Appendix 1: Organizations/institutions that work in Nigeria, Lagos or Jigawa on pneumonia-related projects, which we contacted for grey literature

	Organisation	Focus	Successfully contacted
National/other states focus	*Access Challenge*	Advocacy and Communications Working Group for the Every Breath Counts Coalition	yes
	Association for Reproductive and Family Health (ARFH)	Promotes access to health for underserved communities.	no
	Clinton Health Access Initiative (CHAI)	In Nigeria, it works on malaria, HIV/AIDS, diarrhoea. Focuses on healthcare professionals' training and advocacy for amoxicillin DT.	yes
	GAVI The Vaccine Alliance	Explores accelerated introduction of PCV3 vaccine and increasing its coverage in focus countries with very low coverage for the Every Breath Counts Coalition	no
	International Vaccine Access Center (IVAC) - Johns Hopkins University	Works on routine immunization and access to vaccines	yes
	John Snow Inc (JSI)	Works to improve pediatric health care, HIV and AIDS services, and strengthen the health system in-country.	yes
	JustActions	Advocacy work on pneumonia	yes
	Malaria Consortium	Its goal is to 'improve lives through sustainable, evidence-based programmes that combat targeted diseases and promote child and maternal health	no
	Ministry of Health	Supporting and coordinating activities of various projects.	yes
	National Postgraduate Medical College of Nigeria (Faculty of Public Health)	Works on Public Health, possibly interesting on-going projects	no

	Oxygen for Life	Works with hospitals and governments to design, install and sustain effective oxygen systems, to make sure that every patient who needs oxygen has access to it.	yes
	Save the Children	Multiple on-going projects on Child Protection, Child Poverty, Education, Health (WASH) & Nutrition in all Nigeria (including Lagos and Jigawa)	yes
Lagos state	*Assist International*	Biomedical Equipment Technician (BMET) Training Programme in Nigeria, in Lagos and Ibadan	yes
	Faculty of Clinical Sciences, University of Lagos	Possibly interesting on-going projects	no
	General Hospital of Lagos	Possibly interesting on-going projects	no
	Lagos University Teaching Hospital	Possibly interesting on-going projects - In 2013, it was published a study on mothers' awareness on childhood pneumonia.	no
	Management Science for Health (MSH)	Previous works in Lagos – among other states – to improve the wellbeing of orphans/vulnerable children.	yes
	Pharmaceutical Society of Nigeria Partnership for Advocacy in Child and Family Health (PSN-PACFaH)	Advocacy role, they promote the usage of Amoxicillin DT over suspension. In the past, succeeded to include Amoxicillin as first line treatment over Cotrimoxazol, and in the essential medicine list.	yes
Jigawa state	*Federal University of Dutse*	Possibly interesting on-going projects	no
	Partnership to Engage, Reform and Learn (PERL)	They conducted a case study on the Jigawa Health Sector Governance Reform.	no
	Society for Family Health (SFH)+ Department for International Development (DFID)	MNCH2 project in Jigawa works to improve maternal and newborn care (works on vaccination coverage)	no

Appendix 2: Secondary data analysis variable selection and definitions

We defined the variables *a priori* before conducting statistical analyses, informed by our conceptual framework for risks of paediatric pneumonia, in the figure below.

