Research Article

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# Nutritional Status and Its Association with the Pattern and Risk of Acute Respiratory Infections among Infants in Rivers State, Nigeria: The Salient Factors and Way Out

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## ABSTRACT

*Nutritional status measures a child's health, in view of normal growth and development, physical activity and response to serious illness. Acute respiratory infections present diverse risks of clinical conditions among infants of varying nutritional status. The aim was to determine the extent and pattern of relationship between risk of acute respiratory infections (ARI) among infants and nutritional status. The study design was population-based case-control study of 1,100 randomly selected infants from 12 communities in 6 Local Government Areas of the 3 senatorial districts of Rivers State. The subjects were selected using multistage random sampling technique down to the community level. The characteristics of the subjects were represented using descriptive method whereas bivariate logistics regression at 5% level of significance was used to test the differences in ARI between normal nutritional status and some types of malnutritional status. Measures of size effect of ARI on nutritional status disparities were interpreted using odds ratio (OR). Pattern of ARI occurrence among infants with undernutrition status indicated by weight-for-age (15.4%) is higher in rural communities, than in urban communities (13.3%). While the difference in pattern of ARI occurrence among infants with undernutrition status indicated by weight-for-height (11.6%) is higher in urban communities, than in rural communities (9.1%)**.** Overall, infants with underweight (weight at -2SD and below) malnutrition status from weight-for-age and wasting malnutrition status from weight-for-height had higher frequencies of occurrence of ARI, 22.9% and 26.2% respectively than their control subjects of same nutritional status of ARI, 8.7% and 15.6% respectively. Among infants of weight-for-age (≤ - 2SD) undernutrition, the odds for ARI (unadjusted) was 3.09 times higher in significance compared to infants with normal weight-for-age, OR- Unadjusted=3.09 (p<0.0001,95%CI=0.227-0.478), whereas the odds for ARI (adjusted) was a significant risk lower among infants with normal weight-for-age by 70% (OR=0.31, p< 0.0001, 95%CI = 0.201 – 0.475) against infants having underweight malnutrition, while infants of weight-for-height (wasting) malnutrition, the odds for ARI (unadjusted) was 1.89 times higher in significance compared to infants with normal weight-for-height, OR-Unadjusted=1.89, (p<0.0001, 95% CI=0.406-0.786). These findings indicate trend of focus regarding rural and urban communities in the occurrence of ARI among infants based on under-nutritional status to effectively manage the condition, including renewed public health interventions from the prenatal period of life of the child.*

**Keywords**

Nutritional status, Acute Respiratory Infection, Pattern, Population-based Case-Control, Urban, Rural, Weight-for-age, Weight-for-height.

## Introduction

Nutritional status has been quite useful and reliable in the overall measure of a child's health, in terms of normal growth and development, physical activity and response to serious illness. Malnutrition may stem from the deficiency or absence of any nutrient. According to [1], some nutritionists had defined malnutrition as the overconsumption or under-consumption of any vital nutrient.

There are many forms of malnutrition, but our consideration is under-nutrition, one of which is Protein-Calorie Malnutrition (PCM) or Protein-Energy Malnutrition (PEM). The condition is a potentially fatal body-depletion disorder. It develops in children and adults whose consumption of protein and energy (measured by calories) are insufficient to satisfy the body's nutritional needs and so one of the leading causes of death in children in developing countries [2]. Whereas pure protein deficiency can manifest when a person's diet provides enough energy but deficient of the protein minimum, in most cases the deficiency will be dual. PEM or PCM may also manifest in persons who were unable to absorb vital nutrients or convert them to energy required for healthy tissue formation and organ function [1].

According to [3], severe PCM appears in three principal clinical forms:

1. Marasmus, characterized by chronic wasting condition and a gross underweight status that is habitually associated with early weaning.
2. Kwashiorkor, characterized by moderate growth retardation, changes to hair and skin colour, oedema, moon faces, and hepatosplenomegaly.
3. Marasmic-kwashiorkor, characterized by severe wasting and the presence of oedema. Marasmus appears by caloric and protein insufficiency, whereas kwashiorkor develops from protein deficiency.

Malnutrition is diagnosed by anthropometric measurements, physical examination and biochemical determinants. PCM is defined by measurements that fall at or below -2 standard deviations (SD) of standard weight-for-age chart (z-score chart) as, (underweight), height-for-age (stunting) and weight-for-height (wasting) [4]. Wasting indicates recent weight loss, whereas stunting usually results from being chronically underweight. For the purpose of this paper, our consideration is the weight-for-age and weight-for-height. Underweight, wasting and stunting, make up PCM, each representing different histories of nutritional deficits [2].

Low weight-for-age indicates a history of poor health or nutritional deficiencies, including recurrent illness and/or starvation. In contrast, low weight-for-height is an indicator of wasting or thinness and is generally associated with recent illness, weight loss or a failure to gain weight [5].

Epidemiological and experimental remarks had proven that malnourished children were more susceptible to infectious disease; therefore, PCM is considered a strong risk factor for higher morbidity and mortality rates in infectious disease [6].

Malnutrition-infection complex can be viewed under two facets, malnutrition compromising host defense, or infection aggravating a previously existing deficient nutritional status or triggering malnutrition through disease pathogenesis. Malnutrition can facilitate pathogen invasion and propagation; in addition, it can increase the probability of a secondary infection occurring, thus modifying both disease pathogenesis and prognosis [7]. Certain infectious diseases also cause malnutrition. It appears that there is a vicious cycle involved, where malnutrition increases disease susceptibility and disease causes a reduction in food intake. Consequently, the nutritional status of the host critically decides the outcome of infection [8]. Therefore, malnutrition is a health outcome as well as a risk factor for disease and exacerbated malnutrition and it can increase the risk of morbidity and mortality, but not necessarily the direct cause of death.

