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Determinants of Community Acquired Pneumonia Among Children 2-59 Months in Adaba District, Central Ethiopia: A Case Control Study

Kedir Mude, Ayalew Astatkie

School of Public and Environmental Health, College of Medicine and Health Sciences, Hawassa University, Hawassa, Ethiopia

Email address:
intuenat2111@gmail.com (K. Mude), ayelewastatkie@gmail.com (A. Astatkie)

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Abstract: Introduction: In a year, 158 million cases of under-five Community Acquired Pneumonia (CAP) occur worldwide. Ethiopia is one of the top 15 countries in which 72% of global childhood CAP death occurs. In recognizing consequences of childhood CAP, it is important to understand the variation in the determinants. But, few studies conducted on the determinants of childhood CAP in Ethiopia and there is no previous scientific study done in Adaba district. Hence we aimed to identify determinants of CAP among children aged 2-59 months in Adaba district, West Arsi Zone, Ethiopia. Methods: We conducted a 1:1 unmatched case-control study using structured-questionnaires from April 23 to May 26, 2018 in Adaba district Ethiopia. The cases were 2-59 month's old children who visited under-five clinics and diagnosed for CAP. The controls were children 2-59 months age who were apparently healthy and live in the community from which the cases came. We identified cases from health facility and controls by conducting house-to-house surveys. Result: A total of 528 children aged 2-59 months) took part with a response rate of 95%. Age of the child, 2-11 months (AOR=5.78, 95% CI 2.94, 11.41) and 12-23 months (AOR=4.17, 95% CI 2.22, 7.83), overcrowding (AOR=2.21, 95%-CI 1.10, 4.45) children usually located on mothers back or kept besides the mother when the mothers cook food (AOR=4.33, 95% CI 2.16, 8.68), sever stunting (AOR=3.76, 95% CI=1.58,8.93) wasting (AOR=4.77, 95% CI=1.91, 11.91) and diarrhea (AOR=5.99, 95% CI=2.91, 12.33) were risk factors. Conclusion: Age of the child, household-crowding, keeping the child with the mother while the mother cooks food, undernutrition (stunting and wasting) and diarrhea were risk of CAP. The district health office with its partners has to work to improve nutritional status of the children and existing CAP and diarrheal preventive and control methods must be strengthened and due attention should be given to children aged less than two years of old.

Keywords: Community-Acquired-Pneumonia, Adaba, Central, Ethiopia

1. Introduction

Pneumonia is an acute infection of the lungs. When an individual has pneumonia, the alveoli in the lungs are filled with pus and fluid, which makes breathing painful and breathing difficult and limits oxygen intake Based on the origin, pneumonia can be classified as either 'community acquired' when the presumed pathogen is acquired in community setting, whereas facility based pneumonia when the etiological agents can be traced to a health facility [1].

The Sustainable Development Goals (SDGs) 3.2 states that "by 2030 end preventable under-five deaths by reducing under 5 mortality to at least as low as 25 per 1,000 live births." However, in 2015, more than 666 under five children continue to die every hour globally. A large percentage of under-five deaths were caused by the leading infectious and preventable diseases like CAP, diarrhea, malaria, meningitis of which the largest share goes to CAP and diarrheal diseases [2-5].

Childhood CAP still the top leading causes of morbidity and mortality of the post-2015 era in the world. Most reports and studies around the world suggest that CAP is the top leading killer in the history of under-five deaths [3, 6-9]. In 2015 CAP accounted for almost three in every twenty under-five deaths [1, 4, 7] and 158 million cases occur every year worldwide [10]. It is predominantly distributed in South Asia and sub-Saharan Africa. Specifically in Africa, each year there are more than 35 million episodes of CAP in under-five children and more than 53% of children who do not live to celebrate their fifth birthday because of pneumonia live in sub-Saharan Africa [1, 10].

Although Ethiopia achieved substantial decline in under-five mortality rate attributed by pneumonia and diarrhea, still it is among the top 15 countries in which 72% of the total CAP and diarrhoea mortality in children under five is concentrated. Ethiopia is sixth in terms of absolute number of death attributed by CAP (46,888 death caused by CAP) in 2015 [1, 4]. In 2012 CAP was directly responsible for 21% total under-five deaths [11] and the most prevalent diseases among under-five children in Ethiopia. Although CAP is preventable and treatable disease, the loss of life particularly due to this is tragic [12-17].

