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Assessing the Trend of Malnutrition among Children Under Five Years in West Gonja District, Ghana

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Abstract:
The research paper seeks to investigate the trend of malnutrition cases among children under five years in the West Gonja District. A cross-sectional survey approach was used to recruit respondents for primary results. Desktop analysis was used to collect secondary data that included opinions of other people on the field of study. 150 sample sizes were determined with a malnutrition prevalence rate of 200 percent and a margin of 5 percent error and a confidence interval of 95 per cent. Stratified sampling was employed. The primary and secondary data were analyzed using SPSS, R program, Minitab and Gretl. The responses were put into summary statistics, figures, one-way ANOVA, trend to facilitate successful discussion. Finding revealed that underweight of the children under five years can be described by quadratic trend and ARIMA(0,1,1). The findings further revealed that, there were significant difference among children weight categories but remain same across the various years from 2014 through 2019.The findings finally revealed that the malnutrition of the children under five years of age are likely to decrease drastically for next five years if the intervention program is effectively managed and maintained. The research paper concluded that the malnutrition of the children under five years of age likely to decrease drastically for next five years if the intervention program are effectively managed and maintained as indicated on the forecasted curve. The District Health Directory should deploy more Nurses for home monitoring in order to arrest the situation at stake.

Keywords: *Autocorrelation function, partial autocorrelation function, stationarity, parameter estimation, parsimonious model and differencing, time series analysis, linear trend model and quadratic trend model, malnutrition, analysis of variance, underweight and malnourish*

1. Introduction

In many ways, children worldwide are considered to be fragile and sensitive, especially in health matters. Nutritional and malnutritional deficiencies typically affect children more than any other group. Bad nutrition exists both in developing countries, and in the world's more developed regions. According to the WHO Progress Report (2002), hunger and malnutrition remain the most crippling issues for the poor and vulnerable in the world.

Malnutrition refers to a dietary deficit. Malnutrition is, thus, both a health consequence and a risk factor for illness. It can make morbidity and mortality more likely. Child malnutrition in developing countries in 2001 was associated with 54 per cent (10-8 million) child deaths. Worldwide, children under 5 years are considered to be vulnerable in health matters. Nutritional deficiencies typically have more effect on children than any other group.

Malnutrition affects as many as 800 million people globally, and more than half of childhood deaths in developed countries are malnutrition-related (Benson and others 2004). About 30 per cent of mankind was suffering from one or more forms of malnutrition (WHO, 2000). According to the United Nations Standing Nutrition Committee (SCN). Malnutrition is the world's greatest single contributor to illness. According to the UNICEF report, in Ghana too many children suffer from health problems caused by malnutrition, which is the underlying cause of one third of all child deaths. In Ghana more than one out of five infants is stunted (suffering from chronic malnutrition).

The situation in the northern region is worse, where 37% of children are stunted because of childhood malnutrition. Ghana Health Service (GHS) figures available on September 20, 2012 suggest that 12,000 children in Ghana die each year from malnutrition-related underweight ailments. Statistics also suggest that under nutrition, one out of thirteen (13) children in Ghana die before their fifth birthday mainly as an infant leads to around half of all deaths after early childhood under nutrition.

Globally and locally, a number of efforts are being made to reduce the burden of malnutrition, especially in developing nations to which Ghana is no exception. Among other issues, the Fourth Millennium Development Goals (MDGs) target to reduce under five 2/3rd mortality by 2016. As a result, a variety of measures were placed in motion to ensure this is done. Encouraging exclusive breastfeeding, implementing the school feeding system, encouraging balanced

healthy diets are the main strategies implemented over the years to accomplish this. The district of West Gonja lies in the northern region. For many years this District has been combating child malnutrition. The District health directory launched multiple measures to address the problem. Many of these measures include: public education on healthy nutrition, breastfeeding, pregnancy attendance

Malnutrition is a human-life deficiency that often affects children. It is killing, it is retarding human growth. It is a disease that affects a lot of people all over the world. When it comes to malnutrition problems, Ghana is no exception. According to the latest UNICEF report, in Ghana too many children suffer from health problems caused by malnutrition, which is the root cause of child death.

