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## Factors Influencing ESD in NICUs and Adult Chest X-ray Examination in Bangladesh

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### ABSTRACT

Understanding the factors that influence Entrance Surface Dose (ESD) in neonatal and adult chest X-ray examinations is crucial for improving radiation safety. This study explores these influences, along with patterns in chest X-ray usage in Bangladesh, highlighting demographic trends, symptoms, and diagnostic outcomes. Conducted in a single hospital in Dhaka, the study assessed radiation doses in 150 adults and 150 neonates. Data collection involved using a 1000 mA X-ray machine for adults (aged 11-80 years) and a portable Medion MI 100 MOVX Mobile X-ray Machine for neonates (aged 1-20 days), with participants chosen through simple random sampling. X-ray exposure parameters (kVp and mAs) were recorded, and ESD (measured in milligrays) was calculated using a formula tailored for adults and neonates. The results showed a higher number of males (57.3%) than females (42.7%) seeking X-rays. The most common symptoms were fever (51.3%), cold and cough (32%), and chest pain (13.3%). Pulmonary inflammatory lesions were observed in 13.3% of cases, with pleural effusion and cardiomegaly present in 8% and 6.7% of patients, respectively, while 72% had normal findings. There was a noticeable link between certain symptoms and diagnoses, such as chest pain correlating with cardiomegaly and fever with pulmonary inflammatory lesions. ESD levels generally increased with age, though there was a slight decrease in the 51-60 age groups. These findings provide valuable insights into chest X-ray practices, which could guide better patient care and targeted interventions in Bangladesh.

**Keywords:** ESD, Chest X-ray patterns, Radiation exposure, Diagnostic techniques, and Radiology.

### INTRODUCTION:

The use of X-ray imaging is a crucial diagnostic tool in modern medicine, particularly in intensive care units and for patients with respiratory symptoms. In Bangladesh, as in many developing countries, chest X-rays are a common procedure for diagnosing a variety of conditions ranging from infections to chronic diseases. However, the radiation exposure associated with these procedures raises significant health concerns, especially for vulnerable popu-

lations like neonates and the elderly. Understanding the factors that influence Entrance Surface Dose (ESD) during these procedures is essential for optimizing safety and efficacy (Bushberg, J.T. *et al.*, 2011).

Radiation exposure in medical imaging, particularly in chest X-ray examinations, is a significant concern due to the potential health risks associated with ionizing radiation. Understanding and minimizing these risks is crucial, especially in vulnerable

populations such as neonates in intensive care units (ICUs) and adults undergoing diagnostic evaluations. Entrance Surface Dose (ESD) is a critical parameter for assessing radiation exposure, reflecting the dose received by the skin at the entry point of the X-ray beam. Evaluating ESD in both neonates and adults can provide valuable insights into radiation safety practices and help identify areas for improvement (Tappouni, R. F. *et al.*, 2020).

Neonatal intensive care units (NICUs) often require frequent radiographic evaluations to monitor and diagnose conditions in critically ill infants. Due to their small size and developing tissues, neonates are particularly sensitive to radiation, making it imperative to minimize exposure while ensuring diagnostic accuracy. Conversely, adult patients, who undergo chest X-rays for a range of symptoms such as fever, cough, and chest pain, also need to be protected from unnecessary radiation exposure. This study aims to explore the factors that influence ESD in both neonatal and adult chest X-ray examinations, thereby contributing to improved radiation safety protocols (ICRP *et al.*, 2007). In Bangladesh, where healthcare resources are often limited and the burden of respiratory diseases is high, optimizing X-ray examination protocols is essential to ensure patient safety and diagnostic efficacy. Previous studies have highlighted the importance of monitoring radiation doses and implementing standardized protocols to reduce unnecessary exposure, particularly in high-risk groups such as neonates. Neonates are particularly susceptible to radiation due to their rapidly dividing cells and longer life expectancy, which increases the likelihood of radiation-induced effects over time. (Vassileva J. *et al.*, 2015). Adult chest X-ray examinations are common diagnostic procedures for various conditions, including pulmonary infections, cardiovascular diseases, and routine health checks. However, the factors influencing ESD in adults, such as patient age, sex, and specific clinical indications, require further exploration to optimize radiation doses and improve patient outcomes (Brenner, D. J. *et al.*, 2007). Previous research has highlighted the variability in radiation doses received by patients during X-ray procedures, influenced by factors such as machine settings, patient positioning, and the physical characteristics of the patients themselves. Studies focusing on pediatric populations have underscored the importance of tailored radiographic techniques to