Ethiopia is implementing relatively inexpensive, safe and effective preventive, protective and treatment interventions, but CAP is the major causes of under-five mortality and morbidity in this country [5, 8, 18]. Hence it is central to recognize risk factors that contribute to the occurrence of childhood CAP and that may provide clues to intervene the disease. However, few studies were conducted on risk factors of CAP with methodological difference in Ethiopia. Additionally, there were no previous studies done in the study area. Therefore, this study is designed to assess determinants of community acquired pneumonia among children 2-59 months old in Adaba district of Oromia Region, Ethiopia.

2. Methods and Materials

2.1. Study Setting

The study was conducted in Adaba district West Arsi Zone, Oromia regional state central Ethiopia. The district is divided in to 25 kebeles of which 22 of them are peasant associations acting as rural administrative units with 182,878 total populations, 38,100 households and 30,046 under five children projected from national population census [19]. The district is found at 100 km, East of Shashemene, on the main road to Bale. The main ethnic groups in the district are Oromo and the rural population depends on farming. Wheat, teff and sorghum are the main agricultural products. Beside the main staple food is of cereal origin. According to district health office there are 9 health centers, 22 rural health posts. Except two health posts which is not fully functional, all health post are providing iCCM. All health centers are providing IMNCI with all trained nurse/health officers. There are also 39 health extension worker who are trained on iCCM.

2.2. Study Design

Unmatched case- control study was conducted from April 23 to May 26, 2017 in Adaba district.

2.3. Source and Study Population

All children aged 2-59 months who live in Adaba district.
Cases were children 2-59 months old who visited under five clinics, registered and classified for Community Acquired Pneumonia (CAP) as defined by the World Health Organization's IMNCI guideline [20] and adapted by Ethiopian ministry of health. Community acquired pneumonia is diagnosed based on clinical sign and symptoms according to IMNCI/iCCM approach [21]. Accordingly the child with cough of two or less weeks of duration plus fast or difficult breathing due to a problem in the chest for specific age. Controls were children 2-59 months of age who are apparently healthy and live in the selected community.

2.4. Inclusion and Exclusion Criteria

Children aged 2-59 month who visited under five clinics of all health centers in Adaba district and classified for CAP during the study period were included as cases. Those children who were classified and treated as CAP two days before data collection started and who were receiving an antibiotic and returns under-five clinic for follow up were also included in the study.

Controls were children aged 2-59 month who were apparently healthy and live in the community where cases came from.

Children who or whose mothers/caretakers were severely ill and/or have hearing impairments or talking problem were excluded. And cases that need urgent referral were excluded from cases.

2.5. Sample Size Calculation and Sampling Technique

Sample size was determined based on sample size calculation for two population proportions formula using EPI info version 7 software and was calculated for as many factor as possible and then we took the largest sample size. The largest sample size was obtained by taking assumptions of a 95% confidence level, 80% of power to detect an odds ratio of 1.9 [22] at alpha 0.05 and considering the percentage of current parental smoking of 19.2% [22] with a proportion of 1 case for 1 control. The sample size obtained by adding 10% for possible non-response rate was 560 (280 cases and 280 controls).

All nine health centers that provide service for children as per the Integrated Management of Neonatal and Childhood Illness (IMNCI) protocol were included. The cases were distributed to each health center based on proportional allocation of case load from nine months of the 2009 EFY district HMIS report. Ascertainment of cases was done by nurses/health officers who are trained on IMNCI and currently working in under-five clinics in the selected health centers.

On the other hand, controls were randomly selected from 9 kebeles (the lowest administrative unit) where cases were identified. All Health Centers (HCs) except one HC serve for a minimum of two kebeles and maximum of five kebeles. From the catchment kebeles of all health centers, nine kebeles (one kebeles per health centers) was selected using simple random sampling. Then controls were distributed to kebeles proportional to the selected cases in respective health center. After identifying the kebele and the proportion of control per Kebele, a mother or care taker of a children age 2-59 month old who came to health post or at outreach for routine nutritional screening were selected randomly. In this district children aged 6-59 months and pregnant and lactating women (mothers of children less than 6 month) came for nutritional screening monthly.

