Original Research Article

Determinants of the occurrence of acute respiratory infections in under five children in South-Eastern Benin in 2023

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ABSTRACT

Background: Acute respiratory infections are among the leading causes of morbidity and mortality in children under five years, particularly in low- and middle-income countries. This study aimed to estimate the prevalence of ARIs and to identify the determinants of their occurrence in children under five in the Sado arrondissement (or borough) in Benin.

Methods: This was an analytical cross-sectional study involving 131 children under five years and their mothers recruited by convenience sampling in the community and at the Sado health centre using the integrated management of childhood illness (IMCI) register. Data collected through a questionnaire were analysed using STATA version 14. The primary outcome was the occurrence of acute respiratory infections in the child. Associations between independent variables and the occurrence of acute respiratory infections were explored using bivariate analyses and multivariate logistic regression at a 5% significance threshold.

Results: The prevalence of acute respiratory infections was 64.12% (95% CI=55.45-71.95%). The determinants for the occurrence of acute respiratory infections were: mother's marital status (OR=6.06; 95% CI=1.59-23.02; p=0.008), number of people living in the household (OR=0.34; 95% CI=0.12-0.94; p=0.038), cooking meals inside the rooms of the house (OR=0.39; 95% CI=0.16-0.91; p=0.030) and living near a dusty road (OR=3.19; 95% CI=1.18-8.58; p=0.022).

Conclusions: The high frequency of acute respiratory infections in Sado and the influence of sociodemographic and environmental factors underscore the necessity for integrated interventions. Strengthening mother' awareness and control measures targeting these factors (housing conditions, exposure to domestic and environmental pollutants, social determinants) will sustainably reduce the burden of acute respiratory infections in children under five years.

Keywords: Acute respiratory infections, Prevalence, Benin, Child under five, Determinant, Sado

INTRODUCTION

Acute respiratory infections (ARIs) remain a leading cause of morbidity and mortality in children under five, particularly in low- and middle-income countries.[1]

Caused by various pathogens, they affect the respiratory tract (nose, throat, larynx, trachea, bronchi, lungs) and present with fever, cough, nasal congestion, and breathing difficulties.[2] They generally last less than 14 days and are

transmitted mainly by direct contact with secretions from coughing or sneezing.[3]

Pneumonia remains the deadliest infection in children, causing more than 700,000 annual deaths in children under five, including nearly 190,000 newborns, while the majority of these deaths are preventable. The annual global incidence exceeds 1,400 episodes per 100,000 children <5 years, with particularly high levels in South Asia and West and central Africa. Despite progress, the reduction in deaths attributable to pneumonia is slower than for other infectious diseases.[1,4] In west Africa, the average prevalence of ARI symptoms in children under five is about 15.9%.[5] In Benin, ARIs are a major reason for paediatric consultations and the second most frequent diagnosis after malaria, with one study reporting a prevalence of 74.60% in the Yénawa neighborhood of Cotonou.[6,7]

Factors associated with the occurrence of ARIs are individual (age and vaccination status), behavioural (lack of exclusive breastfeeding, insufficient hygiene), and environmental (household air pollution, passive smoking, cohabitation with animals, household overcrowding).[5,7-10] The aggravating role of exposure to biomass smoke and low socio-economic status has been confirmed in Ethiopia.[11,12]

To reduce this burden, WHO and UNICEF promote the integrated management of childhood illness (IMCI) strategy, expanding vaccination programmes to include vaccines targeting ARI causes, promoting exclusive breastfeeding, and WASH interventions.[13]

In Benin, these measures are integrated into national child health policies, but incomplete vaccination coverage, inequalities in access to care between urban and rural areas, persistent poverty, widespread use of polluting fuels, and insufficient hygiene practices maintain a high prevalence.[5,6,14,15] It is therefore essential to study the determinants of ARIs to guide the adoption of context-appropriate strategies.

