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RESEARCH ARTICLE

Do fuel type and place of cooking matter for acute respiratory infection among Afghan children? Evidence from the Afghanistan DHS 2015

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Abstract

In Afghanistan, acute respiratory infection (ARI) is a leading cause of under-five mortality. Previous studies on the effects of cooking fuel on ARI have only looked at the types of cooking fuel, and not the effects of the location of the cooking place. The present study aimed to assess the effects of fuel type and place of cooking on the prevalence of ARI among under-five children in Afghanistan. Descriptive statistics and multilevel logistic regression analysis were performed for 31,063 children using data from the first round of the Afghanistan Demographic and Health Survey conducted in 2015. Overall, 13% of the children suffered from ARI symptoms in the 2 weeks before the survey, but this varied widely across the country. The multilevel analysis showed that, compared with households using clean cooking fuel in a separate building or outside, households using clean cooking fuel within the house and without a separate kitchen had a 32% lower risk [95% confidence interval (CI)=0.51–0.91] of having under-five children with ARI, and those using clean fuel in a separate kitchen in the house had a 17% lower risk (95% CI=0.67–1.03). On the other hand, households using polluting cooking fuel in the house without a kitchen had a 14% (95% CI=0.91–1.44) higher risk of having under-five children with ARI, and those using polluting cooking fuel in the house with a separate kitchen had a 5% (95% CI=0.85–1.30) higher risk, after adjusting for other covariates. The findings indicate that type of cooking fuel is not the only issue affecting ARI in children. Place of cooking (in a house with or without a separate kitchen versus outside) also affects the risk of ARI among under-five children. The study also found that mother's education and occupational status, community poverty and ethnicity are other important factors affecting the prevalence of ARI in under-five children in Afghanistan.

Keywords: Acute Respiratory Infection (ARI); Fuel type and place of cooking; Afghanistan

Introduction

Acute respiratory infection (ARI) is a leading cause of illness and death in children under the age of five in developing countries (Rudan *et al.*, 2008; Fischer Walker *et al.*, 2013). About 19% of deaths in children under the age of five in developing countries could be attributed to ARI in 2008 (WHO, 2015b). In Afghanistan, ARI was the leading cause of under-five mortality in 2013, accounting for 20% of under-five deaths (WHO, 2015a). About 750,000 under-five children are suffering from ARI per year in Afghanistan (Afghanistan Humanitarian Country Team, 2014). Despite the United Nations Millennium Development goal to reduce child mortality [Goal-4: to reduce child mortality; Target 4.A: to 'reduce child mortality by two thirds, between 1990 and 2015, the under-five mortality rate (United Nations, 2000)], the target was off-track and the under-five mortality rate was 97 per 1000 live births in Afghanistan in 2010 (Afghanistan Government & United Nations, 2015). According to recent estimates reported by the State of the World's Children Report, Afghanistan's under-five mortality rate of 91 per 1000 live births is the 16th highest in the world and was the highest in South Asia in 2015 (UNICEF, 2016). The figure is still high in Afghanistan and this is a matter of concern.

Much work has been done on the risk factors for ARI in sub-Saharan African countries, whereas in South Asian countries, and particularly Afghanistan, there has been little research at the national level. There is a general lack of nationally representative sample survey data on the indicators of child and maternal health at the individual level in Afghanistan. The first nationally representative cross-sectional Demographic and Health Survey was conducted by USAID in 2015. Existing studies are mostly based on simple logistic regressions, which do not allow neighbourhood or community effects on ARI to be assessed. In view of the heterogeneous characteristics of Afghan communities and neighbourhoods, in terms of poverty, types of cooking fuel used, regional-level policy and so on, the present study used multilevel logistic regression analysis to examine the risk factors associated with ARI among Afghan children aged under-five years and the effects of community and neighbourhood factors.

According to the WHO, about 3 billion persons are cooking and heating their living place with simple stoves and open fires, burning biomass (crop waste, wood and animal dung) and coal. More than 4 million persons die prematurely because of illness due to the air pollution arising from cooking with solid fuel. More than 50% of premature deaths as a result of respiratory disease among under-five children are caused by the material (soot) breathed in from household air pollution (WHO, 2016). Many previous studies have also documented that the smoke from polluting fuel or biomass is an influential risk factor for acute respiratory infection among under-five children in developing countries (Mishra, 2003; Mishra *et al.*, 2005; Wichmann & Voyi, 2006; Kilabuko & Nakai, 2007; Sanbata *et al.*, 2014; Buchner & Rehfuess, 2015; Jean-Daniel, 2016; Capuno *et al.*, 2018). However, most of these studies only assessed the effects of various type of cooking fuels on ARI symptoms as 'sources of origin' of smoke, and did not look at the effects of having or not having a separate kitchen or the location of the cooking place (i.e. 'place of origin' of the smoke). Thus, studies are needed to examine the effects of various type of cooking fuels, the availability of a separate kitchen and the location of the cooking place. Therefore, a specific objective of this study was to assess the effects of fuel types and place of cooking on ARI symptoms among Afghan children aged under-five years.