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reduce radiation doses while maintaining image quality. Similarly, investigations into adult radiography have examined the balance between dose optimization and diagnostic efficacy (Frush, D. P. *et al.*, 2009). The findings from this study are expected to inform clinical guidelines and enhance the understanding of radiation safety in both neonatal and adult populations. By addressing the critical need for optimized radiographic techniques, this research aims to support the ongoing efforts to improve patient care and outcomes in medical imaging (Doyle, P. *et al.*, 2006).

This study aims to investigate the factors influencing ESD in neonatal intensive care units and examine the patterns of adult chest X-ray examinations in Dhaka, Bangladesh. By analyzing demographic data, symptoms, and diagnostic findings, this research seeks to enhance our understanding of radiation exposure in these populations and contribute to the development of safer, more effective imaging protocols (Brenner, D. J. *et al.*, 2007; Symum *et al.*, 2021).

## Objectives of the Study

### General Objectives

- To investigate the factors influencing Entrance Surface Doses (ESD) in neonatal intensive care units (NICUs) and to analyse the patterns of adult chest X-ray examinations in Bangladesh.

### Specific Objectives

- Measure the Entrance Surface Doses (ESD) during X-ray procedures for neonatal and adult patients.
- Compare the Entrance Surface Doses (ESD) across different NICUs and among adult patients in Bangladesh to identify variability in exposure.
- Evaluate the compliance of current X-ray practices with international safety standards.
- Develop recommendations for minimizing radiation exposure in NICU and adult chest X-ray procedures.
- Promote awareness and provide training for healthcare professionals on radiation safety for patients.

## MATERIALS AND METHODS:

This preliminary descriptive cross-sectional study investigated radiation doses in 150 adult patients

and 150 neonates in Dhaka, Bangladesh, using a non-experimental, qualitative design. Conducted at a single diagnostic hospital, the study assessed radiation exposure during chest X-ray examinations. For adults aged 11 to 80 years, data were collected using a 1000 mA X-ray machine, while for neonates aged 1 to 20 days, a portable Medion MI 100 MOVX Mobile X-ray Machine was used. Simple random sampling selected the participants, and X-ray exposure parameters (kVp and mAs) were recorded for each patient and projection. Adult examinations were standard, while neonate examinations occurred in the intensive care unit. The formula for calculating the Entrance Surface Dose (ESD) in milligrays (mGy) is given by:

$$ESD (mGy) = c \left( \frac{KVp}{FSD} \right)^2 \left( \frac{mAs}{mm.Al} \right)$$

For adult chest X-rays, the parameters are

- Focus Skin Distance (FSD): 160 cm
- Filter thickness (mm.Al): 2.5
- KV range: 60-100

For neonate chest X-rays, the parameters are:

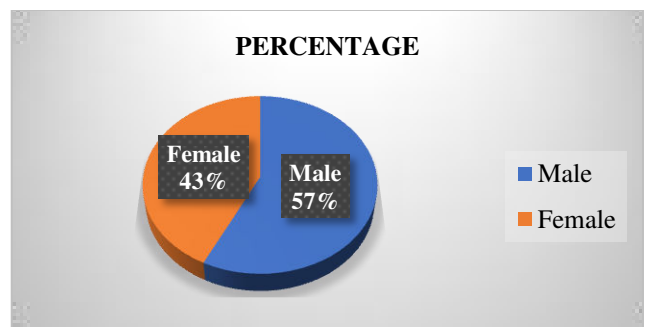
- Focus Skin Distance (FSD): 106 cm
- Filter thickness (mm.Al): 0.7
- KV range: 40-60

The constant C is 0.2775 for both cases.