There are multiple mechanisms of action in the relationship between malnutrition and susceptibility to bacterial infectious diseases. For instance, PCM impairs normal immune system development [9]. Stimulation of an immune response by infection increases the demand for metabolically derived anabolic energy, leading to a synergistic vicious cycle of adverse nutritional status and increased susceptibility to infection (See Figure. 1). Infection itself can cause a loss of critical body stores of protein, energy, minerals and vitamins. During an immune response, energy expenditure increases at the same time that the infected host experiences a decrease in nutrient intake [10]. The metabolic response to infection includes hypermetabolism, a negative nitrogen balance, increased gluconeogenesis and increased fat oxidation, which is modulated by hormones, cytokines and other pro-inflammatory mediators [11]. During an infection, a negative nitrogen balance occurs after fever induction and then it increases and persists for days to weeks after the febrile phase. Additionally, negative nitrogen balance appears to correlate with net loss in body weight; both conditions were the result of reduced food intake and infection induced-increased nitrogen excretion [12,13].

Malnourished children suffer in greater proportion from bacterial gastrointestinal and respiratory infections [14]. The first line of defense against these types of infection is the innate immune response, particularly epithelial barriers and the mucosal immune response [15]. PCM majorly compromises mucosal epithelial barriers in the respiratory tract just as it does in the gastrointestinal and urogenital tracts. According to [16], barrier defects of mucous membranes were critical in the pathogenesis of respiratory... tract infections. Secretory immunoglobulin A (IgA) is an important constituent of the mucosal immune response that protects the upper respiratory tract against infection with pathogenic organisms.

The works of [2], suggest that protein malnutrition may deplete IgA content by suppressing the proliferation and/or maturation of IgA-producing B-cells. Additionally, studies had shown that protein malnutrition suppresses the expression of the epithelial IgA-transporting protein, which depletes the total IgA concentration in the tract. Thus, PCM appears to impair IgA-dependent mucosal immune defenses, including the production of IgA by plasma cells and its secretion into the tract.

Furthermore, serum levels of leukotrienes, which enhance leukocyte accumulation and phagocyte capacity, had been reported to be markedly diminished in children with PCM. For example, diminished leuokotriene levels were associated with reduced microbial ingestion and killing by phagocytic cells [17]. Consequently, PCM may aggravate susceptibility to respiratory infections, perhaps as a result of impaired mucosal immune response and/or systemic alterations of immune response [2]. Also, [2], in their works further stated that, there is evidence that the susceptibility of malnourished children to respiratory infections caused by encapsulated bacteria is due to defects in the production of IgG antibodies.

It is known that, one of the factors that influence the outcome of infection is the nutritional status of the person concerned (host). In this regard acute respiratory tract infections (morbidity) usually present diverse risks of clinical conditions among infants of varying nutritional status. The nutritional status for this work was assessed and graded based on calculating expected weight-for-height and by plotting expected weight-for-age, in recommended standard child's growth chart (Z-Score Chart).

The nutritional status of infants measured by weight-for-age in this study, which is associated with most favourable health outcome in view of acute respiratory infections, is the weight at respective age that falls above the -2 SD as the normal weight-for-age. Outside this range, any nutritional status of infants, indicated by weight-for-age that falls at or below the -2SD of the growth chart may mean under-nutrition or malnutrition, which may be associated with increased risk of varying degree of acute respiratory infections.

Height measured in centimeters, the average heights for age were; At birth – 50cm; at 6 months – 65cm; at 1 year – 75 cm. Average height gain, end of first year height increases by 50% [18].

## Pattern and Risk of Acute Respiratory Infections and Nutritional Status

Pattern in epidemiological reasoning in this paper refers to difference in occurrence of ARI in relation to nutritional status among study population based on geographical location [19]. The study conducted by [20], reflected that, undernourished children had an increased risk of ARI as contrasted to normal participants (RR = 3.77). A strong statistical difference exists between diseased and non-diseased participants in terms of the poor nutritional status of the child. The study from Brazil reported that ARI was not associated with the nutritional status in under-five years' children [21]. Researchers from Bangladesh reported that the prevalence of ARI in the rural community was significantly higher in ARI cases contrasted to those devoid of ARI when malnutrition (63 *vs*. 37%) was a risk correlate [22]. In the study from Ahmadabad, reported

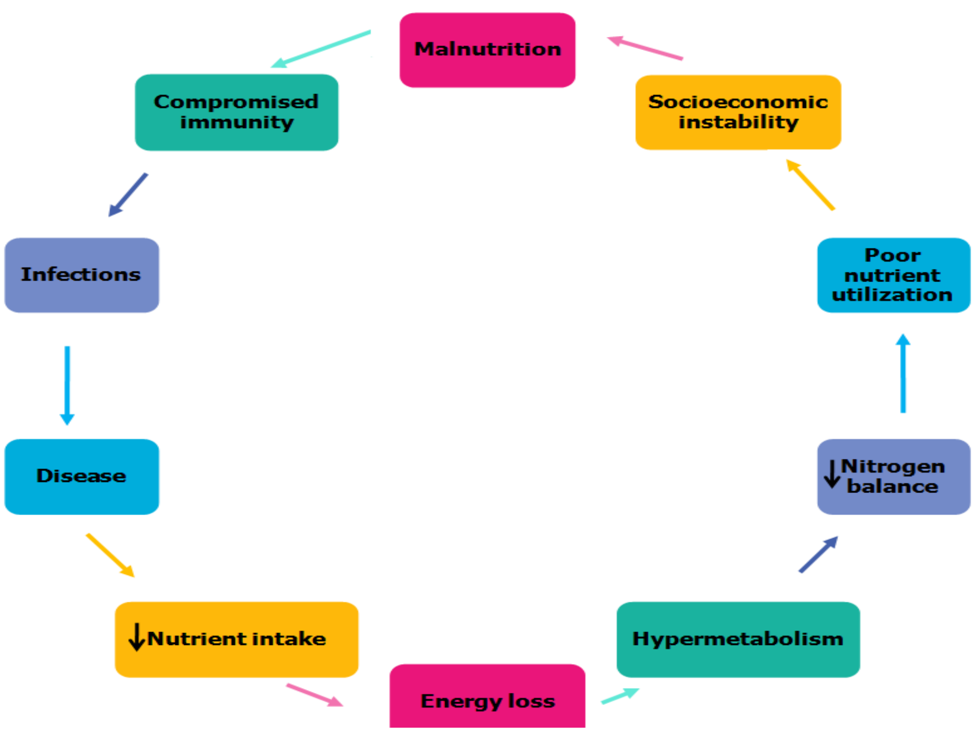


**Figure 1:** Protein Energy Malnutrition (PCM) Increases Prevalence of Infection, Leading to Energy loss for the Individual. Adapted from [8].

prevalence of ARI among under-five, significant statistical association of ARI was seen in regard to malnutrition [23]. The Delhi study observed that severe malnutrition was a significant contributor of ARI in children under-five years [24].

