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Research Article

THE EFFECTS OF ENVIRONMENTAL POLLUTION OF EASTERN INDUSTRIAL PARK ON HUMAN HEALTH AND COMFORT OF DUKEM TOWN, ETHIOPIA

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ABSTRACT

Eastern industrial zone was established for economic and social development, despite the fact that some of the industries inside the industrial park become causes of respiratory and other diseases. Consequently, the study aimed to investigate the effects of industrial pollution on human health from the perspectives of the local community. The study employed quantitative approach using both primary and secondary data. On the other hand, systematic sampling was used to select the required sample. The target population of this study was the households of selected kebele of Dukem town. A self-administered survey was distributed to the households. The quantitative data was analysed using SPSS software and multinomial logistic regression model and descriptive statistics such as percentage were applied. Tables, figures, charts and graph were employed for data presentation. Output from multinomial logistic regression revealed, air pollution was the dominant type of pollution that affects the health of local community. On the other hand, Acute Respiratory Infection (ARI) was the prevailing disease that affects the health of local people. Based on output from descriptive statistics, the majority of residents believed that skin rashes and sneezing were the major allergy treat that impact their health. Finally, the researcher recommended that there should be local and national government intervention in the enforcement of industrial park policies that formulate to safeguard the environment in general and human health in particular.

INTRODUCTION

Industry play significant role to promote the rapid development of national economy. However, the essential industrial activities in the course of economic development are reshaping the Earth's environmental system. Unsustainable industrial development are causing enormous damage on natural resources, and hindering efficient and sustainable development due to improper waste management and pollution control, emission of greenhouse gas and resource depletion. However, currently, there has been growing corporate concern for the environment and its management. The degree of this concern has been global, and much has been written on the issue of environmental management. Environmental management providing nation with a clean and healthy environment through promotion of ecologically oriented, least cost and human-friendly eco-engineering for treatment and reusing of industrial wastes, sewage and garbage, minimizing air pollution and noise. On the other hand, eco-industry focuses on industrial shift from industry emphasizing on conventional products, to function-oriented and process-closed industry, through combination of production, consumption, transportation, reduction and regulation. Currently, industrial parks are designed and developed for the aim of industrial and related infrastructure, commercial, and service activities. Through grouping companies in a particular site, industrial parks present mutual and efficiency gains. Conversely, at the same time as industrial parks may benefit to economic growth and social development, parks can also bring negative environmental and social impacts consisting: climate change, pollution and resource depletion. On the other hand, sustainable development of industrial park is not a goal, instead a social process through which the principles of sustainable development are considered. It is also a beginning point for measuring ecological, social, and economic features of decisions in an integrated manner.

The aim of industrial parks in Ethiopia is to promote job creation, export and foreign investment. Other goals,

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such as regional and local development, inspiration of technology transfer, creation of linkages, and industrialization policy and strategy development. In light of this, the Ethiopian government has considered the Eastern Industrial Park as an integral part of Sustainable Development and Poverty Reduction Program (SDPRP) (Giannecchini and Taylor, 2018). According to UNIDO (2018), EIP has been demonstrating the positive influence of Chinese industrial development. It has become a place for industrial excellence and a platform for advancing and transferring knowledge and skills. The park is admired by the government of Ethiopia for inspiring Ethiopia's journey to industrialization. It is also an organization where thousands of Ethiopians have been hired and obtained skills. However, the pollutants discharged from the industries in the park are degrading the environment such as water, soil and air (Giannecchini and Taylor, 2018). The local community surrounding the industrial park is also affected by the activities in the industrial park. According to Dukem environmental protection office, some of the industries which have been polluting the environment include cement factory, textile, steel product, leather, car assembly, plastic product, wood board and ceramic products industry. On the other hand, the Ethiopian national environmental pollution control proclamation No. 300/2002 mainly intends to protect the right of citizens to a healthy environment and to enforce law to safeguard the environment of the nation. Regarding this, the proclamation offers a source from which the right environmental standards relevant to Ethiopia can be designed, while endorsing violation of these standards as unlawfully punishable offences.