The Annual Report of the Damongo Health Service (2009) shows that children suffer from malnutrition in every five years. Yet the situation has been a problem for the District ever since.

This is since the 2015 annual report reveals that infant mortality is the second-largest cause of child death in the district. In addition to malaria, child malnutrition is the next cause of most child deaths according to the study. This paper looks at the trend of child malnutrition in the northern part of Ghana's West Gonja District

2. Research Methods

The research was a descriptive analysis with a cross-sectional analytical design conducted to access malnutrition trend in the West Gonja District. A cross-sectional survey approach used to recruit respondents for primary results. Desktop analysis was used to collect secondary data that included opinions of other people on the field of study. The target population refers to the study population of interest and has been described as households in communities with children under five years of age and who have lived in the community for at least six months.

The sample frame consists of the set of elements from which actually the sample is taken. This was composed of a list of malnourished cases obtained from the District Hospital in Damongo. Saunders et al (2007) claimed that the sample size and the way it is chosen certainly indicate the trust you can have in your data and the degree to which you can generalize with a population. Using EPI STAT CALC version 4.0.3, 150 sample sizes was determined with a malnutrition prevalence rate of 200 percent and a margin of 5 percent error and a confidence interval of 95 per cent. Stratified sampling was employed. The instrument used to gather primary data for the analysis was a questionnaire. The data were analyzed to identify the trend of child malnutrition in district. Various statistical applications such as Minitab and SPSS were used for both primary and secondary data analysis. The primary data were analyzed using SPSS, R program, Minitab and Gretl. The responses were put into summary statistics, figures, one-way ANOVA, trend to facilitate successful discussion.

3. Results and Discussion

The findings cover the effects of the various statistical methods used in the collated and coded analysis of the data. This serves as the basis for the definition, debate and conclusion to achieve the research goal

Mean	**35.50**
Standard Error	10.51
Median	30.00
Mode	NA
Standard Deviation	25.74
Sample Variance	662.30
Kurtosis	-2.45
Skewness	0.31
Range	58.00
Minimum	9.00
Maximum	67.00
Sum	213.00
Confidence Level(95.0%)	27.0074255

Table 1: Summary Statistics of the Weight of Children Under Five Years of Age below 2.5kg

The minimum number of children underweight was found to be 9 whiles the maximum underweight was also found to be 67. The average number of children underweight was 35.5 with a standard deviation of 25.74, which denote that children weightare widely spread over the mean. For the period of 2014 to 2019total number of children underweight was recorded to be 213.The distribution of the children underweight exhibits positive skewness of 0.31 which shows that most of the children underweight are centered on the right of the mean indicating that there is an improvement malnutrition among children under five years of age within the districtand -2.45 of the kurtosis value shows that the children underweight wasless extreme to the normal peak which means that the underweight data have a platykurtic distribution.

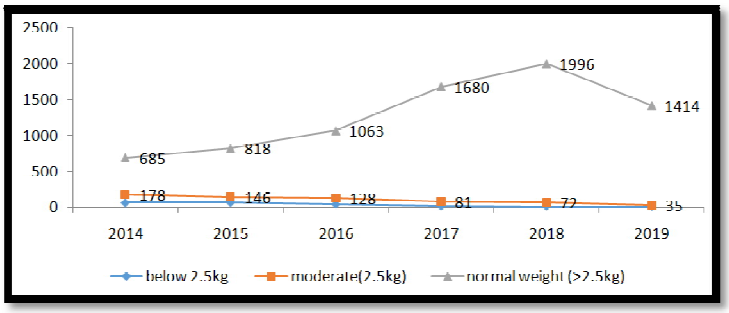

Figure 1: Shows the Weight of Children Under Five Years of Age

The normal weight of children curve flits above both the underweight and moderate weight, this suggest that there is an improvement of malnutrition situation within the district as indicated in figure 1.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	5822491	2	2911245	33.02047	**3.2E-06**	3.68232
Within Groups	1322473	15	88164.86			
Total	7144964	17				