In addition to cooking fuel types, maternal smoking (Dahal *et al.,* 2009) and smoking by other household members (Adesanya & Chiao, 2016; Langbein, 2017) also have a positive effect on the incidence of ARI symptoms in children. A national-level study in Ethiopia found that children of lower socioeconomic status were more susceptible to ARI diseases (Tekle *et al.*, 2015). Another cross-country study in developing countries revealed that older children, male children, those with low weight at birth and with a working mother were at higher risk of ARI (Pinzón-Rondón *et al.*, 2016). Several studies have shown that [low] maternal education and [poor] household wealth status are important risk factors for ARI among children (Azad, 2009; Dahal *et al.*, 2009; Astale & Chenault, 2015; Buchner & Rehfuess, 2015; Tekle *et al.*, 2015; Adesanya & Chiao, 2016; Pinzón-Rondón *et al.*, 2016). Moreover, studies have also demonstrated that rural–urban residence (Harerimana *et al.*, 2016), maternal age at the child's birth and the child's birth order (Mishra, 2003) and water and sanitation facilities (Jabessa, 2015) are other risk factors for child ARI symptoms.

Methods

Data

The study data were from the first round of the Afghanistan Demographic and Health Survey 2015 (AfDHS). This provides a wide range of information on household characteristics and maternal and child health care indicators. The 2015 AfDHS is the first cross-sectional, nationally representative survey to be implemented in Afghanistan under the programme of the worldwide Demographic and Health Survey (DHS) (Central Statistics Organization *et al.*, 2015). The survey adopted a stratified two-stage sampling framework. Afghanistan was stratified into 34 provinces and rural and urban areas. In the first stage, 956 clusters or enumeration areas (EAs) were identified using the probability proportional to size (PPS) method within each stratum. An EA is a geographical region comprising a sufficient number of residential units that act as counting units in the census. A city block is an EA in urban areas, whereas a village or a group of adjacent small villages or a part of a large village is an EA in rural areas. In the second stage, households were selected using a systematic sampling technique and a fixed number of 27 households per EA were identified. Finally, 25,741 households were identified for sampling purposes and of these 24,941 were occupied at the time of field survey. Among the occupied households, 24,395 were successfully interviewed with a 97.8% response rate. In the interviewed households, 30,434 ever-married women aged between 15 and 49 years were selected for interviews and the interview were successfully accomplished with 29,461 of these women with a 96.8% response rate. More details are available in the survey report (Central Statistics Organization *et al.*, 2015). Information on the symptoms of ARI and other child health indicators in the five years preceding the survey were asked of the mothers of 32,712 under-five children. However, the present analysis was based on the 31,063 children (30,304, weighted) who were alive along with the respondent mothers at the time of the survey.

Outcome measure

The outcome variable of this study was ‘ARI symptoms suffered by under-five children’, as defined by the DHS (DHS, 2006) and measured by the AfDHS 2015 (Central Statistics Organization *et al.*, 2015). Mothers were asked whether their children aged under five years suffered from a cough during the 2 weeks before the survey. Those whose children were suffering from a cough were further questioned about whether their children had been suffering from short and rapid breathing accompanied by a fever. If the mothers reported that their children suffered all of these symptoms at any point in time in the 2 weeks before the survey, then it was recognized that the child had an ARI and was coded ‘1’; children not having an ARI were coded ‘0’ (Adesanya & Chiao, 2016; Adesanya *et al.*, 2017).

Explanatory measures

Main explanatory measure

The prime explanatory variable was ‘cooking fuel and place’ calculated by combining three household characteristics: type of cooking fuel, place of cooking and whether the household had a separate room that was used as a kitchen. The DHS standard survey questions were: 1) What type of fuel does your household mainly use for cooking? 2) Is the cooking usually done in the house, in a separate building or outdoors? 3) Do you have a separate room which is used as a kitchen?’ (ICF International, 2011). For the first question, respondents reported the various types of fuel that they were using. The study categorized the households into two groups according to the fuel used for cooking: ‘polluting fuels’ (animal dung, agricultural crop, straw/shrubs/grass, wood, charcoal, coal/lignite and kerosene) and ‘clean fuels’ (electricity, LPG and biogas) (Wichmann & Voyi, 2006). The responses ‘no food cooked in house’ and ‘other’ were excluded from the analysis. The second question was categorized as ‘house’ if cooking was done inside the house and ‘outside’ if it was done outside the house. The last question was in binary form (‘yes’ or ‘no’). Finally, a variable ‘cooking fuel and place’ was produced which had six categories: Outside+Clean Fuel; House with Kitchen+Clean Fuel; House without Kitchen+Clean Fuel; Outside+Polluting Fuel; House with Kitchen+Polluting Fuel; and House without Kitchen+Polluting Fuel.

Covariates

The potential confounding factors included as explanatory variables in the analysis included child's age in months (categorized into five groups), birth order (1, 2, 3, 4, 5+), size at birth as a proxy for birth weight (normal, small), mother's education level (no education, primary, secondary, higher), mother's occupation (not working, agricultural worker, manual worker, professional or clerical worker), mother's smoking status (no, yes), number of household members (continuous), wealth index (poorest, second, middle, fourth, richest), improved drinking water and toilet facilities (yes, no), based on the WHO/UNICEF definition (WHO/UNICEF, 2006), ethnicity (Pashtun, Tajik, Hazara, Uzbek and Other), place of residence (urban, rural) and community poverty (no, yes). The wealth index, as given in the AfDHS dataset (Central Statistics Organization *et al.*, 2015), was considered as a proxy for income; this was a composite measure of the living standard of a household based on its possession of different assets and is generally given in quintiles (Rutstein & Johnson, 2004). The variable 'community poverty' was created from an aggregate of the households in the first quartile of wealth index score within a given cluster (Adedini, 2013; Adesanya & Chiao, 2016).