**RESULTS:**

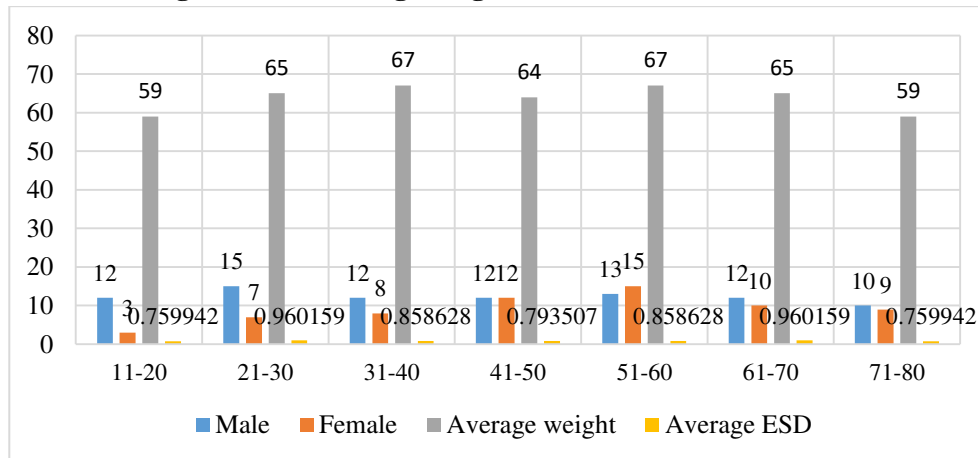
The data in this study is divided into two segments, comprising information gathered from adult chest X-rays and neonatal intensive care units. Conducted within private hospitals in Dhaka city, Bangladesh, the research entails the analysis of data presented through tables, figures, and various charts such as bar and pie charts. A total of 150 adult patients and 150 neonates were included in the study, ensuring a nearly equal ratio of adult to neonatal cases.

**Presentation of data collection from adults  
Gender distribution for adults**



In the dataset, there are 86 males, constituting 57.3% of the total, and 64 females, accounting for 42.7%.

**Frequency chart according to adult’s average weight and ESD**



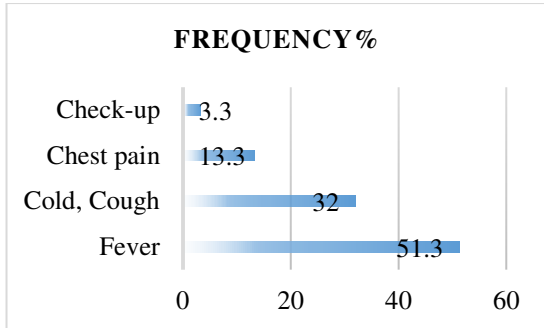
The dataset illustrates various age ranges along with corresponding counts of males and females, along with their average weight and average Entrance surface dose (ESD) values. Upon comparison, it's evident that there are fluctuations in male and female counts across different age groups. For instance, in the 21-30 and 51-60 age brackets, there are notably more males compared to females, whereas in the 31-40 and 61-70 age ranges, the female count surpasses that of males. Interestingly, UniversePG | [www.universepg.com](http://www.universepg.com)

the average weight seems to slightly increase from younger to older age groups, with the highest average weight observed in the 51-60 and 61-70 age ranges. Moreover, the average ESD values demonstrate some consistency across age groups, with slight variations. The 21-30 and 61-70 age groups exhibit the highest average ESD, while the 11-20 and 71-80 age groups have the lowest. These variations in male and female counts, average weight, and average ESD across different age ranges