Table 2: Analysis of Variance of the Weight of Children Under Five Years of Age

The researchers want to determine whether there is a significant difference in weight categories (below 2.5kg, moderate2.5kg and normal 2.5kg+) of children age under five in West Gonja District. As shown in table 2, there is a statistical significant difference among weight categories of children aged under five in West Gonja District as indicated by p-value=0.0000032. This implies that there is a reduction of malnutrition cases among children under five years of age within the district. Therefore, a follow-up research must be conducted to ascertain which weight categories is contribution the difference in children underweight within the district. Details of the follow-up analysis are shown in table 3 below.

	(I) weight	(J) weight	Mean Difference (I-J)	Std. Error	P-value
Tukey HSD	below 2.5kg	moderate 2.5kg	-71.16667	1.71430E2	.910
		normal>2.5kg	-1240.50000*	1.71430E2	.000
	moderate 2.5kg	below 2.5kg	71.16667	1.71430E2	.910
		normal>2.5kg	-1169.33333*	1.71430E2	.000
	normal>2.5kg	below 2.5kg	1240.50000*	1.71430E2	.000
		moderate 2.5kg	1169.33333*	1.71430E2	.000
LSD	below 2.5kg	moderate 2.5kg	-71.16667	1.71430E2	.684
		normal>2.5kg	-1240.50000*	1.71430E2	.000
	moderate 2.5kg	below 2.5kg	71.16667	1.71430E2	.684
		normal>2.5kg	-1169.33333*	1.71430E2	.000
	normal>2.5kg	below 2.5kg	1240.50000*	1.71430E2	.000
		moderate 2.5kg	1169.33333*	1.71430E2	.000

Table 3: Multiple Comparison of the Weight of Children Under Five Years of Age
**. The Mean Difference Is Significant at the 0.05 Level*

From table 3, both Tukey HSD and LSD methods were used to ascertain the weight categories that contribute the difference. It is clearly shown that the comparing normal weight to that of underweight and moderate saw a statistical significant difference among children under five years of aged within the district but below 2.5kg and moderate weight was not statistical difference from each other. These results re-affirm that there is a lot of improvement in malnutrition cases among children under five years of age within the district because of the social intervention like school feeding program, exclusion breastfeeding campaign and public health campaign about malnutrition among children within the district.

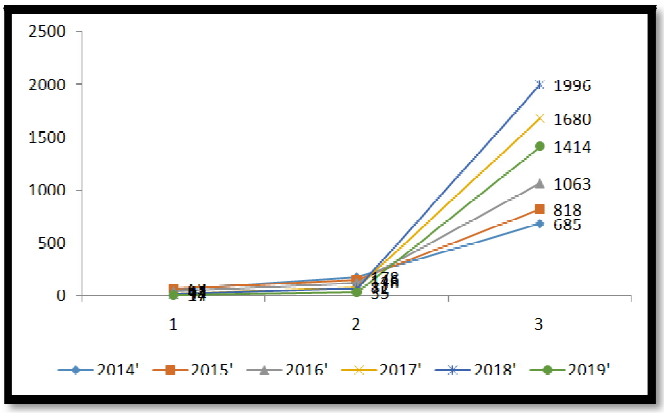

Figure 2: Shows Plot of Yearly Weight of Children under Five Years of Age

From figure 2, it is clearly shows that the normal weight experience increasing trend over six consecutive years ranging between 2014 through 2019. This again confirmed the results in table 2 and 3.

Source of Variation	SS	df	MS	F	P-value	F crit
Between Groups	332594.9	5	66518.99	0.117173	0.986092	3.105875
Within Groups	6812369	12	567697.4			
Total	7144964	17				

Table 4: Shows Analysis of Variance for Yearly Weight of Children Under Five Years of Age

The researchers again wants to established whether there is a statistical significant reduction of malnutrition cases among children under five years of age within the district. It is clearly shows that there is no statistical significant reduction of malnutrition cases from 2014 through 2019. This implies that district health directory should roll out more programs to combat the situation at stake.