Statistical analysis

The descriptive characteristics of the sample children were first described. Then random intercept logistic regression analysis was performed for the binary measure of ARI symptoms (Guo & Zhao, 2000) in STATA version 13.1. (StataCorp, 2013). ArcGIS 10 was used to map the ARI prevalence rates across provinces (ESRI, 2011). The AfDHS had a hierarchical structure of data where the 31,063 study children belonging to 19,344 mothers were nested within 16,712 households, nested within 956 clusters (considered as communities), and the clusters were nested within 34 provinces. Cluster or province was considered a 'neighbourhood' in the analysis. It was presumed that the communities and provinces themselves would also explain variation in ARI prevalence. Thus, multilevel binary logistic regression was employed to estimate the effects of random effects parameters (community level, province level) and the effects of fixed effects parameters such as individual- (child) and household-level characteristics and the community-level characteristics, on the symptoms of ARI in Models 1 and 2. The mother- and household-level effects on ARI were not estimated since the study assumed that children belonging to the same mother and the same households would experience the same indoor environment and housing condition.

Results

Descriptive statistics

The descriptive statistics of the sampled children show that they were almost equally distributed across age groups and more than half were male (Table 1). Nearly a fifth of the children were firstborns and more than a third were fifth or more birth order. Around 23% were small in size at birth, as reported by their mothers. A large proportion of mothers (83%) did not have any formal education. About 88% were housewives or not working, and 6.6% were working as professional or clerical workers. Only 2.5% smoked. The average number of household members was quite high (mean=10.12, SD=5.09). The largest proportion of children (41.76%) were of Pashtun ethnicity, followed by Tajik (31.56%). Almost 77% of children lived in rural areas.

Figure 1 shows that the largest proportion of children (almost 31%) were living in households using polluting fuel for cooking in a separate building or outside of the house. This was followed by 27.61% of children living in households using polluting fuel for cooking in the house with a separate kitchen. However, the prevalence of ARI was highest (16.49%) for the children living in households using polluting fuel for cooking in the house without a separate kitchen, followed by those living in a house with a separate kitchen.

Table 1. Descriptive statistics of sample under-five children, AfDHS-2015

Characteristic	Percentage	Unweighted number	Weighted number
Child's age			
00–11 months	19.19	5890	5815
12–23 months	18.84	5820	5708
24–35 months	21.77	6717	6598
36–47 months	20.73	6480	6282
48–59 months	19.48	6156	5902
Child's sex			
Male	51.50	16,102	15,605
Female	48.50	14,961	14,699
Birth order			
1	19.03	5714	5768
2	17.79	5290	5391
3	15.36	4719	4654
4	12.72	4057	3854
5+	35.10	11,283	10,638
Size at birth			
Normal	73.53	23,313	22,283
Small	23.38	6539	7087
Missing	3.08	1211	934
Mother's educational level			
No education	83.36	26,678	25,261
Primary	8.02	2118	2429
Secondary	7.03	1838	2130
Higher	1.60	429	484
Mother's occupation			
Not working	87.71	27,011	26,566
Agricultural worker	1.82	1621	552
Manual worker	3.87	1039	1172
Clerical/professional worker	6.60	1370	2000
Missing		22	22
Mother's smoking status			
No	97.46	30,423	29,535
Yes	2.54	640	769
Mean number of household members (SD)	10.12 (5.09)	31,063	30,304
Wealth Index			
Poorest	19.12	5616	5795
Second	20.41	7215	6185

(*Continued*)

Table 1. (*Continued*)

Characteristic	Percentage	Unweighted number	Weighted number
Middle	21.11	6960	6398
Fourth	20.83	6798	6312
Richest	18.52	4474	5614
Ethnicity			
Pashtun	41.76	13,942	12,645
Tajik	31.56	8860	9555
Hazara	8.45	2422	2558
Uzbek	10.98	2047	3324
Other	7.25	3736	2195
Missing		56	56
Place of residence			
Urban	23.23	7490	7040
Rural	76.77	23,573	23,264
All	100.00	31,063	30,304

Source: computed from the Afghanistan DHS, 2015.

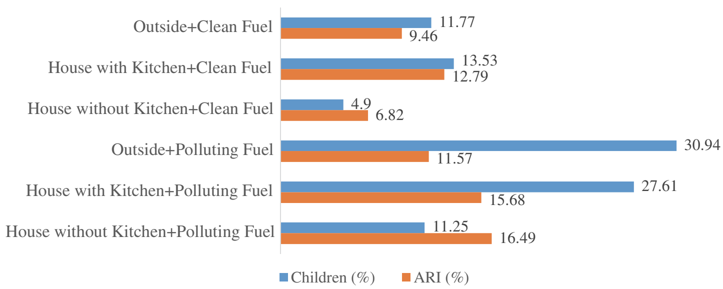

Figure 1. Percentage of under-five children and their ARI prevalence by types of cooking fuel and places of cooking, AfDHS-2015.

Prevalence of child ARI by province

Figure 2 shows the spatial distribution of the prevalence of ARI in under-five children across the 34 provinces of Afghanistan. Overall, 13% of the sample children suffered from ARI during the 2 weeks before the survey, but this varied widely across the country. The highest prevalence was found in Ghor, where almost 47% of children were affected by ARI symptoms. The highest ARI prevalences were observed in other north-western and northern provinces. Relatively lower prevalences were observed in the south-west and southern parts of the country, with a few exceptions. Kandahar – a war-affected province – had the highest ARI prevalence in the south of the country. The provinces of Farah, Nimroz and Hilmand, which are the most war-affected areas, showed relatively lower ARI prevalences.

