Acute Respiratory Infection of under-five children associated with place of food cooking in Ethiopia: Multilevel Analysis of 2005-2016 Ethiopian Demographic Health Survey data

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Abstract

Background: Acute respiratory infection is the leading causes of under-five child mortality globally especially in least income countries. Exposure to toxic pollutants from solid biomass fuel in the indoor environment is the main risk factor. In Ethiopia, where more than 90% of population use this energy source and the disease is one of the top health problems, there is a paucity of evidence on the association of cooking places with the disease based on nationally representative data. Therefore, the current study is intended to at assess the association of food cooking places with acute respiratory infection based on a large-scale and time varying data.

Methods: The data of Ethiopian Demographic and health surveys collected in 2005, 2011 and 2016 were used for this study. The data were obtained via online registration and analyzed using a multilevel analysis. The “svy” command in Stata was used to weight the data to adjust for cluster sampling design.

Result: The total number of children included in the analysis was 30895, with 9,517 from 2005, 11,176 from 2011 and 10, 291 from 2016 survey. In total, 11.9% of children had an acute lower respiratory infection with 12.7%, 11.9% and 11.1% respectively in 2005, 2011 and 2016. In 2005, 71% of mothers cooked food inside the house and it declined to 43% in 2016. The risk of the infection to children whose mother cooked food outside the house compared to inside the house was 68% less likely (AOR = 0.32, 95% CI= 0.10, 0.98). Watching television at least once in a week had also reduced the risk of infection (AOR=0.60, 95% CI =0.38, 0.94). There was a statistically a significant difference among the children of within survey to have an infection and no difference among the children of between surveys.

Conclusion: The mothers’ cooking of food outside the house lessen the risk of children to have acute respiratory infection. No difference among different surveys on the infection suggests the rareness of progress in the practices that could minimize the risk therefore measures like encouraging to cook in indoor environment of well-ventilated needs to be taken.

Introduction

Acute Respiratory Infection (ARI) is an infection of any part of the respiratory tract, from the middle ear to the nose and the lungs, and related structures [1]. Acute Respiratory Infection is a leading cause of mortality in children under the age of 5 years throughout the world [2, 3]. Nearly 265,000 in-hospital deaths and more than 12 million hospital admissions of young children took place due to ARI globally in 2010, 70% of which were reported in sub-Saharan Africa and South Asia [4, 5]. It also accounts for 16% of all deaths occurred globally in the year 2015 by killing around one million children under the age of five years [6]. The recent analysis of the data of DHS in sub-Saharan countries shows that the overall prevalence of ARI is 25.3% [7].

Multiple risk factors are associated with the occurrence of ARI of which exposure to toxic pollutants in the indoor environment, mainly from biomass smoke is one [8–12]. A smoke from biomass and coal contains a large number of particulate matters of different sizes such as nitrogen dioxide, carbon

monoxide, methylene chloride, and dioxins [9, 10, 12]. Exposure to these pollutants is remarkably high among women and under-five children who are spending more time in proximity to fires while cooking and heating [13]. Pollution generated in kitchens and heating areas can also immediately spreads into living areas so as children and other household members are exposed [13, 14]. Despite all the health problems, the use of biomass fuels like animal dung, crop residues, wood and coal for cooking and heating purposes is predominant globally with approximately 3 billion people [15, 16]. Evidence suggests that controlling exposure to biomass fuel could reduce the risk of multiple children and adult health outcomes by 20–50% [17].

In Ethiopia, the prevalence of the disease and its association with biomass, absence of separate kitchen, and lack of window were indicated [18, 19]. However, in the country where more than 90% of population use solid biomass fuel [20–22], and how food cooking places associated with the disease based a large scale national representative data is scares. Moreover; a multilevel analyses of the three DHS data, that the current study aimed at, to indicate the difference in the children's risk of developing the infection within and between surveys is the first to shows the progress in the country. Therefore, the study would produce evidence for policy makers for better intervention in progressing the achievement of under-five mortality and morbidity of SDG strategic plan.