In addition, Ethiopian national solid waste management proclamation no. 513/2007 aims to promote community participation to avoid adverse effects and get better benefits that comes from solid waste. Similarly, according to article 5.1 of the proclamation, urban administrations shall encourage the participation of industrialists, local administrative levels and their corresponding local communities in designing and implementing their respective solid waste management plans. Besides, article 5.1 states that each region or urban administration shall prepare its own timetable and, depending on that, design solid waste management plan and report its implementation. Furthermore, the proclamation obliged not to dispose solid, liquid or any other kinds of waste in a manner which degrade the environment or affects the health of the local community. Moreover, regulation 159/2008a which was formulated by the Federal Environmental Protection Authority of Ethiopia, intended to prevent industrial pollution and bring compatibility of industrial development with environmental protection. The regulation presents main duties to industrialists. A company subject to the regulations is forced to avoid or reduce the production and discharge of pollutants to a level not above the environmental standards. Despite the country designed various regulatory frameworks that intended to avoid or minimize environmental pollution, even the industrial park which the government regarded the model of sustainable development has been polluting the environment through its solid, liquid and gaseous waste emission. Hence, this study aimed to investigate the effects of industrial pollution on human health from the perspectives of the local community.

Statement of the Problem

The impact of human actions on the environment has been increasing since the commencement of the industrial revolution and at present it extends to a much bigger level, at continental and global scale (Van and Slawinski, 2015). In addition to this, IPCC (2014) reported that if the present-day global carbon intensive development system is continuing, it will degrade the environment. Moreover, the environmental impacts that are related with industrialization in developing countries remain significant as they encroach mostly on the poor and vulnerable communities. Chemical and heavy metals residues contaminate local foods, urban air pollution causes premature deaths and waterborne internal organ pathogens bring the death of children (McMichael et al., 2008).

In Ethiopia following population increase and urbanization, industries are rapidly emerging in different parts of the country. Although, these industries have social and economic benefit still they have environmental impacts that affect the health of local communities. Dukem is one of small town found in Oromia regional state that hosts the Eastern industrial park manifest this problem. Eastern industrial park was established for social and economic benefit, although some of the industries inside the park become causes and aggravators of respiratory diseases such as Asthma, lung cancer and others. Moreover, unpleasant odour is the other bad features of the industrial park. Consequently, residents near the factory either abandoned their house or rented with very low prices. Beside this, land value near to the factory is below current market price of the town because of bad odour and air pollution of the factories. Furthermore, liquid wastes generated from the textile industries are polluting the surrounding environment as they are not properly treated and discharged. For instance, the Oromia environmental protection Bureau, examined that concentration of phosphorous (P) in the sample treated liquid waste from dong fang textile industry was 35.8 mg/L which is above the national limit that is <5 mg/L. Likewise, the concentration of heavy metals such as Cr, Cd, Zn Fe, Pb and Cu from the sampled waste water, soil and vegetables are above the maximum level set by WHO. Besides, from the outlet of the treatment plant of the sampled industries dark colour of liquid wastes and unpleasant odour were observed showing the effluent of inadequately treated liquid waste from the sampled industries. The waste water that has been generating from sampled industries used as source of irrigation water utilized by local farmers to grow vegetables. This might

have considerable health effects on the local community. Several scholars have conducted number researches on the health impact of industrial pollution dealing with different parameters and hazardous wastes with less considering the investigation of the effects of industrial pollution on human health from the perspectives of the local community. Thus, the focuses of this study was to fill some of these gaps (Dadi et al., 2017; Claudio, 2007; Lo et al., 2012).

Research Objective

To investigate the effects of environmental pollution of eastern industrial park on human health from the perspectives of the local community of Dukem town.

Scope of the Study

The study was conducted in the Easter Industry Park of Dukem town. The industries which were considered for this study include dong fang spinning, printing and dyeing textile manufacturing, zong shun cement, diyuan ceramics, east steal, linde garment, lida textile, and ty wood manufacturing.

