Open Access Library Journal
2026, Volume 13, e15627
ISSN Online: 2333-9721
ISSN Print: 2333-9705

Socio-Demographic, Environmental and Nutritional Determinants of Acute Respiratory Infections among School-Aged Children in the Democratic Republic of Congo: A Cross-Sectional Analytical Study

Chancelle Nasoro Abiba[1], Simon Ilunga Kandolo[2*], Guillaume Ngoie Mwamba[3], Georges Banza Maloba[1], Michel Kabamba Nzaji[4], Celestin Muleka Kimpanga[5], Oscar Luboya Numbi[2,6]

[1]School of Public Health, University of Kamina, Kamina, Democratic Republic of Congo
[2]School of Public Health, University of Lubumbashi, Lubumbashi, Democratic Republic of Congo
[3]McKinsey Consulting Corporation/Gates Foundation, Kinshasa, Democratic Republic of Congo
[4]Faculty of Medicine, University of Kamina, Kamina, Democratic Republic of Congo
[5]Department of Biochemistry, Higher Pedagogical Institute of Lubumbashi, Lubumbashi, Democratic Republic of Congo
[6]Department of Public Health and Paediatrics, Faculty of Medicine, University of Lubumbashi, Lubumbashi, Democratic Republic of Congo
Email: *ilunga.kandolo@unilu.ac.cd, *profsimmoniluga@gmail.com, *silungak@gmail.com

How to cite this paper: Abiba, C.N., Kandolo, S.I., Mwamba, G.N., Maloba, G.B., Nzaji, M.K., Kimpanga, C.M. and Numbi, O.L. (2026) Socio-Demographic, Environmental and Nutritional Determinants of Acute Respiratory Infections among School-Aged Children in the Democratic Republic of Congo: A Cross-Sectional Analytical Study. *Open Access Library Journal*, **13**: e15627.
https://doi.org/10.4236/oalib.1115627

Received: June 15, 2026
Accepted: August 10, 2026
Published: August 13, 2026

Abstract

Introduction: Acute respiratory infections (ARIs) remain a major cause of morbidity in children, particularly in disadvantaged communities where living conditions and access to healthcare are precarious. In the Kamina Health Zone, the factors associated with these infections remain poorly documented. This study aimed to identify the determinants of ARIs in children aged 0 to 14 years. **Methods:** A community-based cross-sectional analytical study was conducted with 384 children aged 0 to 14 years. Data were collected using a structured questionnaire administered via KoBoCollect. ARIs were defined as the presence of a cough, with or without respiratory distress, during the two weeks preceding the survey. Associated factors were investigated using multivariate logistic regression. **Results:** The prevalence of ARIs was 88%. The absence or delay of seeking healthcare was the main factor associated with ARIs. Consuming street food significantly increased the risk of acute respiratory infections (ARIs) (aOR = 3.12). Overcrowded households were also associated with ARIs (aOR = 1.88; 95% CI: 1.05 - 3.36). Carrying children while lighting fires and exposure to household chemicals were also significantly associated with the occurrence of ARIs. **Conclusion:** ARIs in children in Kamina result from determinants related to living conditions, domestic exposures, and access to healthcare. Their prevention requires an integrated approach based on early access to care, reducing harmful exposures within households, and improving living conditions.

Subject Areas

Public Health

Keywords

Acute Respiratory Infections, Children, Determinants, Home Environment, Access to Healthcare, Kamina Health Zone

1. Introduction

Acute respiratory infections (ARIs) remain a leading cause of morbidity and mortality in children, particularly in low- and middle-income countries (LMICs) [1]. Despite progress in reducing infant mortality, they continue to account for a significant proportion of preventable consultations, hospitalizations, and deaths [2].

Sub-Saharan Africa bears a large part of this burden, driven by structural factors such as poverty, inadequate housing, and limited access to clean energy sources [3]. The use of biomass fuels exposes many children daily to harmful particles and toxic gases, constituting a major respiratory risk factor [4]. This is compounded by socioeconomic constraints, including low household income, low parental education levels, and limited access to healthcare, which contribute to delays in seeking treatment, limit preventive practices, and worsen disease progression [5]. Overcrowded households also contribute to the transmission of respiratory pathogens [6].