Methods

Study setting

Ethiopia, according to the world population review report, has an estimated population of 114.96 million in 2020, which makes it the second in Africa and 12th in the world most populous country [23]. The country has a population growth rate of 3.02% per year and fertility rate of 4.73% [23, 24]. It has an administrative structure of nine regional states (Tigray, Afar, Amhara, Oromiya, Somali, Benishangul-Gumuz, Southern Nations Nationalities and People (SNNP), Gambela, and Harari) and two city administrations (Addis Ababa and Dire Dawa) [25].

Study design and data source

A two-stage stratified sampling designs based on the Ethiopian Demographic and Health surveys conducted in 2005, 2011 and 2016 were used. These nationally representative household surveys were conducted among women aged 15–49 years. The study included both urban and rural areas in 9 regions and two city administrative in each survey. In total, the child data used for analysis were 30,985 (9,517 from 2005 survey, 11,176 from 2011 survey, and 10,291 from 2016 survey).

Sample size determination and sampling technique

DHS survey collect nationally representative data using clustered stratified two stage sampling method. First, determine the enumeration area (EAs) followed by household selection. All regions were stratified based on residence into urban and rural areas. Then the appropriate sample size were selected using probability proportional allocation to sample size. For the 2016 DHS, 645 enumeration areas (EAs) (202

from urban and 443 from rural). The 2011 DHS included 624 EAs (187 from urban and 437 from rural areas), and the 2005 DHS included 540 EAs (145 from urban and 395 from rural areas) [20–22].

Measurement of variables

The outcome of interest was acute respiratory infection (ARI). The DHS survey assessed whether the children of participating mothers suffered from cough in the last two weeks before survey. Mothers responded “yes” were then asked about whether the cough was with the sign of short or rapid breathing problems during the specified period. Therefore, we defined ARI as the condition in which a child suffered a cough with shortness of breathing. It is a binary outcome with “1” as those mothers responded to the preceding questions in a positive way and “0” in either or both cases.

During the each survey, households were asked about the type of fuels they reportedly used and place of food cooking. We categorized households into with indoor air pollution when there was a reported cooking of food inside the house using wood, charcoal, kerosene, grass, crop products as source of fuel no air pollution otherwise. Those households reportedly used electricity, liquid petroleum gas, natural gas and biogas as household fuel source were also taken as with no indoor air pollution problem.

All the other factors associated with the outcome were taken as confounders. They were age of child, maternal age, education status of mother, education status of father, residency, nutrition status, household wealth quintile, frequency of watching television, frequency of listening radio, occupation of mother, occupation of father as indicated elsewhere. The child stunting, underweight and wasting were determined based on the World Health Organization Child Growth Standards and the National Center for Health Statistics (NCHS)/WHO international growth reference [26].

Data Analysis

We used STATA 14 version (Stata Corp LP, College Station, TX, USA) for all statistical analyses and data management. All analyses took into account the sampling design using svy command in the Stata to account for the clustering nature of the data and the probability of selection and non-response in the EDHS. We first present the characteristics of the study population by ARI status and by exposure variables: solid fuel use and exposure to IAP. The association between solid fuel use and ARI outcome was examined using two-level multilevel logistic regression by considering the households nested in different surveys (difference among children of different surveys) and children nested in the households of the same survey (difference within survey among children of different households). Results are presented as adjusted Odds Ratios (AOR). All statistical tests were considered significance at p-value < 0.05.

Ethical consideration

The three EDHS were conducted after obtaining ethical approval from the ICF Institutional Review Board (IRB), Ethiopia Health and Nutrition Research Institute Review Board and the Ministry of Science and Technology. The data collectors read the informed consent statement to obtaining informed and

voluntary participation before data collection. The confidentiality of the information was maintained. For this particular study, a brief description of the protocol was submitted to the MEASURE DHS program to access and analyze the data.