Also, a study from West Tripura reported that malnourished under-five children had higher likelihood for developing respiratory infection [25]. Similarly, researchers from Kolkata opined that malnutrition is significantly associated with occurrence of ARI among under-five children [26].

Results from the study by [27], showed that there were significant association regarding the nutritional status on occurrence and severity of ARI. Similar observations were documented in the studies by [22,28-30] in Southeast Asia, Bangladesh and Iraq. This could be explained that, the immunologic insufficiency which is common in malnutrition leads to infection [31,32].

The study by [33], stated that, in Enugu state, Nigeria, severe malnutrition was found to affect the prevalence of severe forms of ARI; the relative risk of malnourished children developing pneumonia was 3 times higher than the well-nourished children. Earlier, the studies by [34,35], showed an association between third degree malnutrition (severe malnutrition weighing 60% or less than their peers) and severe acute lower respiratory tract infections.

Therefore, the study that formed the foundation for this paper sought to determine the extent to which nutritional status is implicated in the pattern and risks of ARIs among infants in our setting, Nigeria.

### Aim of the Study

The aim was to ascertain the extent and pattern of association between risk of ARI among infants and nutritional status.

### Research Hypotheses

Null Hypothesis $H_0$ – There is no association between pattern and risk of ARI and nutritional status among infants in Rivers State, Nigeria.

Alternative Hypothesis $H_1$- There is association between pattern and risk of ARI and nutritional status among infants in Rivers State, Nigeria.

## Materials and Methods

### Research Design

The design for the study was population-based case – control method, aimed at determination of the pattern and risk of ARI among infants in relation to nutritional status in the areas of study.

The inclusion criteria for cases were children below 12months of age in the study areas presenting at least any two of the signs and symptoms of cough, running nose or fever less than 3 days duration among others within 2weeks of enrollment/interview. While the inclusion criteria for controls were children below 12 months of age in the study areas without such signs and symptoms within 2weeks of enrollment/interview. The exclusion criteria were removal of any case or control with difficulty in obtaining complete information required for the study. See figure 2, illustrating the design concept.

### Area of Study

The study was conducted in 12 communities of rural and urban settings, in 6 Local Government Areas (LGAs), out of 23 LGAs in the 3 senatorial districts in Rivers State, Nigeria. Rivers State with Port Harcourt as the State capital, is one of the 36 states in Nigeria with coordinates, latitudes $4^{0}51^{1}29.0761^{11}$ and $4^{0}51.4846^{1}$N, longitude $6^{0}55^{1}15.2886^{11}$ and $6^{0}55.2548^{1}$E, [36]. It has land mass of about 37,000 square kilometers and bounded in the north by Imo and Abia States; in the south by the Atlantic Ocean; to the east by Akwa Ibom State and to the west by Bayelsa and Delta States. Table 1 showed the sampling communities in the study. Urban communities in this study are defined as settlements with more population densities or concentration with more city life like economic and social activities, while rural communities, defined as settlements with less population and less economic and social activities.

**Table 1:** Communities where Samplings were conducted in the Study.

| S/N | Community | Community Status | LGA | Senatorial District |
|---|---|---|---|---|
| 1 | Akinima | Urban | Ahoada West | Rivers West |
| 2 | Okarki | Rural | Ahoada West | Rivers West |
| 3 | Buguma City | Urban | Asari-Toru | Rivers West |
| 4 | Krakrama | Rural | Asari-Toru | Rivers West |
| 5 | Okehi | Rural | Etche | Rivers East |
| 6 | Chokocho | Urban | Etche | Rivers East |
| 7 | Rumuwoji | City/Urban | Port Harcourt City | Rivers East |
| 8 | Town City Slum | Rural | Port Harcourt City | Rivers East |
| 9 | Oyigbo | Urban | Oyigbo | Rivers South East |
| 10 | Okoloma | Rural | Oyigbo | Rivers South East |
| 11 | Botem/Genebuee | Rural | Tai | Rivers South East |
| 12 | Nonwa | Urban | Tai | Rivers South East |

### Study Population

The population for the study was children under 1year. The estimated population of Nigeria was about 167 million (2006 census report) and children under 1year of age constitute 4% (6.6 million) of the total population [37].

In developing countries, such as Nigeria, 10-15 percent of all ARI may progress to disease of moderate to severe intensity [38], resulting in 29,040 to 43,560 cases annually, with variations in geographical zones and urban/rural settings.

### *Sample Size Determination*

The sample size determination was based on [39] formula.

$$\text{Sample size} = \frac{r + 1\,(p^*)\,(1-p^*)\,(Z_\beta + Z_{\alpha/2})^2}{r\,(P_1 - P_2)^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{Eq 1}$$

Where;