Nutritional status also influences vulnerability to infections. Malnutrition and micronutrient deficiencies impair immune defenses and increase the risk of severe respiratory infections [7]. While most research focuses on children under five, school-aged children remain exposed to similar risks related to communal living and environmental exposures [8]. However, data on this population remain limited in the Democratic Republic of Congo.

Ecosocial and syndemic approaches emphasize that the risk of acute respiratory infections (ARIs) results from the interaction of biological, environmental, and socioeconomic determinants rather than from a single factor [9]. In the DRC, rapid urbanization, the continued use of biomass, and high population density maintain conditions conducive to the transmission of respiratory diseases [10].

In this context, this study aimed to assess the independent and combined effects of sociodemographic, environmental, and nutritional determinants of ARIs in the Kamina Health Zone, in order to better understand risk factors and guide integrated public health interventions.

2. Methods

2.1. Study Design

A community-based cross-sectional analytical study was conducted among households in the Kamina Health Zone to assess the determinants of acute respiratory infections (ARIs) in children aged 0 - 14 years.

2.2. Study Framework

The study was conducted in the Kamina Health Zone, in Haut-Lomami province, in the southeast of the Democratic Republic of Congo. This urban and rural area, with over 300,000 inhabitants, has unequal access to healthcare and a fragile socioeconomic context. The frequent use of wood and charcoal for cooking, often in poorly ventilated homes, exposes children to indoor air pollution and could increase the risk of respiratory infections.

2.3. Study Population and Sampling and Sample Size

The study population consisted of children aged 0 to 14 years residing in selected households within the Kamina Health Zone. This selection aimed to explore the determinants of acute respiratory infections at different stages of childhood, including young children, who are particularly vulnerable, as well as school-aged children, who remain understudied despite their persistent exposure to various risk factors.

A multi-stage sampling approach was used: health areas were first randomly selected, and then households were recruited through systematic sampling within each selected area. When a household had several eligible children, only one child was randomly selected to limit bias related to the pooling of observations.

The sample size was calculated using a single population proportion formula, assuming an expected ARI prevalence of 50% to maximize sample size in the absence of precise local estimates. A 95% confidence level and a margin of error of 5% were applied.

The initial sample size was calculated as follows:

$$n = (Z^2 \times p \times (1 - p))/d^2$$

where:

$Z = 1.96$ (standard normal value for 95% confidence level);

$p = 0.5$ (assumed prevalence);

$d = 0.05$ (margin of error);

$p = 0.5$ (assumed prevalence);

$d = 0.05$ (margin of error).

The final size retained was 384 participants.

Data collection

Data were collected from parents or guardians using a structured questionnaire, developed based on the literature and pre-tested for its suitability to the local context. Administered door-to-door by trained interviewers via the KoBoCollect application, the interviews focused on the characteristics of the children and households, living conditions, environmental exposures, health habits, and healthcare utilization. Supervision and control mechanisms were implemented to ensure data quality and confidentiality.

3. Resultats

Table 1. Sociodemographic characteristics and nutritional profile of the children studied (N = 384).

Variables	Modalities	n (%)
Sex	Male	204 (53.1)
	Female	180 (46.9)
Age (Years)	Means ±SD	8.2 ± 3.9
	<5 years	112 (29.2)
	5 - 9 Years	156 (40.6)
	≥10 years	116 (30.2)
Socio-economic status	Low	248 (64.6)
	Medium/High	136 (35.4)
BMI	Malnutrition	10 (2.6)
	Normal	313 (81.5)
	Overweight	61 (15.9)
Water used for food preparation	Non potable	297 (77.3)
	Potable	87 (22.7)
Exclusive breastfeeding	Yes	197 (51.3)
	No	187 (48.7)

A total of 384 children aged 0 to 14 years were included in the study. Boys were slightly in the majority (53.1%), and the mean age was 8.2 ± 3.9 years, with a predominance of children aged 5 to 9 years (40.6%). The majority of households belonged to a low socioeconomic group (64.6%). Nutritionally, most children had a normal BMI (81.5%), while the coexistence of malnutrition (2.6%) and overweight (15.9%) indicates a double nutritional burden. Furthermore, more than three-quarters of households used unsafe water for food preparation (77.3%). Finally, approximately half of the children were exclusively breastfed (51.3%) (see Table 1).

Bivariate analysis revealed a statistically significant association between several anthropometric characteristics and the occurrence of acute respiratory infections (ARIs). Children under 5 years of age had a higher risk of ARI than those aged 5 years or older (PR = 2.41; 95% CI: 1.12 - 5.18; p = 0.024). The BMI is not significantly associated with an increased PR of ARI (see Table 2).

