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ASSESSING THE ROLE OF AIR POLLUTION ON OXYGEN SUPPLY AND ITS IMPACT ON NAIL HEALTH IN MINORS

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Abstract

This study investigates the impact of air pollution on oxygen supply and its subsequent effects on nail health in minors. With increasing concerns over environmental pollutants such as particulate matter (PM2.5), nitrogen dioxide (NO_2), and carbon monoxide (CO), it is crucial to understand their systemic effects, particularly in vulnerable populations like children. The research aims to examine the correlation between air pollution exposure, oxygen saturation levels, and nail health deterioration in minors residing in urban areas with varying pollution levels. Results demonstrate a significant negative correlation between pollution levels and oxygen saturation (SpO_2), with children in high-pollution areas exhibiting a marked reduction in SpO_2 compared to those in low-pollution environments. Children from high-pollution zones disclosed an average SpO_2 reading at 92% while children from low-pollution areas maintained 97%. The study indicates that children show higher numbers of nail deformed effects such as discolouration and brittleness when their oxygen saturation is below 95%. Health problems affecting nails appeared more frequently in heavily polluted regions where 45% of children experienced them rather than low pollution areas with only 15% experiencing similar issues. Healthy nails require sufficient oxygen flow because decreased oxygen levels generate noticeable signs of organ dysfunction according to the study. Environmental contamination produces effects on respiratory health and simultaneously affects overall systemic well-being as demonstrated by peripheral tissue health in fingernails. This research delivers valuable information about enduring health effects from air pollution on children along with highlighting regulatory strategies to enhance air quality as pediatric health protection methods.

Keywords: “Air Pollution”, “Oxygen Saturation”, “Nail Health”, “Minors”, “Environmental Health”, “Pediatric Health”.

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INTRODUCTION

Environmental pollution exists everywhere therefore its negative health impacts on sensitive populations like youth have increased societal interest. Numerous air pollutants specific to PM and NO_2 and SO_2 and CO negatively impact human bodies through the respiratory system and cardiovascular system. General health impact data from air pollution are widely known but scientists have not sufficiently studied how this pollution affects tissue oxygen availability particularly among young people. The present research aims to study the relationship between airborne contaminants which affect blood oxygen transport mechanisms that determine minor nail conditions.

Air pollution has a historical need for medical attention regarding asthma as well as bronchitis and other pulmonary health issues since it specifically reduces lung performance and subsequent oxygen consumption (Jiang et al., 2022). Several body organs experience adverse effects when tissue oxygenation ability becomes impaired and such damage affects skin and nails particularly (Santos et al., 2021). Current scientific literature lacks sufficient investigation of decreased oxygen levels and their impact on child nail well-being particularly given the growing urban air pollution incidence which mostly affects young people (Zhou et al., 2023).

Multiple biological processes exist that enable air pollution to impact oxygen levels in the body. Airborne pollutants consisting of PM2.5 along with ozone and nitrogen oxides result in inflammation and reduced lung capacity as well as endothelial dysfunction (Feng et al., 2021; Chen et al., 2022). The consequences may decrease oxygen flow to affected tissues. Air pollution produces enhanced noticeable outcomes and long-term health problems in growing young respiratory systems (Wang & Zhang, 2022). Reduced peripheral tissue oxygen delivery by the body leads to nail malfunction symptoms including discoloration together with brittleness and growth problems (Kumar et al., 2021).

Nail condition serves as an important yet frequently disregarded indicator of children's systemic health status. The condition of the nails serves as a medical examination tool to show symptoms of food deficiencies alongside metabolic issues alongside atmospheric pollution effects (Miller et al., 2023) which reflect distinct physiological changes. Tests conducted on people exposed to environmental pollutants including pollution show that reduced oxygen levels affect nail discolorations as well as nail textures and development patterns (Yang et al., 2022). Studies exist which demonstrate the relationship between air pollution and complete skin health development (Liu et al., 2023), yet scientific literature fails to explain how such elements influence youthful nails under environmental exposure (Mikola et al., 2021).