Result

Socio-demographic characteristics of households with under-five children

The number of children included in the analysis were, 9971 from 2005, 10729 from 2011 and 10195 from 2016 survey with the total of 30895. Two-fifth of the children had an average size and nearly one-fifths of children had an age of 3 years and four each. In total, nearly nine-tenths of children were resided in rural, 42% children were stunted, 30% were under-weight, and 17% were wasted. About nine-tenths of included in the analysis were from rural, about two-fifth were stunted, and the children had almost comparable age category. The children's stunting status was in a declining trend in three surveys with 50% in 2005 to 42% in 2011 and 38% in 2016. Similarly, the number of underweight children in 2005 about 50% was declined to 27% in 2011 and 24% in 2016. Households' experiences of listening twice in a week in 2005 was nearly 25% which increased to 32% in 2011 and declined to 13% in 2016. On the other hand, the households watching of television in three times a week increased from 0.7% in 2005 to 8.3% in 2011 and 8.1% in 2016. Of mothers included in the survey, nearly three-fifth did not have work and more than 70% of them did not attend school even if the trend is slightly decreased from 2005 to 2016 (Table 1)

Table 1
Socio-demographics of households and under-five children characteristics, EDHS 2005–2016

Characteristics		Survey year, N (%)			Total
		2005	**2011**	**2016**	**N (%)**
Residence	Urban	762 (7.0)	1,427(12.5)	1,149(10.7)	3338 (10.1)
	Rural	10,075(93.0)	9,982(87.5)	9,559(89.3)	29616 (89.9)
Stunting	Normal	2,222(50.2)	6,210(58.6)	5,987(61.9)	14420 (58.4)
	Stunted	2,208(49.8)	4,397(41.5)	3,679(38.1)	10283 (41.6)
Weight	Normal	2,222(50.2)	7,747(73.0)	7,368(76.0)	17337 (70.1)
	Underweight	2,208(49.8)	2,860(27.0)	2,327(24.0)	7395 (29.9)
Wasting	Normal	2,222(50.2)	9,637(90.9)	8,710(89.9)	20569 (83.2)
	Wasted	2,208(49.8)	971(9.2)	978(10.1)	4156 (16.8)
Breast feeding	Never	380 (3.5)	332 (2.9)	520 (4.9)	1231 (3.8)
	Ever	10,302(96.5)	11,028 (97.1)	10,189 (95.2)	31519 (96.2)
Child age in years	O years	2,211(22.0)	2,324(21.5)	2,243(21.9)	6778 (21.8)
	1 years	1,869(18.6)	1,878(17.4)	1,966(19.2)	5713 (18.4)
	2 years	1,875(18.7)	2,016(18.7)	1,911(18.7)	5803 (18.7)
	3 years	2,081(20.7)	2,342(21.7)	1,973(19.3)	6396 (20.6)
	4 years	2,000(19.9)	2,229(20.7)	2,150(21.0)	6379 (20.5)
Size of child	Very small	2,411 (22.3)	2,191(19.3)	1,890(17.8)	6492 (19.8)
	Smaller than average	1,013(9.4)	1,451(12.8)	1,491(14.0)	3954 (12.1)
	Average	4,343(40.2)	4,365(38.4)	4,457(42.0)	13165 (40.2)
	Larger than average	792(7.3)	1,005(8.8)	1,072(10.1)	2868 (8.8)
	Very large	2,237(20.7)	2,357(20.7)	1,712(16.1)	6307 (19.2)
Father education	No education	6,322 (58.9)	5,651(50.2)	4,866(48.2)	16839 (52.5)