2.6. Dependent and Independent Variables

2.6.1. Dependent Variable

Community acquired pneumonia.

2.6.2. Independent variable

Socio demographic characteristics.
1) Mother's age
2) Occupation of parent
3) Child's age and sex
4) Place of residence
5) Parental ethnicity
6) Parental smoking status
7) Education of Parent
8) Parental religion

Vaccination Status
1) Child vaccination against Pentavalent, PCV_{10}, Measles

Environmental characteristics
1) Indoor air pollution
2) Source of drinking water
3) Type of fuel, mainly used for cooking
4) Overcrowding
5) Type of toilet
6) Existence of separate kitchen for cooking
7) The materials of the house made up of
8) Ventilation status of the house

Nutritional factors
1) Child's weight for age
2) Child's weight for height
3) Child's height for age
4) Exclusive breast feeding
5) Complementary feeding
6) Vit A supplementations

Diseases condition
1) Child's history of Asthma, Malaria, Measles, TB, ARI other than pneumonia, diarrhea,

Behavioral Factor and accessibilities
1) Parental health seeking behavior
2) Distance of health facilities

2.7. Operational Definition [8, 20, 21]

1. Community Acquired Pneumonia (CAP): when the presumed pathogen is acquired outside the health facility.
2. Suspected pneumonia case: The child with cough or history of cough of two or less weeks and fast or difficult breathing for specific age.
3. Suspected severe pneumonia case: The child with cough or history of cough of two or less weeks of duration with one or more of the danger signs with fast breathing for specific ages.
4. Fast breathing: 60 breaths per minutes or more for children aged less than 2 months, 50 breaths per minute or more for children aged 2 to less 12 months and 40 breaths per minute or more for children aged 12 months -5 years
5. Danger signs: Any of the following sign and symptoms in a child aged 2-59 month old: convulsion, inability to drink/eat, vomiting everything, unconsciousness, Lower chest in drawing, stridor.
6. IMNCI syndromic classification: a protocol used to classify common child illness in all Ethiopian Health Centers using clinical signs and symptoms.
7. Apparently healthy: if the mother/caretakers perceive the child was healthy and declared no symptoms of disease such as fever, cough, difficulty of breathing, and diarrhea before and during the data collection period.
8. Solid fuels: These include such fuel as wood, crop waste, animal dung and charcoal.
9. Improved latrine: that is designed to hygienically separate human excreta from human contact. These includes.
   1) Flush or pour flush to: piped sewer system septic tank pit latrine.
   2) Ventilated improved pit latrine.
   3) Pit latrine with slab.
   4) Compositing toilet.
10. Unimproved latrine: one that that do not hygienically separate human excreta from human contact, and following is few example: Dry pit latrines without a slab.
11. Overcrowding was determined by number of family members per room [23, 24] A child who was not found to be in the following norm was labeled as staying in overcrowded house.
    1) 1 Room 2 persons
    2) 2 Rooms 3 persons
    3) 3 Rooms 5 persons
    4) 4 Rooms 7 persons
    5) 5 or more rooms 10 persons
12. Height-for-age is a measure of chronic under nutrition and children whose height-for-age is within -3 to -2 standard deviations and -3 standard deviations below the median of the reference population are considered as stunted and severely stunted children respectively.
13. Weight-for-height describes current nutritional status and a child who is -3 to-2 standard deviations and below -3 standard deviations from the reference median for weight-for-height is considered wasted and severely wasted [25].

2.8. Instrument and Data Collection

Structured questionnaire contained six parts: socio-demographic factors, environmental factors, vaccination factors, nutritional factors, co-morbidity and behavioral factors were used for data collection. The socio-demographic variables were adopted from the women and household questionnaires of the EDHS [17].

After cases were identified and verbal consent obtained from the mothers/care takers, they were sent to separate room and interviewed face-to-face using structured questionnaire on socio-demographic, environmental, behavioral, nutritional, behavioral factors and vaccination status of the child. Caretakers of controls, from the same Kebeles which cases came, and who came to health post or at outreach for routine nutritional screening were selected randomly were interviewed.