Households in the selected kebele were the population of the study. It was proposed to examine the effects of industrial pollution on human health from the perspectives of the local community. In conducting this, the researcher employed cross sectional data.

MATERIALS AND METHODS

Study Area

The study is located in Dukem town Eastern Industry Zone, where it is bordered in the South East by Bishoftu, in the North West by Galan town, in the south west by a peasant association, Akaki Wereda. The town is located 37 Km far from the capital city, Addis Ababa. The total area of the town is 9,630.3 ha. The astronomical location of Dukem ranges 8°45′25″ N to 8°50′30″N and 38°51′55″E to 38°56′5″E.

The climatic condition of the town is, mainly, semi temperate. The highest temperature of Dukem is 29.3°C in the month of March, April and May. However, the lowest temperature is 7.1°C in the month of August. The highest mean annual rainfall is 95 mm while the lowest mean annual rain fall is 48 mm.

The population of the town is 58,017 (49.12%) males and 56,010 (50.88%) females which is totally 114,027 Dukem town municipalities.

Data Collection Method

Quantitative and qualitative data from both primary and secondary data source were used in the study. Secondary data was collected from different sources such as the town annual report, documented data in the industries and audit report and management plan of industries. On the other hand, the primary data was collected from the households of selected kebele using survey questionnaires (Al-Yousfi, 2004).

Sampling Method and Size

In this study, systematic sampling was used to select the sample households from purposively selected kebeles. This was done, through arranging the target households according to some ordering scheme and then selecting elements at regular intervals through that ordered list.

Conversely, the total households who were calculated using the Yamane's formula (Equation 1) was 366. This was determined from a total of 8,200 households in the study area, using the purposely selected 2,000 households from one kebele. According to Yamane for a 95% confidence level and P=0.5, size of the sample should be using Equation (1).

$$n=N/1+N(e^2) \quad \text{..... equation (1)}$$

Where, N is population size and e is the level of precision. This formula used for our population, in which N=2,000 with +5% precision assuming 95% confidence level and P=0.5, we get the

sample size as n=2000/1+2000 (0.052)=333. By adding 10% contingency plan 333+(333)*10/100=333+33=366. Therefore, the total simple size of the study was 366.

Data Analysis and Presentation

The quantitative data was analysed first, then, the open-ended question was used, for methodological triangulation and to further information and explain the quantitative findings. On the other hand, the quantitative data was analysed using the Statistical Package for Social Science (SPSS) using multinomial logistic regression model and descriptive statics while tables, figures, charts and graph were used for data presentation.

Ethical Consideration

The research conducted with the households of sampled kebele was aided by supporting letters from Ethiopian Civil Service University. The researcher gathered data carefully to ensure confidentiality of information, privacy and personal safety of the respondents. Verbal permission was got from the respondents. The participants were told about the aim of the research before distributing the survey questionnaire. Those who were willing to take part were interviewed with survey questionnaire. The collected data was checked for completeness, clarity and accuracy.

RESULTS AND DISCUSSION

The Perception of Communities on the Impacts of Industrial Pollution on their Health and Comforts

Statistical procedure: Primarily, descriptive analysis was performed to explain the personal profile of the respondents. Secondly, multinomial logistic regression analyses were conducted to see the influence of socioeconomic and demographic factors on the types of industrial pollution and the prevailing diseases around the industrial park. To assess the likelihood that the respondents identify the type of pollution and the

kind of diseases that come mostly determined with five explanatory variables such as age, gender, proximity to industry site, income of the household and occupation of the households considered.

To predict the respondent's perception of the prevailing type of industrial pollution around industrial park and the kind of disease affecting the health of community, five predictors were incorporated in the model. These are age, gender, proximity to industry site, income of the household and occupation of the households. The choice of independent variables was relied on common sense and literature. For the constituents of the questionnaire reliability analyses were employed.

Thirdly, cross tabulating the prevailing allergic disorders in the industrial zone with the proximity to industry site, the ways air pollution affects the residents with age, the place where air pollution affect the local residents with occupation of the residents, the more respiratory effect of industrial air pollution with proximity to industry site and residents family members faced air pollution related sickness with age were made.

