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ASSESSING ENVIRONMENTAL AND HEALTH IMPACTS OF THE DYEING AND BLEACHING INDUSTRY IN TIRUPUR, TAMIL NADU

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ABSTRACT
There are serious environmental and health issues as a result of Tamil Nadu's Tirupur district's fast industrialization, especially in the bleaching and dyeing sector. In both contaminated and non-polluted communities, this project intends to explore the intricate connections between industrial pollution, agricultural productivity, land degradation, and health effects. Using a mixed-method approach, the study examined data from 223 people who were chosen by systematic random sampling processes and represented 20% of the overall population. The study's main emphasis is on important government initiatives, such as Individual Effluent Treatment Plants (IETPs) and Common Effluent Treatment Plants (CETPs). The study evaluates how well these actions work to lower pollution levels and their effects on the ecosystem. Furthermore, the study investigates how industrial pollution has led to the expansion of healthcare infrastructure, looking at the incidence of incurable diseases, disparities in life expectancy, and medical costs between the two types of villages. Strong links between industrial operations, land degradation, and health effects are found in the study using regression and correlation analysis. Preliminary results show that in contaminated communities, agricultural productivity has significantly decreased and land degradation has significantly increased. In addition, healthcare expenses are significantly greater in these regions, which is associated with a reduced life expectancy and a rise in chronic illnesses such skin disorders and respiratory ailments. In order to address the negative effects of industrial pollution on Tirupur's environment and public health and ensure a healthier future for its citizens, these findings highlight the urgent need for strengthened regulatory measures and sustainable practices.

KEYWORDS: *Dying and bleaching industry in Tirupur district: Health impacts: CETPs: IETPs: Medical expenses: Polluted and Non-polluted villages: Economic consequences.*

1. INTRODUCTION

Tamil Nadu's Tirupur District, dubbed the textile capital of India, is essential to the nation's apparel production sector. It makes a substantial contribution to the state's economic growth and national revenues with more than 6,250 industrial units. With 200,000 migrant labor and 600,000 local employees, the business exports goods valued at Rs. 120 billion a year. The dyeing and bleaching facilities, however, have seriously harmed the environment by contaminating water sources and destroying agricultural land. Although increased industrial activity has unquestionably had positive economic effects, there have also been significant environmental costs, especially in the agricultural sector. The dyeing and bleaching industry's effluents have significantly contaminated soil and water bodies, reducing agricultural productivity and causing long-term land degradation in the area (Kumar & Chakraborty, 2019).

Greater agricultural productivity has been maintained in non-polluted villages farthest from the industrial area. These two sets of villages differ greatly from one another, underscoring the dire environmental effects of uncontrolled industrial pollution. As an illustration of the significance of clean water and good soil for sustainable agriculture, farmers in non-polluted areas continue to report consistent crop yields (Krishnan & Meenakshi, 2022). According to studies, a range of hazardous chemicals found in textile effluents, such as dyes, bleaching agents, and heavy metals, infiltrate into the groundwater and soil, rendering the area unusable for farming (Sivakumar, 2021). Farmers have reported a significant drop in agricultural yields, low soil fertility, and decreased irrigation capacity in polluted communities close to the industrial clusters. These issues are clearly related to the contaminated farming water (Ramanathan et al., 2020).

Farmers in polluted villages spend up to 30% more on agricultural inputs like fertilizers and pesticides in an effort to make up for the harm caused by pollution, which puts further burden on their finances, according to a study by Rajan and Sudha (2021). Many of these rural villages are already in debt as a result of the economic difficulties they have already encountered.

India's knitwear exports are dominated by Tirupur, which produces 55% of all knitwear exports and 90% of the nation's cotton knitwear. The region's exports increased by 14% in 2023–2024, from $294 million in April 2024 to $360 million in May 2024, despite obstacles like rising cotton costs and uncertainty in the global economy. Because of its tenacity, Tirupur will always be significant to India's textile sector.

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2. OBJECTIVES

1. To examine the effects of industrial pollution on the health of the local populace, paying particular attention to life expectancy and incurable diseases.
2. To assess the success of government initiatives to mitigate the effects on the environment and human health, such as CETPs and IETPs.

3. REVIEW OF LITERATURE

Mohamed A. Hassan and Ahmad El Nemr., (2017): This essay discusses the problem of water contamination brought on by textile industry untreated wastewater and how it directly affects human health. Serious health difficulties like bleeding, skin sores, nausea, respiratory problems, permanent blindness, and other conditions are brought on by the contaminated water. Complex compounds that are challenging to manage, such azo dyes and diaminobenzene, are the main contaminants. In order to lower toxicity and permit water reuse in industrial operations, the study recommends the use of Advanced Oxidation operations (AOPs) in wastewater treatment. These actions are essential for reducing the health hazards that tainted water poses.

Govindarajalu K., (2003): The study focuses on industrial pollutants that pollute the Noyyal River, degrading the soil, air, and water in the process. Both the environment and human health are harmed by this pollution. The wellbeing of the settlements in the Noyyal River Basin is examined, emphasizing the negative impacts of river pollution on human health, both naturally occurring and as a result of human activity. The study demonstrates that severe health issues such skin allergies, respiratory infections, gastritis, and ulcers have been brought on by water pollution.