Nutritional status of the child were assessed by measuring length/height and weight of all children. For children aged 2-23 month, salter hanging spring scale with nearest decimal digit of 0.1 kg and a capacity for 25 kg was used and beam scale for children over 24 months of age was used for measuring weight with minimum clothing and no shoes to the nearest 0.1 kg. Recumbent length measurement was taken for children 2-23 months while for children above two years stature was measured in a standing position in centimeters to the nearest of 0.1 cm. Vaccination status of the children was primarily by asking the mother or caretaker.

2.9. Data Analysis and Quality Assurance Method

Data were cleaned and checked using EPI info version 7 software and exported to SPSS Version 20 for further processing and analysis. Nutritional data indices were converted from anthropometric measurement into Z-scores using World Health Organization (WHO) Anthro software. Binary logistic regression model was used to compute the association between the independent variables and community acquired pneumonia. Independent variables associated with outcome during bivariate analysis at P value less than 0.05 and those with P value of <0.25 were included in the multivariate logistic regression. The presence of association between the predictor variables and CAP were determined using Odds Ratio with 95% confidence interval. Multicollinearity was also checked for those variables which were candidate for multivariate analysis and we found strong correlation between presence of kitchen and presence of chimney in the kitchen. Both variables were included into multivariate analysis separately with other candidate variables. Then Hosmer and Lemshowes test for goodness-of-fit of the model was applied to find the appropriateness of model and percentage accuracy in classification was also checked. Finally variable with higher percentage accuracy in classification and with good model of goodness-of-fit (P-value > 0.05) was included in the final multivariate analysis.

The questionnaire was translated into local languages, Afan Oromo, for the field work and back to English to check its consistency by three health workers who are fluent speakers Afan Oromo and English. Pre-testing was done in the neighboring district health centers in 5% of the sample size. Nine diploma nurses for data collection and two BSc nurses for supervision who were fluent speaker of Afan Oromo were trained for three days. The training covered the importance of disclosing the possible benefits and purpose of the study to the study participants before starting data collection. One day on job training/orientation were also given for all health workers working at all under-five clinic in the selected nine health centers for case ascertainment. The scales indicators were checked against zero reading after and before weighing every child. Data was edited daily by the investigator on the day of data collection. Double data entry was used to ensure data quality.

2.10. Ethical Consideration

After obtaining ethical clearance letter from the Institutional Review Board at the College of Medicine and Health Sciences of Hawassa University as per the National Research Ethics Review Guideline (fifth edition) of Ethiopia [26], and permission letter from Adaba district Health office, data collector were deployed to field for data collection. Beside after explaining the purpose and predures of data collection verbal consents was obtained from the parents/caretakers.

3. Result

3.1. Background Information

A total of 528 children aged 2-59 months old (264 cases and 264 controls) were analyzed with a response rate of 95%. The mean age of the cases and controls were 21.1 months and 19.7 months with standard deviation of 2.1 among cases and 2.9 among controls. About 155 (58.7%) of cases and 121 (45.8%) of controls were male. The mean age of the mothers were 29.5 in controls and 28.3 in cases. The average age of the mothers when they give birth their first children were 18.1 for cases and 29.8 for controls. All of the mothers'/caretakers (100%) belong to Oromo ethnic group and 470 (89%) were followers of Muslim religion.

3.2. Socio-demographic Information

Two hundred (75.8%) cases and 206 controls were from rural residents. Majority of the mothers of cases 262 (99.2%) and of control 248 (93.9%) were housewife. Regarding the occupational status of the husbands, about 472 (89.4%) of the fathers of children were farmer. From socio-demographic factor only age of the child was significantly associated in the bivariate analysis. Children aged 2-11 months children and 12-23 months had higher odds of getting (CAP) than 24-59 months old.