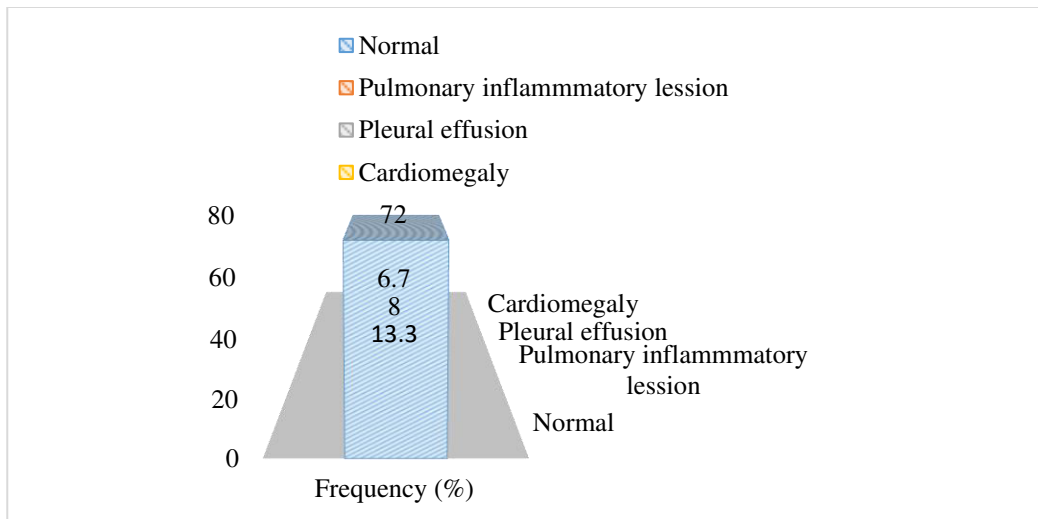
may be attributed to various factors such as physiological changes with age, lifestyle differences, and healthcare interventions, warranting further investigation for a comprehensive understanding.

The data highlights the frequencies of various reported symptoms. Fever is the most common, occurring 77 times and accounting for 51.3% of cases. Cold and cough follow with 48 reports, making up 32% of the total. Chest pain is the third most frequent, reported 20 times and representing 13.3% of cases. Check-up is the least common, with only 5 reports, constituting 3.3%.

**Symptoms for adults**



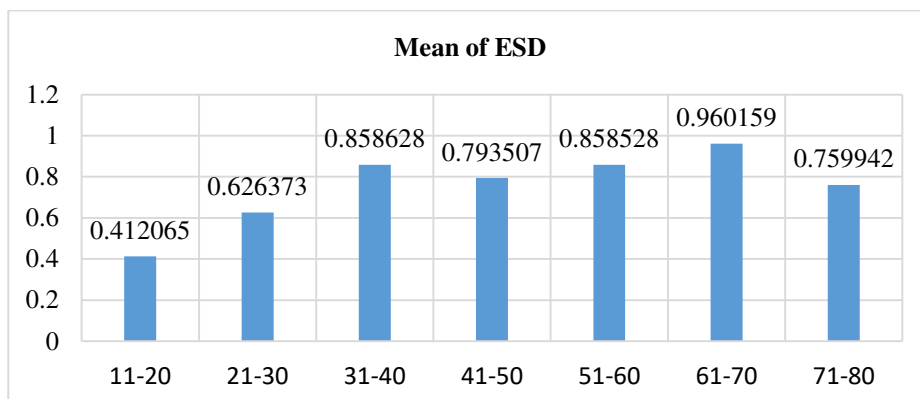
**Findings for adults**



The data shows the frequency of various findings expressed in percentages. "Normal" is the most common finding, occurring in 108 cases (72%). "Pulmonary inflammatory lesion" is noted in 20 cases (13.3%), while "Pleural effusion" and "Cardiomegaly" are reported in 12 (8%) and 10

(6.7%) cases, respectively. This indicates that the majority of cases exhibit normal results, with a smaller proportion showing abnormalities like pulmonary inflammatory lesions, pleural effusion, and cardiomegaly. Further analysis may be needed to explore the factors contributing to these findings.

