Türkiye Klinikleri Biyoistatistik Dergisi
Turkiye Klinikleri Journal of Biostatistics
Turkiye Klinikleri J Biostat. 2020;12(2):193-203

ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

DOI: 10.5336/biostatic.2020-73640

Trends of Respiratory Rate Change Among Under-Five Pneumonia Patients Based on the Day Follow-Ups: A Multivariate Decomposition Analysis

Beş Yaşın Altındaki Pnömoni Hastalarında Günlük Takibe Göre Solunum Hızındaki Değişiklik Eğilimleri: Çok Değişkenli Dekompozisyon Analizi

Muluwerk Ayele DEREBE[a]

[a]Bahir Dar University, Department of Statistics, Bahir Dar, ETHIOPIA

ABSTRACT Objective: To analyze the trends and determinants of changes in respiratory rate and multivariate decomposition over time among under-five pneumonia patients. **Material and Methods:** Poisson (Log-based) decomposition analysis technique was used for analysis of factors contributing to the recent changes. STATA 14 was employed for data management and analyses. All calculations presented in this paper were weighted for the sampling technique and non-response. **Results:** The medical cards of 453 pediatric pneumonia patients out of 1572 pediatric pneumonia patients have been reviewed and all of these 453 patients were hospitalized at least for six days. Among respiratory rate of pneumonia patients decreased from 59 on average from Day 1 to 51 on average in Day 3 and 41 on average in Day 6. The decomposition analysis indicated that 13% of the overall change in respiratory rate was due to difference in patients' characteristics. Changes in the composition of young pneumonia patients' characteristics according to body temperature, treatment type, weather, vomiting history and cough were the major sources of this decrease. The remaining 87% of the decrease in respiratory rate was due to difference in coefficients. Most importantly, the decrease was due to change in respiratory rate change among the fully immunized (55%) and exclusively breast-fed (39%). **Conclusion:** Respiratory rate change among pediatric pneumonia patients has showed a remarkable decrease over the three consecutive measures. Programmatic interventions targeting body temperature, body weight, vomiting history, immunization status, breast-feeding type and family disease history would help to maintain the decreasing trend in respiratory rate change.

Keywords: Respiratory rate; pneumonia; under-five children and multivariate decomposition

ÖZET Amaç: Beş yaşın altındaki pnömoni hastalarında solunum hızındaki zaman içindeki eğilimleri ve belirleyicilerini ve çok değişkenli dekompozisyonunu incelemek. **Gereç ve Yöntemler**: Son değişikliklere katkıda bulunan faktörleri incelemek için Poisson (log-dayalı) dekompozisyon analizi tekniği kullanıldı. Verilerin yönetilmesi ve analizi için STATA 14 kullanıldı. Bu makalede sunulan tüm hesaplamalar örnekleme tekniği ve yanıt vermeme için ağırlıklandırılmıştır. **Bulgular:** Toplam 1572 pediatrik pnömoni hastası içinden 453'ünün tıbbi kayıtları gözden geçirildi ve bu 453 hastanın hepsi en az altı gün hastanede yatmıştı. Hastaların solunum hızı birinci gün 59 iken üçüncü gün 51'e, altıncı gün 41'e düştü. Dekompozisyon analizi solunum hızındaki tüm değişikliklerin %13'ünün hasta özelliklerine bağlı olduğunu gösterdi. Vücut sıcaklığı, tedavi tipi, hava, kusma öyküsü ve öksürük bu azalmanın başlıca kaynaklarıydı. Solunum hızındaki geriye kalan %87'lik azalma katsayılardaki farklılıklara bağlıydı. En önemlisi, solunum hızındaki değişikliğe bağlı azalma tam aşılı (%55) ve tamamen anne sütüyle beslenenlerde (%39) idi. **Sonuç:** Pediatrik pnömoni hastalarında solunum hızı değişiklikleri üç ardışık ölçüm arasında belirgin azalma gösterdi. Vücut sıcaklığını, vücut ağırlığını, kusma öyküsünü, aşılanma durumunu, anne sütüyle beslenme durumunu ve ailede hastalık öyküsünü hedefleyen girişimler solunum hızı değişimindeki azalma eğilimini sürdürmeye yardımcı olacaktır.

Anahtar kelimeler: Solunum hızı; pnömoni; beş yaşın atındaki çocuklar ve çok değişkenli dekompozisyon

Correspondence: Muluwerk Ayele DEREBE
Bahir Dar University, Department of Statistics, Bahir Dar, ETHIOPIA
E-mail: muluwerkayele@gmail.com

Peer review under responsibility of Turkiye Klinikleri Journal of Biostatistics.