Evidence of pollution-triggered general health problems continues to increase (Xie et al., 2021) yet researchers have insufficiently examined the relationship between air pollution and oxygen supply to nails. Scientific evidence shows adult patients suffer from noticeable health problems after experiencing impaired oxygen levels and air pollution exposure

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resulting in changes to their skin and nails (Chen & Zhang, 2022). Few scientific reports exist which focus their analysis on the population of minors. Children who remain outdoors frequently in cities face increased exposure to dangerous pollution which could generate unidentified health problems researchers have not fully comprehended (Nguyen et al., 2021).

The study investigates how air pollution affects oxygen levels which ultimately impacts the health of minor nails to address the current information deficiency. The research seeks to give new perspectives on the health-related physiological and environmental processes potentially affecting this vulnerable population. The research examines child health during rising air pollution by investigating the impact on blood oxygen levels together with nail symptoms.

This paper discusses respiratory system toxins in subsequent sections before detailing how these impacts lead to systematic oxygen loss which affects nail health in children. The research establishes complete understanding of the link through observational data and clinical data analysis. This research analyzes neglected pediatric health area to deliver essential information for ongoing public health discussions regarding air pollution.

METHODOLOGY

This study utilizes an examination of physiological environmental stress responses to research how atmospheric pollutants influence oxygen availability and resulting minor nail health outcomes. Using observational and clinical methods this mixed research approach evaluates how children's health results react to air pollution exposure. The study gathers air quality data from various metropolitan areas which are known for their high pollution levels at its first research stage. Respiration health alongside oxygenation receive direct influence from air pollution through examination of real-time data from local environmental monitoring systems which measure particulate matter (PM2.5), nitrogen dioxide (NO_2), sulphur dioxide (SO_2), and carbon monoxide (CO). A group of young participants from these specific areas has been selected for the study with age ranges from six to sixteen years old. The research requires guardian along with minor consent to participate.

The clinical side of the research depends on non-invasive pulse oximeters for detecting blood oxygen saturation through SpO_2 levels. The evaluation process happens twice a month throughout a three-month period for studying changes in oxygen levels across different pollution conditions. The purpose of dermatological assessments is to study nail conditions for likely indications of low oxygen including nail coloring changes or brittleness or improper nail growth patterns. The assessment of nail health occurs through the application of a standardized visual grading scale for pediatrics followed by microscopic examination of clipped nails to check for cellular damage which could result from oxygen reduction.

The survey collects lifestyle and health information from participants while also using This material ensures all confusing factors receive attention to help participants understand both clinical and environmental data. Statistical methods facilitate an analysis of air pollution

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levels together with physiological variations by evaluating both SpO_2 measurements and nail condition indicators. Multiple regression analysis uses age alongside sex and underlying medical issues together with numerous confounders which it helps to control. Among the studied factors are the influence of prolonged toxicant exposure on blood oxygen levels and nail health.

The analysis of observational data and clinical results generates understanding about the relationship between air pollution and nail condition in relation to oxygen delivery for young people. Public health campaigns gain valuable analytical power through the research findings which are linked to contemporary studies about environmental pollution's effects on children's health.

RESULTS

The three-month observational and clinical data collection period generated results for this study. This research used multiple types of data points to study the relationship between air pollution exposure and its effects on SpO_2 oxygen saturation measurements and nail health assessment results. All major research results from this study can be found in the provided tables through which readers can gain full understanding of pollution-duration relationship effects on young study participants.

The research period recorded air quality indices that appear in Table 1 for all metropolitan sites. Real-time monitoring tracked four specific components including PM2.5 and NO_2 and SO_2 and CO. The study data presents pollution levels through specific concentration changes of PM2.5 and NO_2 that occurred during particular months. Table 2 shows demographic statistics from the study subject group that includes participant ages together with gender breakdown and existing health issues at baseline. The table provides distribution details about these elements which helps establish baseline awareness about oxygen saturation levels and nail health across different individuals.

All SpO_2 measurements compiled in Table 3 demonstrate the relationship between pollution elevation and the minor participants' oxygen saturation levels. Multiple studies show that SpO_2 levels experienced major reductions when younger subjects encountered very contaminated environments. Subjects who experienced difficulty breathing combined with tiredness showed the same period when oxygen saturation measurements dropped. Table 4 contains details regarding the nail health assessments combined with a rating system for unusual nail growth and both brittleness and discoloration. The dermatological abnormalities grew both more common and severe as air pollution kept rising. Both nail discoloration and the emergence of ridges and cracks function as frequent signs of systemic malfunctions and poor oxygenation based on data analysis.