Multilevel logistic regression results

The results of the multilevel binary logistic regression are presented in Table 2. The Wald χ^2 test for the fixed effect parameters suggested that magnitude of the variance in ARI prevalence was significantly ($p<0.001$) explained by the independent factors in both models (Models 1 and 2).

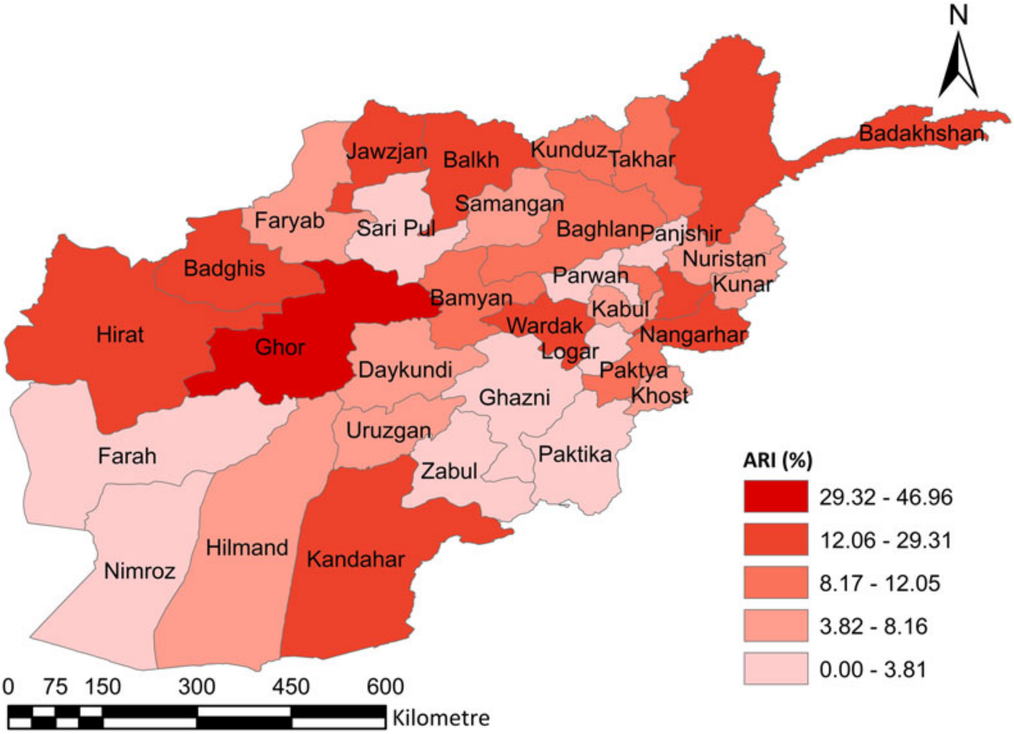

Figure 2. Prevalence of ARI among under-five children by province, AfDHS-2015.

Table 2. Estimated adjusted odds ratio and 95% confidence intervals [CI] for ARI symptoms in under-five children using multilevel logistic regression models

Characteristic	Model 1	Model 2
Fixed effects		
Child's age		
0–11 months (Ref.)		
12–23 months	1.31 [1.15–1.49]	1.31 [1.15–1.49]
24–35 months	1.21 [1.07–1.37]	1.21 [1.07–1.37]
36–47 months	1.01 [0.89–1.15]	1.01 [0.89–1.15]
48–59 months	0.70 [0.61–0.80]	0.70 [0.61–0.80]
Child's sex		
Male (Ref.)		
Female	0.92 [0.85–0.99]	0.92 [0.84–0.99]
Birth order		
1 (Ref.)		
2	0.98 [0.85–1.13]	0.98 [0.85–1.13]
3	1.10 [0.95–1.27]	1.11 [0.96–1.28]
4	1.20 [1.04–1.39]	1.21 [1.04–1.40]

(*Continued*)

Table 2. (*Continued*)

Characteristic	Model 1	Model 2
5+	1.23 [1.09–1.39]	1.24 [1.10–1.40]
Size at birth		
Normal (Ref.)		
Small	1.10 [0.99–1.21]	1.10 [1.00–1.22]
Mother's educational level		
No education (Ref.)		
Primary	1.14 [0.97–1.35]	1.15 [0.98–1.36]
Secondary	0.87 [0.72–1.06]	0.88 [0.72–1.08]
Higher	0.52 [0.32–0.83]	0.53 [0.33–0.85]
Mother's occupation		
Not working (Ref.)		
Agricultural worker	1.53 [1.15–2.04]	1.64 [1.23–2.19]
Manual worker	1.61 [1.26–2.05]	1.74 [1.36–2.22]
Clerical/professional worker	1.65 [1.37–1.98]	1.65 [1.38–1.98]
Mother's smoking status		
No (Ref.)		
Yes	0.83 [0.64–1.09]	0.83 [0.64–1.08]
Mean number of household members (continuous)	0.98 [0.97–0.99]	0.98 [0.97–0.99]
Wealth Index		
Poorest (Ref.)		
Second	1.09 [0.95–1.25]	1.15 [0.99–1.32]
Middle	0.99 [0.85–1.16]	1.09 [0.92–1.28]
Fourth	1.02 [0.86–1.21]	1.16 [0.97–1.40]
Richest	0.96 [0.76–1.22]	1.17 [0.90–1.55]
Cooking facilities		
Outside+Clean Fuel (Ref.)		
House with Kitchen+Clean Fuel	0.85 [0.68–1.05]	0.83 [0.67–1.03]
House without Kitchen+Clean Fuel	0.67 [0.50–0.90]	0.68 [0.51–0.91]
Outside+Polluting Fuel	1.02 [0.83–1.25]	0.95 [0.77–1.17]
House with Kitchen+Polluting Fuel	1.13 [0.92–1.39]	1.05 [0.85–1.30]
House without Kitchen+Polluting Fuel	1.22 [0.97–1.53]	1.14 [0.91–1.44]
Improved drinking water		
Yes (Ref.)		
No	1.09 [0.98–1.21]	1.06 [0.95–1.19]
Improved toilet		
Yes (Ref.)		
No	1.01 [0.90–1.14]	0.99 [0.87–1.12]