	Primary	3,256(30.4)	4,722(42.0)	4,028(39.9)	12006 (37.4)
	Secondary	1,041(9.7)	530(4.7)	771(7.6)	2342 (7.3)
	Higher	109(1.0)	351(3.1)	438 (4.3)	898 (2.8)
Occupation of father	Did Not Work	46(0.43)	93(0.8)	781 (7.7)	920 (2.9)
	Professional	170(1.6)	325(2.9)	402(4.0)	896 (2.8)
	Sales	547(5.1)	867(7.7)	677(6.7)	2091 (6.6)
	Agriculture	9468(88.3)	9,057(80.3)	6,719(66.4)	25244 (79.4)
	Service	60(0.6)	162(1.4)	267(2.6)	489(1.7)
	Skilled	245(2.3)	591(5.2)	549(5.4)	1385 (4.4)
	Unskilled	178(1.7)	116(1.0)	364(3.6)	658 (2.1)
	Other	15(0.1)	69(0.6)	359(3.6)	443(1.4)
Mother occupation	Did not work	7,671(70.9)	5,306 (46.9)	5,975 (55.8)	18953 (57.5)
	Sales	764 (7.1)	1,860(16.5)	1,234 (11.5)	3858 (11.7)
	Agriculture	2,042 (18.9)	3,106(27.5)	2,398 (22.4)	7546 (22.9)
	Skilled	154 (1.4)	790 (7.0)	395 (3.7)	1339 (4.1)
	Other	187(1.7)	147(2.2)	706 (6.6)	1139 (3.5)
Education of mother	No education	8,595(79.3)	7,961(69.8)	7,105(66.4)	23661 (71.8)
	Primary	1,801(16.6)	3,058(26.8)	2,864(26.8)	7724 (23.4)
	Secondary	400(3.7)	237(2.1)	490(4.6)	1127 (3.4)
	Higher	42(0.4)	153(1.3)	248(2.3)	442 (1.3)
Age of mothers	15–19	537(5.0)	447(3.9)	353(3.3)	1,337 (4.1)
	20–24	2,146(19.8)	2,247(19.7)	2,001(18.7)	6,395 (19.4)
	25–29	3,109(28.7)	3,685(32.3)	3,262(30.5)	10,056 (30.5)
	30–34	2,270(21.0)	2,285(20.0)	2,443(22.8)	6,998 (21.2)
	35–39	1,666(15.4)	1,741(15.3)	1,713(16.0)	5,120(15.5)
	40–44	768(7.1)	743(6.5)	705(6.6)	2,217 (6.7)

	45–49	341(3.1)	260(2.3)	230(2.2)	830 (2.5))
Listening radio in the last week	Not at all	7,049(65.1)	5,728(50.2)	7,894(73.7)	20671 (62.7)
	Twice a week	2,601(24.0)	3,658(32.1)	1,386(12.9)	7645 (23.2)
	Three times a week	326(3.0)	2,015(17.7)	1,428(13.3)	3769 (11.4)
	Almost everyday	860(7.9)			860 (2.6)
Watching television in the last week	Not at all	9,931(93.2)	7,699(67.6)	8,814(82.3)	26443 (80.3)
	Twice a week	652(6.1)	2,750(24.1)	1,031(9.6)	4433 (13.5)
	Three times a week	69(0.7)	944(8.3)	863(8.1)	1876 (5.7)
Toilet type	Improved	574(5.3)	1,393(12.4)	1,044(9.8)	3011(9.2)
	Unimproved	10,224(94.7)	9,878(87.6)	9,597(90.2)	29699 (90.8)
Water source	Improved	6,156(57.0)	5,188(46.1)	5,994 (64.3)	17338(55.3)
	Unimproved	4,639(43.0)	6,074(53.9)	3,325(35.7)	14038(44.7)

Type of fuels used in the house and place of food cooking

The number of households using solid biomass as a source of fuel is about 99% in 2005 and 97% is 2016. The non-solid fuel use in 2005 was 1.2% and increased to 3.14% in 2016. With respect to place of cooking foods, 71% of households in 2005 cook inside the household and declined in 2016 to 43%. Figure 1 shows the place of food cooking. Accordingly, there is declining trend in the practice of cooking food inside the house increasing trend of cooking in separate house. Cooking food outside the house increased from 5.8% in 2005 to 10.7% in 2016.

Acute Respiratory Infection

Of 30,895 children included in the survey, those with sign of acute respiratory infection in all survey were 3675 (11.9%). The number of children with the reported diseases was 1266 (12.7%) in 2005, 1274 (11.9%) in 2011 and 1135 (11.1%) in 2016 EDHS. The result shows some decline in the number of children with ARI mainly from 2005 to 2011 and with slight decline in 2016 EDHS.

The Distribution Of Ari Across Selected Variable Categories

The acute lower respiratory infection is low among children reportedly ever breast feed, father education status of high, profession workers. Similarly, children of mothers with high education status, aged between 44–49 years old were found with low ARI. The mothers or respondents listening of radio almost every day, watching television almost every day, households of highest wealth quintiles were also with lower ARI. The prevalence of ARI among households using solid biomass fuel is 11% compared with those who used non-solid fuel which is about 6% (Table 2).