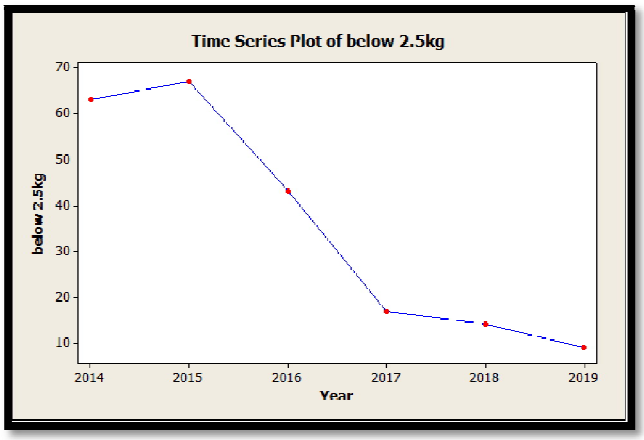

Figure 3: Time Series Plot of the Children Weight below 2.5kg

The series depict an increase between 2014 through 2015 and decrease drastically from 2016, 2017, 2018 to 2019. This increasing and decreasing fluctuation over time indicated that the mean and variance are not constant over time suggesting that the series are not stationary. This implies that the underweight cases experience decreasing trend over the study period.

Test	Statistic	p-value
KPSS	0.12248	0.1
Phillips-Perron	-3.6771	0.02

Table 5: Stationary Test

The stationarity test was conducted to ascertain the claim in figure 3 and the results tend to be true suggesting the series were not stationary. In order to achieve stationarity condition, the series was difference once in order to achieve the stationarity. KPSS test results in table 5 clearly shows that the series is stationary since the p-value (0.1) is greater than 0.05. However, the ADF test with a reverse null hypothesis indicates that the data is stationary with p-value 0.02. In conclusion, the two tests agreed that the series is stationary after first difference.

3.1. Trend Analysis

Determining the behaviour of the series is paramount to identifying the trend model that best describe the behavior of the series. Some of these models are linear, quadratic or exponential. In order to identify the model that best described the series, researchers often use the minimum values of the measures accuracy such as MAPE, MAD and MSD in the selection criterion.

3.2. Trend Models

- Linear Trend Model; is estimated using the Ordinary Least Square estimation with a general model of
  $y_t = \beta_0 + \beta_1 t + e_t$
  Where y_t is the projected value of the y variable for a selected value of t, β_o is the constant intercept; β_1 represents the average change from one period to the next.
- Quadratic Trend Model; which accounts for a simple curve is of the form
  $y_t = \beta_0 + \beta_1 t + \beta_2 t^2 + e_t$
- Exponential Growth Trend Model; accounts for exponential growth or decay. Mathematically,