Table 1. *Socio-demographic characteristics of respondents and association with community acquired pneumonia in Adaba district, central Ethiopia 2017.*

Variables	Case			P-value	COR (95% C. I.)
	Yes	No	Total		
Sex					
Male	140	124	272	0.164	0.783 (0.56, 1.10)
Female	124	140	256	ref	
Age of child in month					

Variables	Case			P-value	COR (95% C. I.)
	Yes	No	Total		
2-11	125	56	181	0.001	4.88 (3.22, 7.41)
12-23	64	43	107	0.001	3.25 (2.03, 5.22)
24-59	75	164	239	ref	
Age of the mothers in year					
<=24	73	68	141	0.58	1.15 (0.70, 1.88)
25-34	135	136	271	0.78	1.06 (0.69, 1.64)
>=35	56	60	116	ref	
Age of the mother at their first child birth (in year)					
<=18	55	70	125	ref	
18-24	197	179	376	0.105	1.40 (0.93, 2.10)
>=25	12	15	27	0.97	1.02 (0.44, 2.35)
Resident					
Urban	64	58	122	0.54	1.14 (0.76, 1.70)
Rural	200	206	406	ref	
Formal education for mothers					
Yes	160	171	331	ref	
No	104	93	197	0.32	1.19 (0.84, 1.70)
Formal school for fathers					
Yes	194	201	395	ref	
No	70	63	133	0.48	1.15 (0.77, 1.706)

3.3. Environmental Factors

Majority of mothers 385 (72.9%) responded that wood and charcoal was used for cooking fuel the rest 143 (27.1%) of mothers used animal dung. The highest proportion of respondents mentioned that, 365 (69.1%) cook their food in the kitchen. Of these, 311 (85.2%) kitchen do not have chimney. Eighty five percent of the mothers of cases and 88.3% mothers of controls mentioned that as they had latrine. Variables such as the main materials of the floor, wall and roof made up of and hand washing practice at critical time[1] were not included in the bivariate logistic regression because of no difference was observed among controls and cases. Variables like children usually located beside the mothers/caregivers while cooking food, and number of person per sleeping room were determinants that revealed significant association with community acquired pneumonia in the bivariate analysis. Beside children who belong to the house in which animals live in the living house were more likely to develop CAP.

3.4. Nutritional Factors

Regarding nutritional status of the children, 82 (31.1%) of the cases and 44 (16.7%) of the controls were very stunted (Z score less than -3) and significantly different at P-value 0.001 in bivariate analysis. Beside both nutritional indices (weight-for-height and weight-for-age) were also significantly associated with CAP.

3.5. Diseases and Behavioral Factors

Previous history (two weeks preceding data collection day) of diseases such as ARI, diarrhea, TB, measles and HIV were assessed for their potential association. All of mothers of the child mentioned that none (0%) of child had experienced TB, measles in their previous last two weeks. However 91 (34.5%) of the cases and 50 (18.9%) of he controls mothers or caretakers mentioned that as the child had ARI. In addition 135 (51.1%) of cases and 49 (18.6%) of controls had diarrheal disease. Both ARI and diarrhea were significantly associated with CAP in bivariate analysis at P-value 0.001.

Regarding behavioral factors, distance from the nearest health facilities (hospitals health centers or health post) and delay in health seeking behavior when the child had cough factors that revealed significant association with CAP. Children who delayed to seek health care by seven days or more were 1.74 times more likely o develop CAP.

None of the vaccination factors were associated with CAP in bivariate analysis. Of 528 children eligible for first dose of Penta/PCV_{10}/Rota, mothers of 513 children (264 controls and 249 cases) mentioned that their child had vaccinated for Penta/PCV_{10}/Rota 1.

3.6. Factors Independently Associated with CAP

After controlling for multiple potential variables, these factor were independently associated with CAP; children aged 2-11 month had 6.04 times (AOR=7.19, 95% CI 3.60, 14.36; P<0.001) and children aged 12-23 months 4.17 times (AOR=4.17, 95% CI 2.22, 7.83; P<0.001) higher odds of developing CAP than those in the age categories of 24-59 months. Beside the odds of getting CAP was 2.44 times higher (AOR=2.44, 95% CI 1.24, 4.80; P<0.01) among children living in the overcrowded house and in children usually located at mothers back or beside mothers when the mothers were cooking food (AOR=2.18, 95% CI 1.11, 4.27; P<0.023). Height-for-age or chronic malnutrition/stunting (AOR=3.77, 95% CI 1.60, 8.86; P<0.002) and height-for-weight (AOR=4.53, 95% CI 1.85, 11.09, P<0.001) were also nutritional determinants associated with CAP in multivariate analysis. In addition there was an increased odds of CAP among children who had suffered from diarrhea (AOR=6.07, 95% CI 2.99, 12.34; P<0.001).