4. RESEARCH METHODOLOGY

The effects of the dyeing and bleaching business in Tirupur District on the environment and human health are investigated in this study using a quantitative research methodology. A systematic questionnaire was used to gather information about the demography of two villages, Karaipudur (non-polluted) and Andipalayam (polluted), which are five kilometers apart. A sample size of 223 respondents, or 20% of the total population, was chosen from among the 1,114 people living in these settlements.

Percentage analysis was used to examine demographic factors, and correlation and regression approaches were used to assess the links between pollution and health outcomes. This research seeks to shed light on how industrial pollution affects agricultural productivity and nearby populations.

5. RESULTS AND DISCUSSION

Significant gender differences in hospital and overall treatment costs are highlighted in the study. Low hospital expenses were noted by a noteworthy 91.5% of respondents, of whom 89.4% were men.

Table: 5.1: Respondent Family expenditure and Treatment Cost for Gender Classification:

Gender	Respondent Family - Hospital Expenses				Total Treatment Cost T + T + M = TC			
	Low	Medium	High	Total	Low	Medium	High	Total
Male	160 (89.4) [78.4]	14 (7.8) [100]	5 (2.8) [100]	179 (100) [80.3]	109 (60.9) [82.6]	23 (12.8) [63.9]	47 (26.3) [85.5]	179 (100) [80.3]
Female	44 (100) [21.6]	0 (0.0) [0.0]	0 (0.0) [0.0]	44 (100) [19.7]	23 (52.3) [17.4]	13 (29.5) [36.1]	8 (18.2) [14.5]	44 (100) [19.7]
Total	204 (91.5) [100]	14 (6.3) [100]	5 (2.2) [100]	223 (100) [100]	132 (59.2) [100]	36 (16.1) [100]	55 (24.7) [100]	223 (100) [100]
Chi-Square	$\chi^2 = 078$				$\chi^2 = 024$			

Source: Primary Date

The female respondents reported low hospital costs, which may indicate variations in reporting practices, treatment options, or access to healthcare. With 59.2% of the overall treatment expenditures falling into the low-cost group, men likewise made up the majority of the data. In the medium and high-cost groups, however, the distribution of males and females was more evenly distributed. There was a somewhat wider range of treatment prices for females, with 52.3% falling into the low-cost category and 29.5% into the medium-cost category.

The distribution of hospital expenses and treatment costs showed weak correlations with gender, according to the Chi-Square analysis (`$\chi^2 = 0.78$ for hospital expenses and $\chi^2 = 0.24$ for total treatment costs). This implies that although there are discernible

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variations between men's and women's financial experiences, these variations are not statistically significant in this particular sample. The results highlight the need for more investigation into potential contributing reasons to the observed gender-based trends in hospital and treatment expenditures, such as socioeconomic status, access to healthcare, or treatment preferences.

Table: 5.2: Respondent Family expenditure and Treatment Cost for Village Classification:

Village Type	Respondent Family - Hospital Expenses				Descriptive Statistics	Total Treatment Cost T + T + M = TC			
	Low	Medium	High	Total		Low	Medium	High	Total
Polluted	28 (87.5) [13.7]	3 (9.4) [21.4]	1 (3.1) [20.0]	32 (100) [14.3]	**Mean SUM N**	19 (59.4) [14.4]	2 (6.3) [5.6]	11 (34.4) [20.0]	32 (100) [14.3]
Non -Polluted	176 (92.1) [86.3]	11 (5.8) [78.6]	4 (2.1) [80.0]	191 (100) [85.7]	**Mean SUM N**	113 (59.2) [85.6]	34 (17.8) [94.4]	44 (23.0) [80.0]	191 (100) [85.7]
Total	204 (91.5) [100]	14 (6.3) [100]	5 (2.2) [100]	223 (100) [100]	**Mean SUM N**	132 (59.2) [100]	36 (16.1) [100]	55 (24.7) [100]	223 (100) [100]
Chi-Square	**$\chi 2 = 3.694^{NS}$**				**ANOVA**	**1.853^{NS}**			

Source: Primary Date

According to the survey, a sizable majority of participants—87.5% in polluted villages and 92.1% in non-polluted areas—reported having minimal healthcare costs. There is a general trend toward decreased healthcare expenditures in both areas, since only a tiny percentage reported medium or high expenses. Both types of villages mainly fell into the low category when looking at overall treatment expenses, with 59.4% in contaminated villages and 59.2% in non-polluted ones. The percentage of responders in the medium category, however, was larger in non-contaminated villages (17.8%) than in polluted villages (6.3%).

Statistical tests revealed no statistically significant variations in hospital expenses or overall treatment costs based on village type, with a Chi-Square value of $\chi^2 = 3.694$ and an ANOVA result of F = 1.853. According to the data, both types of villages have low hospital and treatment costs, and although there are minor variations in the distribution of costs, they are not statistically significant. This implies that respondents must deal with comparable healthcare costs whether they reside in polluted or non-polluted locations. Other variables affecting these trends, such socioeconomic circumstances or access to healthcare, might be examined in future studies.

