EXPOSURE TO CONDITIONS OF HIGH CONCENTRATIONS OF INDOOR AIR POLLUTANTS AND PREVALENCE OF ARIS IN CHILDREN UNDER 5 YEARS OF AGE, IN OUAGADOUGOU/BURKINA FASO

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Research Article

Exposure to Conditions of High Concentrations of Indoor Air Pollutants and Prevalence of ARIs in Children under 5 Years of Age, in Ouagadougou/Burkina Faso

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Abstract

Exposure to $PM_{2.5}$ in indoor air can cause respiratory infections. In Ouagadougou, concentrations of $PM_{2.5}$ produced in households using biomass were found to be very high by WHO standards (25 µg/m^3 for 24 hours). The objective of this study was to highlight the effect of exposure to high concentrations of $PM_{2.5}$ emitted during cooking on the prevalence of acute respiratory infections (ARI) in children under 5 years of age. This was a case-control study that took place from 16 September to 15 October 2018 in sector 15 of Ouagadougou. The sample size was 125 cases and 250 controls. Data collection was carried out using a grid, by two nurses, at the CSPS in sector 15 and in households. The cases were children diagnosed with ARI and the controls were children diagnosed with a diagnosis other than ARI. The data were entered using Epi data software and analyzed using Stata 12. The associations were expressed in Odds ratios and their confidence intervals were estimated at 95%. The results showed that the use of biomass in indoor kitchens in residential buildings was linked to the occurrence of ARI in children under the age of 5. Living in a house with several bedrooms was a protective factor. This would be explained by the better ventilation within these households.

Keywords: Indoor Air Pollution; $PM_{2.5}$; Biomass; Cooking; Acute respiratory infections; Child

1. Introduction

The combustion of biomass produces pollutants that are potentially harmful to human health. $PM_{2.5}$ and carbon monoxide (CO) are the pollutants generally reported in the literature [1]. The main sources of indoor air pollution are the use of wood for meal preparation [2-4]. In the city of Ouagadougou, 60% of the households use biomass (coal and/or wood) as fuel in the cooking of their meals. This biomass is used with improved and/or traditional stoves. Compared to the WHO 24-hour limit of 25 $\mu g/m^3$, concentrations of $PM_{2.5}$ produced in households were found to be very high under some conditions of meal preparation such as [5-6]: i) In outdoor kitchens (110.69 $\mu g/m^3$), ii) In households using the Traditional stoves and wood (95.69 $\mu g/m^3$), iii) In households using wood (62.54 $\mu g/m^3$), iv) In households using improved stoves and coal (27.62 $\mu g/m^3$). Health problems due to exposure to high concentrations of $PM_{2.5}$ are mainly related to the respiratory system. The most common pathologies are: asthma, acute respiratory infections, chronic respiratory infections (chronic bronchitis, chronic obstructive bronchopathy) [7-8]. Despite the high exposure of children in some households to high concentrations of $PM_{2.5}$, few studies have examined the adverse effects of this exposure on their health. The objective of this study aimed at determining the effect of exposure to high concentrations of $PM_{2.5}$ emitted during meal preparation on the prevalence of acute respiratory infections in children under the age of 5.

2. Study Materials and Methods

2.1 Type of study

This is a case-control study carried out from 16 September to 15 October 2018 in district 15 of the city of Ouagadougou.

2.2 Field and study population

District 15 of the city of Ouagadougou, one of the two districts covered by the Ecosanté project's intervention zone. Two-thirds of the dominant habitats were common low-rise courtyards and houses built with temporary materials (78%). Meals were cooked once a day in 69% of households, using traditional or improved stoves in 45% of households, and consuming wood or charcoal in 60% of households. The places where meals were cooked were mainly inside the family home (40.46%) and outside the family home, in a separate building (19%) or outdoors in the yard (38.82%). In most households (90%), children who are not yet in school are looked after by women who are in charge of cooking meals [9].