Received: 18 Jan 2020 ***Received in revised form:*** 03 Mar 2020 ***Accepted:*** 05 Mar 2020 ***Available online:*** 28 May 2020

Respiratory complaints make up the single largest group of disorders about which families seek medical attention and also account for 30% of acute medical pediatric admissions to the hospital.[1] Acute respiratory rate is one of the major causes of morbidity and mortality throughout the world. Acute respiratory rate refers to an extremely high number of breaths per minute with corresponding age categories for pneumonia infected children. The contribution of acute and chronic respiratory rate on pneumonia infected children towards school absenteeism and family disturbance is very great but difficult to quantify. Of children hospitalized/inpatient with high respiratory rate per minute, a high proportion of them have pneumonia as the main diagnosis.[2] Pneumonia is the term used to describe inflammation of the lung and its severity is increased whenever the respiratory rate or pulse rate becomes fast. Pneumonia is a common illness that affects millions of people each year globally.[3,4] At the point when an individual has pneumonia, the alveoli in the lungs are loaded up with secretion and liquid, which makes breathing agonizing (respiratory tract infection) and limit oxygen inhaled. Whenever, the breathing rate per minute increased, the pain becomes fatal. In children, pneumonia with high respiratory rates per minute, is the most important single cause of child mortality globally.[5] It is estimated that approximately 2 million children die each year due to pneumonia in developing countries.[5] Global reports show that the number of childhood deaths in developing countries particularly in Sub-Saharan Africa is still unacceptably high.[6]

In Ethiopia, pneumonia with high respiratory rate is a main single sickness slaughtering under-five years old. It is evaluated that 8,000 kids passed on because of pneumonia every year which adds to 20 percent of all reasons for deaths slaughtering more than 40,000 under-five years old consistently.[7] These deaths are effectively preventable and treatable through straightforward and financially savvy medications. Immunization, great sustenance, restrictive bosom nourishing, suitable integral sustaining and hand washing are among the preventive while, organization of anti-infection agents are among the remedial strategies which can extend the life of youngsters.[7]

Pneumonia affects all age groups. However, it has been observed that certain groups of people are at a more risk of developing the disease than others. A number of studies have been done on risk factors for acute respiratory rates in pneumonia patients and found that severity of acute reparatory rate in pneumonia patients is affected by environmental and social factors such as parental smoking, nutritional status, socio-economic factors, number of siblings under-five years of age in the household, lack of basic health services (vaccination status), lack of awareness and other associated factors like overcrowding.[8-16] A sound youngster has numerous regular guards that shield its lungs from pneumonia. Immune suppressions due to other co-infections are important risk factors for high respiratory rate per minute in pneumonia-related mortality and morbidity. Infants, children and elders experiencing ailments, for example, Acquired Immuno Deficiency Syndrome (AIDS), measles or jungle fever are likewise bound to create pneumonia with high respiratory rate per minute.[17]

Thusly, the target/objective of this investigation was to recognize hazard factors for high respiratory rates per minute in pneumonia infected children of under-five years of age. The scarcity of researches conducted in this area makes this study vital. The result of current investigation helps to have further information for predictors of the variable of interest and this in turn helps in making easy diagnosis of pneumonia in children of under-five years of age. Since, infants cannot express their feelings, the result is also important for parents and care providers in identifying cases of high respiratory rates in pneumonia infected children of under-five years of age.

MATERIAL AND METHODS

Study design and settings: Institutional based longitudinal retrospective study design was employed among pneumonia patients at Felege-Hiwot Teaching and Specialized Hospital, Amhara region, north-west Ethiopia. The investigation was led from July 01, 2016 to June 30, 2018. The hospital is the largest health facility in the region, which has been located with elevation of about 1,800 meter or 5,906 feet above sea level and serving for more than 400 pneumonia case patients per week.

Sample size and selection procedures: Sample observations/records were determined using single proportion formula with the following assumptions: estimated proportion of pneumonia patients 60% (p = 0.60), 95% CI: ($Z_{\alpha/2}$ = 1.96), and a 5% margin of error (d = 0.05).[18,19] The final sample size was therefore, 453 pneumonia patients selected randomly using probability sampling which is stratified sampling, by considering place of residence as strata. The investigation used secondary data, collected by well-trained health service providers.

Quality of data: The nature of the information was constrained by information controllers from pediatric emergency department, at the specialized and teaching hospital. The data extraction tools as well as factors remembered for the examination were tried for consistency of comprehension and their fulfilment of information things on 45 patients selected randomly. Vital corrections were made on the last information assortment sheet.