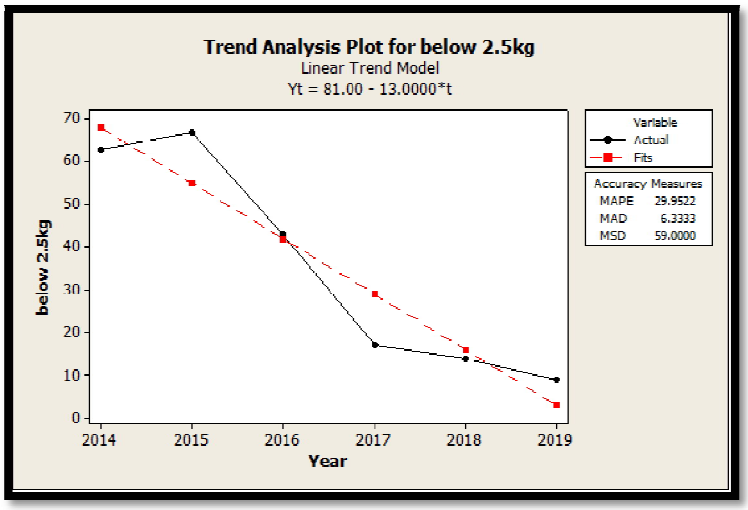

Figure 4: Linear Trend Plot of the Children Weight below 2.5kg

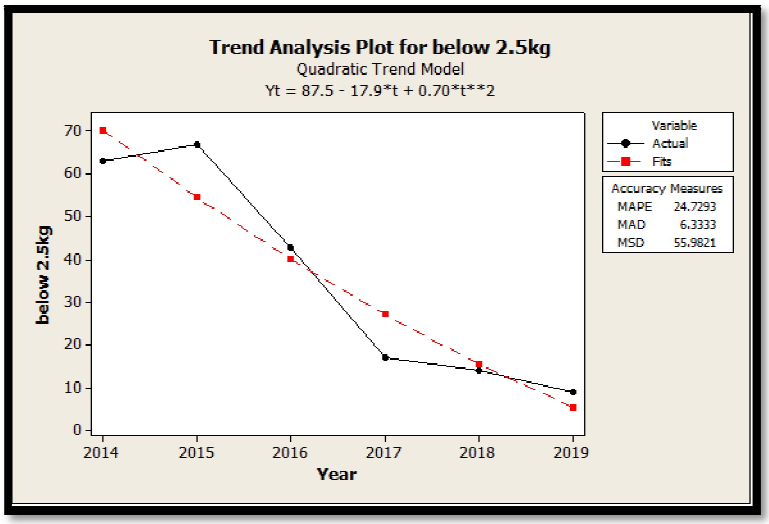

Figure 5: Quadratic Trend Plot of the Children Weight below 2.5kg

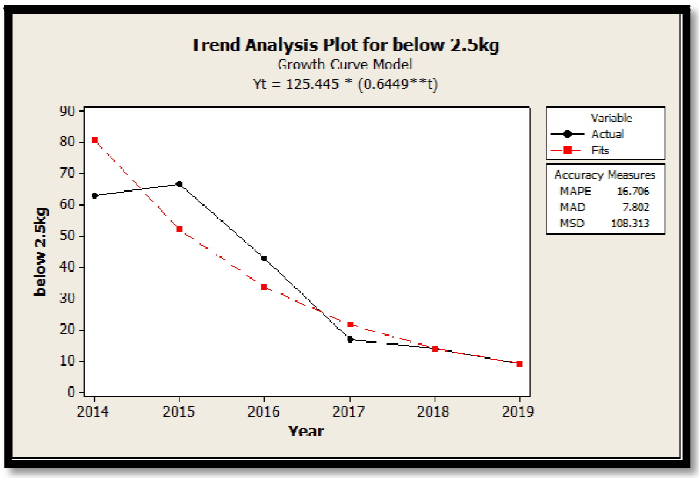

Figure 6: Exponential Trend Plot of the Children Weight below 2.5kg

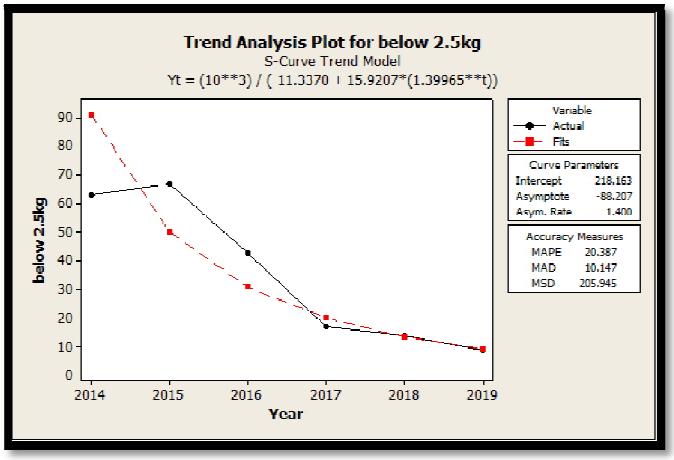

Figure 7: Curve Linear Trend Plot of the Children Weights below 2.5kg

Figures 4, 5, 6 and7show the linear, quadratic, exponential and curve linear models respectively. For the various figures the rounded dotted lines denote actuals values of underweight of the children under five years and fitted lines are based on the various models.