The Health center of district 15 is part of the Sig-Noghin health district, for which the CMA is the reference center. Its health area was located in the 3rd and 9th districts of the city Ouagadougou. Indeed, it includes district 15 (administrative subdivision 3) and 38 (administrative subdivision 9) of the new division. It is limited to the East by the health area’s health center (CSPS) in district 22, to the north of the health area’s health center (CSPS) of Bissighin Pazani and Marcoussi and to the South by that of district 20. According to the 2017 action plan, the population of the health area’s health center (CSPS) in district 15 was estimated at 71,683 people, including 10,541 children under the age of 5. It includes a dispensary, a maternity ward, a MEG storage facility and a cash register.

On a daily basis, curative care is provided by nurses in two rooms. An average of 5000 curative care consultations is carried out per month.

2.3 Sample

Two groups of children were formed from children under 05 years of age received in a curative visit at the health center (CSPS) in district 15. The first group included children who were diagnosed with ARI by health workers. The second group included children with a non-ARI diagnosis. The sample size was calculated using StatCalc from Epi info 7.2.2.2.6. Considering the following parameters: power=80%, number of controls for a case: 2, percentage of exposed controls: 40%, OR=2. The sample size is 323 children, including 108 cases and 215 controls. Considering 15% refusal, the sample size becomes 375 or 125 cases and 250 controls. All children who were admitted and satisfied with the inclusion criteria, in whom the parents agreed to participate in the study, were concerned. Children were included as they were included until the required sample sizes were obtained.

2.4 Case definition

The case of ARI is any child under the age of 05 years who received a curative consultation at the health center (CSPS) in district 21 during the survey period and for whom the diagnosis was a respiratory infection. The definition of respiratory infection was in accordance with the WHO definition: Acute respiratory infections (ARIs) are diseases affecting the upper or lower respiratory tract, usually of infectious origin and can take very different forms, ranging from asymptomatic or benign to severe or fatal, depending on the pathogen and factors related to the environment or to the host. The respiratory tract, including the nose, throat, larynx, trachea, bronchial tubes, bronchioles or lungs. The diseases ranging from common colds to ear infections, sore throats, bronchitis, bronchiolitis and common pneumonia, sore throats, bronchitis, bronchiolitis and pneumonia [10].

2.5 Definition of controls

The witness in our study is any child under the age of 05 years who received a curative consultation at the health center (CSPS) in district 15 during the survey period for who was not diagnosed with an acute respiratory infection.

2.6 Inclusion criteria

The inclusion criteria were:

- **For cases:** Two main criteria were considered: 1) live in the study area and 2) have no other pathologies outside the ARI in order to minimize diagnostic bias
- **For controls:** Live in the study area, do not show symptoms of ARI for 14 days before data collection.

2.7 Data collection techniques

Data on children’s respiratory health were collected by a pair of two investigators holding the State Nurse diploma, trained in integrated management of childhood diseases. A grid was used to collect the child’s demographic and health data. Health data collection was done at the health center (CSPS) level every morning from 8:00 am to 12:00 pm during the survey period. At the health center (CSPS) level, the interviewers worked closely with the health workers on the curative consultation team. For each child in the sample, interviewers visited households in the afternoons and collected information about the households, the conditions for cooking and the family environment in which the children live. To this end, a data collection grid has also been developed. The information thus dealt with: types of kitchens, types of households, types of fuel, the time the meal is cooked daily in the household, the type of housing, the number of people living in the household, the number of bedrooms, the number of children under five years old and the identity of the person looking after the child.

2.8 Data analysis

The data were entered using Epi data software and analyzed using Stata 12. A comparison of the two groups of children was first done to ensure that they are homogeneous on Age and Sex. A description of all the variables was then done after. Proportions were used to describe qualitative variables and quantitative variables were described using averages, with standard deviation or medians, and interquartile spaces. The frequencies of exposure to risk factors were calculated for each group. In the bivariate analysis, the estimation of the Odds Ratio to measure the association between the IRA and each risk factor studied was performed. In multivariate analysis, a logistic regression model was used in a step-by-step, bottom-up procedure. The likelihood ratio test was used to compare successive models and the adjustment of the final model was verified before reporting the results. The associations between the dependent variable and the independent variables were expressed in Odds ratio (OR) and their corresponding confidence intervals (95% CI) were estimated.