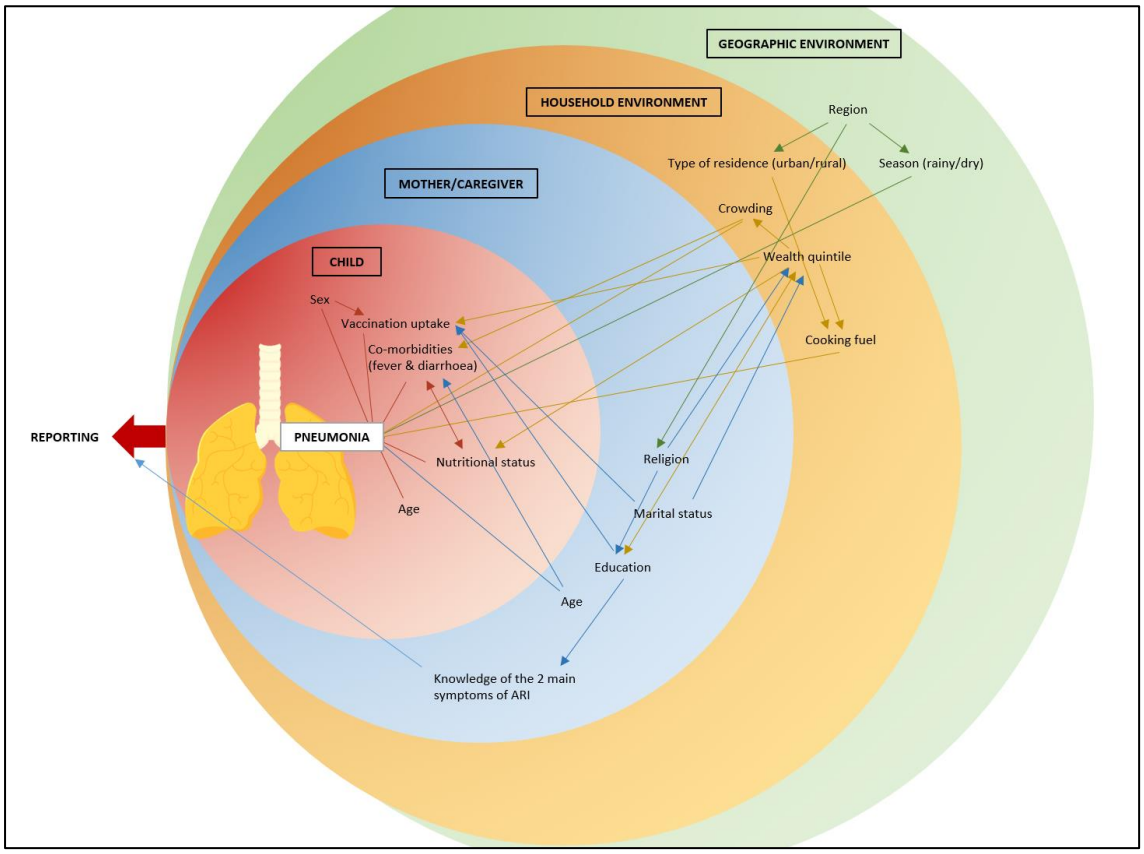

Table 1. Definition of new variables and the corresponding criteria employed before proceeding to the secondary data analysis of the 2013 Nigerian Demographic Health Survey and the 2016-2017 Nigerian Multiple Indicators Cluster Survey in Stata.

Variable	Values	Source of the criteria
Cooking fuel	Electricity, liquefied petroleum gas, natural gas and biogas were considered clean cooking fuels, whereas coal, lignite, charcoal, wood, kerosene, animal dung, straw, shrubs, and grass were considered unclean cooking fuels.	(Akinyemi and Morakinyo, 2018)
Crowding	A household was considered overcrowded when more than five individuals were living in the same space.	(Rudan et al., 2008)
Season of interview	The dry season was considered to last from November to April, whereas the rainy season was considered to last from May to October.	(Akinyemi and Morakinyo, 2018)
Underweight	Considered when the product of age*weight was two times the population standard deviation (SD) under the population average, and severe underweight when it was three times the population SD under the population average.	WHO standards from 2006 (WHO and UNICEF, 2009)
Stunting	Considered when the product of age*height was two times the population standard deviation (SD) under the population average, and severe stunting when it was three times the population SD under the population average.	WHO standards from 2006 (WHO and UNICEF, 2009)
Wasting	Considered when the product of weight*height was two times the population standard deviation (SD) under the population average, and severe wasting when it was three times the population SD under the population average.	WHO standards from 2006 (WHO and UNICEF, 2009)
PCV, Pentavalent BCG vaccine uptake	We considered under-five y.o. (U5) individuals as immunized with any of these three vaccines when either the	

	mother/caregiver or the vaccination card reported the immunization.	
Symptoms of Acute Respiratory Infection (ARI)	We considered U5 individuals as presenting symptoms of ARI when the mother or caregiver reported that the child had been coughing and has at least one of fast and/or difficulty breathing, during the two weeks previous to the household survey (DHS, MICS and NNHS). These criteria are also used in the WHO's Integrated Management of Childhood Illnesses guidelines for the diagnosis of pneumonia.	Recommendation of ARI to be described as "presumed pneumonia" in the United Nations International Children's Emergency Fund/World Health Organization Meeting on Child Survival Survey -based Indicators, held in New York, June 17-18, 2004. (*Demographic and Health Survey*, 2019)

Appendix 3: Summary of the 25 papers included in the literature review.

Study	Setting	Study Design	Data source	Intervention/study description	Data presented	Key results	Socioeconomic determinants
Abdulkadir et al., 2016	National	Analytic cross-sectional study	NDHS 2013	Evaluates the factors associated with appropriate care-seeking	- csb for ARI-like symptoms	- Poor csb by caregivers, with only a minor improvement from 2008 survey	Positive influencing factors: - caregiver's higher education level - urban setting - higher wealth index
Adesanya and Chiao, 2016	National	Analytic cross-sectional study	NDHS 2013	The study explores the association between lifestyles and ARI symptoms.	- Cooking fuel used - Handwashing with soap	- +ve association between ARI symptoms and biomass cooking fuel (AOR 2.38** (95%CI 1.34-4.24)); no handwashing 1.59*** (95%CI 1.28-1.98)	- OR of ARI symptoms higher for children living in poor households AOR 2.72 (1.64-4.51) - OR of ARI symptoms higher for children living in the NW.
Adesanya and Chiao, 2017	NW region and SS region	Analytic cross-sectional study	NDHS 2013	This study examines the effects of environmental and lifestyle factors on children from two regions of N., evaluating their associations with prev. of ARI symptoms.	- Cooking fuel used	- +ve association between ARI symptoms and biomass cooking fuel	- ARI prev. higher: in poorer households. (1.42* (1.01–1.99)); in NW compared to SS (2.86*** (1.62–5.04)) - Not found significant association with maternal