r = Ratio of Control to Case, 1 for equal number of Case and Control

## Schematic Diagram of Case-Control Study (Observational Study)

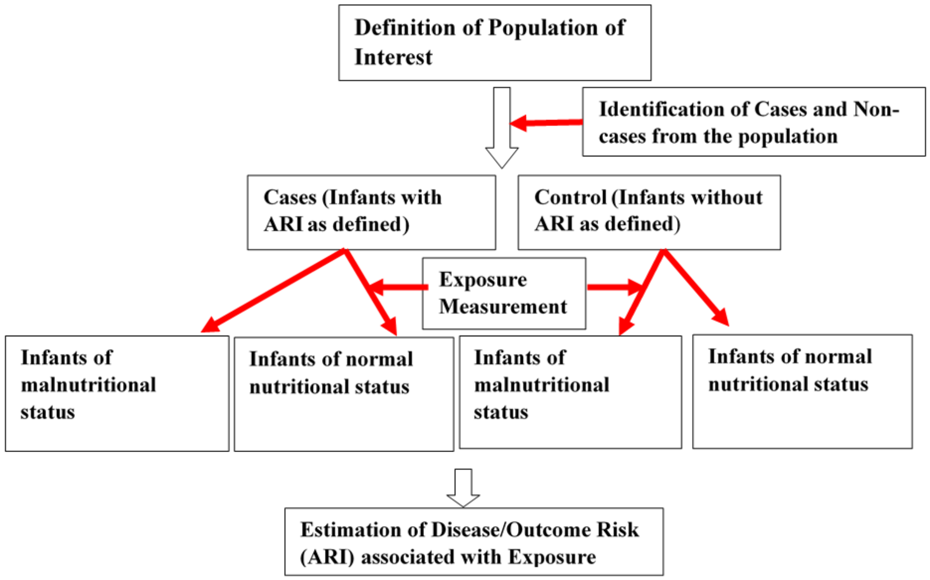


**Figure 2:** Adapted from http://www.drcath.net/toolkit/casecontrol.html

p* = Average proportion exposed = Proportion of Exposed Cases + Proportion of Control Exposed/2

$Z_{\beta}$ = Standard normal variant for power = for 80% power it is 0.84 and for 90% power value is 1.26

$Z_{\alpha/2}$ = Standard normal variant for level of significance = 1.96

$P_1 - P_2$ = Effect size or different proportion expected based on previous studies. $P_1$ is proportion in cases and $P_2$ is proportion in control.

So, from Equation 1 and applying power of study of 80% (0.84), expected proportion in case group and control group to be 0.35 and 0.20 respectively and putting values we have;

$$\text{Sample size} = \frac{1+1}{1}\frac{(0.275)(1-0.275)(0.84+1.96)^2}{(0.35-0.20)^2}$$

= 138.9

≈ 139 Cases and Control each gives a total of 278 at least.

For a matching power of 1:3, the minimum sample size required for this study is;

139 X 3 = 417 + 139 = 556 Cases and Controls.

However, for purpose of representative sample population for the study, the number was increased proportionally from the selected communities, up to 1,100 infants being greater than 3% of the prevalence value in the light of the lower ARI prevalence rate of 10%, [25] which may advance to moderate to severe cases.

### Sample and Sampling Techniques

Figure 3 gave the illustration of multi-stage simple random sampling techniques and stratified sampling method in choosing the caregivers/infants of cases and the control group that were used in the study, which ensured that, every infant/mother/caregiver of the population was given a chance of being selected.

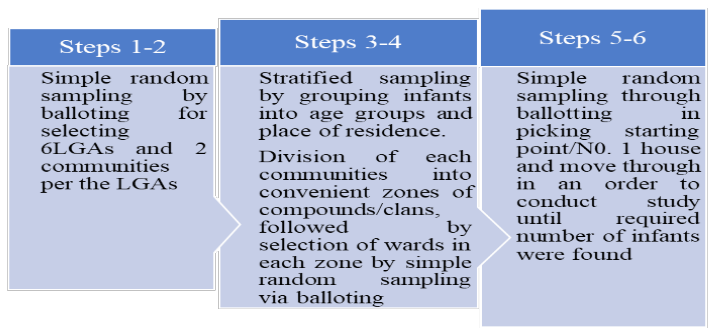


**Figure 3:** Multi-stage simple random sampling techniques and Stratified sampling method.

Total of 1,100 infants consisting 275 cases and 825 controls (1:3) were proportionally selected, among the communities using allocation factor of 6:4 (660:440) for urban and rural communities for both cases and control, based on size of study population of the communities, and allocation factor of 1:4.5:4.5 (100:500:500) for the age group of <2 months, 2months – 6months and 7months up to 12months. Figure 4 showed the summary of the study population per sampling points/LGA.

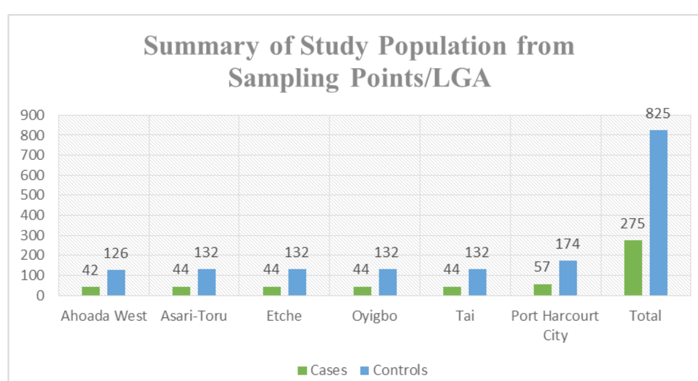


**Figure 4:** Summary of Study Population from Sampling Points/LGA

### Data Collection Instrument

Data collection was with set of structured questionnaires. The items covered were demographic characteristics, signs and symptoms of ARI, anthropometric measurement for nutritional status indicators among the target/study population for determination of the pattern and risk of ARI among infants. Content validity review was conducted on the questionnaire, while pilot-testing for understanding of items by target/study population was done, using 10 caregivers/infants in a settlement (Omuoko), Ikwerre LGA, Rivers East Senatorial District, who did not form part of the sample used for the study.

The researcher personally administered the questionnaires on the mothers/caregivers of the randomly picked infants for relevant information, through the help of recruited Community Health Practitioners after one-day training on the pattern of administration of the questionnaires and retrieved on the same day.

To collect data on ARI, mothers/caregivers were asked whether their child under 1year of age had been ill, presenting at least any 2 of the 3 signs and symptoms of; cough, running nose or fever less than 3 days duration within the 2weeks of enrollment/interview. Those infants with such outcome attributes of ARI at any time during the 2weeks of interview were classified as having ARI (cases).

The control group data was obtained from matched study population to the cases of ARI from the same referent population based on uncontrollable variable (age), grouped as less than 2months, 2months – 6months, 7months up to 12months. Data on nutritional status was generated by using weighing scale for the determination of weight in kilograms (Kg), which data or values were used for the calculation of expected weight-for-height and plotting weight-for-age on standard growth chart ('z' scores) for grading nutritional status to illustrate the extent of its implication in the pattern and risks of acute-respiratory infections among infants. The weight of the children was measured with a standardized weighing scale (bathroom scale) with minimal clothes and bare foot. Where the child was unable to stand, the weight of the child with the caregiver were taken and then the weight of the caregiver, deducted to get the weight to nearest 0.5Kg (500 g) [20].