2.9 Description of the study variables

In addition to the independent variables already discussed in our previous article [9], the following independent variables have been added:

- Gender: Male, female
- Vaccination status: from the child's vaccination record, investigators checked whether the child was up to date with his/her vaccinations, in line with the current vaccination schedule
- Breastfeeding: The investigators asked the parents the question to find out if the child is still breastfeeding or not.
- Nutritional status: using the criterion of the brachial perimeter, the investigators were responsible for measuring it in each child and classifying it as malnourished or not malnourished
- Humidification of nostrils with Shea butter: The investigators asked the parents the question to find out if they are used to humidifying the child's nostrils with shea butter.
- Protection against cold and wind: The investigators observed the clothing of each child. Children who wore at least two layers of clothing were classified as "well protected from the cold and wind". The others were classified as "insufficient protection against cold and wind".

3. Results

A comparison of the two groups according to the age and sex of the children is presented in Table 1.

Case (n=125)			Control (n=250)		Chi^2	P Value
Age						
Less than one year	38	(30.40%)	65	(26.32%)	0.8343	0.841
Between 1 and 2 years old	38	(30.40%)	79	(31.98%)		
Between 2 and 3 years old	16	(12.80%)	35	(14.17%)		
More than three years	33	(26.40%)	71	(28.74%)		
Gender						
Male	70	(56.00%)	140	(56.00%)	0.0018	0.967
Female	55	(44.00%)	110	(44.00%)		

Table 1: A comparison of the two groups according to the age and sex.

3.1 Descriptive analysis of variables

3.1.1 Socio-demographic characteristics of children: The average age of the cases and controls was 21.49 and 23.07 months respectively. The distribution of children by sex was the same for cases and controls, with 56% of boys and 44% of girls respectively.

3.1.2 Characteristics of children by immunization and nutritional status: Of the total sample, 363 (96.80%) were up to date with their vaccination, 118 (94.40%) in cases and 245 (98.00%) in controls. Measurements of the brachial perimeter made it possible to classify a total of 11 malnourished children, i.e. 04 cases (3.20%) and 7 controls (1.62%).

3.1.3 Practices for protecting children from the cold, wind: The practices of humidification of the nostrils with shea butter are found in 100 cases (80%) and 218 controls (87.20%). As for the wearing of at least two layers of clothing, it was found in 42 cases (33.60%) and in 77 controls (30.80%).

3.1.4 Meal cooking practices: Meals were prepared at least three times a day in 21 households: 10 (8%) in cases and 11 (4.45%) in controls. Indoor kitchens were found in 35 (28%) households in the cases and 58 (23.20%) households in the controls. The traditional stove was used in 16 (12.8%) households for cases and 46 (18.40%) for controls. Biomass was used in 52 (41.6%) households for cases and 96 (38.87%) households for controls.

3.1.5 Sociodemographic characteristics of households: In the cases, 18 (14.4%) had more than three bedrooms compared to 47 (18.80%) in the controls. In the cases 13 (10.40%) households had more than 10 inhabitants, compared to 19 (6.88%) households in the controls. The frequencies of exposure of each group to the risk factors studied are presented in Table 2.

Groups	Case (n=125)		Control (n=250)	
Humidification of the nostrils with Shea butter				
Yes	100	(80.00%)	218	(87.20%)
No	25	(20.00%)	32	(12.80%)
Protection against cold and wind				
Wearing a single layer of clothing	83	(66.40%)	173	(69.20%
Wearing at least two layers of clothing	42	(33.60%)	77	(30.80%
Vaccination status				
Up to date	118	(94.40%)	245	(98.00%
Not up to date	7	(5.60%)	5	(2.00%
Breastfeeding				
Yes	72	(57.60%)	132	(52.80%)
No	9	(7.20%)	21	(8.40%)
Not applicable	44	(35.20%)	97	(38.80%)
Nutritional status				
Malnourished	4	(3.20%)	7	(2.80%)
Not malnourished	121	(96.80%)	243	(97.20%)
Number of bedrooms				
One bedroom	78	(62.40%)	146	(58.40%)
Two bedrooms	26	(20.80%)	53	(21.20%)
Three or more bedrooms	18	(14.40%)	47	(18.80%)
No answer	3	(2.40%)	4	(1.60%)
Household size				
Between 1 and 5 people	70	(56.00%)	158	(63.20%)
Between 6 and 10 people	42	(33.60%)	73	(29.20%)
More than 10 people	13	(10.40%)	19	(7.60%)
Number of children under 05 years old				
A child	88	(70.40%)	147	(58.80%)
Two children	23	(18.40%)	70	(28.00%)
Three or more children	14	(11.20%)	33	(13.20%)
Number of people in the same room as the child				
A person	94	(75.20%)	173	(69.20%)
More than 2 people	31	(24.80%)	74	(29.60%)
No answer	0	(0.00%)	3	(1.20%)
Person in charge of the child's care				
Cooks the meal	119	(95.20%)	238	(95.20%)