Table 2
Acute respiratory infection across different variable selected, EDHS 2005–2016

Characteristics		Weighted frequency	ARI, weighted percentage
Breast feeding of child	Never	703	10.5
	Ever	30064	11.9
Father education	No education	15643	11.7
	Primary	11322	12.7
	Secondary	2254	11.6
	Higher	851	5.9
Father occupation	Did not work	869	13.0
	Professional	868	7.1
	Sales	1999	10.4
	Agriculture	23533	12.5
	Services	461	12.1
	Skilled	1338	10.2
	Unskilled	613	11.9
	Other	425	7.6
Mother occupation	Did not work	17732	11.2
	Sales	3643	13.6
	Agriculture	7074	13.5
	Skilled	1254	10.9
	Other	1082	8.9
Mother education	No education	22059	11.9
	Primary	7318	12.7
	Secondary	1090	9.5
	Higher	428	5.8
Household wealth quintile	Poorest	5027	11.6
	Poorer	7858	11.5
	Middle	7622	12.7

Characteristics		Weighted frequency	ARI, weighted percentage
	Higher	6853	12.7
	Highest	3536	9.7
Child sex	Male	15803	11.8
	Female	15092	12.0
Child age	O years	6773	14.6
	1 years	5705	13.9
	2 years	5763	12.1
	3 years	6344	10.7
	4 years	6310	8.1
Age of mother	15–19	1249	13.9
	20–24	5955	12.6
	25–29	9405	11.6
	30–34	6603	11.7
	35–39	4818	11.4
	40–44	2098	12.4
	44–49	768	10.2
Type of fuel used	Solid biomass fuel	12995	11.0
	Non-solid fuel	508	6.2
Location of food preparation or cooking	Inside house	17488	12.6
	Separate building	10883	11.2
	Outside the house	2506	9.6
Child size	Very large	5992	13.3
	Larger than average	3677	9.9
	Average	12503	10.2
	Smaller than average	2708	11.5

Characteristics		Weighted frequency	ARI, weighted percentage
	Very small	5915	15.4
Toilet type	Unimproved	2898	9.6
	Improved	27782	12.1
Drinking Water source	Unimproved	16301	11.6
	Improved	13110	12.5
Residence	Urban	3204	8.4
	Rural	27691	12.3
Stunting	Normal	14404	12.0
	Stunted	10272	11.7
Underweighting	Normal	17318	11.4
	Underweighted	7388	13.0
Wasting	Normal	20547	11.5
	Wasted	4151	13.6
Frequency of Listening radio the last week	Not at all	19414	11.5
	Less than once a week	7113	12.4
	At least once a week	3556	13.2
	Almost everyday	805	10.4
Frequency of Watching television in the last week of survey	Not at all	24742	12.2
	Less than once a week	4172	12.3
	At least once a week	1789	7.4
	Almost everyday	160	3.5

The association of ARI with place of food preparation in the house

From the fixed part of the multilevel analysis, the children's risk of having ARI is 68% less likely in the households of mother cooked food outside the house compared to those cooked food inside the house (AOR = 0.32, 95% CI = 0.10, 0.98). The risk of developing ARI is 27%, 34% and 52% less likely respectively among of children of aged 2–3 years, 3–4 years and 4–5 years compared with children of below one year. The children whose mother watching television at least once in a week had less likely to develop the disease compared to those who did not watch (AOR = 0.60, 95% CI = 0.38, 0.94). On the other hand, mother's listening of radio is not protective of their children to develop the disease compared with those who did not radio at all. The random part of the analysis shows that there is a significant different among children of within survey to have an ARI. However, the risk of developing the disease among children of the three surveys did not statistically differ (Table 3).