Height was measured with a height scale calibrated in centimeters. For children below two (2) years who cannot stand properly, recumbent length (crown to heel length) is usually being measured with infantometer/measuring tape to the nearest centimeter. The legs were held straight and firm. All of these, guided against increasing the 5% chance of erroneously rejecting the null hypothesis when making comparism of study variable between cases and control groups of the study.

For assessment of severity (mild, moderate and severe) of malnutrition by weight-for-height, an age independent criterion in form of ratio of weight in kilograms and length or height in $cm^2$ multiplied by 100 (weight/length$^2$ X 100) was calculated. The ratio of more than 0.14 or equal to 0.14 was considered as normal or mild malnutrition respectively, while a ratio of less than 0.14 was considered as moderate - severe malnutrition [40].

### Data Analysis

Data from responses as collated were presented in a tabular form with nominal scale, reflecting values for cases and controls for the variable of study (nutritional status indicator). The entries were double-checked for identification of any error of recording. Statistical Package for Social Sciences (SPSS), software version 21.0 was used for the statistical analysis, to test the hypothesis for result at 5% significant level and to show distribution of difference in normal nutritional status and malnutrition. Descriptive method was employed to represent the characteristics of the subjects and the disparities in ARI between malnutrition and normal nutritional status of infants were tested in a bivariate and stepwise logistics regression at 5% level of significance. Odds ratio (OR) was used to interpret the measures of size effect of ARI from malnutrition and normal nutritional status differences.

### Ethical Approval

Ethical approval for the study was gotten from the University of Port Harcourt Teaching Hospital Ethical Committee and the Research Ethics Group of the Centre for Medical Research and Training, College of Health Sciences, University of Port Harcourt. Permission was obtained from the respective Medical Officers of Health of the Local Government Areas and leaderships of communities where the study was conducted. Explanation on the nature and purpose of the study and level of participation of the respondents (mothers/caregivers) and their infants were made and their informed consent sought before the interview. Participation was still voluntary even after providing consent in the course of the study.

## Results

**Table 2:** Distributions of Demographic Characteristics of Study Population.

| Variables | | Frequency | % |
|---|---|---|---|
| **Child Age (in Months)** | < 2months | 101 | 9.2 |
| | 2-6 months | 506 | 46 |
| | 7-11 months | 491 | 44.6 |
| | Unknown | 2 | 0.2 |
| | Total | 1,100 | 100 |
| **Gender** | Male | 566 | 51.4 |
| | Female | 532 | 48.4 |
| | Unknown | 2 | 0.2 |
| | Total | 1,100 | 100 |
| **Study Area** | Infants from Rural Communities | 440 | 40 |
| | Infants from Urban Communities | 658 | 59.8 |
| | Unknown | 2 | 0.2 |
| | Total | 1,100 | 100 |

***Source: Field Survey, (2019)***

Table 2 on distribution of demographic characteristics, revealed that a total of one thousand, one hundred infants were studied, in which the age distributions indicated that majority 506 (46.0%) were within 2-6 months' age bracket, against 491 (44.6%) within 7-11 months' age group and 101 (9.2%) within less than 2 months, whereas the age of 2 (0.2%) were unknown so, excluded.

The gender distribution showed that 566 (51.4%) were male infants, against 532 (48.4%) female infants.

The study area distribution, indicated that 658 (59.8%) of the study population were from urban communities, against 440 (40.0%) study population who were from rural communities, while 2 (0.2%) of them were excluded, due to incomplete information.

Table 3, showed the initial descriptive statistics of the study population based on age in months, weight-for-age in kilogramme (Kg), height-for-age in centimeter (cm) and body mass index (BMI). Those infant cases (N=275) with minimum and maximum ages as (1and11months) respectively, had a mean age of 5.73 ± 3.16 months, while those infants' controls with the same age bracket (N=823) had a mean age of 5.92 ± 3.15months.

For those infant cases with minimum and maximum weight-for-ages in Kg as (2 and 13.8 Kg) respectively (N=275), the mean weight-for-age was 6.87 ± 2.19 Kg, whereas the control infants with minimum and maximum weight-for-age in Kg as (2.2 and 14 Kg) respectively (N=821), the mean weight-for-age was 7.42 ± 2.11 Kg.

**Table 3:** Initial Descriptive Statistics of the Study Population.

| Quantity | Cases | | | Control | | |
|---|---|---|---|---|---|---|
| | N | Min (Max) | Mean (Std. dev) | N | Min (Max) | Mean (Std. dev) |
| Age (in months) | 275 | 1 (11) | 5.73 (3.16) | 823 | 1 (11) | 5.92 (3.15) |
| Weight-for- age (in kg) | 275 | 2 (13.8) | 6.87 (2.19) | 821 | 2.2 (14) | 63.43 (8.79) |
| Height-for- age (in cm) | 275 | 40 (88) | 63.53 (8.50) | 817 | 41 (95) | 7.42 (2.11) |
| BMI | 275 | 0.08 (0.37) | 0.17 (0.04) | 823 | 0.09 (0.42) | 0.19 (0.05) |

***Source: Field Survey, (2019)***

Similarly, those infant cases with minimum and maximum height-for-age in cm as (40 and 88cm) respectively (N=275) had a mean height-for-age of 63.53 ± 8.50cm, against mean height-for-age of 63.43 ± 8.79cm for those control infants of minimum and maximum height-for-age as (41 and 95cm) respectively (N=817).

The table 3, further showed that for those infant cases with minimum and maximum body mass index (BMI) as (0.08 and 0.37) respectively (N=275), the mean BMI was 0.17 ± 0.04, against the mean BMI of 0.19 ± 0.05 for those control infants with minimum and maximum BMI (0.09 and 0.42) respectively (N=823).

The close values of the descriptive statistics among cases and control reflect adequacy in matching between cases and control subjects used for the study, therefore, portraying quality data collection.

Table 4., showing association between nutritional status and occurrence of acute respiratory infection of the study population (N=1,100) indicated that, for weight-for-age, nutritional status indicator (N=961); n=749 (90.8%) of the controls had normal weight-for-age (weight-for-age above -2SD) within the period under review, against n=212 (77.1%) of cases who also had normal weight-for-age (weight-for-age above -2SD).

