ORIGINAL ARTICLE

Effect of Body Temperature on Respiratory Rate in Children with Acute Respiratory Infections

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ABSTRACT

Objective: The objective of this study is to investigate the role of body temperature in influencing respiratory rate in children with acute respiratory infections

Study Design: It is a cross-sectional study

Place and Duration of Study: Study was conducted at Department of Pediatrics, Combined Military Hospital Lahore from May 2023 till May 2024.

Material and Method: 214 patients were included in this study after approval from Research review board number 539/2024. Body temperature and respiratory rate were recorded upon presentation, then every 6 hours for 24 hours. Data was entered and analyzed using SPSS 24. p-values of ≤0.05 will be considered statistically significant.

Result: The study included a total of 214 children with acute respiratory infections, with an average age of 22.6 ± 17.9 months. Among the participants, 60.28% (129) were male and 39.72% (85) were female. At the time of presentation, body temperature was 37.5 ± 1.8°C and respiratory rate was 38.7 ± 11.5 breaths per minute (bpm). Six hours later, the body temperature slightly decreased to 37.1 ± 1.1°C, with a decrease in the respiratory rate to 36.3 ± 10.2 bpm. By the 12-hour mark, the body temperature had increased to 37.9 ± 1.9°C, and the respiratory rate raised to 39.1 ± 9.5 bpm. Finally, at 24 hours, the body temperature was 36.5 ± 0.6°C, and the respiratory rate further decreased to 27.1 ± 6.2 bpm.

Conclusion: This study highlights body temperature has significant influence respiratory rate among children with acute respiratory infections

Key Words: *Body temperature, Respiratory rates, Acute respiratory infections*

INTRODUCTION

Among the most common illnesses in children and leading to high rates of morbidity and mortality on a global scale, there are Acute Respiratory Infections (ARIs). There were about 10.1 million cases of acute lower respiratory infection with associated influenza viruses in children under five years in 2018 worldwide, of these 5% cases required hospital admission.[1] In addition, the global cost of inpatient and outpatient Respiratory syncytial virus associated Acute Lower Respiratory Tract Infection management in young children in 2017 was approximately €4.82 billion,

with 65% in developing countries and 55% accounted for by hospitalization.[2] ARIs encompass a range of infections affecting the respiratory tract, including the common cold, bronchiolitis, and pneumonia. The respiratory infection may manifest itself in the form of a common cold, bronchiolitis or pneumonia among others. Infections may be caused by various microbes including bacteria and viruses. Fever, coughing and tachypnea are some of the symptoms mostly associated with ARIs. These conditions are more prevalent in kids since their immune systems and respiratory systems are in developing stage.[3] Understanding the physiological responses, such as changes in respiratory rate and body temperature, is crucial for effective management and treatment of these infections.

The respiratory rate is an important vital sign that reflects the frequency of breathing movements. It is influenced by many factors including metabolic rate, oxygen demand and body temperature. Fever is a common symptom of ARIs and it represents a natural response to infection. Fever strains the body metabolism; triggers increased production of carbon dioxide (CO_2) and leads by extension to an elevated respiratory rate that effectively removes excess CO_2 in the body.[4] Hyperthermia triggers thermoregulatory mechanisms, including increased ventilation, to dissipate heat and regulate body temperature. Inflammatory cytokines released during infection can directly affect respiratory centers in the brain, promoting an increased respiratory rate.[5]

Several studies have documented a clear correlation between elevated body temperature and increased respiratory rate in children with ARIs. A study conducted by Jensen et al has revealed that at low, normal and high body temperature the change in respiratory rate values for every degree centigrade rise in temperature was -0.5 ± 0.5, 1.5 ± 0.5 and 2.3 ± 0.3 bpm, respectively.[6] Similarly, another study has revealed that for every 1°C increase in body temperature, respiratory rate increases by 5.7/minutes in children with acute respiratory infections.[7] While other studies have also suggested that fever cam increase respiratory, leading to respiratory distress.[8,9]

Fever-induced changes in respiratory rate play a critical role in influencing the classification and management of acute respiratory infections (ARI). Elevated respiratory rates due to febrile tachypnea, a physiological response to increased metabolic demand during fever, can mimic signs of pneumonia, potentially leading to over classification of severity and unnecessary interventions. This misinterpretation often results in the over diagnosis of pneumonia, particularly in children with mild ARI or viral infections, where antibiotics are not required. Incorporating fever correction into ARI classification allows for more precise differentiation between febrile tachypnea and true respiratory distress, ensuring accurate diagnoses and appropriate treatment.[9] By preventing the overuse of antibiotics in febrile children who do not have bacterial pneumonia, this approach addresses a critical public health concern antimicrobial resistance while reducing unnecessary hospital admissions and side effects. Ultimately, correcting for fever when evaluating respiratory rates aligns with evidence-based practices, optimizes resource utilization, and enhances the quality of care in pediatric ARI management.