METHODS

Study setting

The study was conducted in the Sado arrondissement, a subdivision of Avrankou commune, located in the Ouémé department, in south-eastern Benin. It borders the communes of Sakété to the north, Adjarra and Porto-Novo to the south, Akpro-Missérété to the west, and Ifangni and the Federal Republic of Nigeria to the east. Its relief consists of low-altitude plateaus crossed by a depression, and its Sudan-Guinean climate is characterized by moderately high temperatures and a double alternation of dry and rainy seasons.[16] This climate is increasingly disrupted by the vagaries of climate change. In 2023, the population of the Sado arrondissement was estimated at 10,285 inhabitants, including 2,112 children under five years.

Study participants and eligibility criteria

The primary target population of the study consisted of children aged 0 to 59 months residing in the Sado arrondissement. The secondary targets were their mothers or any person caring for them at the time of the survey.

Inclusion criteria

The study included any child under five who had attended the Sado health centre during the two weeks preceding data collection and was seen in the community or at the health centre. Any child whose mother or caregiver was present and available on the survey day to answer the questionnaire. Any child for whom free and informed consent was obtained.

Exclusion criteria

Not included were children for whom necessary information could not be reliably obtained.

Study design

This analytical cross-sectional study collected data from 1 to 16 June 2023 at the Sado health centre and in the community. Children under five were selected using a non-probabilistic method with a convenience sampling technique from the integrated management of childhood illness (IMCI) register.

The sample size was determined using the Schwartz formula, considering: reference prevalence p=48.2% (national prevalence of ARIs in children <5 years according to the 2021 Health Statistics Yearbook); precision i=10%; error risk α=5% and no response rate 10%.

$$N=(\varepsilon\alpha^2 pq)/(i^2)$$

The minimum required sample size for the study was estimated at 106 children <5 years.

Variables and data collection tools

The dependent variable studied was the occurrence of acute respiratory infections in children under five. The four groups of explanatory variables explored were the child's individual characteristics (age in months, sex, and vaccination status, etc.), sociodemographic characteristics (age, marital status, religion, education level, etc.), behavioural characteristics (exclusive breastfeeding up to six months, type of sweeping practiced, child's personal hygiene, mother's hand hygiene, etc.) and environmental characteristics (season, proximity of dwelling to a dusty road, etc.) of the mother.

A structured questionnaire was administered to mothers or caregivers to collect information on the aforementioned determinants.

Data processing and analysis

Data collected with digitalized tools in the KoboCollect software were subjected to quality control, systematic review of submitted forms, and then cleaning of the database using Excel 2019 software. Data analysis was performed with Stata version 14 software.

Quantitative variables were summarized as mean (±standard deviation) or median [with interquartile range (Q1;Q3)] depending on whether the distribution was symmetrical or not. Qualitative variables were presented as frequency, proportions with confidence interval. The prevalence of acute respiratory infections was estimated, followed by univariate regression and multivariate logistic regression to identify factors associated with the occurrence of ARIs. Association measures [odds ratios (OR) and 95% confidence intervals] were assessed at the 5% significance threshold.

Ethical and deontological considerations

In line with ethical and deontological requirements in Benin, access to the study participants received the approval of the scientific committee through protocol validation and the no-objection notice from the Avrankou-Adjarra-Akpromissérété health zone. Free and informed consent was obtained for each participant before enrolment. Anonymity and confidentiality were respected for all respondents. The researchers committed to publishing only aggregated data free of any identifying elements.

RESULTS

Sociodemographic characteristics of participants

The mean age of the children surveyed was 22.06±11.89 months. The majority were male (62.63%) and up to date with vaccination (83.57%). The mean age of mothers was 27.70±5.36 years. The majority were married (82.44%), of Tori ethnicity (53.44%), and Christian (73.28%). More than half were retailers (52.67%) and had no formal education (56.49%). Over three-quarters of children lived in households composed of at least five people (77.10%).

Table 1: Sociodemographic characteristics of participants in the study on ARIs in under-fives in south-eastern Benin in 2023 (n=131).