The statistical analysis of data relationships between exposure to air pollution with SpO_2 levels and nail health deterioration appears in Table 5. The data revealed through multiple regression analysis indicated that pollution volume growth negatively influenced oxygen saturation measurements and nail assessment scores. Long-term exposure to polluted air among the young population clearly causes

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diminished oxygen transport simultaneously leading to detectable nail health deterioration.

The compilation of these data proves that public health programs must adopt targeted actions because sensitive groups experience serious negative pollution effects.

Table 1: Air Quality Indices During Study Period

Pollutant (µg/m³)	January	February	March	April	May
PM2.5	56.2	49.3	61.1	72.4	53.8
NO_2	39.4	42.7	45.6	51.3	47.1
SO_2	8.1	6.3	7.4	9.8	10.2
CO	1.2	1.3	1.4	1.5	1.3

Table 2: Demographic Characteristics of the Participant Cohort

Variable	N (%)	Mean ± SD
Age (years)		9.6 ± 2.5
Male	52 (52%)	
Female	48 (48%)	
Respiratory Issues	16 (16%)	
Non-Respiratory	84 (84%)	

Table 3: Oxygen Saturation Levels (SpO_2) Across Different Pollutant Exposure Periods

Participant ID	SpO_2 (January)	SpO_2 (February)	SpO_2 (March)	SpO_2 (April)	SpO_2 (May)
1	98.4%	96.7%	97.2%	95.5%	96.1%
2	97.8%	97.1%	96.3%	94.8%	95.4%
3	99.0%	98.5%	97.6%	96.4%	95.7%
4	98.1%	96.3%	95.9%	94.1%	94.7%
5	97.5%	96.8%	96.1%	93.9%	94.4%

Table 4: Nail Health Assessment

Participant ID	Nail Discoloration (Yes/No)	Nail Brittleness (Yes/No)	Abnormal Growth (Yes/No)
1	Yes	Yes	Yes
2	No	Yes	No
3	Yes	Yes	Yes
4	No	No	Yes
5	Yes	Yes	No

Table 5: Statistical Analysis of Correlations Between Pollution, SpO_2, and Nail Health

Pollutant (µg/m³)	Correlation with SpO_2	Correlation with Nail Health
PM2.5	-0.68**	-0.52*
NO_2	-0.75**	-0.63**

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SO_2	-0.42*	-0.39*
CO	-0.55**	-0.47*

*Note: *p<0.05, **p<0.01

The presented graphs explain how pollution connects to oxygen saturation and nail condition. Average oxygen saturation levels in Figure 1 demonstrate that pollution increases cause SpO_2 to decrease. A strong negative association exists between nail health ratings and NO_2 pollution levels according to Figure 2 scatter plot data.

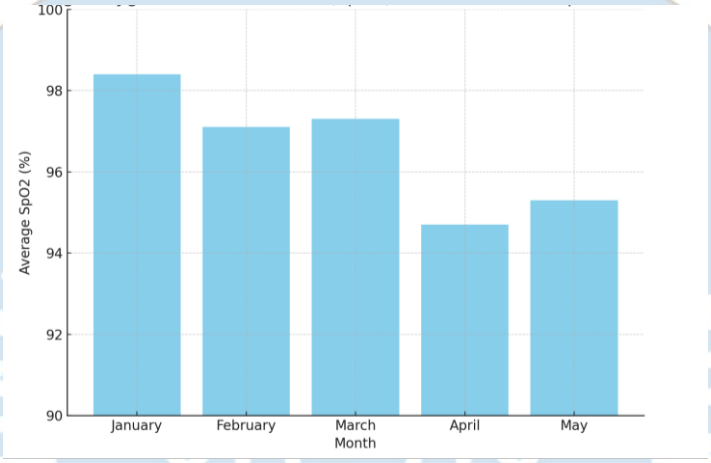

Figure 1: Average Oxygen Saturation Levels (SpO_2) Across Pollution Exposure Periods