Inclusion criteria: Pneumonia infected patients of under-five years of age and who had more than sixty breaths in each minute for children whose ages were less than two months, more than 50 breaths in a minute for child patient whose ages were months and more than forty breaths in a minute for those child patient whose ages were years were included under current investigation.[1-11] The study included patients under-five years of age visited the hospital repeatedly from July 01, 2016 to June 30, 2018 for pneumonia cases. Patients had visiting times because of pneumonia for getting treatment from the hospital in the study period.[2-14] Hence, the investigation included those patients who had at least two visits and some of the patients had maximum of 14 visits. Patients visit the hospital for getting treatment related to pneumonia cases. The investigation didn't included those patients whose ages were greater than five years and children whose ages were under five years but had only one visits in the study period. This was done to have more observations on the same individual repeatedly.

Variables included under investigation: The response or outcome variable for this study was number of respiratory rate per minute in pneumonia patients of under-five years of age. The response variable was count or discrete in nature.

The explanatory variables were sex (male, female), age in months, weight in kg, body temperature in degree Celsius, residence area (urban, rural), family disease history: asthma (yes, no), tuberculosis (yes, no), seasonal variation (autumn, spring, summer, winter), cough history (yes, no), previous disease history such as: asthma (yes, no), tuberculosis (yes, no), malaria (yes, no), diarrhea (yes, no), vaccination history of the child (yes, no), treatment type (amoxicillin, ampicilline, ceftriaxone, gentamicin, penicillin),vomiting status (yes, no) breast feeding type: exclusive (B), complimentary (C), both (B and C), number of follow-ups (visits) and number of waiting time in a hospital (being inpatient) in days.

STATISTICAL METHOD OF ANALYSIS

This study used trend analysis of respiratory rate change and multivariate decomposition for respiratory rate change. The trend in respiratory rate measure was analysed by applying explanatory data analyses, classified by gender, male-female, and for the selected socio-demographic factors (characteristics). The pattern was inspected independently for the periods Day 1-Day 3, and Day 3-Day 6.

Statistical multivariate decomposition analysis of change in respiratory rate change was utilized to respond to the significant research question of this study. The analysis was a multivariate regression decomposition of the difference in respiratory rate change into two measures (Day 1 and Day 3 with Day 3 and Day 6). The reason for the multivariate decomposition investigation was to recognize the wellsprings of changes in the respiratory rate for six day. Both changes in population composition and population behaviour related to respiratory rate (effect) are important. This strategy is utilized for a few purposes in demography, economical aspects, and different fields. The present study investigation focused on how respiratory rate changes in under-five pneumonia patients' characteristics and how these factors shape differences across admitted as admitted days at different times. The technique utilizes the output from Poisson regression model to parcel out the observed difference in respiratory rate change into components. This difference can be attributed to compositional changes between days (endowment or differences in characteristics) and to changes in effects of the selected explanatory variables (i.e. differences in the coefficients due to changes in population behaviour). Hence, the observed difference in respiratory rate change between different days is additively decomposed into a characteristics (or endowments) component and a coefficient (or effects of characteristics) component. STATA 14 was utilized for data on the board and examinations. During testing of statistical importance or significance (95% confidence interim), complex inspecting methods were considered.

Algebraically multivariate decomposition equation for count models:

$$\frac{\bar{Y}_A}{\bar{R}_A} - \frac{\bar{Y}_B}{\bar{R}_B} = \frac{\overline{F(X_A\beta_A + \log R_A)}}{\overline{R_A}} - \frac{\overline{F(X_B\beta_B + \log R_B)}}{\overline{R_B}} \quad \text{Multivariate Decomposition}$$

The characterstic component (Endowment):

$$E = \frac{\overline{F(X_A\beta_A + \log R_A)}}{\overline{R_A}} - \frac{\overline{F(X_B\beta_A + \log R_B)}}{\overline{R_B}}$$

The coefficient component (Coefficient):

$$C = \frac{\overline{F(X_B\beta_A + \log R_B)}}{\overline{R_A}} - \frac{\overline{F(X_B\beta_A + \log R_B)}}{\overline{R_B}}$$

The portion that can be attributed to the change in multivariate decomposition or the prevalence of a set of characters (referred to as the endowments portion, and represented by X_A and X_B), and the portion that can be attributed to the change in the effect of these indicators (referred to as the coefficients portion, and represented by β_A and β_B [18-20]

RESULTS

The medical cards of 453 pediatric pneumonia patients have been reviewed out of 1572 pediatric pneumonia patients and all of the 453 patients had visited the hospitalized at least twice, 45 patients were dropouts because of death, change treatment site and for other reasons. Among these, 320 (70.6%) had 14 visiting times, only 130 (28.7%) had 6 days being inpatient(admitted at each visiting times for treatment) in the hospital for the study period; this is because of the severity of their illness and 84 (18.5%) patients were outpatients(the cases were non-fatal). Out of the selected samples, 201 (44.37%) were females, 42 (9.3%) had previous asthma cases, 63 (13.9%) had previous diarrheal cases, 10 (2.2%) had previous malaria cases, 20 (4.4%) had tuberculosis and the remaining had no previous disease history. The vaccination history indicates that, 350 (77.3%) of them were fully vaccinated and the rest were partially vaccinated or not vaccinated by the World Health Organization (WHO) criteria. The feeding type category shows that 159 (35.1%) were exclusively breast-fed (B), 24 (5.3%) had complementary feeding (C) and the had both exclusively breast-fed (B) and complementary feeding (C).