Model	MAPE	MAD	MSD
Linear	29.952	6.333	59.000
Quadratic	24.729	6.333	55.982
Exponential	16.706	7.802	108.313
Curve linear	20.387	10.147	205.945

Table 6: Measures Accuracy

It can be observed from table 6 that the best model to describe the trend in underweight of the children under five years over the period of 2014 to2019 is quadratic trend, since it has the minimum values of MAPE, MAD and MSD**.** This implies that quadratic trend is the most appropriate model that best describe the underweightof the children under five years within the district.

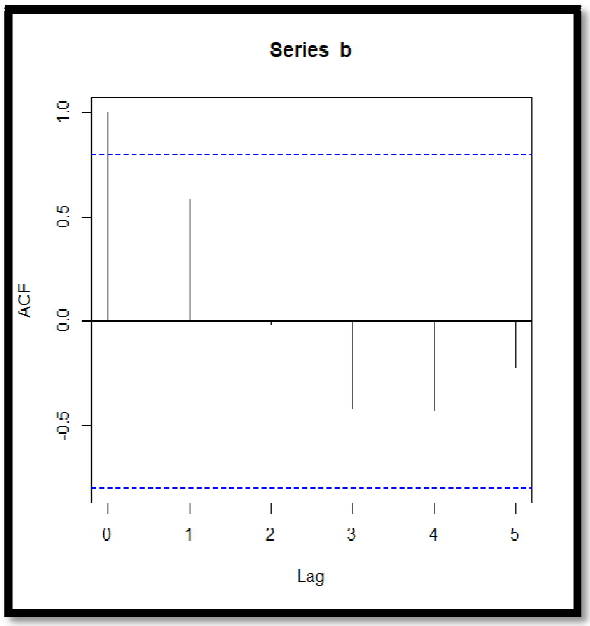

Figure 8: Acf Plot of the Children Weight below 2.5k

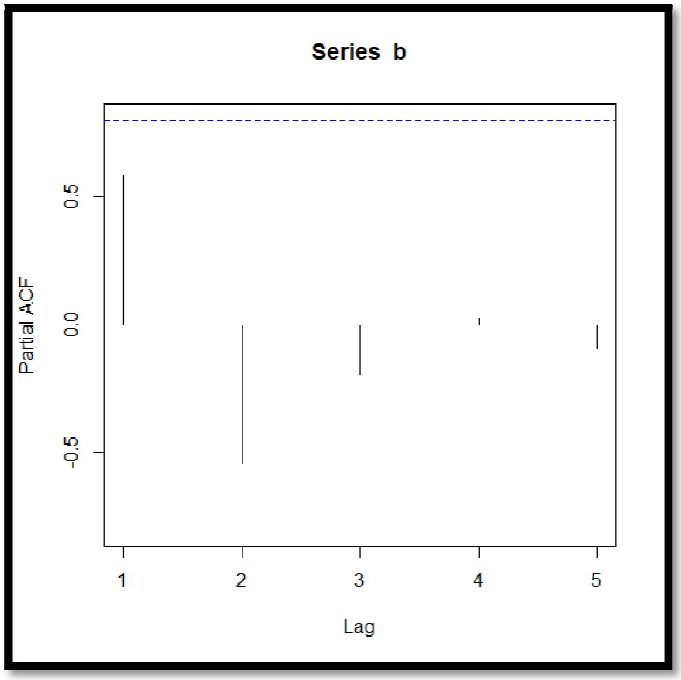

Figure 9: Pacf Plot of the Children Weight below 2.5kg

A follow-up analysis was conducted on Partial Autocorrelation Function (PACF) and Autocorrelation Function (ACF) plots. The plot of ACF and PACF for the series appears not be stationary at 95% confidence interval. The ACF divesup and down slowly with significant spikes at lags 1and there was no significant of lags of the PACF plotas illustrated in Figures 8