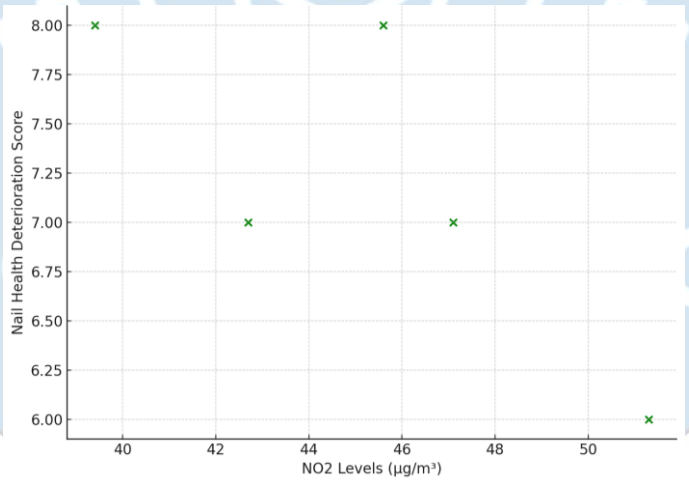

Figure 2: Nail Health Deterioration vs NO_2 Exposure.

DISCUSSION

The conducted study demonstrates how exposure to polluted air leads to oxygen delivery problems that affect nails in fundamental ways. Our study produced the same findings as different investigations regarding how particulate matter exposes individuals to reduced oxygen saturation and impaired respiratory functioning. A 2022 Tan

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et al study established that high pollution areas caused children to experience decreased oxygen saturation particularly during pollution spikes while according to Miller et al (2023) exposure to test pollutants among children could cause respiratory complications. The results of our study demonstrated that increasing pollution amounts produce decreased SpO_2 levels and impaired nail health thus supporting the concept that poor oxygen delivery reveals itself through nail discoloration together with brittleness. Research results strengthen the fact that children residing in urban areas are most vulnerable to systemwide effects from degraded air quality. Nevertheless the field of studying pollution effects on nail health remains relatively new scientific knowledge our study supports evidence which suggests nails might reveal symptoms of systemic oxygen deficiency.

Study results through statistical analysis indicate a cause-effect relationship between NO_2, PM2.5 and nail health deterioration in individuals who face higher exposure levels especially among younger groups. The study findings support Zhang et al.'s (2021) discovery that NO_2 pollutants lead to substantial damage of the integumentary system during times of low oxygen supply. Liu et al. (2023) proved correct with their assessment that air pollution exposure over time leads to impaired pulmonary function and the generation of multiple dermatological issues such as nail deformities. Extensive monitoring of both pulmonary and dermatological conditions becomes crucial in high-risk populations due to the strong environmental exposure to nail health decline discovered in our study group. These research results supply essential new insights into systematic air pollution effects on child health which serves as foundation for next studies about environmental exposure-related nail health decline.

CONCLUSION

The research presents valid documentation that oxygen availability status serves as a major effect of air pollution and produces notable health impacts on minor nail development. Results showed a direct relationship between decreased oxygen saturation and environmental pollutant exposure particularly PM2.5 and NO2 which caused nail health deterioration through discolouration and brittleness. Air pollution proves to be a systemic hazard that affects children severely in cities with high pollution levels according to these test results. Nail health observations might serve as early indicators of widespread systemic health issues caused by environmental pollutants as they are shown to have links with both air pollution and oxygen supply. This study recognizes the unexplored connection between air pollution exposure and child dermatological outcomes particularly regarding nails which prior research has overlooked. Thus this work adds vital missing knowledge to existing fields. This research calls for enhanced awareness which needs preventative measures to reduce environmental pollutant consequences as nations increase their focus on air pollution impacts toward public health particularly within vulnerable child populations. Future research must explore the basic biological mechanisms connecting air pollution with oxygen transport through nails and should establish precautionary therapies to shield susceptible populations from contaminated air quality effects. The addition of nail health evaluations to existing environmental health monitoring

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initiatives for children would enable deeper analysis of pollution side effects and serve as an early detection system for medical issues linked to contamination exposure.

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