Table 2. Relationship between anthropometric parameters and the occurrence of acute respiratory infections.

Variable	Modalities	ARI Yes n (%)	ARI No n (%)	Accute PR (CI 95%)	p-value
Age	<5 Years	106 (27.6)	6 (1.6)	2.41 (1.12 - 5.18)	0.024
	≥5 Years	238 (62.0)	34 (8.9)	1	—
Weight	≥25 kg	176 (45.8)	6 (1.6)	7.24 (2.96 - 17.7)	**<0.001**
	<25 kg	162 (42.2)	40 (10.4)	1	—
Size	≥100 cm	277 (72.1)	26 (6.8)	3.49 (1.94 - 6.27)	**<0.001**
	<100 cm	61 (15.9)	20 (5.2)	1	—
BMI	Overweight	52 (85.3)	9 (14.7)	0.8 2 (0.38 - 1.8)	**0.62**
	Malnutrition	8 (80)	2 (20)	0.57 (0.1 - 2.8)	0.48
	Normal	274	39	1	—

Note: PR = Prevalence ration; CI = confidence interval.

Table 3. Domestic environmental pollution factors associated with acute respiratory infections (ARIs) in children surveyed in the Kamina community.

Variables	Modalities	ARI Yes n (%)	ARI No n (%)	Crude PR (CI à 95%)	p-value
Household chemicals	No (Reference)	222 (85.1)	39 (14.9)	1	—
	Yes	116 (94.3)	7 (5.7)	2.91 (1.26 - 6.71)	0.009
Carrying the child during cooking	No (Reference)	34 (10.2)	299 (89.8)	1	—
	Yes	12 (23.5)	39 (76.5)	2.70 (1.29 - 5.65)	0.006
Carrying the child when lighting the fire	No (Reference)	28 (9.6)	263 (90.4)	1	—
	Yes	18 (19.4)	75 (80.6)	2.25 (1.18 - 4.29)	0.012
Open fireplace	No (Reference)	162 (85.3)	28 (14.7)	1	—
	Yes	176 (90.7)	18 (9.3)	1.69 (0.90 - 3.17)	0.100
Passive smoking	No (Reference)	218 (87.9)	30 (12.1)	1	—
	yes	120 (88.2)	16 (11.8)	1.03	0.957

Table 3 shows that certain household exposures were significantly associated with the occurrence of acute respiratory infections (ARIs) in children. Exposure to household chemicals nearly tripled the PR of ARIs compared to unexposed children (PR = 2.91; 95% CI: 1.26 - 6.71; p = 0.009). Similarly, carrying the child during cooking (PR = 2.70; 95% CI: 1.29 - 5.65; p = 0.006) and during fire lighting (PR = 2.25; 95% CI: 1.18 - 4.29; p = 0.012) were associated with a significantly increased risk of ARIs, reflecting the harmful effect of close exposure to combustion smoke.

Furthermore, the use of an open fireplace tended to increase the odds of ARI (PR = 1.69; 95% CI: 0.90 - 3.17), although this did not reach statistical significance (p = 0.100). Conversely, no association was observed between passive smoking and ARI after data verification (PR = 1.03; p = 0.957).

Table 4. Independent determinants of acute respiratory infections: results of multivariate logistic regression.

Variables	Comparaison	aOR	CI 95%	p-value
Low socioeconomic status	Low vs. medium/high	2.81	1.45 - 5.42	0.002
Overcrowding	Yes vs No	1.88	1.05 - 3.36	0.032
Indoor smoke	Yes vs No	2.42	1.31 - 4.50	0.004
Chemicals	Yes vs No	2.65	1.15 - 6.10	0.021
Carrying children while cooking	Yes vs No	2.48	1.18 - 5.21	0.016
Carrying children during fire	Yes vs No	2.12	1.05 - 4.28	0.034
Lack of access to healthcare	Yes vs No	3.57	1.78 - 7.14	0.001
Street food	Yes vs No	3.12	1.60 - 6.08	0.001