							education, nor religion
Adesanya et al., 2017	NW region SW region	Analytic cross-sectional study	2013 NDHS	This study analyses the factors that influence the prev. of ARI symptoms, focusing mostly on regional diff.	- ARI prev. - cooking fuel used	- ARI prev. NW 0.9%; SW 0.8% - ARI prev. higher in children from households that use solid cooking fuel (1.69**(1.05, 2.71))	- Higher rates of ARI associated with: maternal higher education (1.69** (1.25, 2.30)); North compared to South (NE specifically with 8.51*** (4.72, 15.3) compared to SW) - richer wealth index associated with lower ARI prev. (0.58** (0.38, 0.88))
Adewemimo et al., 2017	NW region SW region	Analytic cross-sectional study	NDHS 2013 EAVA 2014	This study analyses the Verbal and Social Autopsies done - based on the results of the 2013 NDHS - on children who died under-59 months.	- U5/neonatal m. rates - Proportion of U5/neonatal m. due to ARI	-higher proportion of neonatal deaths in the SW, compared to the NW - diarrhoea, ARI and malaria deaths in all age groups higher in the NW than in the SW.	SW has more peri-natal deaths than post-natal, due to epidemiological transition.

Adewuyi et al., 2017	NW region SW region	Analytic cross-sectional study	2013 NDHS	This study analyses the factors associated with low rates of early initiation of breastf., focusing on urban/rural diff.	- Early breastf.	- Poor early breastf. in all N., worst in rural areas.	- In rural areas higher early breastf. associated with high maternal education, high wealth index - Urban areas have higher rates of early breastf. compared to rural ones. - SW has worst early breastf. rates in urban areas, NW in rural ones.
Akinyemi and Morakinyo, 2018	National level	Analytic cross-sectional study	2013 NDHS	This study performs an analysis of variations linked to ARI symptoms during the years, from 2003 to 2013.	- Cooking fuel used - Toilet use - Safe drinking water av.	- Unclean cooking fuel +vely associated with ARI symptoms - Trend over the years shows an improvement.	- >70% of children with ARI are from rural areas - ARI prev. higher in poorer households; higher in dry season (1.58* (1.21–2.06)); higher in NW compared to SW (OR 4.55* (2.69–7.67))
Anand and Roy, 2016	National level	Analytic cross-sectional study	2013 NDHS	This study examines the link between risks of morbidity (fever, cough, diarrhoea) and malnutrition	- Cooking fuel used - Toilet use - Safe drinking av.	- Improved access to safe water and sanitation, use of non-solid cooking fuels are associated with a	Higher health risks are +vely associated with poorer households.

				and households conditions in N. and other 14 countries.		reduction of u5 m. - Non-solid cooking fuel associated with reduction of cough symptoms.	
Bawankule et al., 2017	National level	Analytic cross-sectional study	NDHS 2013	This study analyses the effect of measles vacc. on ARI symptoms and diarrhoea in U5 children from N. and other 4 states.	- ARI prev. - Diarrhoea prev. - Cooking fuel used - Toilet use - Safe drinking water av.	- ARI prev. 2.4% - ARI prev.: higher in children from households that use solid cooking fuel (OR 2.11 (95%CI 1.32–3.36)); no diff. based on rural/urban variation	- ARI prev.: did not vary by the size of child, mother's literacy level and religion; was higher in children with low wealth index (OR 1.99 (95%CI 1.33–2.98))
Chiao, 2017	National level	Analytic cross-sectional study	2013 NDHS	This study performs an analysis of factors associated with ARI prev. in N.	- ARI prev. - cooking fuel used	- ARI prev. 2.4% - ARI prev. higher in children from households that use solid cooking fuel (OR 1.64* (95%CI 1.06–2.53))	- ARI symptoms' prev. higher in poorer households.
Ekure et al., 2013	Lagos State	Analytic cross-sectional study	2011 Questionnaire at LUTH	Small study conducted in LUTH to assess the caregivers' know. and csb in childhood ARI	- Cg recogn. of ARI danger signs	- Poor know. of causes, symptoms, risk factors of ARI	- Caregiver higher education level linked to increased ARI know.

IVAC, 2018	National level	Report	2018 WHO&MCEE; 2016-17 MICS	This report examines the progress made by the 15 highest-burden countries - one of which is N. - on 10 key indicators identified in the integrated GAPPD.	- Proportion of U5 m. due to ARI - csb for ARI-like symptoms - PCV/ Pentavalent vacc. coverage - excl. breastf.	- In 2017 Rotavirus vacc. has not been introduced in N. - Excl. breastf. low and only slightly increased from prev. year - csb decreased from prev. year.	- Excl. breastf. coverage is higher in urban areas than rural, and over twice in the wealthiest than the poorest quintile. - csb is more frequent in people living in urban areas. - vacc. coverage is higher for children from wealthier households.
Government, 2017	Jigawa State	Guidelines (Unpublished)	2013 NDHS; 2015 NNHS; 2015 SMART	Multi-sectoral approach for nutritional response during and after an emergency. Plan strategy for 2017-2020.	- U5/U1/neonatal m. rates - Wasting prev. - Toilet use - Early/exclusive breastf. - Vit. A suppl.	- High levels of wasting prev. - Early and excl. breastf. rates are very low. - Low levels of access to improved water and sanitation.	- Low status and level of education of women is a key cause of malnutrition. - J. is the 2nd state with the largest % of people living in poverty (69%).
KantarPublic, 2019	Lagos State	Report (Unpublished)	2018 SDI	This report shows information on a 4-years study focused on treatment and prevention of diarrhoea in targeted	- Diarrhoea Incidence - Rotavirus vacc. coverage - Toilet use - Handwashing with soap - Safe drinking av. - Early/excl.	Only 3 indicators have met the 80% target: - Access to improved toilet (97%) - Handwashing with soap and water after	