Table 3
Multilevel logistic regression output on the association of ARI with place of food cooking in controlling other variables, EDHS, 2005–2016

Factors and their category		AOR (95%CI)
Location of food preparation or cooking	Inside house	1
	Separate building	0.39(0.13, 1.18)
	Outside the house	0.32 (0.10, 0.98)
Father education	No education	1
	Primary	1.09(0.91, 1.30)
	Secondary	1.01(0.73, 1.40)
	Higher	0.92(0.50, 1.68)
Occupation of Father	Did not work	1
	Professional	0.66(0.37, 1.18)
	Sales	0.84(0.51, 1.37)
	Agriculture	0.90(0.58, 1.40)
	Services	1.14(0.57, 2.31)
	Skilled	0.87(0.49, 1.54)
	Unskilled	1.00(0.52, 1.92)
	Other	0.51(0.25, 1.03)
Mother occupation	Did not work	1
	Sales	1.21(0.97, 1.51)
	Agriculture	1.18(0.98, 1.42)
	Skilled	1.00(0.71, 1.41)
	Other	0.68(0.45, 1.04)
Education of mother	No education	1
	Primary	1.07(0.90, 1.28)
	Secondary	0.97(0.61, 1.54)
	Higher	1.43(0.66, 3.10)
Quintile	Poorest	1

AOR, Adjusted Odds Ratio

Factors and their category		AOR (95%CI)
	Poorer	0.93(0.73, 1.19)
	Middle	0.96(0.75, 1.23)
	Higher	0.96(0.75, 1.23)
	Highest	0.76(0.57, 1.02)
Frequency of Listening radio the last week	Not at all	
	Less than once a week	1.22(1.00, 1.49)
	At least once a week	1.48(1.18, 1.85)
	Almost everyday	0.98(0.54, 1.75)
Frequency of Watching television in the last week of survey	Not at all	1
	Less than once a week	0.86(0.68, 1.08)
	At least once a week	0.60(0.38, 0.94)
	Almost everyday	0.23(0.04, 1.38)
Age of mother	15–19	1
	20–24	0.91(0.60, 1.38)
	25–29	0.89(0.60, 1.33)
	30–34	0.95(0.63, 1.43)
	35–39	0.86(0.56, 1.32)
	40–44	1.05(0.63, 1.75)
	44–49	0.63(0.35, 1.14)
Toilet type	Unimproved	1
	Improved	1.03(0.77, 1.37)
Drinking Water source	Unimproved	1
	Improved	0.97(0.82, 1.15)
Child sex	Female	1
	Male	1.01(0.89, 1.14)
Breast feeding of child	Never	1

AOR, Adjusted Odds Ratio

Factors and their category		AOR (95%CI)
	Ever	1.10(0.58, 2.09)
Child age	O years	1
	1 years	0.90(0.74, 1.09)
	2 years	0.74(0.61, 0.89)
	3 years	0.66(0.56, 0.79)
	4 years	0.49(0.39, 0.60)
Child size	Very large	1
	Larger than average	0.73(0.57, 0.94)
	Average	0.73(0.60, 0.87)
	Smaller than average	0.84(0.65, 1.10)
	Very small	1.15(0.93, 1.42)
Residence	Rural	1
	Urban	1.28(0.88, 1.87)
Stunting	Stunted	1
	Normal	1.14 (0.95, 1.36)
Underweight	Underweight	1
	Normal	0.77 (0.61, 0.97)
Wasting	Wasted	1
	Normal	0.99 (0.81, 1.22)
ARI variation between households within survey		0.50(0.40, 0.63)
ARI Variation between households in surveys		0.03(0.00, 1.10)
AOR, Adjusted Odds Ratio		

Discussion

Based on the three survey, in Ethiopia, more than 96% of the households use solid biomass fuel for cooking even if these fuels are known to be emitting large amount of indoor air pollutants which implies that the children's exposure to biomass and charcoal fuel lead to high chance of getting ARI [27]. The

finding also shows that 9.6% of the total households prepare food out-door which is different from the study conducted in African countries that reported 18% in East Africa and 43% in West Africa [28]. The difference could be due to variation in the types of cooking stoves used; having fixed or movable stove.

The average prevalence of ARI among children of under-five years old in three surveys (2005 to 2016) is 11.9% which is incomparable with the finding in the slum urban of Addis Ababa which is 23%[18] that could be because of a small number of samples considered in latter study. On the other hand, the finding is almost comparable with the finding from Tanzania, 11% [29], and East Africa, 10% [28].