Multivariate logistic regression analysis shows that ARIs in children in the Kamina Health Zone result from the interaction of socioeconomic, environmental, and behavioral factors. Children from low socioeconomic status households had a higher risk of ARIs (aOR = 2.81; 95% CI: 1.45 - 5.42), as did those living in overcrowded households (aOR = 1.88; 95% CI: 1.05 - 3.36). Domestic exposures were also important determinants, including indoor smoke (aOR = 2.42; 95% CI: 1.31 - 4.50), the use of household chemicals (aPR = 2.65; 95% CI: 1.15 - 6.10), carrying the child while cooking (aPR = 2.48; 95% CI: 1.18 - 5.21), or while lighting a fire (aPR = 2.12; 95% CI: 1.05 - 4.28). Lack of access to healthcare appeared to be the factor most strongly associated with ARIs (aOR = 3.57; 95% CI: 1.78 - 7.14), while the consumption of street food also increased the odds of developing these infections (aOR = 3.12; 95% CI: 1.60 - 6.08) (see Table 4).

4. Discussion

The study population lived in a socioeconomic and environmental context conducive to the occurrence of acute respiratory infections (ARIs) [11]. The slight male predominance observed is consistent with available data, as sex is not generally considered an independent risk factor [12]. While the high proportion of school-aged children may reflect greater exposure to contact in group settings, the vulnerability of younger children remains linked to immune immaturity [13]. In the Kamina Health Zone, precarious living conditions, overcrowding, domestic smoke, and limited access to healthcare illustrate the significant role of structural and environmental factors in maintaining the burden of ARIs in children, as also highlighted by the WHO [14], UNICEF [15], and the Global Burden of Disease study [16].

The majority of children had a normal BMI (81.5%), but the coexistence of malnutrition (2.6%) and overweight (15.9%) reflects a nutritional transition [17]. The literature shows that malnutrition impairs immune mechanisms and increases susceptibility to respiratory infections, while adequate nutrition strengthens protection against these diseases [7] [18]. However, despite this recognized link, our study did not find a statistically significant association between malnutrition and ARIs. This lack of association could be explained by the small proportion of malnourished children included in the study, thus limiting the statistical power needed to detect a significant effect (**Table 2** and **Table 3**).

Regarding dietary practices, only the consumption of street food was associated with ARIs. The direct exposure to pathogenic agents (bacteria, viruses, toxins) linked to microbiological contamination and lack of hygiene during preparation/sale [19]. This direct exposure entails indirect effects via a nutritional disturbance (ultra-processed, micronutrient-poor foods) entraining a weakening of mucosal barriers and respiratory immunity [20]. This result is consistent with studies highlighting the importance of food hygiene in preventing infections [21], as well as with African studies documenting high levels of microbiological contamination of street food [22]. More recent studies confirm this reality in urban African settings [23]. Street food consumption (aOR = 3.12) was one of the strongest associations observed after the absence of healthcare access. However, our study suggests an indirect effect, mediated by increased nutritional and immune vulnerability, rather than a direct infectious effect. Conversely, no significant association was found with the use of potable water, meal frequency, or exclusive breastfeeding, consistent with the observations of other authors [24]. Although exclusive breastfeeding is widely recognized as a protective factor, this effect was not observed in our setting, likely due to the influence of other environmental and socioeconomic factors.

Our observations also suggest that childhood respiratory infections (ARIs) occur in a home environment characterized by multiple harmful exposures. Indoor air pollution, particularly from household smoke and fuels used in homes, remains a major concern [4] [25]. Although secondhand smoke is recognized as a significant risk factor [26], no significant association was found in our study. This lack of association could reflect specific exposure patterns in the Kamina Health Zone or certain measurement limitations, but it is consistent with the observations of previous researchers [27].

Furthermore, exposure to household chemicals appears consistent with data from the literature [28]. Disinfectants and volatile organic compounds (VOCs) present in the home environment are likely to contribute to pediatric respiratory morbidity, suggesting that an accumulation of irritants in homes promotes the occurrence of ARIs [29]. Similarly, holding a child while cooking or lighting a fire increases their direct exposure to biomass fumes, a phenomenon already described in similar contexts [30]. Recent literature highlights that these repeated early exposures can not only promote acute infections but also induce chronic bronchial inflammation that can permanently impair respiratory function [31].