Groups	**Case (n=125)**		**Control (n=250)**	
Does not cook the meal	6	(4.80%)	10	(4.00%)
No answer	0	(0.00%)	2	(0.80%)
Children's playgrounds				
Court	65	(52.00%)	144	(57.60%)
Interior	15	(12.00%)	19	(7.60%)
Outside	45	(36.00%)	86	(34.40%)
No answer	0	(0.00%)	1	(0.40%)
Frequency of meal preparation				
Once in a while	76	(60.80%)	182	(72.80%)
Twice	39	(31.20%)	56	(22.40%)
Three times and more	10	(8.00%)	11	(4.40%)
No answer	0	(0.00%)	1	(0.40%)
Mother's education level				
Illiterate	42	(33.60%)	82	(32.80%)
Literate / Primary	39	(31.20%)	94	(37.60%)
Secondary/higher	44	(35.20%)	74	(29.60%)
The existence of a person who smokes within the household				
Yes	34	(27.20%)	46	18.40%)
No	91	(72.80%)	204	81.60%)
Type of kitchen				
Open-air cooking	33	(26.40%)	82	(32.80%)
Indoor kitchen	35	(28.00%)	58	(23.20%)
Outdoor kitchen	57	(45.60%)	110	(44.00%)
Type of stove				
Gas	73	(58.40%)	152	(60.80%)
Improved	36	(28.80%)	52	(20.80%)
Traditional	16	(12.80%)	46	(18.40%)
Type of fuel used				
Gas	73	(58.40%)	154	(61.60%)
Wood	30	(24.00%)	68	(27.20%)
Coal	22	(17.60%)	28	(11.20%)
Combinations stove /fuel				
Gas	73	(58.40%)	152	(60.80%)
Improved stove +Wood	14	(11.20%)	22	(8.80%)
Improved stove + coal	22	(17.60%)	30	(12.00%)

Groups	**Case (n=125)**		**Control (n=250)**	
Traditional stove + wood	16	(12.80%)	46	(18.40%)
Conditions for cooking meals				
Open-air kitchen + Gas	12	(9.60%)	32	(12.80%)
Outdoor kitchen + improved stoves + wood	8	(6.40%)	12	(4.80%)
Open-air kitchen + improved stoves + coal	7	(5.60%)	13	(5.20%)
Open-air kitchen + Traditional stove + Wood	6	(4.80%)	28	(11.20%)
Outdoor kitchen + Gas	13	(10.40%)	20	(8.00%)
Outdoor kitchen + improved stove + wood	5	(4.00%)	8	(3.20%)
Outdoor kitchen + Traditional stove + Wood	8	(6.40%)	17	(6.80%)
Outdoor kitchen + improved stove + coal	9	(7.20%)	13	(5.20%)
Indoor kitchen + Gas	48	(38.40%)	100	(40.00%)
Indoor kitchen + Traditional/improved stove + Wood/coal	9	(7.20%)	7	(2.80%)

Table 2: frequencies of exposure of each group to risk factors.

3.2 Bivariate analysis

Table 3 shows the results of the bivariate analysis.