(*Continued*)

Table 2. (*Continued*)

Characteristic	Model 1	Model 2
Ethnicity		
Pashtun (Ref.)		
Tajik		0.96 [0.81–1.13]
Hazara		0.77 [0.58–1.03]
Uzbek		1.01 [0.77–1.32]
Other		0.63 [0.49–0.82]
Place of residence		
Urban (Ref.)		
Rural		1.22 [1.00–1.48]
Community poverty		
No (Ref.)		
Yes		1.48 [1.20–1.81]
Random effects variance (SE)		
Cluster level	0.65 (0.03)	0.63 (0.03)
Province level	1.12 (0.15)	1.10 (0.15)
ICC		
Cluster level	0.17	0.16
Province level	0.25	0.25
Variance decomposition (percentage by level)		
Child level	65.03	65.60
Cluster level	12.93	12.53
Province level	22.04	21.87
Model fit statistics		
Wald test χ^2 (df)	236.19	271.03
Probability $>\chi^2$	$<$0.001	$<$0.001
LR test vs logistic regression: *p*-value	$<$0.001	$<$0.001

ICC: intra-class correlation coefficient; SE: standard error; LR: likelihood ratio; Ref.: reference category.
Computed from the Afghanistan DHS, 2015.

For the random effect parameters, the Likelihood Ratio (LR) test versus logistic regression was significant ($p<0.001$) for both models, suggesting that the variance in ARI prevalence differed meaningfully by individual children, community and province.

Model 1 is a conditional model comprising child- and household-level characteristics as the explanatory measures. Households using clean cooking fuel in the house with a separate kitchen and without a separate kitchen had 15% (95% confidence interval [CI] =0.68–1.05) and 33% (95% CI=0.50–0.90), respectively, lower risk of having symptoms of ARI among under-five children than households using clean fuel for cooking in a separate building or outside. On the other hand, households using polluting cooking fuel in the house with a separate kitchen and without a separate kitchen had 13% (95% CI=0.92–1.39) and 22% (95% CI=0.97–1.53), respectively, higher risk of having ARI symptoms compared with households using clean fuel for cooking in a separate building or outside. Using polluting cooking fuel in a separate building or outside made no significant difference to the occurrence of ARI symptoms compared with using clean cooking fuel in a separate building or outside.

Two- and three-year-old children were more prone to have ARI symptoms – 31% (95% CI=1.15–1.49) and 21% (95% CI=1.07–1.37), respectively – compared with one-year-old children. In contrast, five-year-old children had a 30% lower risk (95% CI=0.61–0.80) of ARI than one-year-old children. Female children were less likely to have ARI symptoms than their male counterparts. Higher birth order children were more prone to have ARI than first-order children. Size at birth was also associated with the prevalence of ARI. Children of higher educated mothers were 48% less likely (95% CI=0.32–0.83) to be affected by ARI symptoms in comparison to the children of uneducated mothers. A higher magnitude of effect of mother's occupational status on the symptoms of ARI was reported after controlling for other factors in Model 1. The chances of having ARI were 53% (95% CI=1.15–2.04) greater for the children of mothers who were agricultural workers compared with the children of non-working mothers, 61% (95% CI=1.26-2.05) for manual worker and 65% (95% CI=1.37–1.98) for clerical or professional workers. The number of household members was negatively associated with the incidence of ARI symptoms. After decomposing the effects of random effects variance, as estimated by multilevel analysis, it was observed that a considerable proportion of the variance in ARI prevalence was due to province-level (22.04%) and cluster-level effects (12.93%). However, the largest variance in ARI prevalence was due to individual- (child) level effects (65.03%).

In Model 2, community-level characteristics (ethnicity, place of residence and community poverty) were adjusted for. It was observed that all three community variables affected ARI prevalence. In comparison to the Pashtun (as the major ethnic group), the children of other ethnic groups had a 37% (95% CI=0.49–0.82) lower chance of suffering from ARI. Children living in rural areas had a 22% (95% CI=1.00–1.48) higher tendency to be affected by ARI symptoms. Children belonging to communities or clusters with relatively higher proportions of poverty (community poverty) had a 48% (95% CI=1.20–1.81) higher risk of being affected by ARI than their counterparts. After controlling for community-level factors in the fixed effects parameter, the variance decomposition did not show any major change in the random effects parameter. Further, there were not so many changes in the adjusted odds ratio of the fixed effects parameter from Model 1 to Model 2, except for mother's occupation. The chances of having ARI increased for both agricultural and manual workers by 11% and 13% points respectively from Model 1 to Model 2. In the random part of the model, the largest variation in the symptoms of ARI lay at the child level (65.60%), followed by the province level (21.87%), and the lowest variation was observed at the cluster level (12.53%).