MODEL	AIC	SIC	HQ
ARIMA(0,1,0)	240.6954	241.5286	240.7782
ARIMA(0,1,1)	43.28044	42.10875	40.13575

Table 7: Model Identification

In order to identify the model suitable to describe the underweight of the children under five years the researchers made use of the Akaike Information Criteria (AIC), Bayesian information criterion (BIC) and Hannan-Quinn (HQ). This selection criterion would be based on the minimum values of the AIC, SIC and HQ. Thus, by careful examination of all the calculated models in Table 9the ARIMA (0, 1, 1) model has the minimum values and hence the appropriate model for estimating.

coefficient	std. error	z	p-value
const	â˜’11.3006	5.15960	â˜’2.190 0.0285 **
phi_1	â˜’0.131055	0.522709	â˜’0.2507 0.020

Table 8: Parameter Estimation

Table 8 shows the estimations of the parameters of the ARIMA (0, 1, 1) model. AR (0) and MA(1) are significant at 5% levels with coefficients and p-values of0.0285*and respectively* less than 0.05 indicating the significance of the parameters.

3.3. Model Diagnosis

To determine appropriate model there is the need to perform the following diagnosis.

3.4. Residual Plot

The patterns of the residuals over time around the zero mean as seen in figure 10 indicate that the residuals are random and independent of each other, thus, indicating that the model is fit.

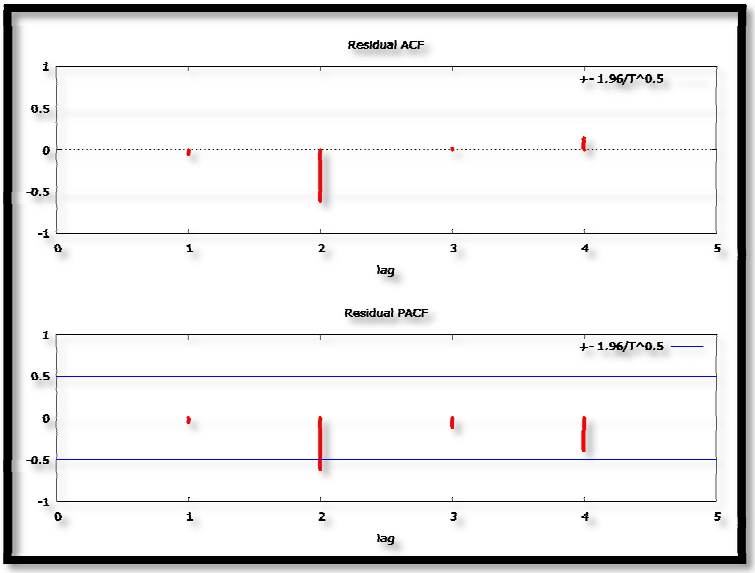

Figure 10: ACF and PACF Plot of Residuals

Figure 10: residual plot of ACF and PACF

Figure 10 shows all autocorrelation spikes within the 99% confidence interval. This means that there is no serial correlation between residuals indicating that they are accurate and the model is adequate.

3.5. Normal Q-Q Plot of the Residual

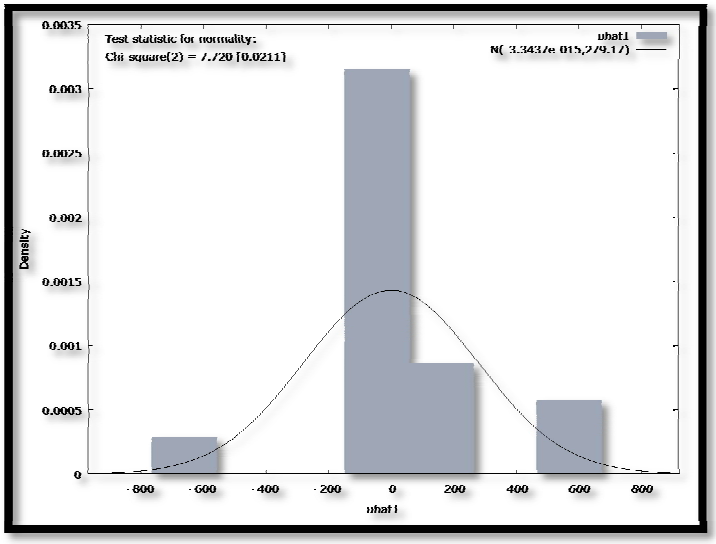

Figure 11: Normal Q-Q Plot of the Residual

The residual are normal distributed at the p-value=0.01 and this indicated that the model deemed fit.