From the treatment type, 40 (8.9%) cases were treated by Amoxicillin, 15 (3.4%) cases were treated by Ampicillin, 184 (40.7%) cases were treated by Ceftriaxone, 25 (5.6%) cases were treated by Gentamicin,149 (32.9%) cases were treated by Penicillin, 34 (7.5%) cases were treated by both Gentamicin and Ampicillin, 4 (0.9%) cases were treated by both Gentamicin and Ceftriaxone.

The seasonal variation indicates that, 143 (31.6%) cases were treated in autumn,118 (26.1%) cases were treated in summer, 81 (17.8%) cases were treated in spring and the remaining were treated in winter. The vomiting status indicates that 132 (51.1%) cases had vomiting history. Of all the patients, 229 (50.6%) cases were from rural areas. Among the patients, 331 (73%) had cough history. Regarding family disease history, 54 (11.9%) cases had history of asthma (Asm), 42 (9.3%) cases had history of tuberculosis (TB) and the remaining had no disease history from their families. All the baseline results are summarized in Table 1.

TABLE 1: Baseline socio-demographic and clinical characteristics of the pneumonia patients (n=453).

Characteristics	**Levels**	**Median (Q1, Q3)**	**n (%)**
Respiratory rate	Quantitative	49.35(24,84)	
Age in months	Quantitative	13.91(6,48)	
Weight in kg	Quantitative	7.83(2,18)	
Temperature (C^0)	Quantitative	37.1(38.5,40.4)	
Sex	Female		201(44.4)
	Male		252(55.6)
Previous disease history	Asthma(Asm)		42(9.3)
	Diarrhea(Dia)		63(13.9)
	Malaria(Mal)		10(2.2)
	Tuberculoses(TB)		20(4.4)
	No		318(70.2)
Vaccination status	Yes		350(77.3)
	No		103(22.7)
Breast feeding	Exclusive Breast(B)		159(35.1)
	Complementary(C)		24(5,3)
	B&C		159(59.6)
Treatment type	Amoxicillin(Amo.)		40(8.9)
	Ampicillin(Amp.)		15(3.4)
	Ceftriaxone(Cef.)		184(40.7)
	Gentamicin(Gent.)		25(5.6)
	Penicillin(Pen.)		149(32.9)
	Gent.&Amp.		34(7.5)
	Gent.&Cef.		4(0.9)
Season of the year	Autumn		143(31.6)
	Summer		118(26.1)
	Spring		81(17.8)
	Winter		111(24.5)
Vomiting status	Yes		232(51.1)
	No		221(48.9)
Residence	Rural		229(50.6)
	Urban		224(49.4)
Cough status	Yes		331(73)
	No		122(27)
Family disease history	Asthma		54(11.9)
	Tuberculosis (TB)		42(9.3)
	No		357(78.8)

Q1: Quartile one, Q3: Quartile three, n (%): Total number (percentage).

TRENDS IN RESPIRATORY RATE

Based on Table 2, the mean respiratory rate for child pneumonia patients at Day 1 were around 59 with 9.238 standard variation. Similarly, the mean respiratory rates of child pneumonia patients' at Day 3 were 51 with 8.302 standard deviations. Lastly, the mean respiratory rates of child pneumonia patients' at Day 6 were 41 with 6.867 standard variances.

Among pneumonia patients, respiratory rate decreased from 59 on average from Day 1 to 51 on average in Day 3 and 41 on average in Day 6. Also, the standard deviation shows decreasing from 9.238 to 6.867 this means the respiratory rate becomes more consistent when the number of days stayed in hospital increases. The calculated skewness (shape parameter) shows that the data is statistically negative skewed for Day 1 and

Day 3 means the minimum values are more frequent than the maximum; and positive skewed for Day 6 which means maximum values are more frequent than minimum by referring the mean value or generally the normal distribution.

TABLE 2: Descriptive statistics for the response variable.