Accurate assessment of respiratory rate, alongside body temperature, is vital for diagnosing and managing ARIs in children. Current clinical guidelines emphasize the importance of monitoring respiratory rate and body temperature in children with ARIs. The World Health Organization (WHO) recommends using respiratory rate thresholds, adjusted for age and fever, to identify children at risk of severe illness[10]. For instance, in febrile children aged 2-12 months, a respiratory rate of over 50 breaths per minute may indicate pneumonia, necessitating prompt medical intervention.

The review of literature has highlighted certain gaps. Inconsistencies in the methods used to measure body temperature and respiratory rate across studies pose a significant gap. Different techniques (e.g., tympanic, axillary, oral, or rectal temperature measurements and manual vs. automated respiratory rate counting) can yield varying results. There is lack of differentiation in studies between various types of ARIs (e.g., viral vs. bacterial, upper vs. lower respiratory tract infections)[11]. Each type may influence the body

temperature-respiratory rate relationship differently, and more detailed investigations are needed to elucidate these differences. The influence of hydration status on the relationship between body temperature and respiratory rate has not been extensively explored. Dehydration, which can be common in febrile children, might alter respiratory patterns and needs further investigation to clarify its impact. There is a lack of research exploring how ethnic and genetic differences might affect the relationship between body temperature and respiratory rate in children with ARIs.[12] Understanding these variations could lead to more personalized and effective treatment strategies.

The primary objective of this study is to investigate the relationship between body temperature and respiratory rate in children diagnosed with acute respiratory infections (ARIs). Specifically, the study aims to determine the degree of correlation between body temperature and respiratory rate in pediatric patients with ARIs and analyze how different levels of fever (mild, moderate, and high) influence respiratory rate in children with ARIs.

MATERIAL AND METHODS

It is a cross-sectional study conducted at Combined Military Hospital (CMH) Lahore from May 2023 to May 2024 after taking approval from ethical review board number 539/2024.

A specific criterion of inclusion and exclusion was designed. All the patients aged between 2 months to 60 months of age, admitted in the pediatric emergency or pediatric outdoor patient department due to lower acute respiratory infection presenting with fever (body temperature ≥ 38°C) were included in this study.

Only children who were admitted in the pediatric ward were included in this study. Children with chronic respiratory conditions (e.g., asthma, cystic fibrosis), congenital heart disease and immunodeficiency disorders were excluded from this study.

Similarly, children on medications that could affect respiratory rate (e.g., bronchodilators, sedatives) were also excluded.

The sample size was calculated by using WHO formula while considering prevalence of acute respiratory infections is 14% and power of the study at 80%. The sample size was calculated to be 214.[13] After screening, 214 patients were included in this study. Informed consent was obtained from the parents or legal guardians before participation in the study.

A detailed medical history and physical examination were conducted to confirm the diagnosis of a lower acute respiratory infection and to record demographic information (age, sex, weight, and height). Baseline body temperature was measured using a mercuric thermometer at the axilla. Respiratory rate was measured by counting the number of breaths per minute for one full minute while the child is at rest. Body temperature and respiratory rate was recorded upon presentation, then every 6 hours for 24 hours. The 24-hour observation period was chosen to capture the immediate effect of fever resolution on respiratory rate as the study was designed to explore the physiological changes in respiratory rate associated with fever, rather than the entire clinical course of pneumonia. Each measurement was taken twice and the average of the two values was noted. All the measurements were noted by pediatrician and trained nursing staff. Every child was given treatment recommended by consultant pediatrician according to their diagnosis. The supportive care, including antipyretics, in line with standard clinical practice were also given. The study was not focused on reassessing for changing the initial diagnosis after 24 hours, as the primary objective was to observe changes in respiratory rate in relation to fever resolution

We defined “pneumonia” in a child with a cough or have difficulty in breathing or any of the danger signs such as inability to feed, lethargy, central cyanosis, or grunt; RR≥ 50/min in infants up to 12 months of age and RR≥40/min in children older than 12 months; and a suggestive radiograph[14].