Delayed or insufficient access to healthcare [5] [32] and household overcrowding [6] also illustrate the significant role of living conditions in the development of acute respiratory infections (ARIs). Lack of early access to care appears to be a major determinant, consistent with previous observations [33]. Overcrowding (aOR = 1.88; 95% CI: 1.05 - 3.36) showed a significant but more moderate association. This result is consistent with the literature, which describes overcrowding less as a direct causal factor than as an amplifier of infectious agent transmission [6]. In our study, its relatively moderate effect compared to toxic exposures suggests that person-to-person transmission may play a secondary role in an already heavily polluted environment.

In this context, ARIs appear less as the consequence of an isolated factor than as a reflection of cumulative vulnerability, where domestic exposures, daily behaviors, socioeconomic conditions, and constraints in accessing healthcare intersect [9]. These results underscore the need for integrated interventions combining improvements to the home environment, the promotion of protective behaviors, and enhanced early access to healthcare services to sustainably reduce the burden of ARIs in children.

5. Limites

Acute respiratory infections are defined as the presence of fever, cough as well as rapid breathing.

6. Conclusions

Acute respiratory infections in children in the Kamina Health Zone appear to be the expression of a multifactorial vulnerability, shaped by the interaction between living conditions, environmental exposures, and constraints in accessing healthcare. The absence or delay in seeking healthcare services is the main factor associated with ARIs. The consumption of street food, domestic exposures related to cooking fumes, carrying children while lighting fires, and the use of household chemicals, as well as household overcrowding, also contribute to maintaining this burden on children.

The interpretation of these results must take into account the cross-sectional nature of the survey, the reliance on self-reported data, and the lack of objective measurements of environmental exposures. Longitudinal studies incorporating a more precise assessment of these exposures would allow for a deeper understanding of the mechanisms involved.

The sustainable reduction of childhood acute respiratory infections (ARIs) in Kamina requires an integrated and multisectoral approach, combining improved early access to care, reduced harmful domestic exposures, the promotion of protective practices, and improved living conditions for households.

Conflicts of Interest

The authors declare no conflicts of interest.

References

[1] World Health Organization (2020) Global Health Estimates 2020: Deaths by Cause, Age, Sex, by Country and by Region, 2000-2019. World Health Organization. https://www.who.int/data/global-health-estimates

[2] Nair, H., Simões, E.A., Rudan, I., Gessner, B.D., Azziz-Baumgartner, E., Zhang, J.S.F., *et al*. (2013) Global and Regional Burden of Hospital Admissions for Severe Acute Lower Respiratory Infections in Young Children in 2010: A Systematic Analysis. *The Lancet*, **381**, 1380-1390. https://doi.org/10.1016/s0140-6736(12)61901-1

[3] Smith, K.R., Samet, J.M., Romieu, I. and Bruce, N. (2000) Indoor Air Pollution in Developing Countries and Acute Lower Respiratory Infections in Children. *Thorax*, **55**, 518-532. https://doi.org/10.1136/thorax.55.6.518

[4] Smith, K.R., Bruce, N., Balakrishnan, K., Adair-Rohani, H., Balmes, J., Chafe, Z., *et al*. (2014) Millions Dead: How Do We Know and What Does It Mean? Methods Used in the Comparative Risk Assessment of Household Air Pollution. *Annual Review of Public Health*, **35**, 185-206. https://doi.org/10.1146/annurev-publhealth-032013-182356

[5] Noordam, A.C., Carvajal-Velez, L., Sharkey, A.B., Young, M. and Cals, J.W.L. (2015) Care Seeking Behaviour for Children with Suspected Pneumonia in Countries in Sub-Saharan Africa with High Pneumonia Mortality. *PLOS ONE*, **10**, e0117919. https://doi.org/10.1371/journal.pone.0117919

[6] Murray, E.L., Klein, M., Brondi, L., Mcgowan, J.E., Van Mels, C., Brooks, W.A., *et al*. (2012) Rainfall, Household Crowding, and Acute Respiratory Infections in the Tropics. *Epidemiology and Infection*, **140**, 78-86. https://doi.org/10.1017/s0950268811000252

[7] Black, R.E., Victora, C.G., Walker, S.P., Bhutta, Z.A., Christian, P., de Onis, M., *et al*. (2013) Maternal and Child Undernutrition and Overweight in Low-Income and Middle-Income Countries. *The Lancet*, **382**, 427-451. https://doi.org/10.1016/s0140-6736(13)60937-x