While, for the category of underweight (weight at -2SD &below) nutritional status indicator (N=135); n=63 (22.9%) of the cases fell in that category, as infants having underweight nutritional status, contrasted to 72 (8.7%) of the controls who were also classified as having underweight nutritional status. Nevertheless, the nutritional status, indicated by weight-for-age of N=4, n=4 (0.5%) of controls were unable to be determined due to lack of necessary information.

For the nutritional status, indicated by weight-for-height (N=891), the table 4., revealed that, n=688 (83.4%) of the controls, had normal weight-for-height nutritional status in the period under review, against n=203 (73.8%) of the cases who were also classified as having normal weight-for-height nutritional status. In the case of the various grades of wasting malnutrition status derivable from weight-for-height N=201; n=72 (26.2%) of the cases were observed to be in the category of such malnutrition status, contrasted to n=129 (15.6%) of the controls who also had such malnutrition status. Meanwhile, the nutritional status, indicated by weight-for-height of N=8; n=8 (1.0%) of the controls was difficult to obtain due to lack of necessary information also.

In the overall analysis, the data in table 4. had shown clearly that the cases presented an association between nutritional status; indicated by both underweight (weight-for-age at -2SD and below) malnutrition status from weight-for-age (22.9%) as well as wasting malnutrition status from weight-for-height (26.2%) and acute respiratory infection, contrasted to their control subjects of same nutritional status from weight-for-age (8.7%) and weight-for-height (15.6%) respectively. Consequently, we can adduce that, acute respiratory infection and nutritional status indicated by weight-for-age (14.2% difference in frequency of occurrence) among cases and control infants, exist as a pattern in this study, while weight-for-height nutritional status indicator exists also as a pattern of association between acute respiratory infection and nutritional status (10.6% difference in frequency of occurrence) among infants' cases and control as observed in this study.

**Table 4:** Association between Nutritional Status and Occurrence of ARI of the Study Population.

| Nutritional Status (Weight for Age) | | | | | |
|---|---|---|---|---|---|
| | Total (N) | Cases (n) | % | Control (n) | % |
| Underweight (-2SD & below) | 135 | 63 | 22.9 | 72 | 8.7 |
| Normal (above -2SD) | 961 | 212 | 77.1 | 749 | 90.8 |
| Unknown/Indeterminate | 4 | 0 | 0 | 4 | 0.5 |
| Total | 1,100 | 275 | 100 | 825 | 100 |
| **Nutritional Status (Weight for Height)** | | | | | |
| Wasting | 201 | 72 | 26.2 | 129 | 15.6 |
| Normal | 891 | 203 | 73.8 | 688 | 83.4 |
| Unknown/Indeterminate | 8 | 0 | 0 | 8 | 1.0 |
| Total | 1,100 | 275 | 100 | 825 | 100 |

***Source: Field Survey, (2019)***

Table 5, showed association between nutritional status and occurrence of acute respiratory infection among infants (N=660) in urban communities, indicating that, for weight-for-age, nutritional status indicator (N=566); n=440 (88.9%) of the controls had normal weight-for-age (weight-for-age above -2SD) within the period under review, against n=126 (76.4%) of cases who also had normal weight-for-age (weight-for-age above -2SD).

For the category of underweight (weight-for-age at -2SD &below) nutritional status indicator (N=90); n=51 (10.3%) of the controls fell in that category, as infants having underweight nutritional status, contrasted to 39 (23.6%) of the cases who were also classified as having underweight nutritional status. Nevertheless, the nutritional status, indicated by weight-for-age of N=4, n=4 (0.08%) of controls were unable to be determined due to lack of necessary information.

**Table 5:** Association between Nutritional Status and Occurrence of ARI among Infants in Urban Communities.

| Nutritional Status (Weight for Age) | Total (N) | Cases (n) | % | Control (n) | % |
|---|---|---|---|---|---|
| **Underweight (-2SD &below)** | 90 | 39 | 23.6 | 51 | 10.3 |
| **Normal (above -2SD)** | 566 | 126 | 76.4 | 440 | 88.9 |
| **Unknown/Indeterminate** | 4 | 0 | 0 | 4 | 0.8 |
| **Total** | 660 | 165 | 100 | 495 | 100 |
| **Nutritional Status (Weight for Height)** | | | | | |
| **Wasting** | 111 | 42 | 25.5 | 69 | 13.9 |
| **Normal** | 542 | 123 | 74.5 | 419 | 84.7 |
| **Unknown/Indeterminate** | 7 | 0 | 0 | 7 | 1.4 |
| **Total** | 660 | 165 | 100 | 495 | 100 |

***Source: Field Survey, (2019)***

**Table 6:** Association between Nutritional Status and Occurrence of ARI among Infants in Rural Communities.

| Nutritional Status (Weight for Age) | Total (N) | Cases (n) | % | Control (n) | % |
|---|---|---|---|---|---|
| **Underweight (-2SD & below)** | 45 | 24 | 21.8 | 21 | 6.4 |
| **Normal (above -2SD)** | 395 | 86 | 78.2 | 309 | 93.6 |
| **Unknown/Indeterminate** | 0 | 0 | 0 | 0 | 0 |
| **Total** | 440 | 110 | 100 | 330 | 100 |
| **Nutritional Status (Weight for Height)** | | | | | |
| **Wasting** | 90 | 30 | 27.3 | 60 | 66.7 |
| **Normal** | 349 | 80 | 72.7 | 269 | 81.5 |
| **Unknown/Indeterminate** | 1 | 0 | 0 | 1 | 0.3 |
| **Total** | 440 | 110 | 100 | 330 | 100 |

***Source: Field Survey, (2019)***

For the nutritional status, indicated by weight-for-height (N=542), the table 5, revealed that, n=419 (84.7%) of the controls, had normal weight-for-height nutritional status in the period under review, against n=123 (74.5%) of the cases who were also classified as having normal weight-for-height nutritional status. In the case of the various grades of wasting malnutrition status derivable from weight-for-height N=111; n=69 (13.9%) of the controls were observed to be in the category of such malnutrition status, contrasted to n=42 (25.5%) of the cases who also had such malnutrition status. However, the nutritional status, indicated by weight-for-height of N=7; n=7 (1.4%) of the controls was difficult to obtain due to lack of necessary information also.