Description of respondent's socioeconomic and demographic characteristics of residents: In this section, different respondents' socioeconomic and demographic characteristics which included gender, age, educational background, and year of living in the town, proximity to industry site, income of the household and occupation of the households were described.

As Table 1 depicts, 50.3% of the respondents were males and the remaining 49.7% were females. This implies that there was gender proportion among respondents.

Table 2 presents, 6.7% of the respondents their age range between 18 to 25 years and 38.1% of the respondents their age range between 26-34 years. On the other hand, 38.3% of the respondents their age range between 35-54 years. The rest 14.7% and 2.2% of the respondents their age range between 55-64 years and 64 years and above respectively. This indicates that, the majority of the respondents were households whose their age ranges between 26-34 and 35-54 years.

Table 3 reveals the majority of respondents 55% were households whose their educational background was below high school. On the other hand, 19.4% of the respondents were high school completed. The remaining 16.1%, 8.3% and 1.1% of respondents were households their educational background were diploma, degree and masters respectively. This indicates the majority of households who participated in the survey were people with low educational background.

Table 4 presents 6.1% of the candidates were households who resided below 2 years. On the other hand, 25% of the respondents were households who inhabited between 2-5 years. The other 36.4% of the sampled representatives were households who stayed in the town between 6-10 years. The rest 32.5% of the respondents were households who lived in the town above 10 years. The above stated data reveals the majority of the respondents were households who inhabited in the town 6-10 years and above.

As Table 5 depicts, the majority 52.5% of the respondents were households who inhabit below 1 km from industrial park. The others, 36.9% of the respondents were households who dwell between 1-3 kms. The rest 10.6% of the respondents were households who live 3-5 km. This implies that the majority of respondents were households who inhabit below 1 km from industrial park.

Table 1. Respondent's gender profile.

Gender					
Solid by Solid	**Solid by Solid**	**Frequency**	**Percent(%)**	**Valid percent(%)**	**Cumulative percent(%)**
Valid	Male	181	50.3	50.3	50.3
	Female	179	49.7	49.7	100.0
	Total	360	100.0	100.0	

Table 2. Respondent's age profile.

Age					
		Frequency	**Percent(%)**	**Valid percent(%)**	**Cumulative percent(%)**
Valid	18-25 Years	24	6.7	6.7	6.7
	26-34 Years	137	38.1	38.1	44.7
	35-54 Years	138	38.3	38.3	83.1
	55-64 Years	53	14.7	14.7	97.8
	64 and above	8	2.2	2.2	100.0
	Total	360	100.0	100.0	

Table 3. Respondent's educational background profile.

Educational background					
		Frequency	**Percent (%)**	**Valid percent(%)**	**Cumulative percent(%)**
Valid	Less than high school	198	55.0	55.0	55.0
	High school	70	19.4	19.4	74.4
	Diploma	58	16.1	16.1	90.6
	Degree	30	8.3	8.3	98.9
	Masters	4	1.1	1.1	100.0
	Total	360	100.0	100.0	

Table 4. Respondent's year of living in the town profile.

Year of living in the town					
		Frequency	**Percent (%)**	**Valid percent(%)**	**Cumulative percent(%)**
Valid	Below 2 Years	22	6.1	6.1	6.1
	2-5 Years	90	25.0	25.0	31.1
	6-10 Years	131	36.4	36.4	67.5
	Above 10 years	117	32.5	32.5	100.0
	Total	360	100.0	100.0	

Table 5. Respondent's proximity to industry site profile.

Proximity to industry site					
		Frequency	**Percent (%)**	**Valid percent(%)**	**Cumulative percent(%)**
Valid	below 1 km	189	52.5	52.5	52.5
	1-3 km	133	36.9	36.9	89.4
	3-5 km	38	10.6	10.6	100.0
	Total	360	100.0	100.0	

As Table 6 presents, the majorities 63.3% of the respondents were households that earn below 30 birr per day income. On the other hand, 13.6% of the respondents were households that earn 30-40 birr per day income. The remaining 2.5%, 5.6% and 15% of the respondents were households whose daily income was 50-70 birr, 80-100 birr and above 100 birr respectively. The stated data reveals that the majority of respondents were households who get very low daily income.