1 Critical time= before and after meal, before food preparing or cooking, before child feeding, after washing child excreta and after larine utilizing

Table 2. *Environmental factors and association with community acquired pneumonia in Adaba district, central Ethiopia 2017.*

Variables	Case		Total	P-value	COR (95% C. I.)
	Yes	No			
Fuel for cooking					
Wood/charcoal	183	202	385	ref	
Animal dung	81	62	143	0.098	1.39 (0.94, 2.05)
Have a kitchen					
Yes	173	192	365	ref	
No	91	72	163	0.074	1.40 (0.97, 2.03)
Chimney in kitchen					
Yes	19	35	54	0.05	0.55 (0.30, 1.01)
No	154	157	311	ref	
Location of the child during cooking					
Mothers back/ besides	169	101	270	0.001	2.87 (2.02, 4.09)
Outside the cooking area	95	163	258	ref	
Animal live in the house					
Yes	47	31	78	0.033	1.71 (1.04, 2.79)
No	207	233	440	ref	
Have latrine					
Yes	226	233	454	ref	
No	38	31	69	0.367	1.26 (0.76, 2.10)
Source of drinking water					
piped water	90	83	173	ref	
Protected [1]	83	106	189	0.323	0.72 (0.48, 1.09)
Unprotected [2]	91	75	166	0.61	1.12 (0.70, 1.72)
Window in the house					
> 2	120	107	227	0.423	1.15 (0.81, 1.64)
<= 2	135	139	274	ref	
Person per sleeping room					
normal	197	235	432	ref	
overcrowding	67	29	96	0.001	2.78 (1.73, 4.48)

Table 3. *Nutritional factors associated with community acquired pneumonia in Adaba district, central Ethiopia 2017.*

Variables	Cases		Total	P-value	COR (95% C. I.)
	Yes	No			
Age at complementary feeding initiated					
< 6 months	20	16	55	0.279	1.46 (0.74, 2.90)
At six month	184	215	380	ref	
Frequency of breastfeeding					
< 7 times	16	12	28	0.54	1.29 (0.56, 2.95)
< 10 times	32	53	85	0.61	0.58 (0.33, 1.02)
> 12 times	63	61	124	ref	
Height-for-weight					
Normal	206	235	441	ref	
Wasted	58	29	87	0.001	2.28 (1.41, 3.70)
Weight-for-age					
Normal	183	200	383	ref	
UW[2]	41	50	91	0.64	0.90 (0.57, 1.42)
SUW[3]	40	14	54	0.001	3.12 (1.64, 5.93)
Height-for-age					
Normal	141	163	304		
Stunted	41	53	94	0.001	2.15 (1.40, 3.31)
Severely stunted	82	44	126	0.001	2.25 (151, 3.35)

2 UW (Under Weight)= Z score between -3 and -2

3 SUW (Sever Under Weight)= <-3

Table 4. *Diseases and behavioral factors associated with community acquired pneumonia in Adaba district, central Ethiopia 2017.*

Variables	Case		Total	P-value	COR (95% C. I.)
	Yes	No			
Have ARI					
Yes	91	50	141	0.001	2.25 (151, 3.35)
No	173	214	387	ref	
Have diarrhea					
Yes	135	49	184	0.001	4.59 (3.10, 6.80)
No	129	215	344	ref	
Distance from health facilities					
=< 5 km	168	207	275		
6-10 km	70	41	111	0.001	2.10 (1.36, 3.25)
>= 11 km	24	16	40	0.07	1.85 (0.95, 3.59)
When do you seek health care					
=< 3 days	122	171	293	ref	
3-7 days	62	44	106	0.003	1.97 (1.26, 3.10)
>=7 days	62	49	111	0.014	1.74 (1.12, 2.71)
Smoker in the house					
Yes	29	20	49		
No	235	244	479	0.17	2.82 (0.84, 2.76)
Measles vaccination					
Yes	177	219	396		
No	21	17	38	0.214	1.53 (0.78, 2.98)

