and regulations.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Not applicable.

Authors contribution

ARO contributed substantially to the conception, design, acquisition and interpretation of the data, drafting the manuscript, and critically reviewing the drafted manuscripts. JCRPO analysed the data and made substantial contributions to the understanding and the manuscript drafting.

SO and OBO contributed to the interpretation of data, drafting the manuscript, and the critical review of the draft manuscripts. ANT contributed to the acquisition of the data and the review of the draft manuscripts. AS, KB, GO, GB and MO contributed to the review of the draft manuscripts.

All authors read and approved the final draft of the document.

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