As Table 7 presents 8.9% of the respondents were government employees. On the other hand, 2.2% of the respondents were farmers. The other 30.6% of the respondents were private employees. However, the majority 58.3% of the respondents were unemployed households. This implies that the majority of the households' representatives were people who were unemployed and inhabited around industrial park.

Analysis of Multinomial Logistic Regression Model

The association of the kind of industrial pollution that affects the health of residents and their socioeconomic and demographic characteristics: As Table 8 indicated, out of 360 respondents, 348 (96.7%) of them replied that the kind of industrial pollution that affects their health more was air pollution. The other 5 (1.4%) of the respondents said that the kind of industrial pollution that affects their health more was waste pollution. The remaining 7 (1.9%) of the respondents answered that the type of industrial pollution that affects their health more was sound pollution. The above stated data reveal that, air pollution was the dominant type of pollution that affects the health of local community.

On the other hand, in order to get the whole measure of the model, bearing in mind the statistics demonstrated in the model fitting information table is vital. Accordingly, the model fitting information was depicted in the following Table 9.

Table 6. Respondent's income of the household profile.

Income of the household					
		Frequency	**Percent (%)**	**Valid percent(%)**	**Cumulative percent(%)**
Valid	Below 30 birr	228	63.3	63.3	63.3
	30-40 birr	49	13.6	13.6	76.9
	50-70 birr	9	2.5	2.5	79.4
	80-100 birr	20	5.6	5.6	85.0
	Above 100 birr	54	15.0	15.0	100.0
	Total	360	100.0	100.0	

Table 7. Respondent's occupation of the households profile.

Occupation of the households					
		Frequency	**Percent (%)**	**Valid percent(%)**	**Cumulative percent(%)**
Valid	Government Employees	32	8.9	8.9	8.9
	Farmer	8	2.2	2.2	11.1
	Private employees	110	30.6	30.6	41.7
	Unemployed	210	58.3	58.3	100.0
	Total	360	100.0	100.0	

Table 8. Summary of the kind of industrial pollution that affects the health of residents.

Case processing summary			
		N	**Marginal percentage(%)**
The kind of industrial pollution that affects your health more	Air pollution	348	96.7%
	Waste pollution	5	1.4%
	Sound pollution	7	1.9%
Gender	Male	181	50.3%
	Female	179	49.7%
Age	18-25 Years	24	6.7%
	26-34 Years	137	38.1%
	35-54 Years	138	38.3%
	55-64 Years	53	14.7%
	64 and above Years	8	2.2%
Proximity to industry site	Below 1 km	189	52.5%
	1-3 km	133	36.9%
	3-5 km	38	10.6%
Income of the household	Below 30 birr	228	63.3%
	30-40 birr	49	13.6%
	50-70 birr	9	2.5%
	80-100 birr	20	5.6%
	Above 100 birr	54	15.0%
Occupation of the households	Government employees	32	8.9%
	Farmer	8	2.2%
	Private employees	110	30.6%
	Unemployed	210	58.3%

Valid		360	100.0%
Missing		0	
Total		360	
Subpopulation		95[a]	
a- The dependent variable has only one value observed in 87 (91.6%) subpopulations.			

Table 9. The model fitting information on kind of industrial pollution that affects human health.

Model fitting information			
Model	**Model fitting criteria**	**Likelihood ratio tests**	
	-2 Log Likelihood	**Chi-square**	**df Sig.**
Intercept Only	96.286		
Final	26.213	70.073	28.000

In the Table 9 as it can be seen from the "Sig." column that p=0.000, which means that the full model statistically significantly predicts the dependent variable better than the intercept-only model alone.

In this model, dependent variable is the kind of pollution that affects the health of the community. On the other hand, the independent variables are age, gender, proximity to industry site, income of the household and occupation of the households influencing the type of pollution that affect the health of the community this is a model which we call it the final model.