Table 5. *Independent factors significantly associated with community acquired pneumonia in Adaba district central Ethiopia 2017.*

Variables	Case		COR (95% C. I.)	AOR (95% C. I.)
	No	No		
Age child in month				
2-11	125	56	4.88 (3.22, 7.41)	6.04 (3.10, 11.78)
12-23	64	43	3.25 (2.03, 5.22)	4.17 (2.22, 7.83)
24-59	75	164	ref	
Usual location of the child during cooking				
Mothers back or besides	169	101	2.87 (2.02, 4.09)	4.89 (2.47, 9.70)
Outside of the cooking area	95	163	ref	
Person-per- room				
Normal	197	235	ref	
overcrowding	67	29	2.78 (1.73, 4.48)	2.44 (1.24, 4.80)
Height-for-weight				
Normal	206	235	ref	
Acute malnutrition	58	29	2.28 (1.41, 3.70	4.53 (1.85, 11.09)
Height-for-age				
Normal	141	163	ref	
Stunted	41	57	0.83 (0.52, 1.32)	1.72 (0.76, 3.89)
Very stunted	82	44	2.15 (1.40, 3.31)	3.77 (1.60, 8.86)
Have diarrhea				
Yes	135	49	4.59 (3.10, 6.80)	6.07 (2.99, 12.34)
No	129	215	ref	

4. Discussion

We conducted unmatched case control study to identify factor associated with WHO defined community acquired pneumonia among children 2-59 month in Adaba district central Ethiopia. All socio-demographic, environmental, nutritional, vaccination and behavioral factors were assessed for potential association with the occurrence of CAP. Based on our finding child's age, usual location of the child when the mothers/caregivers were cooking food, the number of people person per sleeping room, child's age at which complementary feeding was initialed, child's high-for-age, presence of smoker in the house and, occurrence of diarrhea and ARI were significantly associated with CAP after controlling other variables.

In our study, we found that being in both age group of 2-11 months and 12-23 months were at risk of developing CAP than being in the age group of 24-59 months i.e. Children aged 2-11 months had 7.19 times higher odds of developing CAP than children aged 24-59 months old and the odds of developing CAP pneumonia was 4.17 times higher among children aged 24-59 months than children aged 24-59 months old. Facility-based case-control study in Ethiopia reported that a child in both 2-11 months and 12-23 months age group were more likely to develop CAP than children in 23-59 months of age [12]. Similarly, a cross-sectional study conducted in SNNPR, Ethiopia revealed that children aged 2-11 months had higher odds of developing CAP than 12-59 month. On other hand a cross-sectional study in northwest Ethiopia [13] and a case control study in central Ethiopia [22] indicated age of the child is not determinant factor. Other study from Sudan reported that the percentage of CAP among children aged 6-18 months was highest than children aged 19-59 months [27]. Beside a systematic review conducted in developing countries showed as children under 18 months of age being more vulnerable to CAP [28]. Beside the 2013 Lancet report, population-based surveillance in Pakistan and longitudinal study from India indicated that the burden of CAP was higher among children younger than 2 years [29-31]. However hospital based case control study in Brazil showed that age of children were not associated with CAP [32]. The variation might be a selection bias of the control or cases or age categorization used by different study.

Children who were usually carried on their mother's/caregiver's back or located beside mother's during cooking food was higher with 2.19 times odds of developing CAP than those who were not. This may be due to indoor air pollution resulted from using of solid fuels (wood, animal dung and charcoal). Sold fuel is the primary source of household energy in developing countries [33] especially in Ethiopia solid fuel in the form of firewood, agricultural residues and animal dung is the primary source of household energy in Ethiopia [14, 34] and more than 98% of them use for cooking purpose [35]. This in turn increases exposure to indoor air pollution and the risk of pneumonia increases when the child is exposed to solid fuels [36]. Two cross-sectional studies conducted in Ethiopia also showed similar findings [13, 37].