The finding shows the association of place of cooking food with the prevalence of ARI in children in current study. In view of that, children whose mother prepare food outdoor are less likely to suffer from ARI by 68%, (AOR = 0.32, 95% CI = 0.10, 0.98). The current finding is consistent with a finding from 27 African countries that shows cooking out-doors is associated with a decrease in ARI by 0.5 percentage points compared to cooking indoors [28]. Moreover, a study conducted in Tanzania measured higher concentration of PM10 and $NO_{2,}$ which are predisposing factors for ARI, in the poorly ventilated indoor kitchens in the living room, compared to other locations that indicates cooking outdoor is safer than cooking indoor [29].

The current study shows cooking in separate building was not significantly different from with cooking inside building that could be due to mothers' carrying their children to the building where they cook food, and the condition of the building like air ventilation, number of available windows, and window sizes which were not measured in the DHS survey. In this regard, studies conducted in one part of the country show that households in a ventilated kitchen had less to suffer from the disease compared to kitchen with no window and poorly ventilated houses [27].

The multilevel modeling shows that the odds of children to develop ARI is significantly different between children of within survey than children of different surveys which suggest that there is no progress in changing the practice of households either to use non-solid biomass or preparing their food outside and/or ventilated kitchen so that the risk will be minimized. On the other hand, there is great effort at the country level to improve the use of non-solid biomass like biogas and others [30–34].

The parents' occupation, education status and wealth quintiles had no a statistical association with children's ARI status though there is a prior study that shows socio-demographic characteristics mainly education and occupation had association with children ARI [7]. The mother's watching of television at least once in a week is protective of her child to develop ARI while listening of radio is not. Exposure to mass media increases awareness and dissemination of knowledge about the programs and policies related to under-five children health care services as indicated in prior finding [35]. The discrepancy about radio might be because of the type of information disseminated and it's persuasiveness that would lead to behavioral changes.

Regarding child related risk factors associated with ARI, risk of having ARI is 26%, 34% and 51% less likely respectively among children of aged 2–3 years, 3–4 years and 4–5 years compared to children of

below one year which suggests the exposure of children for cooking induced indoor air pollutants decreases with age. The finding complies with a prior study in urban areas of Oromia region, Ethiopia [36]; in Wondo-Genet district, southern Ethiopia [19] and in Afghanistan [37]. This could be because of the few time the older children spend with their mothers in the house [37], and the higher number in younger children could be associated with the underdeveloped epithelial linings of the lungs and weaker immune system of younger children compared with the older counterparts [37–39].

The finding that the normal children's risk of developing ARI is less likely compared to underweighted children that corroborate with the finding from India [40] and [41] is due to the fact that severely malnourished children are often immune-compressed and more prone for various infections. In addition, the under-weighted children's respiratory tract mucosa also lacks an adequate protective ability against pathogenic microbes that commonly cause ARI India [40].

Conclusion

In total, more than 10% if children suffer from acute respiratory infection in the country. Those children whose mother cook food outside the house were less likely to have a disease compared to those cooking inside the house. From the multilevel analysis, there was a significant difference of ARI among children within a survey than between surveys which suggests the rareness of progress in changing the practice of cooking outside the house, using non-solid biomass fuel or cooking in a well ventilated kitchen to lower the disease. Concerned sectors in the country should take proper measures like awareness creation on cooking indoor environment of well-ventilated, shifting to non-solid biomass fuel like biogas and others.

Abbreviations

ARI: Acute Respiratory Infection, ARR:Adjusted Risk Ratio, DHS:Demographic Health Survey, PM10:Particulate matter.

Declarations

Ethics approval:

We follow the principles and procedures of the data owner (Measure DHS Program). Each survey was conducted after ethical clearance was obtained from the appropriate Ethics Review Committee of the country.

Availability of data

The datasets used and/or analyzed during the current study are belong to DHS program. The authors can provide in discussion with the data owner.

Conflict of interests:

The authors declare that they have no competing interest.

Funding:

It is not applicable

Authors' contribution:

AG, SG, YM and TA conceived and designed the study, analyzed the data, interpreted and drafted the manuscript. Both authors have read and approved the final manuscript.