				communities in Somolu LGA, Lagos	breastf. - Vit. A suppl.	defecation (82%) - Vit. A suppl. (81%)	
Statistics, 2018	Jigawa State Lagos State National	Report	2018 NNHS	This report presents the results of a national survey to assess key indicators of N.n U5 population.	- Wasting prev. - Diarrhoea prev. - Pentavalent vacc. coverage - Toilet use - Safe drinking water av. - Early/excl. breastf. - Complementary feeding - Vit. A suppl.	- Low rates of early breastf. and of complementary feeding appropriate practices	- SW has a higher vacc. coverage (Lagos: 92.6% - highest coverage in N.) than NW. - Diarrhoea prev. is higher in the NW than in the SW. - L. has high level of sanitation, but low access to safe water - excl. breastf. rates higher in SW than NW.
Nkemjika and Kitaw, 2015	National level	Analytic cross-sectional study	MICS 2009-11	The study analyses the association between early breastf. and prev. of ARI and diarrhoea.	- prenumonia prev. - Diarrhoea prev. - Early breastf.	- ARI prev. 4.32% - diarrhoea prev. 15.7% - Not found any significant association between early brestf. and ARI (OR 0.685 (95% CI 0.554-0.846))	Women with secondary level of education were more likely to seek assistance for their children in appropriate structures (i.e. public/government hospital)
Noordam et al., 2015	National level	Analytic cross-sectional study	MICS 2011	This study examines the csb for children with suspected ARI in N. and other 5 states,	- U5 m. rates - csb for ARI-like symptoms	Only 62.3% of suspected cases were brought to care, of which 38% to non-appropriate providers.	Utilization of inadequate facilities was found among women from poorer households and/or

				and the influencing factors.			with lower level of education.
Noordam et al., 2017	National level	Analytic cross-sectional study	MICS 2011	The study explores the association between ARI symtpoms' know. and csb in N. and other 5 states.	- Cg recogn. of ARI danger signs - csb for ARI-like symptoms	- General poor know. of ARI symptoms - +ve association between know. of symptoms and csb only in DRC and N.	
Save the Children, 2018a	Jigawa	Factsheet	MICS 2016-17; Jigawa MoH 2016	This factsheet outlines J. main health-related issues, inviting the government to focus on key problems to improve the situation.	- U5 m. rates - Proportion of U5 m. due to ARI - Cg recogn. of ARI danger signs - Wasting prev. - PCV/ Pentavalent vacc. coverage - excl. breastf.	- U5 m. rates, m. rates due to ARI, wasting prev., excl. breastf. are far from reaching SDG 2030 or WHA 2025 targets - Poor caregivers' know. about ARI - vacc. coverage is very high	
Save the Children, 2018b	Lagos State	Factsheet	MICS 2016-17; 2016 DVD-MT	This factsheet outlines L. main health-related issues, inviting the government to focus on key problems to improve the situation.	- U5 m. rates - Proportion of U5 m. due to ARI - Cg recogn. of ARI danger signs - Wasting prev. - PCV/ Pentavalent vacc. coverage - excl. breastf.	- U5 m. rates, m. rates due to ARI, wasting prev. are far from reaching SDG 2030 or WHA 2025 targets (excl. breastf. rates have reached the WHA ones) - Poor caregivers' know. about ARI	

						- vacc. coverage is very high	
Save the Children, 2018c	National level	Factsheet	2018 WHO; MICS 2016-17; UNICEF	This factsheet outlines N. main health-related issues, inviting the government to focus on key problems to improve the situation.	- U5 m. rates- Proportion of U5 m. due to ARI - csb for ARI-like symptoms - Wasting prev. - PCV/ Pentavalent vacc. Coverage - excl. breastf.	- U5 m. rates, m. rates due to ARI, wasting prev., excl. breastf. are all very far from reaching SDG 2030 or GAPPD or WHA 2025 targets - Poor csb for ARI-like symptoms - Poor vacc. coverage	U5 m. rates are 3 times higher in NW than in SW.
Thaly, 2016	Jigawa	Internal report (Unpublished)	NDHS 2013; NNHS 2015	This report analyses nutrition factors in Jigawa, and drafts a strategy to raise the rates of early breastf. practices.	- Wasting prev. - Handwashing with soap - Early/excl. breastf. - Complementary feeding	- J. is one of the most vulnerable states in terms of nutrition indices. - Correct breastf. practices and complementary feeding are very low	
Uneke et al., 2018	NW region SW region National	Analytic cross-sectional study	2013 NDHS	This study uses the EQUitable Impact Sensitive Tool (EQUIST) to assess	- Mortality rates - Safe drinking - Exclusive breastfeeding	High rates of inequalities between urban and rural areas, and based on	- U5 deaths are higher for children from poorer households and from rural areas.