Discussion

The study found that, in Afghanistan, about 13% of children suffered from an acute respiratory infection in the 2 weeks before the survey conducted in 2015. The percentage varied widely across provinces. Ghor had the highest prevalence with almost 47% of children being affected by ARI. Ghor is located at 2500 m above sea level in the Hindu Kush mountains and is one of the least-developed provinces in terms of child health indicators, with only 8% of children being fully immunized (World Bank, 2011). That could be a possible reason for the higher prevalence of ARI symptoms among Ghor's children. The provinces of Kandahar, Badghis and Balkh had higher ARI prevalences than the other provinces, and their suboptimal rate of immunization coverage (<25%) (World Bank, 2011) might be responsible for this (Selvaraj *et al.*, 2014; Bawankule *et al.*, 2017).

The multilevel analysis showed that households' type of cooking fuel (clean versus polluting) had an effect on the incidence of ARI symptoms among under-five children, irrespective of the place of cooking or the availability of a separate kitchen for cooking. However, the size of the effect varied with the place of cooking or the availability of a separate kitchen. For households using clean fuels (electricity, LPG or biogas), children in households that cooked inside the house, with or without a separate kitchen, were less likely to be affected by ARI symptoms than children in households that cooked in a separate building or outside. This is a surprising finding and contradicts the finding of a previous study in developing countries (Langbein, 2017), although that study did not control for fuel types simultaneously. The result might be due to the relatively lower quality housing conditions of households that cooked food outdoors compared with those that had indoor kitchens. This is an area for future research.

Children's demographic characteristics were found to be important risk factors of ARI symptoms. Two- and three-year-old children were more prone to ARI symptoms than one-year-old children. However, five-year-old children had a lower risk of suffering from ARI than the one-year-old children. This finding is consistent with other studies in developing countries (Savitha *et al.*, 2007; Prajapati *et al.*, 2011; Tekle *et al.*, 2015). Why are children in their second or third years more susceptible to ARI, and five-year-olds less susceptible than one-year-olds? Further work is needed to address this phenomenon. A male child is more likely to have ARI symptoms than a female one. This might be due to male children being more exposed to the outside environment than female children in this conservative society. Small size at birth, as a proxy measure for low birth weight, increases the chances of having ARI symptoms. It is documented that a child born with low birth weight is at higher risk of having lung disease in later life (Walter *et al.*, 2009). Higher birth order children are more likely to have ARI symptoms, which could be because such children have more siblings, resulting in them receiving less parental care and increasing the chances of disease.

Mother's educational level was found to play a crucial role in the occurrence of ARI symptoms in their children. The children of highly educated mothers had an almost 50% lower chance of being affected by ARI symptoms than those of uneducated mothers. Previous studies had similar findings (Azad, 2009; Sanbata *et al.*, 2014; Adesanya & Chiao, 2016). In general, high-educated mothers have fewer children, and they are more aware of the health and quality of care for their children need to reduce their chances of having different kinds of childhood disease. Mother's occupational status was the most influential factor in children's ARI symptoms throughout the models after controlling for all the factors. The children of agricultural, manual and clerical or professional workers were more likely to have ARI symptoms by 64%, 74% and 65%, respectively, than those of non-working mothers in the Model 2. This is an unexpected result, especially for clerical and professional workers, and contradicts the results of studies conducted in Ethiopia and India (Bhat & Manjunath, 2013; Jabessa, 2015; Tekle *et al.*, 2015). Perhaps the children of working women are left in the house or the women bring their children to work with them, which could lead to them receiving less care or being exposed to the outside environment during travel to, and at, the workplace, resulting in a higher ARI prevalence.

Another unexpected finding of this study was that, with an increase in the number of household members, the chances of having ARI among children decreased, contradicting the finding of a study in Kenya and one in Copenhagen, Denmark (Von Linstow *et al.*, 2008; Muthoni, 2017). This might be caused by children in Afghanistan getting more attention and care from household members. Other household's factors, such as wealth index, improved drinking water and sanitation facilities, did not have any significant effects on ARI symptoms.

The study included ethnicity, place of residence and community poverty as community-level characteristics. It was found that all three community variables affected the prevalence of ARI symptoms. Children belonging to minor ethnic communities, i.e. Turkmen, Nuristan, Baloch, Pashai and Others, were less likely to have ARI symptoms than Pashtun children. Furthermore, children belonging to communities with a higher proportion of poverty had a 48% higher risk of having ARI symptoms than their counterparts from richer communities after controlling for other factors (Model 2). It is interesting to note that an individual household's level of income (wealth index) did not have any effect on the prevalence of ARI symptoms in the adjusted models, whereas the community's level of income (community poverty) had a considerable effect on the prevalence of ARI symptoms. Thus, a child living in a poor household as well as in a poor community is more vulnerable to ARI than a child living in a poor household and a non-poor community.

From the random effects parameters, it was found that a substantial proportion of the variation in ARI prevalence could be explained by the communities and provinces themselves because of their homogeneous nature within the communities and provinces, and the heterogeneous nature between communities and provinces. Most of the variance (65.6%) in ARI prevalence could be explained by individual children themselves, as expected, because it is directly related to the children.

The paper has its limitations. One of the major limitations is that it was unable to establish causal effects as the analysis was based on cross-sectional data. Secondly, the outcome of interest was symptoms of ARI in under-five children during the 2 weeks before the survey as reported by the mothers based on their own observations, and this could have led to under- and over-reporting problems. Thus, there is scope for further study based on the diagnoses of ARI symptoms among children by experts. Moreover, the study was unable to control for the effects of nutritional status and immunization coverage among children because of the unavailability and higher missing information in the dataset, which might have effects on ARI. Accordingly, future research should take these factors into consideration.