Variables	Frequency	Proportion (%)	95% CI
Child sociodemographic characteristics			
Child's age (in months)			
≤24	75	57.25	48.53-65.54
24-59	56	42.75	34.45-51.46
Child's sex			
Male	71	54.20	45.51-62.63
Female	60	45.80	37.36-54.48
Child's vaccination status for age			
Up to date	101	77.10	69.01-83.57
Not up to date	30	22.90	16.42-30.98
Mother's sociodemographic characteristics			
Mother's age (in years)			
<28	69	52.67	44.01-61.17
28-38	55	41.98	33.73-50.70
38-48	7	5.34	2.54-10.88
Mother's marital status			
Married	108	82.44	74.84-88.10
Not married	23	17.56	11.89-25.15
Ethnicity			
Tori	70	53.44	44.76-61.90
Goun	42	32.06	24.55-40.63
Fon	19	14.50	9.39-21.73
Religion			
Christian	96	73.28	64.95-80.23
Muslim	27	20.61	14.46-28.50
No religion	8	6.11	3.05-11.83
Education level			
None	74	56.49	47.77-64.81

Continued.

Variables	Frequency	Proportion (%)	95% CI
Primary	40	30.53	23.17-39.04
Secondary	17	12.98	8.17-19.99
Occupation			
Homemaker	41	31.30	23.85-39.84
Retailer	69	52.67	44.01-61.17
Artisan	21	16.03	10.63-23.45
Number of people in the household			
<5	30	22.90	16.42-30.98
≥5	101	77.10	69.01-83.57

Table 2: Behavioural characteristics of mothers and those related to children's environment in the study on ARIs in under-fives in south-eastern Benin in 2023 (n=131).

Variables	Frequency	Proportion (%)	95% CI
Behavioural characteristics of children's mothers			
Exclusive breastfeeding until 6 months			
Yes	110	83.97	76.54-89.36
No	21	16.03	10.63-23.45
Type of sweeping practised			
Wet	46	35.11	27.33-43.77
Dry	85	64.89	56.22-72.66
Energy source for cooking			
Wood	95	72.52	64.14-79.56
Charcoal/Gas	36	27.48	20.43-35.85
Place of meal preparation/cooking			
Inside the rooms of the house	82	62.60	53.89-70.54
Outside the rooms of the house	49	37.40	29.45-46.10
Child's location during cooking			
Living room	17	12.98	8.17-19.99
Kitchen	91	69.47	60.95-76.82
Bedroom	23	17.56	11.89-25.15
Child's personal hygiene			
Good	45	34.35	26.63-42.98
Poor	86	65.65	57.01-73.36
Mother's hand hygiene			
Good	120	91.60	85.37-95.32
Poor	11	8.40	4.67-14.62
Characteristics related to the child's environment			
Presence of windows in all rooms			
Yes	81	61.83	53.12-69.83
No	50	38.17	30.16-46.87
Presence of a special room for cooking			
Yes	105	80.15	72.32-86.18
No	26	19.85	13.81-27.67
Presence of smoker in the child's vicinity			
Yes	13	9.92	5.80-16.44
No	118	90.08	83.55-94.19
Dwelling close to a dusty road			
Yes	33	25.19	18.41-33.43
No	98	74.81	66.56-81.58
Cohabitation with animals			
Yes	74	56.49	47.77-64.81
No	57	43.51	35.18-52.22
Time when child has more ARIs			
Dry season	88	67.18	58.57-74.75
Rainy season	43	32.82	25.24-41.42

Table 3: Associations between variables and the occurrence of ARI in children under five in south-eastern Benin in 2023.