				inequalities in N. and other 5 states.		wealth index influence the m. rates.	- NW has the highest U5 m. rates in the country.
WINNN, 2018	Jigawa	Report	2018 WINNN	This report shows the results of a survey to assess the health-related prev.s of U5 population in 3 LGAs of Jigawa (Birnin Kudu, Guri, Gwiwa).	- ARI prev. - U5 mortality - Wasting prev. - Diarrhoea prev. - Safe drinking water av. - Early/excl. breastf. - Complementary feeding - Vit. A suppl.	Generally poor nutrition and health status: - ARI prev.: 5% - Low rates of breastf. practices - Low level of complementary feeding - Low level of safe drinking water av. and improved sanitation - Good level of vit. A suppl.	
World Health Statistics, 2017	National	Report	2015 UNICEF; 2017 UNICEF; 2016 WHO	This report shows statistical data on various SDGs indicators.	- U5/neonatal m. rates - Wasting prev. - Cooking fuel used - Toilet use - Safe drinking av.	- High U5 and neonatal m. rates - High wasting prev. - Low utilization of clean cooking fuel - Low rates of improved access to water and sanitation.	

U5 = under-five; av.= availability; ARI = Acute Respiratory Infection; csb = careseeking behaviour; DVD-MT= District Vaccines and Devices Monitoring Tool; know. = knowledge; LUTH = Lagos University Teaching Hospital; m.= mortality; MIcsb= Multiple Indicators Cluster Survey; N.= Nigeria; NDHS = National Demographic Health Survey; NNHS = National Nutrition Health Survey; NW = North West; ARI = Acute Respiratory Infection; prev.= prevalence; suppl.= supplementation; SW = South West; vacc. = vaccination

Appendix 4: Sensitivity analysis with the 2013 Nigerian Demographic Health Survey data

	NIGERIA (n=28,950)[g]			
Variables	**Frequency (%)**		**OR[2] (95% CI[4])**	**aOR[3] (95% CI) (n=27,837)**
	No ARI[1] (n=27,459)	**ARI (n=1,094)**		
Household environment				
Cooking fuel[a]				
Clean	1.65	0.89	1	1
Unclean	98.35	99.11	1.86 (0.85-4.05)	1.16 (0.49-2.75)
Crowding[b]				
Normal	23.87	21.98	1	1
Overcrowded (> 5 members)	76.13	78.02	1.11 (0.93-1.33)	1.03 (0.83-1.28)
Wealth quintile				
Richest	17.19	11.27	1	1
Richer	18.28	13.18	1.14 (0.79-1.65)	1.00 (0.68-1.49)
Middle	18.87	24.22	2.03 (1.43-2.88)*	1.53 (1.04-2.24)*
Poorer	22.11	28.82	2.06 (1-45-2.92)*	1.87 (1.26-2.76)*
Poorest	22.95	22.51	1.55 (1.06-2.26)*	1.37 (0.89-2.09)
Type of residence				
Urban	36.22	29.98	1	1
Rural	63.78	70.02	1.33 (1.05-1.67)*	0.95 (0.75-1.20)
Season				
Dry (Nov-Apr)	62.31	74.85	1	1
Rainy (May-Oct)	37.69	25.15	0.56 (0.42-0.74)*	0.69 (0.55-0.87)*
Region				
North Central	13.66	16.72	1	1
North East	16.31	42.19	2.11 (1.56-2.86)*	1.48 (1.13-1.94)*
North West	37.14	14.54	0.32 (0.22-0.47)*	0.36 (0.25-0.50)*
South East	8.83	12.69	1.17 (0.79-1.74)*	0.45 (0.29-0.69)*
South South	9.47	9.89	0.85 (0.60-1,22)	0.53 (0.37-0.75)*
South West	14.6	3.98	0.22 (0.13-0.39)*	0.26 (0.14-0.45)*
Maternal characteristics				
Age of mother				
<25	24.16	28.74	1	1
25-29	28.26	27.58	0.82 (0.66-1.02)	0.89 (0.69-1.14)
30-34	22.11	20.01	0.76 (0.61-0.95)*	0.88 (0.67-1.17)
35-39	15.66	12.16	0.65 (0.50-0.84)*	0.74 (0.54-0.99)*
≥40	9.82	11.50	0.98 (0.74-1.31)	1.11 (0.78-1.58)
Education				
Secondary/higher	32.72	31.93	1	1
Primary	19.05	23.54	1.27 (1.02-1.57)*	1.01 (0.80-1.27)
No education	48.23	44.53	0.95 (0.77-1.16)	0.78 (0.59-1.03)
Religion				
Islam	61.76	56.10	1	1