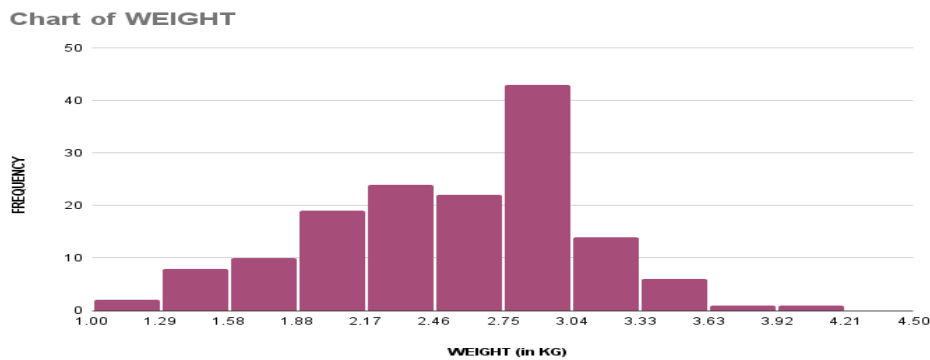
**Mean of ESD for adults**



The data presents mean ESD values across different age ranges, showing variability. The lowest mean ESD occurs in the 11-20 and 71-80 age groups, at 0.412065 and 0.759942, respectively. In the 21-30 age group, there's a noticeable increase to 0.626373, suggesting higher ESD levels compared to younger ages. This trend continues, peaking at 0.960159 in the 61-70 age range. However, a slight dip in mean ESD occurs in the 51-60 age group, despite the overall increasing trend, possibly due to various factors. Overall, the data indicates a gradual increase in mean ESD with age, with occasional fluctuations, suggesting potential age-related changes in electrostatic discharge characteristics. Further research may be needed to explore these findings' implications and underlying mechanisms (Aliasgharzadeh *et al.*, 2015).

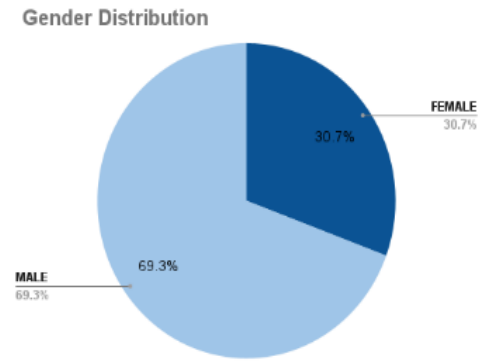
**Presentation of data collection from NICU patients**

**Chart of weight for neonates**



Analysis of birth weight distribution in the surveyed population reveals a diverse range, with the majority falling between 2.17-2.75 KG. This range includes the highest number of births, with 24 and 22 individuals in the 2.17-2.46 KG and 2.46-2.75 KG categories, respectively. Notably, adjacent categories such as 1.88-2.17 KG and 2.75-3.04 KG

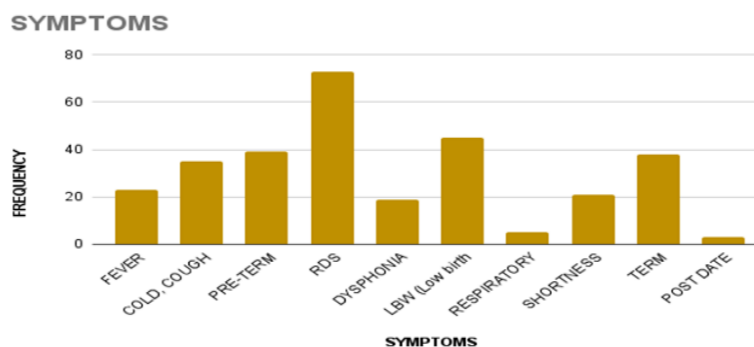
**Gender distribution for neonates**



The data shows that 69.3% (104) of the surveyed individuals were male, while 30.7% (46) were female. This distribution reveals a significant gender imbalance in the sample population, with approximately twice as many males as females represented.