“Bronchiolitis” was defined as the first episode of wheezing with evidence of an acute viral respiratory tract infection (coryza), an axillary temperature of ≥37.8°C, cough, predominant wheeze, or rhonchi on chest auscultation and suggestive radiograph[14].

And a child with cough or difficult breathing but none of the signs as chest in-drawing, stridor and fever is classified as “cough or cold”. Children diagnosed with “cough and cold” were admitted to the hospital primarily for the purpose of observation and to ensure compliance with study protocols. These cases were included to compare respiratory rates across febrile and afebrile states in non-severe ARI presentations

Data was entered and analyzed using SPSS (Statistical Package for the Social Sciences) version 24. It was presented as mean, standard deviation, and percentages. p-values of ≤0.05 will be considered statistically significant. The findings were interpreted in the context of the study objectives and existing literature

RESULTS

The study included a total of 214 children with acute respiratory infections, with an average age of 22.6 ± 17.9 months. Among the participants, 60.28% (129) were male and 39.72% (85) were female.

Notably, 21.96% (47) were identified as having low birth weight, and 28.5% (61) were born prematurely.

The diagnoses among the participants were categorized as follows: 25.23% (54 children) were diagnosed with pneumonia, 45.33% (97 children) with bronchiolitis, and 29.43% (63 children) with cough or cold (table 1, fig 1). This demographic and clinical profile highlights the diverse characteristics of the pediatric population affected by acute respiratory infections in this study.

TABLE 1: Demographic characteristics of the study population

Parameters	Result
Age (mean ± SD) (months)	22.6 ±17.9
Sex	
Male	129 (60.28%)
Female	85 (39.72%)
Pre-maturity	61 (28.5%)
Past history of lower respiratory infections	132 (61.68%)
Diagnosis	
Pneumonia	54 (25.23%)
Bronchiolitis	97 (45.33%)
Cough or cold	63 (29.43%)

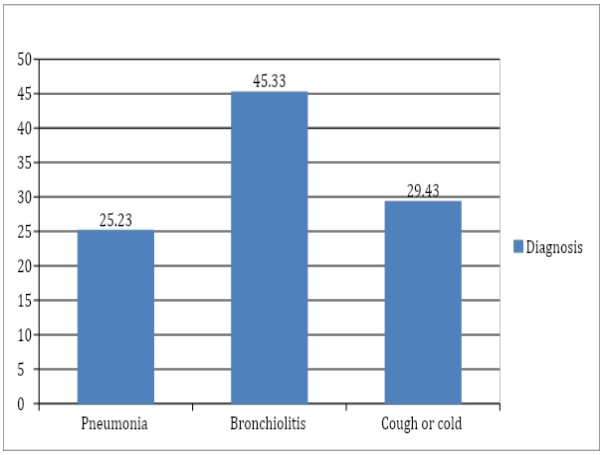

Fig 1: Diagnosis observed in children admitted with acute respiratory infection

TABLE 2: Relationship of body temperature with respiratory rate

Time interval	Body temperature (C)	Respiratory rate (per minute)
At presentation	37.5 ± 1.8	38.7 ± 11.5
6 hours	37.1 ± 1.1	36.3 ± 10.2
12 hours	37.9 ± 1.9	39.1 ± 9.5
18 hours	36.8 ± 0.9	30.2 ± 8.1
24 hours	36.5 ± 0.6	27.1 ± 6.2