Catholic	8.46	15.17	1.97 (1.45-2.69)*	2.33 (1.55-3.52)*
Other Christian	28.84	27.59	1.05 (0.85-1.30)	1.38 (1.02-1.87)*
Traditionalist & other	0.94	1.13	1.33 (0.73-2.43)	1.49 (0.87-2.56)
Child characteristics				
Age (months)				
24-59	55.64	44.77	1	1
12-23	19.92	29.06	1.81 (1.55-2.13)*	1.22 (1.02-1.47)*
2-11	18.69	23.96	1.59 (1.34-1.89)*	1.32 (1.08-1.62)*
0-1	5.74	2.21	0.48 (0.32-0.73)*	0.68 (0.43-1.05)
Sex				
Male	50.11	50.52	1	1
Female	49.89	49.48	0.98 (0.86-1.12)	1.01 (0.87-1.18)
Underweight[d, h]				
No	71.20	70.81	1	
Underweight (-2 SD)	17.04	18.78	1.11 (0.90-1.37)	
Severe underweight (-3 SD)	11.76	10.41	0.89 (0.68-1.16)	
Stunting[e, h]				
No	63.17	63.48	1	
Stunting (-2 SD)	15.76	14.25	0.90 (0.71-1.15)	
Severe stunting (-3 SD)	21.07	22.27	1.05 (0.85-1.30)	
Wasting[f, h]				
No	81.60	81.26	1	
Wasting (-2 SD)	9.46	12.12	1.29 (1.03-1.61)*	
Severe wasting (-3 SD)	8.94	6.62	0.74 (0.54-1.02)	
Diarrhea in the last 2 weeks				
No	90.81	60.73	1	1
Yes	9.19	39.27	2.53 (2.34-2.73)*	1.56 (1.42-1.71)*
Fever in the last 2 weeks				
No	89.48	32.94	1	1
Yes	10.52	67.06	17.31 (14.25-21.03)*	12.72 (10.56-15.33)*
BCG[5] vaccination				
No	50.85	46.29	1	1
Yes	49.15	53.71	1.20 (1.01-1.43)*	1.06 (0.79-1.43)
Penta[6] vaccination				
No	53.18	48.35	1	1
1 dose	5.27	7.99	1.67 (1.25-2.24)*	1.23 (0.81-1.88)
2 doses	6.41	9.90	1.70 (1.31-2.20)*	1.43 (0.99-2.06)
3 doses	35.14	33.76	1.06 (0.88-1.28)	1.08 (0.78-1.48)

	JIGAWA (n=1,380)[g]			
Variables	**Frequency (%)**		**OR[2] (95% CI[4])**	**aOR[3] (95% CI) (n=1,342)**
	No ARI[1] (n=1,288)	**ARI (n=74)**		
Household environment				
Cooking fuel[a]				
Clean	0.20	-		
Unclean	99.8	100		
Crowding[b]				
Normal	18.32	21.48	1	1
Overcrowded (> 5 members)	81.68	78.52	0.82 (0.40-1.66)	0.61 (0.36-1.03)
Wealth quintile				
Richest	1.36	1.79	1	1
Richer	4.55	1.39	0.23 (0.01-8.15)	0.44 (0.01-18.40)
Middle	11.37	20.66	1.38 (0.22-8.53)	6.89 (1.67-28.47)*
Poorer	31.45	30.96	0.75 (0.28-1.98)	5.33 (1.17-24.23)*
Poorest	51.28	45.20	0.67 (0.29-1.57)	5.35 (1.13-25.42)*
Type of residence				
Urban	7.77	18.81	1	1
Rural	92.23	81.19	0.36 (0.05-2.51)	0.50 (0.10-2.37)
Season				
Dry	62.42	47.35	1	1
Rainy	37.58	52.65	1.85 (0.83-4.12)	1.21 (0.68-2.16)
Maternal characteristics				
Age of mother				
<25	29.31	20.58	1	1
25-29	27.15	36.49	1.91 (0.78-4.69)	1.33 (0.50-3.55)
30-34	20.98	19.82	1.35 (0.46-3.94)	1.21 (0.32-4.58)
35-39	11.66	12.31	1.50 (0.62-3.67)	1.28 (0.55-2.99)
≥40	10.90	10.79	1.41 (0.31-6.37)	1.85 (0.25-13.56)
Education				
Secondary/higher	3.38	10.57	1	1
Primary	12.91	22.43	0.56 (0.18-1.70)	0.23 (0.02-2.22)
No education	83.71	67.00	0.26 (0.08-0.82)*	0.13 (0.01-1.85)
Religion				
Islam	99.78	100		
Catholic	-	-		
Other Christian	0.13	-		
Traditionalist & other	0.08	-		
Child characteristics				
Age (months)				
24-59	53.15	50.33	1	1
12-23	22.23	26.44	1.26 (0.62-2.55)	0.77 (0.36-1.64)

0-11	24.63	23.22	1.00 (0.50-1.98)	0.86 (0.46-1.63)
Sex				
Male	48.17	56.21	1	1
Female	51.83	43.79	0.72 (0.46-1.13)	0.78 (0.47-1.31)
Underweight[d, h]				
No	55.96	52.48	1	
Underweight (-2 SD)	25.41	29.03	1.22 (0.60-2.49)	
Severe underweight (-3 SD)	18.63	18.49	1.06 (0.32-3.52)	
Stunting[e, h]				
No	40.83	31.78	1	
Stunting (-2 SD)	17.82	16.47	1.19 (0.44-3.21)	
Severe stunting (-3 SD)	41.34	51.75	1.61 (1.01-2.55)*	
Wasting[f, h]				
No	83.06	80.94	1	
Wasting (-2 SD)	8.58	16.20	1.94 (0.85-4.40)	
Severe wasting (-3 SD)	8.36	2.86	0.35 (0.05-2.65)	
Diarrhea in the last 2 weeks				
No	86.63	56.09	1	1
Yes	13.37	43.91	2.25 (1.65-3.07)*	1.49 (1.07-2.08)*
Fever in the last 2 weeks				
No	84.77	12.91	1	1
Yes	15.23	87.09	37.57 (17.54-80.49)*	32.79 (14.98-71.78)*
BCG[5] vaccination				
No	83.89	78.01	1	1
Yes	16.11	21.99	1.47 (0.74-2.91)	0.97 (0.30-3.11)
Penta[6] vaccination				
No	86.19	78.28	1	1
1 dose	3.78	5.17	1.51 (0.30-7.57)	0.85 (0.10-7.47)
2 doses	3.01	12.12	4.44 (1.14-17.28)*	2.26 (0.44-11.69)
3 doses	7.03	4.44	0.69 (0.18-2.61)	0.74 (0.10-5.59)