Variables	ARI in children <5 years		Odds ratio (OR)	95% CI	P value
	Yes (%)	No (%)			
Child's age (months)					
≤23	48 (64.0)	27 (36.0)	0.98	0.47-2.03	0.973
24-59	36 (64.3)	20 (35.7)	1	-	-
Child's sex					
Male	44 (62.0)	27 (38.0)	0.81	0.39-1.67	0.577
Female	40 (66.7)	20 (33.3)	1	-	-
Child's vaccination status for age					
Up to date	69 (68.3)	32 (31.7)	1	-	-
Not up to date	15 (50.0)	15 (50.0)	0.46	0.20-1.06	0.069*
Mother's age (years)					
<28	45 (65.2)	24 (34.8)	0.75	0.13-4.15	0.742
28-<38	34 (61.8)	21 (38.2)	0.64	0.11-3.64	0.622
38-48	5 (71.4)	2 (28.6)	1	-	-
Mother's marital status					
Married	64 (59.3)	44 (40.7)	1	-	-
Unmarried	20 (87.0)	3 (13.0)	4.58	1.28-16.36	0.019*
Religion					
Christian	65 (67.7)	31 (32.3)	1	-	-
Muslim	15 (55.6)	12 (44.4)	0.59	0.24-1.42	0.245
No religion	4 (50.0)	4 (50.0)	0.47	0.11-2.03	0.317
Education level					
None	44 (59.5)	30 (40.5)	0.61	0.19-1.91	0.398
Primary	28 (70.0)	12 (30.0)	0.97	0.28-3.37	0.965
Secondary	12 (70.6)	5 (29.4)	1	-	-
Occupation					
Housewife	21 (51.2)	20 (48.8)	1	-	-
Street vendor	53 (76.8)	16 (23.2)	3.15	1.37-7.22	0.007*
Artisan	10 (47.6)	11 (52.4)	0.86	0.30-2.48	0.788
Number of people in the household					
<5	23 (76.7)	7 (23.3)	1	-	-
≥5	61 (60.4)	40 (39.6)	0.46	0.18-1.18	0.108*
Exclusive breastfeeding up to 6 months					
Yes	68 (61.8)	42 (38.2)	1	-	-
No	16 (76.2)	5 (23.8)	1.97	0.67-5.79	0.214
Sweeping method used					
Wet	29 (63.0)	17 (37.0)	1	-	-
Dry	55 (64.7)	30 (35.3)	1.07	0.50-2.26	0.850
Energy source for cooking					
Wood	61 (64.2)	34 (35.8)	1.01	0.45-2.25	0.973
Charcoal/Gas	23 (63.9)	13 (36.1)	1	-	-
Food preparation location					
Inside living quarters	47 (57.3)	35 (42.7)	0.43	0.19-0.95	0.038*
Outside living quarters	37 (75.5)	12 (24.5)	1	-	-
Child's location during cooking					
Living room	11 (64.7)	6 (35.3)	1	-	-
Kitchen	57 (62.6)	34 (37.4)	0.91	0.31-2.69	0.871
Bedroom	16 (69.6)	7 (30.4)	1.24	0.32-4.73	0.746
Child's personal hygiene					
Good	29 (64.4)	16 (35.6)	1	-	-
Poor	55 (64.0)	31 (36.0)	0.97	0.46-2.07	0.956
Windows present in all rooms					
Yes	48 (59.3)	33 (40.7)	1	-	-
No	36 (72.0)	14 (28.0)	0.56	0.26-1.20	0.142*

Continued.

Variables	ARI in children <5 years		Odds ratio (OR)	95% CI	P value
	Yes (%)	No (%)			
Designated kitchen room					
Yes	66 (62.9)	39 (37.1)	1	-	-
No	18 (69.2)	8 (30.8)	1.32	0.52-3.34	0.545
Presence of smoker in child's environment					
Yes	12 (92.3)	1 (7.7)	7.66	0.96-60.95	0.054*
No	72 (61.0)	46 (39.0)	1	-	-
Home near a dusty road					
Yes	26 (78.8)	7 (21.2)	2.56	1.01-6.47	0.047*
No	58 (59.2)	40 (40.8)	1	-	-
Cohabitation with animals					
Yes	52 (70.3)	22 (29.7)	1.84	0.89-3.80	0.096*
No	32 (56.1)	25 (43.9)	1	-	-
Season when child has more ARIs					
Dry season	59 (67.0)	29 (33.0)	1.46	0.69-3.10	0.319
Rainy season	25 (58.1)	18 (41.9)	1	-	-

Note: ARI = acute respiratory infection, 95% CI = 95% confidence interval. *Statistically significant.

Table 4: Variables associated according to the final multivariate model with the occurrence of ARI in children under five in south-eastern Benin in 2023.