The study also has its strengths. First, the data were from the AfDHS, which is a national-level, well-representative sample of high quality, conducted by the Demographic and Health Survey (DHS). Secondly, to the best of the authors' knowledge, this is the first national-level analysis on this topic in the Afghan settings. Thirdly, to the extent of the authors' knowledge, the study is the first to estimate the effects of cooking fuel types by location of cooking and availability a separate kitchen on ARI prevalence in children. Finally this study has measured the effect of community poverty on ARI symptoms. In conclusion, this study has used the multilevel logistic regression models over simple logistic regression models and by that it has estimated the effects of explanatory variables and the effects of communities or clusters and provinces simultaneously on the occurrences of ARI symptoms.

Conclusion and policy implications

This study found that a considerable proportion of children suffered from acute respiratory infection in Afghanistan in 2015, with prevalence varying widely across provinces. The Afghanistan health system needs to introduce preventive measures to reduce this high child ARI prevalence, which is a leading cause of child death, and emphasis should be given to the most highly affected provinces. The study further found that the type of cooking fuel used by households is not the only the issue affecting child ARI prevalence. Place of cooking (in a separate kitchen versus outside) matters too. However, these factors had a relatively lower effects on the occurrence of ARI in children than maternal characteristics, such as educational level and occupational status, and community-level factors such as community poverty and ethnicity. The government could introduce appropriate interventions to reduce ARI and thus lowering child mortality. It should encourage people to use clean cooking fuel and provide LPG at a subsidised price, and promote education and raise awareness about the consequences of using polluting cooking fuels. Special policy programmes should be formulated for specific communities. Furthermore, parents need to be advised on how to care for their children in the early years and to avoid having a large number of children.

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References

Adedini SA (2013) Neighbourhood characteristics and under-five mortality in Nigeria. *Etude de La Population Africaine* **27** (Supplement 2), 273–287.

Adesanya OA and Chiao C (2016) A multilevel analysis of lifestyle variations in symptoms of acute respiratory infection among young children under five in Nigeria. *BMC Public Health* **16**(1), 880.

Adesanya OA, Darboe A, Mendez Rojas B, Abiodun DE and Beogo I (2017) Factors contributing to regional inequalities in acute respiratory infections symptoms among under-five children in Nigeria: a decomposition analysis. *International Journal for Equity in Health* **16**(1), 140.

Afghanistan Government and United Nations (2015) *A Decade of Opportunities: Afghanistan Millennium Development Goals 10 Years Report, Afghanistan*. URL: http://moec.gov.af/Content/files/MDG Final Report v6-2(1).pdf (accessed February 2018).

Afghanistan Humanitarian Country Team (2014) *Afghanistan 2015 Humanitarian Needs Overview*. URL: https://reliefweb.int/sites/reliefweb.int/files/resources/Afghanistan HRP 2015 HNO Final 23Nov2014%281%29.pdf (accessed November 2017).

Astale T and Chenault M (2015) Help-seeking behavior for children with Acute respiratory infection in Ethiopia: Results from 2011 Ethiopia Demographic and Health Survey. *PLoS One* **10**(11), e0142553.

Azad KMAK (2009) Risk factors for acute respiratory infections (ARI) among children under five years in Bangladesh. *Journal of Scientific Research* **1**(1), 72–81.

Bawankule R, Singh A, Kumar K and Shetye S (2017) Does measles vaccination reduce the risk of Acute Respiratory Infection (ARI) and diarrhea in children: a multi-country study? *PLoS One* **12**(1), 1–17.

Bhat RY and Manjunath N (2013) Correlates of acute lower respiratory tract infections in children under 5 years of age in India. *International Journal of Tuberculosis and Lung Disease* **17**(3), 418–422.

Buchner H and Rehfuess EA (2015) Cooking and season as risk factors for acute lower respiratory infections in African children: a cross-sectional multi-country analysis. *PLoS One* **10**(6), 1–21.

Capuno JJ, Tan CAR and Javier X (2018) Cooking and coughing: estimating the effects of clean fuel for cooking on the respiratory health of children in the Philippines. *Global Public Health* **13**(1), 20–34.

Central Statistics Organization, Ministry of Public Health and ICF (2015) *Afghanistan Demographic and Health Survey 2015*. Central Statistics Organization, Kabul, Afghanistan.

Dahal GP, Johnson FA and Padmadas SS (2009) Maternal smoking and acute respiratory infection symptoms among young children in Nepal: multilevel analysis. *Journal of Biosocial Science* **41**(6), 747.

DHS (2006) *Guide to DHS Statistics: Demographic and Health Surveys Methodology*. Measure DHS and ICF International, Calverton, MD. URL: https://dhsprogram.com/pubs/pdf/DHSG1/Guide_to_DHS_Statistics_29Oct2012_DHSG1.pdf (accessed December 2017).

ESRI (2011) *ArcGIS Desktop: Release 10*. Environmental Systems Research Institute, Redlands.

Fischer Walker CL, Rudan I, Liu L Nair H, Heodoratou E, Bhutta ZA *et al.* (2013) Global burden of childhood pneumonia and diarrhoea. *The Lancet* **381**(9875), 1405–1416.

Guo G and Zhao H (2000) Multilevel modeling for binary data. *Annual Review of Sociology* **26**(1), 441–462.

Harerimana JM, Nyirazinyoye L, Thomson DR and Ntaganira J (2016) Social, economic and environmental risk factors for acute lower respiratory infections among children under five years of age in Rwanda. *Archives of Public Health* **74**(1), 19.

ICF International (2011) *Demographic and Health Surveys Methodology–Questionnaires: Household, Woman's, and Man's. Measure DHS Phase III*. ICF International, Calverton, MD. URL: http://www.measuredhs.com/publications/publication-DHSQ6-DHS-Questionnaires-and-Manuals.cfm (accessed December 2017).