	LAGOS (n=1,220)[g]			
Variables	**Frequency (%)**		**OR[2] (95% CI[4])**	**aOR[3] (95% CI) (n=1,169)**
	No ARI[1] (n=1,193)	**ARI (n=12)**		
Household environment				
Cooking fuel[a]				
Clean	10.37	-		
Unclean	89.63	100		
Crowding[b]				
Normal	37.18	41.25	1	1
Overcrowded (> 5 members)	62.82	58.75	0.84 (0.14-4.94)	0.91 (0.17-4.94)
Wealth quintile				
Richest	83.79	70.2	1	1
Richer-Poorest	16.21	29.8	2.19 (0.62-7.82)	0.96 (0.28-3.33)
Type of residence				
Urban	100	100		
Rural	-	-		
Season				
Dry	72.67	57.23	1	1
Rainy	27.33	42.77	1.99 (0.42-9.49)	1.65 (0.43-6.31)
Maternal characteristics				
Age of mother				
≤29	39.41	54.23	1	1
30-34	34.53	24.81	0.52 (0.08-3.48)	0.42 (0.07-2.56)
35-39	19.28	7.99	0.30 (0.03-3.11)	0.34 (0.04-2.97)
≥40	6.79	12.97	1.39 (0.20-9.67)	1.82 (0.49-6.70)
Education				
Secondary/higher	80.60	70.20	1	1
Primary | No education	19.40	29.80	1.76 (0.44-7.01)	1.25 (0.63-2.46)
Religion				
Islam	31.75	23.20	1	1
Catholic, traditionalist & other	9.95	28.34	3.90 (0.45-33.64)	6.68 (1.22-36.60)*
Other Christian	58.31	48.46	1.14 (0.18-7.17)	1.18 (0.30-4.59)
Child characteristics				
Age (months)				
24-59	53.09	58.14	1	1
12-23	22.33	19.35	0.79 (0.18-3.56)	0.48 (0.11-2.07)
0-11	24.59	22.51	0.84 (0.14-4.94)	0.49 (0.07-3.45)
Sex				
Male	52.09	31.14	1	1
Female	47.91	68.86	2.40 (0.92-6.25)	2.60 (0.72-9.36)
Underweight[d, h]				

No	88.04	68.17	1	
Underweight (≤-2 SD)	11.96	31.83	3.44 (0.80-14.69)	
Stunting[e, h]				
No	84.47	54.31	1	
Stunting (-2 SD)	10.33	13.86	2.09 (0.20-22.17)	
Severe stunting (-3 SD)	5.20	31.83	9.53 (1.76-51.64)	
Wasting[f, h]				
No	88.75	91.47	1	
Wasting (≤-2 SD)	11.25	8.53	0.72 (0.09-6.06)	
Diarrhea in the last 2 weeks				
No	92.48	79.65	1	1
Yes	7.52	20.35	1.77 (0.56-5.61)	1.36 (0.47-3.96)
Fever in the last 2 weeks				
No	90.98	66.07	1	1
Yes	9.02	33.93	5.18 (0.86-31.12)	4.59 (0.86-24.61)
BCG[5] vaccination				
No	8.43	16.83	1	1
Yes	91.57	83.17	0.46 (0.05-3.87)	0.97 (0.19-5.04)
Penta[6] vaccination (total)				
No	11.16	27.00	1	1
1 | 2 doses	13.48	37.68	1.16 (0.24-5.56)	1.34 (0.54-3.38)
3 doses	75.36	35.32	0.19 (0.03-1.40)	0.16 (0.03-0.73)*

*p-value < 0.05

[1]Acute Respiratory Infection

[2]Odds Ratio

[3]Odds Ratio adjusted for all the variables specified in the multivariable model

[4]Confidence Interval

[5]Bacillus Calmette-Guérin vaccine

[6]Diphtheria, Pertussis, Tetanus, *Hemophilus Influenza* Type B and Hepatitis B

[a]Considering clean fuel: electricity, liquefied petroleum gas, natural gas or biogas; and unclean fuel: coal, ignite, charcoal, wood, kerosene, animal dung, straw, shrubs, and grass (according to Akinyemi and Morakinyo 2018)

[b]According to Rudan *et al.* 2008

[c]According to Akinyemi and Morakinyo 2018

[d]Considering underweight the product of age*weight two times the population standard deviation (SD) under the population average, and three times sever underweight (according to the latest WHO standards from 2006)

[e]Considering stunting the product of age*height two times the population SD under the population average, and three times sever stunting (according to the 2006 WHO standards)

[f]Considering wasting the product of weight*height two times the population SD under the population average, and three times sever wasting (according to the 2006 WHO standards)

[g]All the children population figures (n) are weighted

[h]Not included in the multivariable model, data available for a reduced number of individuals