Group	**Unadjusted OR**	**Chi^2**	**P value**	**[95 % CI]**	
Age					
Less than one year	1	-	-	-	-
Between 1 and 2 years old	0.823	0.47	0.493	0.471	-1.438
Between 2 and 3 years old	0.782	0.45	0.501	0.382	-1.603
More than 3 years	0.795	0.61	0.435	0.446	-1.416
Gender					
Male	1	-	-	-	-
Female	1.009	0	0.967	0.653	-1.561
Humidification of the nostrils with Shea butter					
Yes	1	-	-	-	-
No	1.703	3.34	0.068	0.956	-3.035
Protection against cold and wind					
Wearing a single layer of clothing	1	-	-	-	-
Wearing at least two layers of clothing	0.88	0.3	0.583	0.556	-1.392
Breastfeeding					
Yes	1	-	-	-	-
No	0.786	0.32	0.57	0.341	-1.81
Non-application	0.832	0.62	0.43	0.526	1.316

Group	Unadjusted OR	Chi^2	P value	[95 % CI]	
Vaccination status					
Up to date	1	-	-	-	-
Not up to date	2.907	3.48	0.062	0.897	-9.417
Nutritional status					
Malnourished	1	-	-	-	-
Not malnourished	0.871	0.05	0.829	0.25	-3.04
Number of bedrooms					
One bedroom	1	-	-	-	-
Two bedrooms	0.717	1.15	0.284	0.389	-1.321
Three or more bedrooms	0.918	0.09	0.759	0.533	-1.583
Household size					
Between 1 and 5 people	1	-	-	-	-
Between 6 and 10 people	1.299	1.17	0.279	0.808	-2.086
More than 10 people	1.63	1.58	0.209	0.754	-3.523
Number of children under 05 years old					
A child	1	-	-	-	-
Two children	0.549	4.8	0.029	0.318	-0.946
Three or more children	0.709	0.99	0.319	0.359	-1.4
Number of people in the same room as the child					
A person	1	-	-	-	-
More than 2 people	0.771	1.09	0.297	0.472	-1.259
Children's playgrounds					
Court	1	-	-	-	-
Interior	1.749	2.23	0.135	0.832	-3.675
Outside	1.159	0.39	0.534	0.728	-1.846
Frequency of cooking meal					
Once a day	1	-	-	-	-
Twice a day	2.177	2.99	0.084	0.882	-5.375
Three times and more	1.668	4.24	0.047	1.019	-2.729
Mother's education level					
Illiterate	1	-	-	-	-
Literate / Primary	0.810	0.61	0.434	0.477	-1.374
Secondary/higher	1.161	0.31	0.58	0.685	-1.969
Existence of a person who smokes within the household					
Yes	1	-	-	-	-

Group	Unadjusted OR	Chi^2	P value	[95 % CI]	
No	0.604	3.84	0.051	0.362	-1.006
Type of kitchen					
Open-air cooking	1	-	-	-	-
Indoor kitchen	1.554	2.22	0.137	0.865	-2.791
Outdoor kitchen	1.372	1.45	0.228	0.818	-2.301
Type of stoves					
Gas	1	-	-	-	-
Improved	1.499	1.86	0.173	0.834	-2.696
Traditional	1.288	0.92	0.337	0.768	-2.16
Type of fuel					
Gas	1	-	-	-	-
Wood	0.931	0.08	0.784	0.557	-1.554
Coal	1.658	2.54	0.111	0.885	-3.106
Combinations Stoves /fuel					
Gas	1	-	-	-	-
Improved stoves +Wood	1.325	0.58	0.447	0.64	-2.744
Improved stoves + Coal	1.636	2.41	0.121	0.873	-3.066
Traditional stoves + wood	0.724	1	0.318	0.383	-1.368
Kitchen/stoves /fuel combinations					
Indoor kitchen + Gas	1	-	-	-	-
Outdoor cooking + Gas	0.781	0.42	0.518	0.369	-1.654
Outdoor kitchen + improved stoves + wood	1.389	0.45	0.502	0.53	-3.637
Open-air kitchen + improved stoves + coal	1.122	0.05	0.819	0.419	-3.002
Open-air kitchen + Traditional stoves + Wood	0.446	2.88	0.090	0.171	-1.162
Outdoor kitchen + Gas	1.354	0.58	0.446	0.62	-2.96
Outdoor kitchen + improved stoves + wood	1.302	0.2	0.658	0.403	-4.21
Outdoor kitchen + Traditional stoves + Wood	0.98	0	0.966	0.394	-2.437
Outdoor kitchen + improved stoves + coal	1.442	0.61	0.433	0.574	-3.624
Indoor kitchen + Traditional/improved stoves + Wood/Coal	2.679	3.59	0.058	0.927	-7.738
The person who looks after the child under 05 years of age					
Is the one who cooks	1	-	-	-	-