Table: 5.3: Correlation Determinants of Various Cost of Medical Expenditure

Independent Variables		Total Treatment Cost T + T + M = TC	Affected Persons - Travel Cost	Affected Persons - Transaction Cost	Affected Persons - Treatment Cost
Total Treatment Cost T + T + M = TC	Pearson Correlation	1	.884**	.888**	.674**
	Sig. (2-tailed)		.000	.000	.000
	N	223	223	223	223
Affected Persons - Travel Cost	Pearson Correlation	.884**	1	.882**	.614**
	Sig. (2-tailed)	.000		.000	.000
	N	223	223	223	223
Affected Persons - Transaction Cost	Pearson Correlation	.888**	.882**	1	.633**
	Sig. (2-tailed)	.000	.000		.000
	N	223	223	223	223
Affected Persons - Treatment Cost	Pearson Correlation	.674**	.614**	.633**	1
	Sig. (2-tailed)	.000	.000	.000	
	N	223	223	223	223

. Correlation is significant at the **0.01 level (2-tailed).

Source: Primary Date

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With correlation coefficients (r) ranging from 0.884 to 0.888, the study finds extremely high relationships between the overall costs of treatment and related expenses for impacted persons, particularly travel and transaction costs. This suggests that travel and transaction expenses climb sharply in tandem with overall treatment costs. Total treatment costs and treatment expenses for affected individuals have a moderately significant correlation (r = 0.674), indicating a positive but weaker link. Additionally, there is a considerable link (r = 0.882) between transaction and trip prices, suggesting that people who spend more on travel also tend to spend more on transactions. Additionally, there is a strong association (r = 0.633) between transaction costs and treatment costs. The reliability of these interactions is confirmed by the statistical significance of all correlations ($p < 0.001$).

The study reveals a correlation between treatment, travel, and transaction costs, suggesting that increased costs are linked to other expenses, potentially influencing healthcare policies and support systems

Table: 5.4: Multiple Regression Model Determinants of Various Cost of Medical Expenditure:

S. No	Independent Variables	B	Std. Error	t	Sig
1.	Constant	-1.068	.113	-9.475	.000
2.	Affected Persons - Travel Cost	.114	.088	1.297	.196
3.	Affected Persons - Transaction Cost	.178	.087	2.057	.041
4.	Affected Persons - Treatment Cost	1.701	.120	14.131	.000
	R and R Square	.848[a]		.719	
	Adjusted R Square			.715	
	F	186.774			.000[b]

Source: Primary Date Significance at one percent and ten percent level

A statistical method for determining an asset, good, or service's value by examining each of its unique attributes is called hedonic regression. Both positive and negative externalities are taken into account as the approach allocates values and weights to these attributes. This method shows how modifications to particular attributes impact total pricing and aids in establishing correlations between independent and dependent variables.

The statistical significance of the model is demonstrated by the p-value and F-statistic, which attest to the independent variables' high predictive ability with respect to the dependent variable. Affected Persons-Treatment Cost stands out as the most important of these factors, with a coefficient of 1.701 and a very significant p-value, highlighting its crucial importance in figuring out the total expenses for affected individuals. The outcome is similarly highly impacted by Affected Persons - Transaction Cost, while Affected Persons - Travel Cost does not exhibit a statistically significant effect, indicating that it is less important in this situation.

Travel expenses have little bearing on the dependent variable, according to the analysis, which shows that treatment costs are the main driver, followed by transaction costs. The necessity of controlling treatment expenses to lessen people's financial burdens is one way that these findings can influence healthcare policy. Future studies could look into more factors or interactions to further understand these connections.

6. ADVANTAGE OF CETPS AND IETPS

Tirupur has more than 750 bleaching and dyeing units, of which 252 use Individual Effluent Treatment Plants (IETPs) and 502 are connected to 20 Common Effluent Treatment Plants (CETPs). A number of facilities were ordered to close by the Tamil Nadu Pollution Control Board (TNPCB) due to environmental infractions. The Noyyal River and groundwater were severely contaminated as a result of the effluents from both CETPs and IETPs failing to fulfill Total Dissolved Solids (TDS) and chloride regulations, despite the installation of treatment systems, including facilities for recycling residential sewage. In order to prevent discharge into the river, the Madras High Court ordered the installation of Zero Liquid Discharge (ZLD) systems in 2006. These systems included Reverse Osmosis (RO) facilities. ZLD systems are now run by 17 CETPs, and evaporators are used to handle RO rejects. Despite advancements, pollution and wastewater management continue to present difficulties.

7. CONCLUSION

The study examines water contamination in the Noyyal River bed, highlighting its negative effects on groundwater, river water, and community health. The textile industry, particularly in Tirupur District, releases high levels of TDS and chlorides, causing medical expenses. The study calls for stronger environmental laws and advanced technologies, community involvement, sustainable investment, and legislative reform.

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