	Smallest	larger	Average (Mean)		Std.	Skw.	
Measure	Value	Value	Value	Std. Error	Value	Value	Std. Error
Respiratory rate Day 1	32	84	58.67	.434	9.238	-.207	.115
Respiratory rate Day 3	28	70	50.67	.390	8.302	-.161	.115
Respiratory rate Day 6	24	60	40.87	.323	6.867	.427	.115

Std= Standard deviation; Skw= Skewness.

Based on Figure 1, in descriptive statistics, exploratory data analysis (EDA) is a technique to analyze data sets to show their main patterns, regularly with visual techniques. A statistical model can be utilized or not, however principally EDA is for seeing what the information can let us know past the conventional displaying or speculation testing task. In this study to visualize the data we use mean profile analysis.

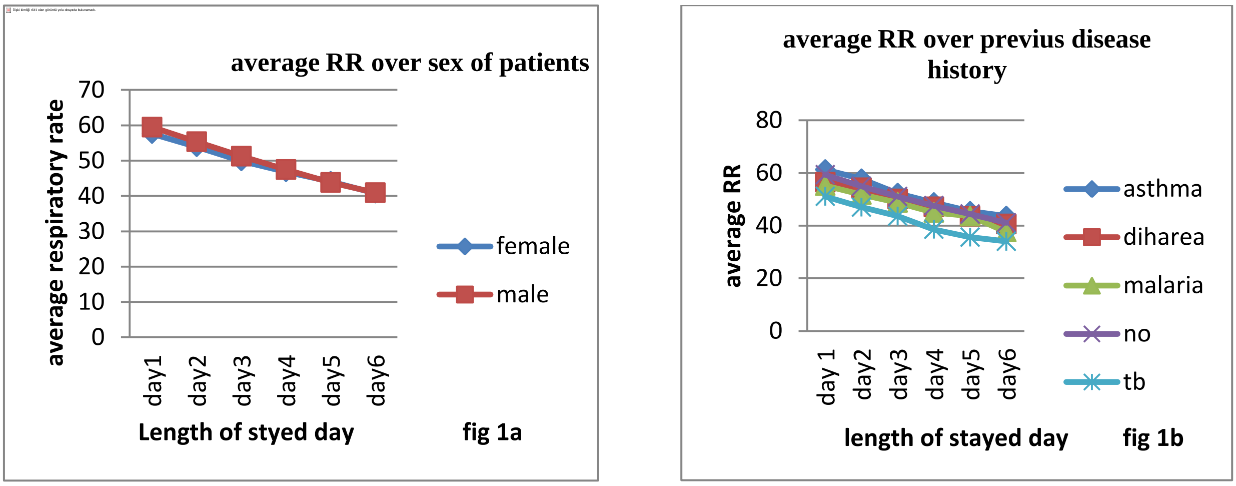

FIGURE 1a,b: Profile plot for sex and previous disease history.

The average number of respiratory rate for both males and females decreased in medium rate from Day 1 up to Day 6. The average number of respiratory rate for males was greater than average respiratory rate of female at Day 1 and it becomes around equal at Day 6 (Figure 1a).

Also, the average number of respiratory rate for asthma, tuberculosis and patients without previous disease history decreased in medium rate from Day 1 up to Day 6; while the average respiratory rate for patients with previous disease history diarrhoea seems unchanged from Day 1 up to Day 2, and decrease by medium rate from Day 2 up to Day 6; similarly, the average respiratory rate for patients with previous disease history malaria decreased in medium rate from Day 1 up to Day 4, seems unchanged from Day 4 up to Day 5 and decreased by high rate from Day 5 up to Day 6. From the above graphs, we can say that there is between or with interaction effects by sex (no parallel profile), between sex main effect (no equal level profiles and no coincident profiles), and within sex main effects (no flatness profiles). Generally for the other categorical variables the graph looks like similar and it indicates that there is decreasing pattern through time stay in hospital (Figure 1a,b).

DECOMPOSITION ANALYSIS

The Day 1 and Day 3 decomposition analysis shows that about 13.498% of the total percentage difference of respiratory rate of pneumonia patients was because of change in characteristics (compositional factors). Among the decomposition factors, a significant contribution to the positive difference in respiratory rate change was associated with body temperature of the patient. Body temperature is the significant variable for change in respiratory rate. Additionally, difference in respiratory rate change was related with variation of the treatment type under that treatment period and the change in the decomposition of treatment type had a statistically significant effect for the change in count of pneumonia patients respiratory rate (Table 3).

Upon tests for the role of compositional changes, 86.502% of the decrease in respiratory rate was attributable to various character effects. Factors including weight, vomiting history, and family disease history show negative and significant change in respiratory rate. Similarly, immunization, breast-feeding show positive and significant change in respiratory rate. Other things being equal, about half of the change in respiratory rate in the within the first three days was due to a change in respiratory rate among the fully immunized patients (Table 3).