Group	Unadjusted OR	Chi^2	P value	[95 % CI]	
Is not the one who makes the meal	1.2	0.12	0.730	0.425	-3.386

Table 3: Results of the bivariate analysis.

The results of the multivariate analysis according to the selected model are shown in Table 4.

Group	OR Unadjusted	OR Adjusted	P value	[95% CI]	
Gender					
Male	1. 000	-	-	-	-
Female	1. 009	1. 002	0. 993	0. 625	-1,608
Humidification of the nostrils with Shea butter					
Yes	1. 000	-	-	-	-
No	1. 703	1. 807	0. 067	0. 959	-3,405
Vaccination status					
Up to date	1. 000	-	-	-	-
Not up to date	2. 907	2. 394	0. 176	0. 676	-8,475
Nutritional status					
Malnourished	1. 000	-	-	-	-
Not malnourished	0. 871	0. 743	0. 678	0. 183	-3,020
Number of bedrooms					
One bedroom	1. 000	-	-	-	-
Two bedrooms	0. 717	0. 691	0. 229	0. 378	-1,263
Three or more bedrooms	0. 918	0. 383	0. 013	0. 179	-0,819
Household size					
Between 1 and 5 people	1. 000	-	-	-	-
Between 6 and 10 people	1. 299	1. 496	0. 150	0. 864	-2,590
More than 10 people	1. 630	1. 915	0. 188	0. 728	-5,033
Frequency of meal preparation					
Once in a while	1. 000	-	-	-	-
Twice	2. 177	1. 564	0. 119	0. 891	-2,745
Three times and more	1. 668	2. 395	0. 098	0. 851	-6,738
Mother’s education level					
Illiterate	1. 000	-	-	-	-
Literate / Primary	0. 810	0. 759	0. 342	0. 430	-1,341
Secondary/higher	1. 161	0. 987	0. 965	0. 538	-1,809
Existence of a person who smokes within the household					

Yes	1. 000	-	-	-	-
No	0. 604	0. 689	0. 190	0. 395	-1,202
Kitchen/stoves/fuel combinations					
Outdoor cooking + Gas	1. 000	-	-	-	-
Outdoor kitchen + improved stoves + wood	0. 781	1. 694	0. 394	0. 504	-5,693
Open-air kitchen + improved stoves + coal	1. 389	1. 709	0. 383	0. 513	-5,698
Open-air kitchen + Traditional stoves + Wood	1. 122	0. 663	0. 502	0. 200	-2,199
Outdoor kitchen + Gas	1. 354	2. 482	0. 208	0. 602	-10,232
Outdoor kitchen + improved stoves + wood	0. 446	2. 497	0. 083	0. 887	-7,035
Outdoor kitchen + Traditional stoves + Wood	1. 302	1. 386	0. 586	0. 429	-4,477
Outdoor kitchen + improved stoves + coal	0. 980	2. 131	0. 209	0. 654	-6,939
Indoor kitchen + Gas	1. 442	1. 617	0. 252	0. 711	-3,681
Indoor kitchen + Traditional/improved stoves + Wood/coal	2. 679	3. 792	0. 044	1. 034	-13,904

Table 4: Results of the multivariate analysis.

4. Discussion

Socio-demographic characteristics of children and ARIs among children under 05 years of age: The data analysis did not find an association between ARI and the socio-demographic characteristics of children. However, other authors had found that the occurrence of acute respiratory infections in children under 5 years of age was associated with the age of the children, particularly those under one year of age were the most at risk [11-13]. The same is also valid for the child's sex, which has been found by many authors, as one of the determinants of respiratory infections. The male sex being most at risk of developing respiratory infections [14-16].