In all of these, the data in table 5 had indicated that the cases presented an association between nutritional status; indicated by both underweight (weight at -2SD and below) malnutrition status from weight-for-age (23.6%) as well as wasting malnutrition status from weight-for-height (25.5%) and acute respiratory infection, contrasted to their control counterparts with same nutritional status from weight-for-age (10.3%) and weight-for-height (13.9%) respectively.

Consequently, we can adduce that, difference in acute respiratory infection and nutritional status indicated by weight-for-age (13.3% difference in frequency of occurrence) among cases and control infants, exist in this study, while that between weight-for-height nutritional status and acute respiratory infection (11.6% difference in frequency of occurrence among cases and controls) also exists in this study in the urban communities.

Table 6, reflecting association between nutritional status and occurrence of acute respiratory infection among infants (N=440) in rural communities indicated that, for weight-for-age, nutritional status indicator (N=395); n=309 (93.6%) of the controls had normal weight-for-age (weight above -2SD) within the period under review, against n=86 (78.2%) of cases who also had normal weight-for-age (weight above -2SD).

In the category of underweight (weight at -2SD & below) nutritional status indicator (N=45); n=24 (21.8%) of the cases fell in that category, as infants having underweight nutritional status, contrasted to 21 (6.4%) of the controls who were also classified as having underweight nutritional status.

For the nutritional status, indicated by weight-for-height (N=349), the table 6, revealed that, n=269 (81.5%) of the controls, had normal weight-for-height nutritional status in the period under review, against n=80 (72.7%) of the cases who were also classified as having normal weight-for-height nutritional status. In the case of the various grades of wasting malnutrition status derivable from weight-for-height N=90; n=30 (27.3%) of the cases were observed to be in the category of such malnutrition status, contrasted to n=60 (18.2%) of the controls who also had such malnutrition status. Whereas, the nutritional status, indicated by weight-for-height of N=1; n=1 (0.3%) of the controls was difficult to obtain due to lack of necessary information.

In this regard, the data in table 6 had indicated that the cases presented an association between nutritional status; indicated by both underweight (weight at -2SD and below) malnutrition status from weight-for-age (21.8%) as well as wasting malnutrition status from weight-for-height (27.3%) and acute respiratory infection, contrasted to their control subjects' nutritional status from weight-for-age (6.4%) and weight-for-height (18.2%) respectively.

Therefore, we can infer that, difference in acute respiratory infection and nutritional status indicated by weight-for-age (15.4% difference in frequency of occurrence) among cases and control infants, exist in this study, while that for weight-for-height nutritional status and acute respiratory infection (9.1% difference in frequency of occurrence among cases and control infants) also exists in the rural communities.

Taking tables 5 and 6 together, the data further indicated that difference in pattern of ARI occurrence among infants with malnutrition status indicated by weight-for-age is 15.4% higher in rural communities, compared to that in urban communities (13.3%). While the difference in pattern of ARI occurrence among infants with malnutrition status indicated by weight-for-height is 11.6% higher in urban communities, compared to that in rural communities (9.1%). Meaning the difference in pattern of ARI occurrence among infants with malnutrition status from weight-for-age indicator was 2.2% (susceptibility disadvantage potential) higher compared to nourished infants in rural than urban communities. While the difference in pattern of ARI occurrence among infants with malnutrition status from weight-for-height indicator was 2.5% (susceptibility disadvantage potential) higher compared to nourished infants in urban than rural communities.

Table 7, showed data on nutritional status in the risk of acute respiratory infection among infants, measured by weight-for-age and weight-for-height. Out of those infants; N=135 with low weight-for-age (-2SD & below), n=63 presented with signs and symptoms of acute respiratory infection as cases, while n=72 was devoid of signs and symptoms of acute respiratory infection as controls within the 2weeks of the interview/enrollment. Also, for the total; N=961 infants with normal weight-for-age (above -2SD), n=212 came down with signs and symptoms of ARI as cases, while n=749 were devoid of signs and symptoms of ARI as controls within the 2weeks of interview/enrollment for the study.

By similar comparism or matching of the two groups based on weight-for-height (wasting), the data revealed that from the total; N=201 infants, with malnutrition ranging from mild, moderate to severe (low weight-for-height), n=72 presented with signs and symptoms of ARI as cases, while n=129 were devoid of signs and symptoms of ARI as controls within the 2weeks of interview/enrollment for the study. Likewise, out of total; N=891 infants with normal nutritional status measured by weight-for-height, n=203 presented with signs and symptoms of ARI as cases, whereas n=688 were devoid of signs and symptoms of ARI as controls within the 2weeks of interview/enrollment for the study.

A bivariate logistic regression analysis for odds ratio (unadjusted) of the data for any association between nutritional status and risk of acute respiratory infection among infants as measured by weight-for-age and weight-for-height showed higher significant association between weight-for-age malnutrition and acute respiratory infection **OR- Unadjusted=3.09 (p<0.0001,95%CI=0.227-0.478)** than weight-for-height malnutrition **OR-Unadjusted=1.89 (p<0.0001, 95%CI=0.406-0.786)**. This means that the odds of contracting acute respiratory infection among infants with underweight-for-age (OR=3.09) was 3.09 times higher than infants with normal weight-for-age. Similarly, the odds of contracting acute respiratory infection among infants with low weight-for-height (wasting) (OR=1.89) was 1.89 times higher than infants with normal weight-for-height.

On the nutritional status of the child (infant), weight-for-age was equally found as significant risk factor of ARI ($p < 0.0001$, 95%CI = 0.201 – 0.475) of which children (infants) whose nutritional status indicated that they were malnourished (≤ - 2SD) were not favoured by the result obtained. The odds for ARI were found to be approximately 70% lower for the normal nutritional status children (infants) contrasted to that of the malnourished ones (OR= 0.31 adjusted) based on weight-for-age.