also show significant representation, indicating variability. Additionally, outliers at both lower and upper ends, with only a few individuals in categories like 1.00-1.29 KG and 3.63-4.21 KG, emphasize the importance of considering extremes in birth weight analysis.

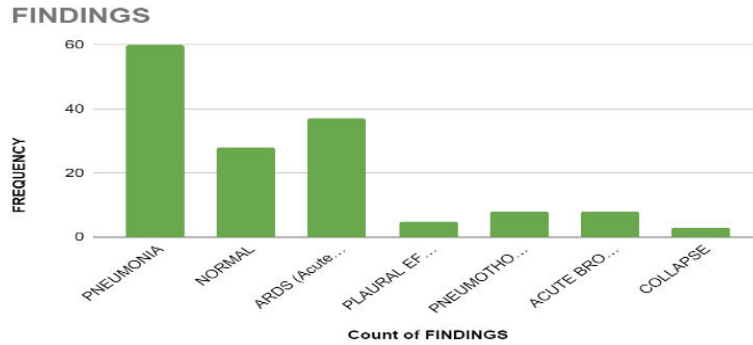
**Chart of symptoms for neonates**



The analysis of symptoms in surveyed newborns reveals diverse health conditions. Respiratory distress syndrome (RDS) affects 73 infants, necessitating urgent medical attention. Pre-Term birth is observed in 39 newborns, requiring careful monitoring due to associated risks. Low Birth Weight (LBW) affects 45 infants, needing specialized care. Additionally, Cold and Cough symptoms are reported in 35 newborns, while Fever

is observed in 23. Other symptoms such as Dysphonia, Shortness of Breath, Respiratory Discharge, and Postdate births are documented in smaller numbers, requiring tailored clinical management. Despite a significant proportion born at Term (38 individuals), various symptoms highlight potential health challenges, emphasizing the need for timely interventions for optimal outcomes.

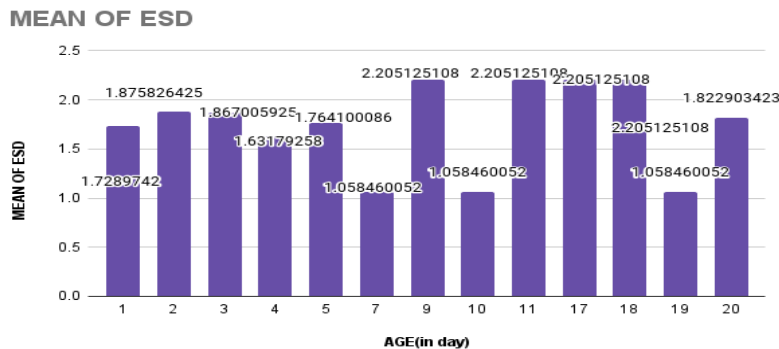
**Chart of findings for neonates**



The analysis reveals a spectrum of respiratory conditions in newborns. Pneumonia is prevalent, affecting 59 individuals, requiring prompt treatment due to their vulnerable immune systems. Acute Respiratory Distress Syndrome (ARDS) impacts 37 newborns, necessitating intensive medical management. Pneumothorax and Pleural Effusion, though less common, require urgent intervention, affecting 8 and 5 individuals, respectively. Acute

Bronchitis affects 8 infants, leading to breathing difficulties. Collapse, observed in 3 newborns, requires immediate medical attention. Despite 27 classified as Normal, ongoing monitoring is crucial for early detection of potential respiratory issues. Overall, the findings stress vigilant monitoring and targeted interventions to optimize respiratory outcomes in newborns.