Variables	ARI Yes (%)	ARI No (%)	Odds ratio (OR)	95% CI	P value
Mother's marital status					
Married	64 (59.26)	44 (40.74)	1	-	-
Not married	20 (86.96)	3 (13.04)	6.06	1.59 - 23.02	0.008
Number of people in household					
<5	23 (76.67)	7 (23.33)	1	-	-
≥5	61 (60.40)	40 (39.60)	0.34	0.12 - 0.94	0.038
Place of meal preparation					
Inside rooms	47 (57.32)	35 (42.68)	0.39	0.16 - 0.91	0.030
Outside rooms	37 (75.51)	12 (24.49)	1	-	-
Dwelling close to dusty road					
Yes	26 (78.79)	7 (21.21)	3.19	1.18 - 8.58	0.022
No	58 (59.18)	40 (40.82)	1	-	-

Table 1 summarizes the sociodemographic characteristics of the children and their mothers.

Behavioural characteristics of the mother and child's environment

Most children had been exclusively breastfed up to six months (83.97%). Common practices in the household were dry sweeping (64.89%), cooking meals inside the rooms of the house (62.60%) with wood as the main energy source (72.52%). Children's personal hygiene was judged poor in 65.65% of cases, whereas mothers' hand hygiene was good (91.60%). Table 2 presents these distributions.

Dwellings had windows in all rooms (61.83%) and a dedicated kitchen (80.15%). Few children had smokers in their surroundings (9.92%) or lived in dwellings close to a dusty road (25.19%). ARI episodes were reported mainly during the dry season (67.18%).

Prevalence of acute respiratory infections in children under five years

The occurrence of an acute respiratory infection was reported in 64.12% of the children surveyed. Lower respiratory infections were twice as frequent (42.75%) as upper respiratory infections (21.37%). Figure 1 presents this distribution in more detail.

Determinants of acute respiratory infections in children under five in Sado

Univariate regression

Univariate regression reported (Table 3) that the mother's marital status (p=0.019), occupation as a retailer (p=0.007), cooking meals inside the dwelling (p=0.038), and proximity of the dwelling to a dusty road (p=0.047) were the only variables associated with the occurrence of ARIs in children. Overall, univariate regression highlighted nine variables with a p value less than 20%.

Multivariate analysis

Nine variables with a p value less than or equal to 20% (Table 3) were included in the initial multivariate model. After stepwise backward elimination of non-significant variables, it resulted that the occurrence of ARIs in children under five in the Sado arrondissement was influenced by the mother's marital status (OR=6.06; p=0.008), the number of people living in the household (OR=0.34; p=0.038), the place of meal preparation (OR=0.39; p=0.030) and the proximity of the dwelling to a dusty road (OR=3.19; p=0.022). Table 4 presents the variables of the final model resulting from the multivariate analysis.
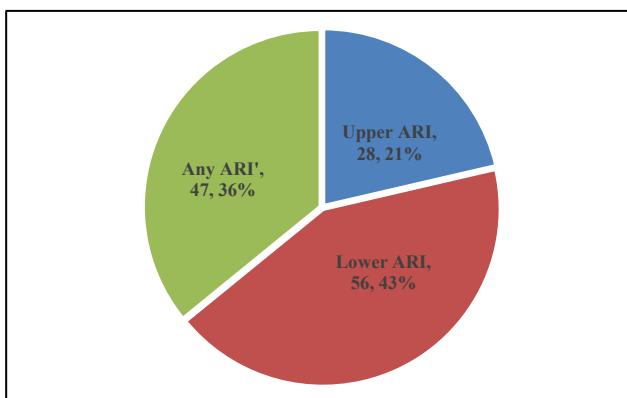
Figure 1: Prevalence of acute respiratory infections in children under five years in south-eastern Benin in 2023 (n=131).

DISCUSSION

Prevalence of ARIs in children under five

In this study, the prevalence of acute respiratory infection among children under five was 64.12% (95% CI=55.45%-71.95%). Lower two-week prevalence have been reported elsewhere, notably in Ethiopia (16.10%; 95% CI=13.80-18.40) and several African countries (prevalences varying between 7% and 9%).[17,18] The findings of this study could raise questions about the real burden of morbidity, the competence of health workers in diagnosing ARIs, and the effectiveness of ARI management and prevention measures such as vaccination, reduction of household air pollution, hygiene, and the quality of care offered in health facilities.[13,19] However, the selection of study participants based on their attendance at a health facility may have introduced selection bias and could explain the higher prevalence compared to other studies where participants were selected directly within communities.