Here the significance value is .000. Since the significance difference is <0.05 the null hypothesis is rejected. This means the final model fits. Hence, since the value of p=0.000 which is <0.05 we reject the null hypothesis which mean the final model more significant than the null value or model.

As Table 10 depicts, the Goodness-of-Fit gives two measures that can be employed to evaluate how well the model fits the data. The first row, labeled "Pearson", depicts the Pearson chi-square statistic. Small chi-square values, which are found under the "Chi-Square" column, reveal a good fit for the model. A statistically significant result (i.e., p<0.05) shows that the model does not fit the data well. However, as we see from the table above that the p-value is 1 (from the "Sig." column) which is >0.05. Therefore, it is not statistically significant. As to this principle, the model fits the data well. If the significance value is <0.05 it is rejected. If it is above 0.05 it is accepted. Since Pearson value is 1.000 which is >0.05 the data adequately fit the model. In general, from these two tables the model that was developed is good.

The other important components of the model are the results depicted in the likelihood ratio tests, as presented in the following Table 11.

The above Table 11 indicates which independent variables are statistically significant. In the Table 11 as it can be seen in the "Sig." column, age, income and occupation of the households are not statistically significant since p=0.857, 0.862 and 0.681 respectively which is greater than 0.05. On the other hand, age and proximity to industry site variables are statistically significant since p=0.003 and 0.004 respectively which is less than 0.05. Hence, both variables have significant impact on the dependent variable the kind of industrial pollution that affects the local people health more.

The association of the prevailing diseases around industry park and households' socioeconomic and demographic characteristics: According to Table 12 reveals, out of 360 respondents, 210 (58.3%) of them replied that the prevailing diseases around Industry Park was Acute Respiratory Infection (ARI). The other 85(23.6%) of the respondents said that the prevailing diseases around Industry Park was Acute Febrile Illness (AFI). The rest 11 (3.1%), 38 (10.6%) and 16 (4.4%) of the respondents replied that the prevailing diseases around Industry Park were diarrhea or non-bleeding, infection of skin diseases and disease of muscle and skeleton system respectively. The above stated data reveal that, Acute Respiratory Infection (ARI) was the prevailing disease that affects the health of local people (Demewoz et al., 2017).

However, to get the whole measure of the model, bearing in mind the statistics indicated in the Model Fitting Information is needed which was depicted in the following Table 13.

In the Table 13 as it can be seen from the "Sig." column that p=0.004, which means that the full model statistically significantly predicts the dependent variable better than the intercept only model alone.

In this multinomial regression model, dependent variable is the prevailing diseases around Industry Park. On the other hand, the independent variables are age, gender, proximity to industry site, income of the household and occupation of the households impacting the prevailing diseases around Industry Park. This is a model which we call it the final model.

Table 10. The goodness-of-fit on kind of industrial pollution that affects human health.

Goodness-of-fit			
	Chi-square	**df**	**Sig.**
Pearson	9.965	160	1.000
Deviance	11.481	160	1.000

Table 11. Likelihood ratio tests on kind of industrial pollution that affects human health.

Likelihood ratio tests				
Effect	**Model fitting criteria**	**Likelihood ratio tests**		
	-2 log likelihood of reduced model	**Chi-square df Sig.**	**df**	**Sig.**
Intercept	26.213	.000	0	.
Gender	26.523	.309	2	.857
Age	49.515	23.301	8	.003
Proximity to industry site	41.496	15.283	4	.004
Income of the household	30.184	3.971	8	.860
Occupation of the households	30.161	3.948	6	.684

Table 12. Summary of the prevailing diseases around industry park.