4.1 Characteristics of children by immunization and nutritional status

The routine immunization program in Burkina Faso includes five different vaccines for the prevention of nine pathogens: (1) BCG against tuberculosis, (2) oral polio vaccine (OPV), (3) pentavalent vaccine against diphtheria, tetanus, pertussis, hepatitis B and Haemophilus influenzae type b (Penta), (4) yellow fever vaccine, and (5) anti-MV vaccine [17]. The analysis of the results of our study did not show any association between the child's immunization status and the prevalence of ARI. However, other authors have found that partial immunization is a risk factor for the development of ARI in children under the age of 5 [18-20].

4.2 Child nutritional status and occurrence of ARIs

An association between the prevalence of ARIs among children under 05 years of age has not been found by our study. This result does not correspond to those of other authors who had found that nutritional deficiency was associated with decreased lung function in children [21-22]. Thus, micronutrient deficiency is a risk factor for acute respiratory infections [23-25].

4.3 Practices for protecting children from the cold, wind

The shea butter is rich in vitamins A, E and omega 9. Among its properties, it is effective against skin dryness and protects the skin against sunburn [26]. It is commonly used to prevent respiratory infections, by wetting the nostrils to retain dust and prevent the deposition of germs in the nasal tract. Data analysis did not find an association between this practice and the prevalence of ARI in children under 05 years of age. A statistically significant association has not also been found between the protection of children through the use of several layers of clothing and the prevalence of ARI.

4.4 Meal cooking practices

In the bivariate analysis, a statistically significant association was found between meal cooking frequency and prevalence of ARIs (OR: 1.640, p=0.047). This association was not found in the multivariate analysis. However, others found that the increase in exposure time to high $PM_{2.5}$ concentrations was associated with ARI. Indeed, a study in Bangladesh indicated that every hour that $PM_{2.5}$ concentrations exceeded 100 $\mu g/m^3$ was associated with a 7% increase in the incidence of ARI in children aged 0 to 11 months [27]. Reducing exposure to $PM_{2.5}$ then involves reducing the frequency of cooking meal. In the multivariate analysis, another association with ARI in children under 5 years of age was found. This was the use of biomass for cooking meals in indoor kitchens (OR=3.792, p=0.044). Similar results were found in a multi-country study conducted in 2015 [28]. In internal kitchens, the lack of a smoke evacuation system for the combustion of biomass would lead to the circulation of polluted air in all rooms. Insufficient ventilation of the bedrooms would favour a high concentration of particles in them. Thus, all room occupants would be exposed to the adverse effects of particulate matter on their respiratory health [29-33].

4.5 Sociodemographic characteristics of households

Children living in residential homes with more than 03 bedrooms were less likely to develop an ARI compared to those living in residential homes with only one bedroom (OR: 0.383, p=0.013). Several authors have also demonstrated this link between housing type and ARIs. Indeed, children living in high quality housing are less likely to develop ARIs related to indoor air pollution [33-36]. This would be explained by better ventilation, but also by a trend towards the use of less polluting fuels in these households, which are considered to have access to financial resources for less polluting fuels. The presence of a smoker in the household has not been identified as a risk factor for the development of ARIs in children under 5 years of age. However, several authors had demonstrated this association [37-38]. Household size, number of children under 5 years of age, child's playgrounds and maternal education level were not also found to be significantly associated with the prevalence of ARIs. However, several studies have shown that these socio-economic factors are related to the prevalence of ARI in children under the age of 05 [23, 29, 33, 39, 40, 41].

5. Conclusion

The objective of the study was to demonstrate the association between exposure to conditions of high indoor air $PM_{2.5}$ concentrations due to biomass combustion and the prevalence of ARI in children under the age of 5 in households in district 15 of the city of Ouagadougou. The results showed that the use of biomass for cooking meals in indoor kitchens in residential buildings was a factor that favoured the occurrence of ARIs in children under the age of 5. In addition, living in a house with several bedrooms was a protective factor against ARIs. This is linked in particular to better ventilation, but also to a trend to the use of less polluting fuels in these households considered as those with financial access to less polluting fuels.

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