[8] Fletcher, S.M., Stark, D., Harkness, J. and Ellis, J. (2012) Enteric Protozoa in the Developed World: A Public Health Perspective. *Clinical Microbiology Reviews*, **25**, 420-449. https://doi.org/10.1128/cmr.05038-11

[9] Singer, M., Bulled, N., Ostrach, B. and Mendenhall, E. (2017) Syndemics and the Biosocial Conception of Health. *The Lancet*, **389**, 941-950. https://doi.org/10.1016/s0140-6736(17)30003-x

[10] Balume, B.S., Bijnens, L., Abrams, S., Banza, B.B. and Deferme, W. (2025) Charcoal and Firewood Use in Urban Areas of Developing Countries: Drivers, Consequences, and the Need for Clean Cooking Solutions. *Renewable and Sustainable Energy Reviews*, **217**, Article 115745. https://doi.org/10.1016/j.rser.2025.115745

[11] Kandala, N., Emina, J.B., Nzita, P.D.K. and Cappuccio, F.P. (2009) Diarrhoea, Acute Respiratory Infection, and Fever among Children in the Democratic Republic of Congo. *Social Science & Medicine*, **68**, 1728-1736. https://doi.org/10.1016/j.socscimed.2009.02.004

[12] Abdala, K.A., Kamavuako, N.E., Longenge, R., Atibu, C., Balanga, B.J., Shongo, Y.P.M., *et al*. (2025) Profile of Paediatric Morbidity in Hospitals in the Democratic Republic of the Congo from 2019 to 2021. *European Journal of Medical and Health Research*, **3**, 94-103. https://doi.org/10.59324/ejmhr.2025.3(2).10

[13] Heinonen, S., Rodriguez-Fernandez, R., Diaz, A., Oliva Rodriguez-Pastor, S., Ramilo, O. and Mejias, A. (2019) Infant Immune Response to Respiratory Viral Infections.

Immunology and Allergy Clinics of North America, **39**, 361-376. https://doi.org/10.1016/j.iac.2019.03.005

[14] Shairsingh, K., Ruggeri, G., Krzyzanowski, M., Mudu, P., Malkawi, M., Castillo, J., *et al.* (2023) WHO Air Quality Database: Relevance, History and Future Developments. *Bulletin of the World Health Organization*, **101**, 800-807. https://doi.org/10.2471/blt.23.290188

[15] Qazi, S., Aboubaker, S., MacLean, R., Fontaine, O., Mantel, C., Goodman, T., *et al.* (2015) Ending Preventable Child Deaths from Pneumonia and Diarrhoea by 2025. Development of the Integrated Global Action Plan for the Prevention and Control of Pneumonia and Diarrhoea. *Archives of Disease in Childhood*, **100**, S23-S28. https://doi.org/10.1136/archdischild-2013-305429

[16] GBD 2019 LRI Collaborators (2022) Age-Sex Differences in the Global Burden of Lower Respiratory Infections and Risk Factors, 1990-2019: Results from the Global Burden of Disease Study 2019. *The Lancet Infectious Diseases*, **22**, 1626-1647.

[17] Popkin, B.M., Adair, L.S. and Ng, S.W. (2012) Global Nutrition Transition and the Pandemic of Obesity in Developing Countries. *Nutrition Reviews*, **70**, 3-21. https://doi.org/10.1111/j.1753-4887.2011.00456.x

[18] Chandra, R. (2002) Nutrition and the Immune System from Birth to Old Age. *European Journal of Clinical Nutrition*, **56**, S73-S76. https://doi.org/10.1038/sj.ejcn.1601492

[19] WHO (1997) Food Safety and Foodborne Diseases. https://iris.who.int/items/385b43ba-cd54-4eb4-902b-6d1be6413547

[20] Wanjohi, M.N., Asiki, G., Wilunda, C., Holdsworth, M., Pradeilles, R., Paulo, L.S., *et al.* (2024) Ultra-Processed Food Consumption Is Associated with Poor Diet Quality and Nutrient Intake among Adolescents in Urban Slums, Kenya. *International Journal of Public Health*, **69**, Article 1607981. https://doi.org/10.3389/ijph.2024.1607891

[21] Khan, S., Sultan, M.T., Abbas, A., Kausar, T., *et al.* (2026) The Interplay between Malnutrition, Persistent Diarrhea, Lactose Intolerance, and Food Associated Gut Dysbiosis in Children; A Comprehensive Review. *BMC Pediatrics*, **26**, Article No. 113. https://doi.org/10.1186/s12887-026-06529-8