TABLE 3: Multivariate decomposition of different characteristics at Day 1 to Day 3.

	Day 1 Respiratory Rate-Day 3 Respiratory Rate					
	Endowment (E)			Coefficient (C)		
Respiratory Rate	**Coef.**	**P>z**	**Per**	**Coef.**	**P>z**	**Per**
Age	0	.	0	1.2028	0.184	15.035
Weight	0	.	0	-4.0065	0.059*	-50.081
Temperature	1.165	0.001***	14.566	-3.8955	0.853	-48.694
Sex	0	.	0	-.26298	0.870	-3.2873
Previous Disease	0	.	0	1.1606	0.477	14.508
Immunized	0	.	0	4.4203	0.065*	55.253
Breastfeeding	0	.	0	3.1665	0.063*	39.582
Treatment type	.011	0.013**	.126	1.2737	0.177	15.921
Weather	-.001	0.547	-.0053	-.80818	0.420	-10.102
Vomiting history	-.069	0.220	-.864	-4.5783	0.005***	-57.228
Resident	0	.	0	1.3048	0.402	16.31
Cough	-.026	0.419	-.325	1.2529	0.694	15.661
Family disease history	0	.	0	-3.563	0.097*	-44.537
Constant	.	.	.	10.253	0.632	128.16
Total			13.498			86.502

* Significant at 0.1 (p<0.1)
** Significant at 0.05 (p<0.05)
*** Significant at 0.01 (p<0.01)

Coef.= Coefficient; P= p-value; z= Wald statistics; Per= Percent.

The Day 3 and Day 6 multivariate decomposition result show that about 7.602% of the total percentage difference of respiratory rate of pneumonia patients was due to difference in characteristics (decomposition factors). Among the decomposition factors, a remarkable effect to the difference in respiratory rate change was related with the vomiting history under that treatment period and the decomposition of vomiting history had a statistically significant effect for the change in count of pneumonia patients respiratory rate. Body temperature is a significant factor for change of respiratory rate. Thus an increase in the decomposition of body temperature had a statistically significant effect for the change in count of pneumonia patients' respiratory rate.

Additionally, compositional changes slightly decreased in their average respiratory rate under the descriptive statistics result and decrease in the cough make negative effect and treatment types make a positive contribution to decrease in respiratory rate.

After controlling for the role of compositional changes, 92.398% of the decrease in respiratory rate was due to difference in the effects of characteristics in Day 3 and Day 6 follow-ups. Factors including body temperature and treatment type showed positive and significant effect on observed change in respiratory rate and cough status showed negative and significant effect on observed change in respiratory rate (Table 4).

TABLE 4: Multivariate decomposition of different characteristics at Day 3 to Day 6.

	Day 3 Respiratory Rate-Day 6 Respiratory Rate					
	Endowment (E)			Coefficient (C)		
Respiratory Rate	**Coef.**	**P>z**	**per**	**Coef.**	**P>z**	**Per**
Age	0	.	0	-.37344	0.657	-3.8101
Weight	0	.	0	.72333	0.710	7.3799
Temperature	1.157	0.001***	11.804	53.797	0.015**	548.87
Sex	0	.	0	1.2847	0.387	13.107
Previous Disease	0	.	0	1.7689	0.239	18.048
Immunized	0	.	0	-.77291	0.722	-7.8858
Breastfeeding	0	.	0	2.066	0.190	21.079
Treatment type	.0178	0.690	.18114	1.5915	0.058*	16.238
Weather	0	.	0	1.3586	0.143	13.861
Vomiting history	.515	0.007***	5.251	-.76412	0.546	-7.7961
Resident	0	.	0	-.99916	0.481	-10.194
Cough	-.944	0.160	-9.635	-3.3468	0.037**	-34.146
Family disease history	0	.	0	-.66263	0.738	-6.7606
Constant	0	.	0	-46.615	0.039	-475.59
Total			7.6024			92.398
* Significant at 0.1 (p<0.1) ** Significant at 0.05 (p<0.05) *** Significant at 0.01 (p<0.01)						

Coef.= Coefficient; P= p-value; z= Wald statistics; Per= Percent.

The Day 1 and Day 6 multivariate decomposition result show that about 8.599% of the total percentage change of respiratory rate of child pneumonia patients was due to difference in characteristics (endowment). Among the compositional factors, treatment type and body temperature had remarkable effect to the change in respiratory rate change of the patient. Again, body temperature is an important variable for change of respiratory rate.