## Discussion

Nutritional status, being an important notion in the assessment of risk associated with acute respiratory tract infections, interested the researchers to find out to what extent is malnutrition, measured by weight-for-age and weight-for-height in infancy is implicated. Consequently, the need to ascertain the extent of association in the pattern and risk of acute respiratory infection and nutritional status.

In view of the foregoing, and based on the analysis, it may consequently, be stated that there is an association between pattern and risk of acute respiratory infection and nutritional status, and that the risk was higher for weight-for-age OR-

**Table 7:** Nutritional Status in the Risk of ARI among Infants.

| Weight-for-age | Cases (n) | Control (n) | Total (N) | Weight-for-height | Cases (n) | Control (n) | Total (N) |
|---|---|---|---|---|---|---|---|
| **Underweight (-2SD & below)** | 63 | 72 | 135 | **Wasting (low weight-for-height)** | 72 | 129 | 201 |
| **Normal Weigh-for-age (above -2SD)** | 212 | 749 | 961 | **Normal Nutrition (weight-for-height)** | 203 | 688 | 891 |
| **TOTAL (N)** | 275 | 821 | 1,096 | **TOTAL (N)** | 275 | 817 | 1,092 |
| Ref.= Normal Weight-for-age | | | | Ref.= Normal weight-for-height | | | |
| Underweight OR- Unadjusted=3.09, (p<0.0001,95%CI=0.227-0.478) | | | | Wasting OR-Unadjusted=1.89, (p<0.0001,95%CI=0.406-0.786) | | | |

***Source: Field Survey, (2019)***

**Table 8:** Multiple Logistic Regression (via Stepwise Method) with adjusted Odds Ratio for study variables with ARI.

| Factor | Coeff | Std. Er. | P value. | Odds ratio | 95% C.I. for Odds Ratio | |
|---|---|---|---|---|---|---|
| | | | | | Lower | Upper |
| Nutritional status: (Weight for age) Malnourished (-2SD & below) vs Normal (≥ -2SD) | -1.175 | 0.219 | <0.0001 | 0.31 | 0.201 | 0.475 |

***Source: Field Survey, (2019)***

Unadjusted=3.09 (p<0.0001,95%CI=0.227-0.478) than weight-for-height malnutrition status OR-Unadjusted=1.89 (p<0.0001, 95%CI=0.406-0.786) among infants.

It is interesting to note that this finding of under-nutrition status in the risk of ARI is similar to earlier studies on acute respiratory infection and nutritional status as documented in [22-27,33], although these were studies conducted on under 5years children, having infants as composite age group. The explanation may not be far from the fact that, malnutrition facilitates pathogen invasion and propagation due to implied immunologic deficiency, consequently, making malnourished infants to contracting ARIs the more, compared to their matched nourished infants.

It is important to note also, that the previous studies on these variables (ARI & Nutritional Status) being conducted on under 5years children used smaller sample size compared to this study, having infants as composite group can mask the impact of ARI on infants in the population in relation to nutritional status. Again, the methods of measurement of nutritional status, using two different anthropometric indicators at the same time is relatively new in terms of available literature on studies in this field. Hence, the separate frequency of occurrence of ARI (22.9%) among infants of underweight malnutrition with 14.2% weight-for-age malnutrition disadvantage susceptibility potential and frequency of occurrence of 26.2% among infants of wasting malnutrition with 10.6% weight-for-height malnutrition disadvantage potential is relatively new in this area of study. More so, the study revealed higher frequency of occurrence of ARI (23.6%) among infants with weight-for-age malnutrition in rural than urban communities (21.8%), indicating 2.1% rural community's weight-for-age malnutrition among infants' disadvantage susceptibility potential while the frequency of occurrence of ARI (27.3%) for weight-for-height malnutrition status was higher in urban than rural communities (25.5%), depicting 2.5% urban community's weight-for-height malnutrition among infants' disadvantage susceptibility potential. Meaning in reality, there are more history of poor health or recurrent illnesses, which may be ARI in the rural than urban communities, whereas there are more of recent illness, which may be ARI and failure to gain weight in the urban than rural communities. In addition, the separate significantly risk of ARI in the two categories of malnutrition as found in this study, is as well relatively new in this field of study.

Quite importantly, noting the interplay between infection (acute respiratory infection) and nutritional status and the challenges of nutritional demand and management during infancy cycle of human development and growth, make the findings of this work quite auspicious to ensure early detection of vulnerable children at the infancy stage for prompt and appropriate management.

The disparity in risk of acute respiratory infection and nutritional status by the two anthropometric determinates (low weight-for-age and low weight-for-height) may provide explanation that, more of the infants had history of poor health or nutritional deficiencies including recurrent illness which may probably be acute respiratory infection as a consequence of low weight-for-age than infants with recent illness (probably ARI), weight loss or failure to gain weight as a consequence of low weight-for-height. This is a discreet finding and seen as the salient factors that may form basis for further studies.

Consequently, aggressive awareness creation and associated benefits in the light of the findings of this study in our consideration is capable of reducing the risk of acute respiratory infection, noting that nutritional status is critical in the immune state of humans. This result will as such, strengthen and put more emphasis on implicated nutritional requirement aimed at promoting health of infants and provides the way out from the burden of malnutrition induced or influenced morbidity and mortality among children in our context, Nigeria.

## Conclusion

This study having revealed different pattern and significant risk of acute respiratory infection among infants in urban and rural communities in relation to nutritional status, therefore, having serious implications in the growth and development of infants in the cycle of human development and health, since acute respiratory infection can be very dangerous to the survival of children at such prime age. Hence, our findings indicate trend of focus as a necessary way forward regarding rural and urban communities in the occurrence of ARI among infants based on under-nutritional status to effectively manage the condition, right from the prenatal period of life of the child.

## Recommendations

1. Attention should be directed at aggressive awareness creation on the two categories of malnutrition influenced ARI among infants and necessary renewed policies to addressing implied factors associated with malnutrition during prenatal period of life of the child in view of urban and rural settings.
2. Efforts should also be directed at specific focused nutritional interventions' measure toward child survival in view of ARI among other public health concern during infancy.
3. A study on implication of nutritional status in viral and bacterial co-infections of ARI among infants in Rivers State, Nigeria, using the two anthropometric indicators of this study should be considered to substantiate the discreet findings between the two indicators.

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