Appendix 5: Description of the Acute Respiratory Infection (ARI) knowledge and care-seeking, by household and care-giver characteristics for Nigeria, Jigawa and Lagos using the 2016-2017 Multiple Indicators Cluster Survey

	Nigeria							Jigawa							Lagos						
	Knowledge of the two ARI symptoms[a] (%) N[1] = 26,884				Seeking advice or treatment[b] (%) N = 2,207			Knowledge of the two ARI symptoms[a] (%) N[1] = 1,331				Seeking advice or treatment[b] (%) N = 59			Knowledge of the two ARI symptoms[a] (%) N[1] = 1,033				Seeking advice or treatment[b] (%) N = 25		
	0	1	2	n	No	Yes	n	0	1	2	n	No	Yes	n	0	1	2	n	No	Yes	n
Wealth quintile																					
Richest	62.7	23.8	13.5	4818	20.0	80.0	314	65.2	31.3	3.5	84	-	100	2	70.2	17.8	12.0	865	6.8	93.2	20
Richer	55.5	23.6	20.9	4928	20.7	79.3	387	47.8	37.1	15.2	84	-	100	5	62.6	26.4	11.0	152	17.7	82.3	5
Middle	56.2	25.0	18.8	5288	27.6	72.4	462	56.4	30.8	12.9	119	-	100	3	70.6	7.03	22.4	15	-	-	-
Poorer	62.4	24.6	13.0	5745	32.2	67.8	500	60.1	33.7	6.1	410	14.5	85.5	14	100	-	-	4	-	-	-
Poorest	65.5	24.4	10.1	6103	37.3	62.7	544	62.8	30.8	6.4	633	38.3	61.7	35	-	-	-	-	-	-	-
Mother's Education																					
Secondary / tertiary	60.3	25.3	14.5	9186	18.4	81.6	689	50.8	38.7	10.5	161	-	100	4	70.5	17.8	11.7	855	20.2	79.8	20
Primary	59.0	25.3	15.7	4129	23.9	76.1	324	66.1	26.0	7.9	136	20.4	79.6	3	64.4	22.3	13.3	131	-	100	5
No education	60.1	26.0	13.9	7603	38.7	61.3	595	68.3	24.2	7.5	623	38.1	61.9	21	53.2	33.4	13.4	43	-	-	-
Non-formal	63.2	20.0	16.8	5966	32.2	67.8	599	51.1	43.4	5.5	412	22.0	78.0	31	100	-	-	4	-	-	-
Marital status																					
Not married	62.5	22.2	15.4	911	27.5	72.5	68	82.6	17.5	-	62	-	-	-	66.0	12.7	21.4	11	-	-	-
Married	60.2	24.6	15.2	25693	29.4	70.6	2039	60.1	32.5	7.40	1266	23.1	76.9	54	69.2	19.3	11.5	1016	12.1	87.9	24
Children <5 years in the household																					
1	62.7	23.4	13.8	7146	30.1	69.9	610	60.5	32.2	7.3	260	26.4	73.6	15	66.8	20.4	12.8	449	23.1	76.9	10
2	59.4	24.7	15.9	11396	27.6	72.4	923	58.7	33.7	7.6	503	29.5	70.5	23	71.5	18.6	9.87	494	10.2	89.8	13
3	59.3	24.7	16.0	5003	32.7	67.3	404	54.3	38.9	6.9	322	27.5	72.5	13	66.0	14.0	20.0	86	-	-	2
4 or more	62.8	24.1	13.1	3339	28.7	71.3	269	73.1	19.8	7.1	247	-	100	7	100	-	-	3	-	-	-
Religion																					
Christian	61.8	25.3	12.9	8439	25.4	74.6	529	61.2	32.6	6.3	124	-	100	1	70.5	17.6	11.9	669	100	-	7
Islam	60.1	23.9	16.1	18222	30.2	69.8	1661	60.6	32.1	7.4	1207	25.0	75.0	58	66.5	21.5	12.0	362	-	100	17

Other	69.0	20.7	10.3	220	46.7	53.3	17	-	-	-	-	-	-	-	100	-	-	1	-	-	1
Mother's age																					
15-19	63.2	23.2	13.6	1153	22.7	77.3	119	77.9	17.2	4.9	65	-	100	5	85.9	14.1	-	9	-	-	-
20-34	60.5	24.2	15.3	17983	28.1	71.9	1448	61.8	30.5	7.7	833	17.5	82.6	27	68.1	19.5	12.4	680	20.2	79.8	19
35-44	59.0	25.8	15.2	6525	34.0	66.1	489	53.9	38.2	7.9	340	46.1	53.9	18	70.0	17.7	12.3	318	-	100	5
45-49	60.8	24.5	14.7	962	28.9	71.1	54	59.1	38.0	3.0	84	-	100	4	75.2	24.8	-	24	-	-	1

[1]Weighted estimated population; [a]The two main ARI symptoms fast and difficult breathing; [b]Only eligible individuals with symptoms of ARI in the last 2 weeks. Includes all public and private health facilities and providers; [c]Only eligible 1-year olds or older individuals with a vaccination card (in which the vaccination dates are shown) seen by the interviewer. Children were only considered as not immunized for any of the three cases when the interviewer explicitly reported that the child had not been vaccinated; [d]Only eligible 1-year olds or older