Jabessa S (2015) Multilevel analysis of acute respiratory infection symptoms among under five children in Ethiopia. *Biometrics and Biostatistics* **6**(4), doi: 10.4172/2155-6180.1000251

Jean-Daniel LP (2016) Effects of biomass fuel on child acute respiratory infections in rural areas of Cameroon and Gabon. *Universal Journal of Public Health* **4**(3), 121–132.

Kilabuko JH and Nakai S (2007) Effects of cooking fuels on acute respiratory infections in children in Tanzania. *International Journal of Environmental Research and Public Health* **4**(4), 283–288.

Langbein J (2017) Firewood, smoke and respiratory diseases in developing countries–the neglected role of outdoor cooking. *PLoS One* **12**(6), 1–14.

Mishra V (2003) Indoor air pollution from biomass combustion and acute respiratory illness in preschool age children in Zimbabwe. *International Journal of Epidemiology* **32**(5), 847–853.

Mishra V, Smith KR and Retherford RD (2005) Effects of cooking smoke and environmental tobacco smoke on acute respiratory infections in young Indian children. *Population and Environment* **26**(5), 375–396.

Muthoni KA (2017) Determinants and spatial modeling of acute respiratory infections (ARI) among children less than five years in Kenya. *American Journal of Theoretical and Applied Statistics* **6**(2), 123.

Pinzón-Rondón ÁM, Aguilera-Otalvaro P, Zárate-Ardila C and Hoyos-Martínez A (2016) Acute respiratory infection in children from developing nations: a multi-level study. *Paediatrics and International Child Health* **36**(2), 84–90.

Prajapati B, Talsania N and Sonaliya KN (2011) A study on prevalence of acute respiratory tract infections (ARI) in under five children in urban and rural communities of Ahmedabad Distric, Gujarat. *National Journal of Community Medicine* **2**(2), 255–259.

Rudan I, Boschi-Pinto C, Biloglav Z and Campbell H (2008) Epidemiology and etiology of childhood pneumonia. *Bulletin of the World Health Organization* **86**(5), 408–416.

Rutstein SO and Johnson K (2004) *The DHS Wealth Index. DHS, Comparative Report No. 6*. Measure DHS, Calverton, MD. URL: https://dhsprogram.com/pubs/pdf/cr6/cr6.pdf (accessed December 2017).

Sanbata H, Asfaw A and Kumie A (2014) Association of biomass fuel use with acute respiratory infections among under- five children in a slum urban of Addis Ababa. *BMC Public Health* **14**(1), 1–8.

Savitha M, Nandeeshwara SB, Pradeep Kumar MJ, Ul-Haque F and Raju CK (2007) Modifiable risk factors for acute lower respiratory tract infections. *Indian Journal of Pediatrics* **74**(5), 477–482.

Selvaraj K, Chinnakali P, Majumdar A and Krishnan I (2014) Acute respiratory infections among under-5 children in India: a situational analysis. *Journal of Natural Science, Biology and Medicine* **5**(1), 15.

StataCorp (2013) *Stata Statistical Software: Release 13. Stata: Release 13*. Stats Corp, College Station, TX.

Tekle AG, Worku A and Berhane Y (2015) Factors associated with acute respiratory infection in children under the age of 5 years: evidence from the 2011 Ethiopia Demographic and Health Survey. *Pediatric Health, Medicine and Therapeutics* **6**, 9–13.

UNICEF (2016) *The State of the World's Children 2016: A Fair Chance for Every Child*. United Nations Children's Fund. URL: http://www.un-ilibrary.org/children-and-youth/the-state-of-the-world-s-children-2016_4fb40cfa-en (accessed November 2017).

United Nations (2000) *United Nations Millennium Development Goals: GOAL-4*. URL: http://www.un.org/millenniumgoals/childhealth.shtml (accessed February 2018).

Von Linstow ML, Holst KK, Larsen K, Koch A, Andersen PK and Høgh B (2008) Acute respiratory symptoms and general illness during the first year of life: a population-based birth cohort study. *Pediatric Pulmonology* **43**(6), 584–593.

Walter EC, Ehlenbach WJ, Hotchkin DL, Chien JW and Koepsell TD (2009) Low birth weight and respiratory disease in adulthood: a population-based case-control study. *American Journal of Respiratory and Critical Care Medicine* **180**(2), 176–180.

WHO/UNICEF (2006) *Core Questions on Drinking-Water and Sanitation for Household Surveys*. WHO, Geneva.

WHO (2015a) *Afghanistan: WHO Statistical Profile*. URL: http://www.who.int/gho/countries/afg.pdf?ua=1 (accessed November 2017).

WHO (2015b) *Countdown to 2015 Decade Report (2000–2010)*. WHO, Geneva. URL: http://www.who.int/pmnch/topics/child/CountdownReportOnly.pdf?ua=1 (accessed February 2018).

WHO (2016) *Household Air Pollution and Health*. URL: http://www.who.int/mediacentre/factsheets/fs292/en/ (accessed 19 December 2017).

Wichmann J and Voyi KVV (2006) Impact of cooking and heating fuel use on acute respiratory health of preschool children in South Africa. *Southern African Journal of Epidemiology and Infection* **21**(2), 48–54.

World Bank (2011) *Afghanistan Provincial Briefs*. World Bank, Washington, DC. URL: https://openknowledge.worldbank.org/handle/10986/27407 (accessed February 2018).

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