Crowding was another environmental risk factor that shows significant association in present study. The definition of household crowding varies greatly [24]. In the present study, household crowding was defined as two or more individuals sleeping in the same room. Children who live in the crowding house had 2.67 time higher odds of developing CAP than who were not. Living conditions in homes with few rooms may facilitate the transmission of respiratory pathogens. This finding are in agreement with a cross sectional study carried out from Ethiopia [13], hospital based case control study from Brazil [32], prospective case-control study conducted in Jamshedpur, India [38] and from São Paul [39] and with systematic review and meta-analysis carried out by different scholars [24]. Beside study done in southwest of Ethiopia household crowding was assessed in terms of family size and significantly associated with CAP [22]. On contrast evident from Amhara region northern Ethiopia came out with no association between household crowding and CAP [12]. The reason for this difference may be introduction of selection bias in control group.

Under nutrition was most important risk factor for occurrence of CAP in this study. Even in bivariate analysis all the three anthropometric indices (height-for-age, weight-for-height, and weight-for-age) were significant. But in multivariate analysis weight-for-height and height-for-age were strongly associated. It is well known that malnourished children have defective cell mediated immunity. In addition, malnutrition decreases T-cell function (natural killer) and cytokine production leading to severe gram negative infections and sepsis [40]. Height-for-age is a measure of chronic under nutrition and children whose height-for-age is within -3 to -2 standard deviations and -3 standard deviations below the median of the reference population are considered as stunted and severely stunted children respectively. Weight-for-height describes current nutritional status and a child who is -3 to-2 standard deviations and below -3 standard deviations from the reference median for weight-for-height is considered wasted and severely wasted [25].

The odds of developing CAP in wasted (below -2 SD) children were 4.53 times higher than normal children (above -2 SD). This finding is similar with the study carried out in Ethiopia [22] a hospital based cases control study in Pakistan, India and southern Iraq [38, 41, 42]. Another a facility based cases control study from India showed that wasted children were more prone to suffer from CAP [43]. There are also studies from Ethiopia [13, 16] other countries [32, 44] that reported no association between wasting and CAP.

Stunting was another nutritional risk factors revealed strong association with CAP. Severely stunted children were 3.77 times more odds of developing CAP. Although there are different consistent findings were reported from Ethiopia [13] and other country [45], there are also evidence that suggest no association between stunting and CAP [22, 32, 43]. This difference may be different in nutritional transition or homogeneity between the case and control groups or different in the skill of data collector.

The occurrence of diarrhea as co-morbidity with CAP was also risk factor identified in this finding. The odds of developing CAP among children with diarrhea were 6 times higher than who had not had diarrhea. The finding was in line with study done by different scholars among under three years of child [46] and a study from Israel also observed diarrhea to be a risk factor for community–acquired alveolar pneumonia in children [47]. However different study conducted in different parts of Ethiopia showed no association [12, 13, 16, 22] between diarrhea and CAP. This is may be different sample size or different in study setting or biased in control selection. Most of the studies were facility based in which both controls and cases were selected from the same facilities.

The limitation of this study was that the diagnostic criteria of CAP was based on clinical WHO IMNCI classification guideline, that shows high sensitivity and low specificity which can overestimate occurrence of the CAP by including ALRI. Despite low specificity of diagnostic criteria it is the only method used to identify CAP at health centers in Ethiopia. Another limitation of the study was recall and selection biases, and to this minimize we employed the incident cases strategy. To make the study feasible, the control group was selected from the neighboring kebeles where cases came.

5. Conclusion

Children age (2-11 months and 12-23 months), children located a mother/care givers back or beside when he mothers/caregivers cooking food were risk factor in this stud. Overcrowding was also potential determinant of CAP. Besides wasting and sever stunting were nutritional risk factors for the occurrence of CAP and childhood illness like diarrhea was also associated with CAP.

6. Recommendations

Our findings indicate that children aged 2-23 months are at particularly high risk of contracting pneumonia so the district health office should give due attention to these children by strengthening preventative, protective and treatment activities of CAP. Beside those children suffering from diarrhea were at high risk of acquiring CAP and since both diseases are intervened with similar preventative strategies and treatment delivery platforms, the existing integrated interventions for CAP and diarrhea had to be strengthened. Generally the district health office had to work with its partner on preventative interventions to improve household crowding and nutritional status of the children.

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