We find that differences in effects account for 86.502% of the decrease in respiratory rate was due to difference in the effects of characteristics (coefficient), with differences in intercepts (baseline logits). Factors including body temperature, breastfeeding, treatment type and vomiting status showed positive and significant effect for the observed change in respiratory rate. Other things being equal, about three folds of the change in respiratory rate in the within the first three days was due to a change in respiratory rate among the variations in patients body temperature (Table 5).

TABLE 5: Multivariate decomposition of different characteristics at Day 1 to Day 6.

	Day 1 Respiratory Rate-Day 6 Respiratory Rate					
	Endowment (E)			Coefficient (C)		
Respiratory Rate	**Coef.**	**P>z**	**per**	**Coef.**	**P>z**	**Per**
Age	0	.	0	.68411	0.432	3.843
Weight	0	.	0	-2.8359	0.162	-15.931
Temperature	2.428	0.001***	13.638	54.142	0.012**	304.15
Sex	0	.	0	1.1383	0.460	6.3943
Previous Disease	0	.	0	2.9394	0.058*	16.513
Immunized	0	.	0	3.1557	0.167	17.727
Breastfeeding	0	.	0	5.065	0.002***	28.453
Treatment type	.125	0.013**	.69941	2.7733	0.001***	15.579
Weather	-.001	0.547	-.00236	.72608	0.453	4.0788
Vomiting history	-.339	0.221	-1.9021	-4.2195	0.002***	-23.703
Resident	0	.	0	.10616	0.943	.59634
Cough	-.682	0.423	-3.833	-2.8226	0.109	-15.856
Family disease history	0	.	0	-3.9199	0.057*	-22.021
Constant	0	.	0	-40.662	0.067*	-228.42
Total			8.599			91.401

* Significant at 0.1 (p<0.1)
** Significant at 0.05 (p<0.05)
*** Significant at 0.01 (p<0.01)

Coef.= Coefficient; P= p-value; z= Wald statistics; Per= Percent.

DISCUSSION

The purpose of this paper was to show trends and to decompose for the progression of respiratory rate of child pneumonia patients in Bahir Dar Felege-Hiwot referral hospital by using EDA and Multivariate Decomposition for count data procedure. The study uses the hospital chart to collect data from January 01/ 2016 up to December 30/ 2018 to identify some of the factors that are responsible for the progression.

This study proves that age in month of a patient has negative effect on being tachypneic. Age of a patient naturally increases breathing per minute decreases naturally. But, age of a child patient over weight of a child patient has positive effect on the respiratory rate of child pneumonia patients. This finding is consistent with[21] and.[5]

This study found that temperature of a patient is another highly and statistically significant variable for the progression of average number of respiratory rate of pediatric pneumonia patients. Temperature of a pediatric pneumonia patient found to be having positive effect on the respiratory rate of a patient. This indicates that fever of a patient is responsible for the average respiratory rate change. Similarly, weight of a child, immunization status, breastfeeding type, and vomiting history were found to have statistically significant effect on the respiratory rate of a patient. This finding is in line with the results reported by other literatures[16] and.[17]

CONCLUSION

Respiratory rate change among pediatric pneumonia patients has shown a remarkable decrease over the six days hospital stay. 13% of the overall change in respiratory rate over the hospitalization period was due to difference in characteristics between Day-one and Day-three. Changes in the composition of body temperature, treatment type and vomiting history were the major sources of the decrease in respiratory rate in patients.

The most (87%) of the decrease in respiratory rate was because of difference in pneumonia patients' behaviour. Most notably, the decrease was due to difference in respiratory rate behaviour among the patients with vomiting history and treatment type variation.

Special attention shall be given to patients who have body fever, vomiting history and treatment type variation among child patient to stabilize patients' status.

Limitation of study: This study is not without limitation. The present study has absence of secondary data about nutrition type. There are time variant variables and we didn't consider the effect. Further studies that can fullfill these gaps need to determine the case for variation of respiratory rate of pneumonia patients under-five years of age.

Ethics Approval and Consent to Participate

This study was reviewed and approved by the Bahir Dar University of Science College Research Ethics Committee and Felege Hiwot Referal Hospital Patient's Ethics Committee. As the study was based on retrospective data, informed consent was not needed.

Consent for Publication

MAD give consent information for himself and relatives to publish this research manuscript

Availability of Data and Materials

The secondary data, which is available with the corresponding author, will not be made available publically due to concerns about protecting participants' identity and respecting their rights to privacy. At the time, the data was collected; informed consent form was not obtained from participants for publication of the dataset.

Acknowledgement

Felege-Hiwot Teaching and Specialized Hospital and all health staff, is gratefully acknowledged for the data they supplied for our health research, Prof. Temesgen Z. and Dr. Esseye K. for their valuable motivations, comments and language corrections.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

This study is entirely author's own work and no other author contribution.