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Figures

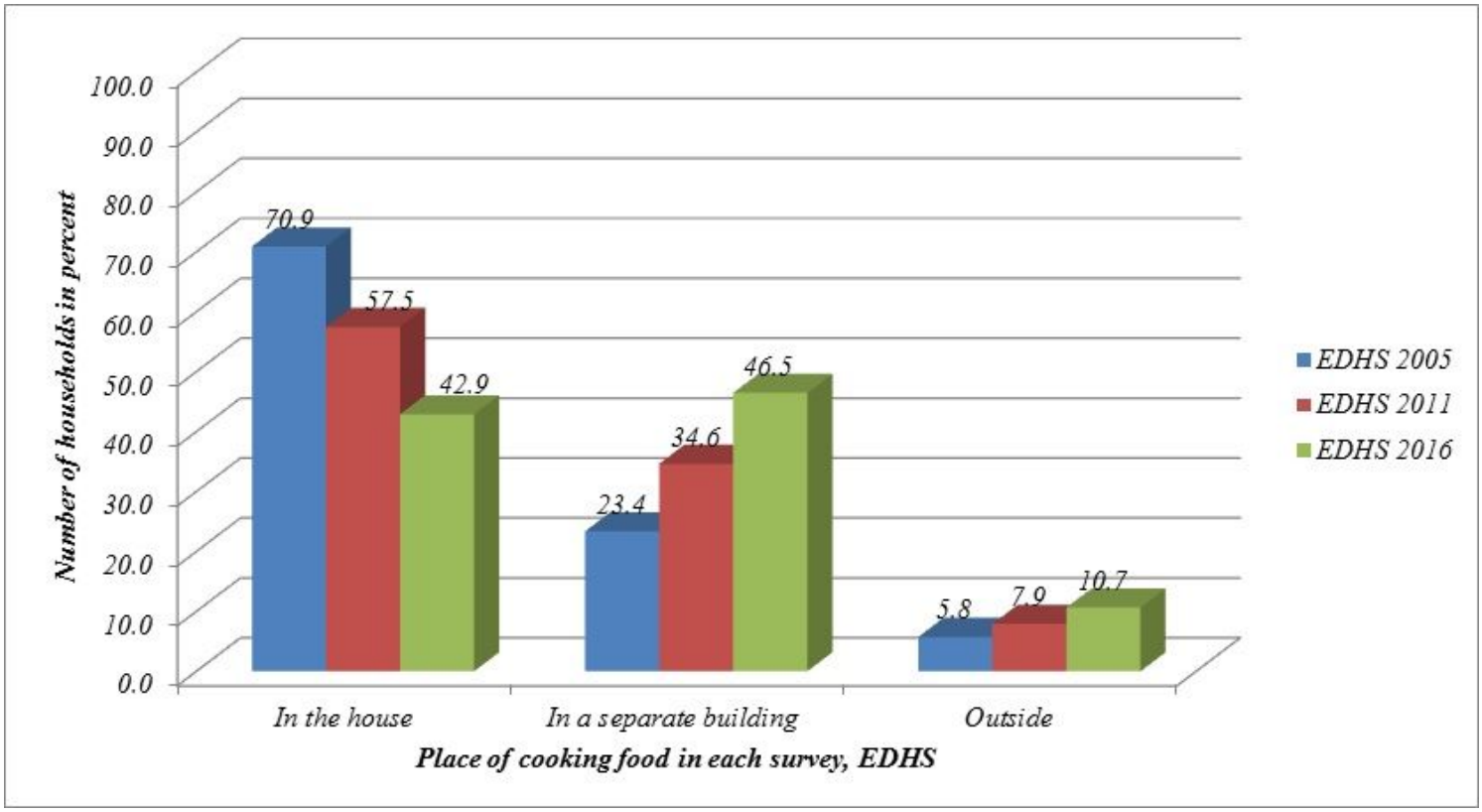

Figure 1

Mothers' place of cooking food EDHS, 2005-2016 The percent distribtuion is calculated by dividing the number of households reportedly cooking food inside the house, outside the house and in separate house to total number of households in each survey.