3.6. Lung-Box Statistic

Model	Statistic	Df	p-value
ARIMA(0,1,1)	22.0653	20	0.8020

Table 10: Lung-Box Statistic

Table 10 indicatesthe lung-box statistic is 22.0653 with p-value of 0.8020 which indicate that the model is adequate and can be used for forecasting.

For 95% confidence intervals, z(0.025) = 1.96				
Obs	below_2_5kg	prediction	std. error	95% interval
2020	undefined	-3.12631	11.8949	(-26.4399, 20.1873)
2021	undefined	-14.3187	15.7582	(-45.2042, 16.5669)
2022	undefined	-25.6335	18.9584	(-62.7912, 11.5243)
2023	undefined	-36.9322	21.6784	(-79.4211, 5.55677)
2024	undefined	-48.2330	24.0949	(-95.4581, -1.00793)

Table 10: Shows Five Year Forecast of the Children Weight below 2.5kg

Figure 11: shows five year forecast of the children weight below 2.5kg

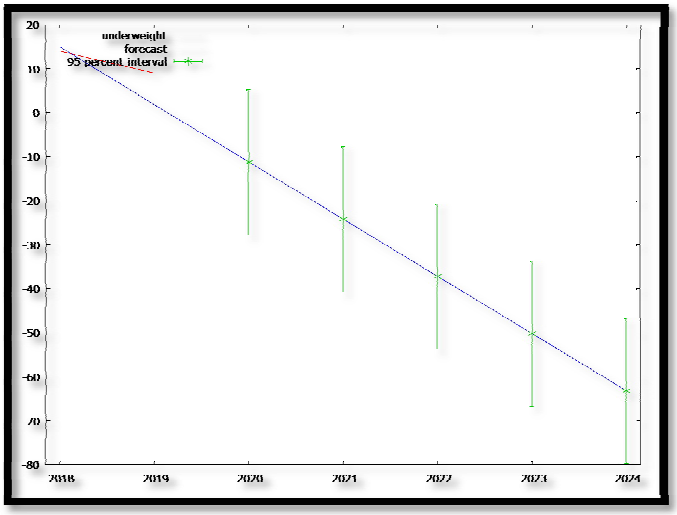

Figure 12: Forecast Graph

Figure 12 shows that the malnutrition cases among children under five years are likely to decrease for next five as indicated in the forecast curve.

4. Summary of the Findings

The finding revealed that the minimum number of children underweight was found to be 9 whiles the maximum underweight was also found to be 67. The average number of children underweight was 35.5 with a standard deviation of 25.74, which denote that children weight are widely spread over the mean. For the period of 2014 to 2019 total number of children underweight was recorded to be 213. The distribution of the children underweight exhibits positive skewness of 0.31 which shows that most of the children underweight are centered on the right of the mean indicating that there is an improvement malnutrition among children under five years of age within the district and -2.45 of the kurtosis value shows that the children underweight was less extreme to the normal peak which means that the malnutrition data have a platykurtic distribution.

Finding also revealed that underweight of the children under five years can be described by quadratic trend and ARIMA(0,1,1).

The findings further revealed that, there were significant difference among children weight categories but remain same across the various years from 2014 through 2019.

The findings finally revealed that the malnutrition of the children under five years of age are likely to decrease drastically for next five years if the intervention program is effectively managed and maintained.

5. Conclusion

The research paper concluded that the malnutrition of the children under five years of age likely to decrease drastically for next five years if the intervention program are effectively managed and maintained as indicated on the forecasted curve. Though there was a significant reduction in the number of malnutrition cases among the weight

categories, the health workers needs to intensify malnutrition campaign within district for almost three times in a month. The district health directorate should deploy nurses for home monitoring in order to arrest the situation at stake.

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