REFERENCES

1. Izurieta HS, Thompson WW, Kramarz P, Shay DK, Davis RL, DeStefano F, et al. Influenza and the rates of hospitalization for respiratory disease among infants and young children. N Engl J Med. 2000;342(4):232-9. PMID: 10648764 [Crossref] [PubMed]
2. Maganga ER. Pneumonia case fatality rate in children under-five: understanding variations in district hospitals in Malawi. 2004. [Link]
3. Garenne M, Ronsmans C, Campbell H. The magnitude of mortality from acute respiratory infections in children under 5 years in developing countries. World Health Statistics Quarterly. 1992;45(2/3):180-91.
4. World Health Organization. Health Situation Analysis in the African Region Atlas of Health Statistics, 2011. World Health Organization: India, Replika Press Pvt. Ltd; 2011. p.85.
5. Black RE, Morris SS, Bryce J. Where and why are 10 million children dying every year? Lancet. 2003;361(9376):2226-34. [Crossref] [PubMed]
6. Organization, W.H., Global Health Risks-Mortality and burden of disease attributable to selected major risks. The Lancet. 2015.
7. National scale-up of integrated community case management in rural Ethiopia: implementation and early lessons learned. Ethiop Med J. 2014;52(Suppl 3):15-26. [PubMed]
8. Armstrong JRM, Campbell H. Indoor airpollution exposure and lower respiratory infections in young Gambian children. Int J Epidemiol. 1991;20(2):424-9. [Crossref] [PubMed]
9. Cerqueiro MC, Murtagh P, Halac A, Avila M, Weissenbacher M. Epidemiologic risk factors for children with acute lower respiratory tract infection in Buenos Aires, Argentina: a matched case-control study. Rev Infect Dis. 1990;12(Suppl 8):S1021-8. [Crossref] [PubMed]
10. Tupasi TE, Manguba NV, Sunico ME, Magdangal DM, Navarro EE, Leonor ZA, et al. Malnutrition and acute respiratory tract infections in Filipino children. Rev Infect Dis. 1990;12(Suppl 8):S1047-54. [Crossref] [PubMed]

11. Victora CG. [Risk factors for acute lower respiratory infections]. In: Benguigui Y, Antuñano FJL, Schmunis G, Yunes J, eds. Infecciones Respiratorias En Niños. Serie HCT/AIEPI-1. Washington, D.C.: Pan American Health Organization; 1999: p.41-58.
12. Smith TA, Lehmann D, Coakley C, Spooner V, Alpers MP. Relationships between growth and acute lower-respiratory infections in children aged less than 5 y in a highland population of Papua New Guinea. American J Clin Nutr. 1991;53(4):963-70. [Crossref] [PubMed]
13. Cruz JR, Pareja G, de Fernández A, Peralta F, Cáceres P, Cano F. Epidemiology of acute respiratory tract infections among guatemalan ambulatory preschool children. Rev Infect Dis. 1990;12(Suppl 8):S1029-34. [Crossref] [PubMed]
14. Selwyn B. The epidemiology of acute respiratory tract infection in young children: comparison of findings from several developing countries. Coordinated Data Group of BOSTID Researchers. Rev Infect Dis. 1990;12(Suppl 8):S870-88. [Crossref] [PubMed]
15. Victora CG, Smith PG, Barros FC, Vaughan JP, Fuchs SC. Risk factors for deaths due to respiratory infections among Brazilian infants. Int J Epidemiol. 1989;18(4):918-25. [Crossref] [PubMed]
16. Graham NM. The epidemiology of acute respiratory infections in children and adults: a global perspective. Epidemiol Rev. 1989;12:149-78. [Crossref] [PubMed]
17. WHO, UNICEF, World Bank. State of the world's vaccines and immunization. 3rd ed. Geneva: World Health Organization; 2009. p.156.
18. Cameron AC, Trivedi PK. Regression Analysis of Count Data. 2nd ed. Vol. 53. Cambridge: Cambridge University Press; 2013. p.587.
19. Powers DA, Yoshioka H, Yun MS. mvdcmp: multivariate decomposition for nonlinear response models. Stata Journal. 2011;11(4):556-76. [Crossref]
20. Cameron AC, Johansson P. Count data regression using series expansions: with applications. Journal of Applied Econometrics. 1997;12(3):203-23. [Crossref]
21. Wingerter SL, Bachur RG, Monuteaux MC, Neuman MI. Application of the world health organization criteria to predict radiographic pneumonia in a US-based pediatric emergency department. Pediatr Infect Dis J. 2012;31(6):561-4. [Crossref] [PubMed]