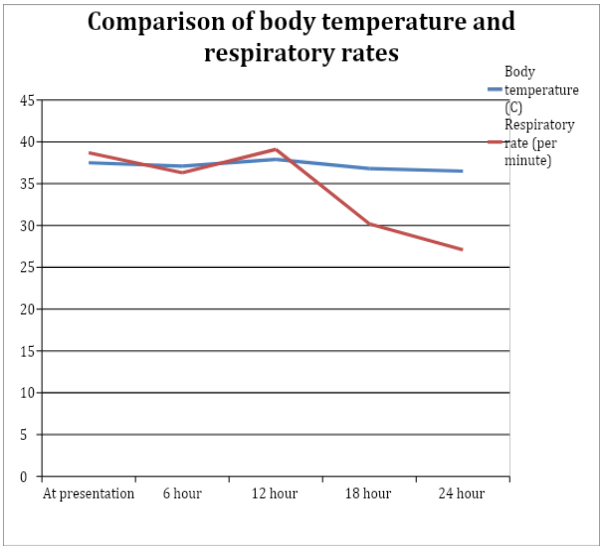

Fig 2: Co-relation of body temperature with respiratory rates

At the time of presentation, the children had an average body temperature of 37.5 ± 1.8°C and a respiratory rate of 38.7 ± 11.5 breaths per minute. Six hours later, the average body temperature slightly decreased to 37.1 ± 1.1°C, with a corresponding decrease in the respiratory rate to 36.3 ± 10.2 breaths per minute. By the 12-hour mark, the average body temperature had increased to 37.9 ± 1.9°C, and the respiratory rate rose to 39.1 ± 9.5 breaths per minute. At 18 hours, the body temperature decreased to an average of 36.8 ± 0.9 °C, with a notable reduction in the respiratory rate to 30.2 ± 8.1 breaths per minute. Finally, at 24 hours, the average body temperature was 36.5 ± 0.6°C, and the respiratory rate further decreased to 27.1 ± 6.2 breaths per minute.

DISCUSSION

The study analyzed the relationship between body temperature and respiratory rate in children with acute respiratory infections (ARIs). Additionally, 61.68% of the children had a history of lower respiratory infections, indicating a vulnerable population [15]. Bronchiolitis was the most common diagnosis (45.33%), followed by cough or cold (29.43%) and pneumonia (25.23%).

This distribution underscores the diversity of ARIs encountered in the study. The data supports the well-established link between fever and increased respiratory rate.

Elevated body temperature at presentation and at the 12-hour mark was associated with higher respiratory rates, reflecting the body's physiological response to infection and fever. The increase in body temperature and respiratory rate at 12 hours may indicate a secondary febrile peak or a delayed response to initial treatment. This pattern suggests the need for continuous monitoring and potential adjustments in clinical management during the first 24 hours of hospitalization.

A retrospective cross-sectional study conducted at more than 90,000 children has revealed similar findings. It stated that there is mean increase in respiratory rates of 2.6 breaths per minute for every 1 °C increase in temperature with a patient-to-patient variation of 4-16 breaths per minutes.[16] Similarly, Davies et al has also found that body temperature is an independent determinant of respiratory rate as change up 10 breaths per minute is noted in children with acute respiratory infections for every degree centigrade change in temperature.[17] Hence, understanding the dynamics between body temperature and respiratory rate can aid clinicians in better assessing the severity and progression of ARIs in children. For instance, persistent fever and tachypnea despite initial treatment may warrant further investigation and possibly more aggressive interventions.[18] The high prevalence of prematurity, and past respiratory infections in the study population emphasizes the importance of targeted prevention and early intervention strategies in these high-risk groups.

The variation in respiratory rate in children with ARI holds significant implications for management and outcomes. Recognizing fever-induced tachypnea as a physiological response, rather than a marker of severity, can prevent misclassification of ARI cases and reduce the risk of unnecessary interventions. This study underscores the importance of considering body temperature when interpreting respiratory rates, particularly in settings where ARI classification guides treatment decisions. By refining diagnostic criteria to account for temperature-related changes, healthcare providers can enhance the precision of management strategies and improve outcomes for affected children. The findings can be utilized to conduct comparative studies across different populations, age groups, and types of respiratory infections. Such studies can validate the results and explore any variations or similarities across diverse settings.[19] In telemedicine, the study findings can enhance remote monitoring capabilities.

The study may have a limited sample size, which could affect the generalizability of the findings. The study may not account for diurnal variations in body temperature and respiratory rate, which can naturally fluctuate throughout the day. The study lacks longitudinal data to assess how the relationship between body temperature and respiratory rate evolves over the course of the infection.[20] Longitudinal studies would provide more insights into temporal changes and recovery patterns.

CONCLUSION

This study highlights the significant role of body temperature in influencing respiratory rate among children with acute respiratory infections. These findings can enhance clinical practice by providing a basis for improved assessment and management of pediatric ARIs.

Conflict of interest: None

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