**Mean of ESD for neonates**



The mean Entrance surface doses (ESD) in newborns varies significantly during the early post-birth period. Initially stable, it gradually increases from 1.7289742 on day one to 1.875826425 on day two, remaining relatively consistent until day five. Subsequent days exhibit notable fluctuations, with a dip on the seventh day (1.058460052) followed by a sharp rise on the ninth day (2.205125108).

Alternating peaks and troughs persist on days eleven, seventeen, and eighteen. Interestingly, days ten, nineteen, and twenty show lower ESD levels (1.058460052 and 1.822903423, respectively), suggesting potential physiological changes. These fluctuations signify dynamic erythrocyte sedimentation rates, crucial for early health monitoring in newborns (Salma et al., 2024).

## **DISCUSSION:**

The provided dataset offers valuable insights into the demographics, symptoms, and findings of individuals undergoing medical evaluation. Notably, a higher proportion of males (57.3%) than females (42.7%) are represented, highlighting a potential gender disparity in healthcare-seeking behaviour or disease prevalence within the studied population. Symptomatology reveals common complaints among patients, with fever being the most prevalent (51.3%), followed by a combination of cold and cough (32%). Chest pain, though less frequent, remains a significant concern, affecting 13.3% of individuals. Additionally, a small percentage (3.3%) present for routine check-ups, underscoring the importance of preventive healthcare practices. Findings from diagnostic evaluations shed light on prevalent conditions. Pulmonary inflammatory lesions are notably frequent (13.3%), potentially indicating respiratory ailments or infections within the population. Conversely, normal findings are predominant (72%), suggesting a substantial number of individuals without significant pathological conditions. However, notable pathological findings include pleural effusion (8%) and cardiomegaly (6.7%), necessitating further evaluation and management.

The correlation between symptoms and diagnostic findings warrants attention. For instance, individuals presenting with chest pain may exhibit a higher prevalence of cardiomegaly, highlighting a potential association between symptoms and underlying pathology. Similarly, fever may coincide with pulmonary inflammatory lesions, indicating possible infectious etiologies. Regarding age-related variations in Entrance surface doses (ESD) levels, an intriguing trend emerges. While ESD generally increases with age, a slight dip in the 51-60 age range suggests complex interplay between physiological factors and environmental influences. Further exploration into these variations may elucidate age-related changes in ESD characteristics and their implications for health. In summary, this comprehensive analysis underscores the multi-faceted nature of healthcare data and the importance of considering demographic, symptomatic, and diagnostic aspects in medical practice. By identifying patterns, correlations, and potential areas for further investigation, healthcare professionals

can enhance patient care and contribute to improved health outcomes.

## **CONCLUSION:**

In conclusion, understanding the factors influencing Entrance surface dose (ESD) in neonatal intensive care units is crucial for optimizing neonatal health monitoring and care. Additionally, examining patterns of adult chest X-ray examination in Bangladesh provides insights into prevalent health concerns and healthcare utilization patterns. By exploring these factors, healthcare providers can enhance diagnostic strategies, improve patient outcomes, and tailor interventions to address specific healthcare needs in both neonatal and adult populations within Bangladesh.

## **ETHICAL CLEARANCE:**

Ethical clearance was obtained from Bangladesh University of Health Sciences (BUHS).

## **AUTHORS' CONTRIBUTION:**

M.A.O.; and A.K.M.H. conceptualized the study, were responsible for the design, methodology, and data analysis, and completed the writing. They were also involved in the interpretation of data and drafting the manuscript. M.J.R.; M.B.I.; S.J.F.; and M.A.M. contributed to data collection. T.P.; and S.M.M.M. provided critical revisions and gave final approval of the version to be published. All authors have read and approved the final manuscript and agree to be accountable for all aspects of the work.

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## **CONFLICTS OF INTEREST:**

The authors declare no conflicts of interest regarding the publication of this work.

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