Determinants of acute respiratory infections

This study highlighted the association of four variables with the occurrence of respiratory infections in the Sado arrondissement. This result presents both concordances and divergences with those from other studies.

Indeed, the analysis showed that, regarding the mother's marital status, children of unmarried mothers had a significantly increased risk of ARI (OR=6.06; 95% CI: 1.59-23.02). Literature on the social determinants of child health documents that single-parent status is associated with unfavourable child health indicators, including greater morbidity and lower use of preventive services. Analyses in the African context have also shown that children of divorced mothers have more unfavourable health and survival profiles.[20] Psycho-social mechanisms (especially parental stress), time constraints (fewer adults available to monitor and protect children, maintain hygiene practices) and lack of social support could explain this relationship between marital status and the occurrence of ARIs.

This study reported that a smaller household size, specifically less than 5 people, led to a higher proportion of ARIs than a larger household size (OR=0.34; 95% CI: 0.12-0.94; p=0.038). This result differs from those of other studies which showed that a household size of four or more people more than doubled the occurrence of respiratory infections in children (OR=2.5; 95% CI: 1.02-6.09), or that children living in overcrowded households were more at risk of developing an ARI (OR=2.66 95% CI: 1.52-4.71).[21,22]

Indeed, household size is not a univocal determinant; it is overcrowding that promotes the transmission of respiratory infections due to promiscuity, but it can also generate shared care, increased monitoring, and better assistance to children due to the presence of several capable adults or role sharing.[23] It is this latter mechanism may explain our findings, especially in the absence of established high contagiosity.

Regarding the place of meal preparation, this study identified it as having a protective role against ARIs (OR=0.39; p=0.030). This finding, which differs from that of several studies which found that cooking outside reduced the risk of ARI, could be explained by the child's low exposure to cold during meal cooking.[24,25] Indeed, some analyses have noted that cold is associated with the occurrence and aggravation of respiratory diseases.[26] Cooking inside the rooms would help warm the rooms where the children are, thus reducing their exposure to cold; no child being outside during this cooking. However, cooking inside, especially with wood or charcoal, would increase children's exposure to fine particulates and combustion products, sources of airway irritation and weakening of the body's defences. Contrary to the present study which did not establish this association, studies conducted in some countries, including Benin, revealed that cooking with wood or charcoal indoors increased the risk of developing severe pneumonia in children by 2 to 5 times.[27,28]

This particulates mechanism could also explain the significant association found between the proximity of the dwelling to a dusty road and ARI (OR=3.19; 95% CI=1.18-8.58; p=0.022). Literature on residential exposure to traffic routes and atmospheric emissions reports an increase in consultations for respiratory diseases in children living in areas close to high-traffic roads (OR=1.24; 95% CI=1.04-1.49), an increase in asthma symptoms and healthcare use in urban asthmatic children living within 100 metres of a major road.[29,30] In Benin, Saharan dust (Harmattan) events have been linked to cough and other respiratory symptoms among children under five in the two weeks following their occurrence.[31] These elements corroborate the determining role of outdoor environmental exposure in the occurrence of ARIs.

In summary, this study highlighted a high prevalence of ARI and significant associations (marital status, cooking location, proximity to a dusty road) which could be used in strategies to reduce morbidity among children. However, its limitations stem from the mode of selection of participants which does not ensure a population prevalence of the disease, possible information bias from mothers, and the poor quality of diagnosis by some providers.

CONCLUSION

This study conducted in the Sado arrondissement established a high prevalence of acute respiratory infections in children under five and identified its key determinants, particularly the mother's marital status, the number of people living in the household, the place of meal preparation, and the proximity of the dwelling to a dusty road. These determinants, which relate to both social and environmental dimensions, indicate the need of an integrated approach to the prevention and management of ARIs. These findings also argue for strengthening control strategies, notably by improving domestic air quality, raising household awareness about cooking practices, and increased support for vulnerable mothers. They also call for a focus on community-based prevention and surveillance, taking into account the environmental and social determinants specific to the local context.

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