[22] Mosupye, F.M. and von Holy, A. (2000) Microbiological Hazard Identification and Exposure Assessment of Street Food Vending in Johannesburg, South Africa. *International Journal of Food Microbiology*, **61**, 137-145. https://doi.org/10.1016/s0168-1605(00)00264-6

[23] Lango-Yaya, E., Agboko, F.M., Bondom, R.L., Saravolia, M., N'yetobouko, S.J., Sezongo, O., *et al.* (2020) Identification and Characterization of Risk Factors Linked to the Bacteriological Contamination of Street Foods: Case of Porridge Made from Rice Sold in the City of Bangui, Central African Republic. *Health*, **12**, 1620-1631. https://doi.org/10.4236/health.2020.1212118

[24] van Meel, E.R., de Jong, M., Elbert, N.J., den Dekker, H.T., Reiss, I.K., de Jongste, J.C., *et al.* (2017) Duration and Exclusiveness of Breastfeeding and School-Age Lung Function and Asthma. *Annals of Allergy, Asthma & Immunology*, **119**, 21-26.e2. https://doi.org/10.1016/j.anai.2017.05.002

[25] Addisu, A., Getahun, T., Deti, M., Negesse, Y. and Mekonnen, B. (2021) Association of Acute Respiratory Infections with Indoor Air Pollution from Biomass Fuel Exposure among Under-Five Children in Jimma Town, Southwestern Ethiopia. *Journal of Environmental and Public Health*, **2021**, 1-9. https://doi.org/10.1155/2021/7112548

[26] Centers for Disease Control and Prevention (2006) The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General. https://www.bing.com/search?q=Centers+for+Disease+Control+and+Prevention+(2006)+The+Health+Consequences+of+Involuntary+Exposure+to+Tobacco+Smoke%3A+A+Report+of+the+Surgeon+General&PC=U316&FORM=CHROMN

[27] Lofuta, P.O.V., Klass, M., Pauwen, N., *et al.* (2024) Exposition professionnelle à la fumée et à la poussière de charbon de bois, un facteur de risque majeur de BPCO: Une étude transversale multirégionale en République démocratique du Congo. *Chest*, **166**, 1334-1346.

[28] Dai, X., Abramson, M.J., Hamilton, G.S., Thompson, B.R., Svanes, C., Benke, G., *et al.* (2026) Cleaning Products and Classes Associated with Poor Respiratory Health. *Environmental Science and Pollution Research*, **33**, 5485-5493. https://doi.org/10.1007/s11356-026-37616-z

[29] Mendell, M.J., Mirer, A.G., Cheung, K., Tong, M. and Douwes, J. (2011) Respiratory and Allergic Health Effects of Dampness, Mold, and Dampness-Related Agents: A Review of the Epidemiologic Evidence. *Environmental Health Perspectives*, **119**, 748-756. https://doi.org/10.1289/ehp.1002410

[30] Bruce, N., Perez-Padilla, R. and Albalak, R. (2002) The Health Effects of Indoor Air Pollution Exposure in Developing Countries. Geneva World Health Organization Report WHO/SDE/OEH/02.05. https://iris.who.int/items/63b2a13b-5f70-4990-90f9-14df3abf5766

[31] Gordon, S.B., Bruce, N.G., Grigg, J., Hibberd, P.L., Kurmi, O.P., Lam, K.H., *et al.* (2014) Respiratory Risks from Household Air Pollution in Low and Middle Income Countries. *The Lancet Respiratory Medicine*, **2**, 823-860. https://doi.org/10.1016/s2213-2600(14)70168-7

[32] Duff, R., Patel, F., Dumouza, A., Brown, L., Embeke, N., Fataki, J., *et al.* (2024) Facilitators and Barriers to Supply-Side Maternal, Newborn, and Child Health Service Availability in DRC: A Systematic Review and Narrative Synthesis. *Journal of Global Health Economics and Policy*, **4**, e2024001. https://doi.org/10.7189/001c.117361

[33] Peters, D.H., Garg, A., Bloom, G., Walker, D.G., Brieger, W.R. and Hafizur Rahman, M. (2008) Poverty and Access to Health Care in Developing Countries. *Annals of the New York Academy of Sciences*, **1136**, 161-171. https://doi.org/10.1196/annals.1425.011