Case processing summary			
		N	**Marginal percentage(%)**
The prevailing diseases around industry park	Acute Respiratory Infection (ARI)	210	58.3%
	Acute Febrile Illness (AFI)	85	23.6%
	Diarrhea or non-bleeding	11	3.1%
	Infection of skin diseases	38	10.6%
	Disease of muscle and skeleton system	16	4.4%
Gender	Male	181	50.3%
	Female	179	49.7%
Age	18-25 Years	24	6.7%
	26-34 Years	137	38.1%
	35-54 Years	138	38.3%
	55-64 Years	53	14.7%
	64 and above Years	8	2.2%
Proximity to industry site	Below 1 km	189	52.5%
	1-3 km	133	36.9%
	3-5 km	38	10.6%
Income of the household	Below 30 birr	228	63.3%
	30-40 birr	49	13.6%
	50-70 birr	9	2.5%
	80-100 birr	20	5.6%
	Above 100 birr	54	15.0%
Occupation of the households	Government employees	32	8.9%
	Farmer	8	2.2%
	Private employees	110	30.6%
	Unemployed	210	58.3%

Valid		360	100.0%
Missing		0	
Total		360	
Subpopulation		95[a]	
a-The dependent variable has only one value observed in 45 (47.4%) subpopulations.			

Table 13. Model fitting information on the prevailing diseases around industry park.

Model fitting information				
Model	**Model fitting criteria**	**Likelihood ratio tests**		
	-2 Log Likelihood	**Chi-square**	**df**	**Sig.**
Intercept Only	499.050			
Final	410.651	88.399	56	.004

Here the significance value is 0.000. Since the significance difference is <0.05 the null hypothesis is rejected. This means the final model fits. Therefore, since the value of p=0.004 which is <0.05 the null hypothesis is rejected which mean the final model more significant than the null value or model. Another, element in the model is Goodness-of-Fit on the prevailing diseases around Industry Park which was depicted in the following Table 14.

A statistically significant result which is p<0.05 shows that the model does not fit the data well. However, as shown on the table above that the p-value is 0.241 which is >0.05 (from the "Sig." column). Therefore, it is not statistically significant. According to this criterion, the model fits the data well. If the significance value is <0.05 it is rejected. If it is above 0.05 it is accepted. Since Pearson value is .241 which is >0.05 the data adequately fit the model. In general, from these two tables the model that has developed is good.

On the other hand, the likelihood ratio tests plays significant role in showing the kind of independent variables that are statistically significant which was presented in the Table 15.

As Table 15 indicates the "Sig." column, gender, age and income of the households are not statistically significant since p=0.484, 0.720 and 0.486 respectively which is greater than 0.05. On the other hand, proximity to industry site and occupation of the household variables are statistically significant since p= 0.039 and 0.000 respectively which is less than 0.05. Hence, both variables have significant impact on the dependent variable the prevailing diseases around Industry Park.

The prevailing allergic disorders around industrial park: In this section, the prevailing allergic disorders around industrial park were described. The section also discussed allergic disorders based on the proximity from industrial site. Accordingly, the following Fig.

Table 14. Goodness-of-fit on the prevailing diseases around Industry Park.

Goodness-of-fit			
	Chi-square	**df**	**Sig.**
Pearson	337.461	320	.241
Deviance	278.694	320	.954

Table 15. Likelihood ratio tests on the prevailing diseases around industry park.

Likelihood ratio tests				
Effect	**Model fitting criteria**	**Likelihood ratio tests**		
	-2 Log Likelihood of reduced model	**Chi-square**	**df**	**Sig.**
Intercept	410.651	.000	0	.
Gender	414.111	3.460	4	.484
Age	422.997	12.347	16	.720
Proximity to industry site	426.904	16.254	8	.039
Income of the household	422.153	11.502	12	.486
Occupation of the households	455.010	44.360	16	.000

1 presented the prevailing allergic disorders around Industry Park.

As Fig. 1 presents, out of 360 respondents the majority 47% of them replied that a skin rash was the prevailing allergic disorders that affecting them. The other 40.6% of the respondents said that sneezing was the prevailing allergic disorders that impacting them. The rest 11.9% of participants responded that the prevailing allergic disorder that affecting them was eye irritation. The above stated data reveals that, the majority of residents believed that skin rashes and sneezing were the major allergy treat that impacted their health. This implies that unless appropriate measure will be taken people who are living around industrial park might encounter skin diseases and susceptible for respiratory infection like asthma and bronchi (Despeisse, et al., 2012).

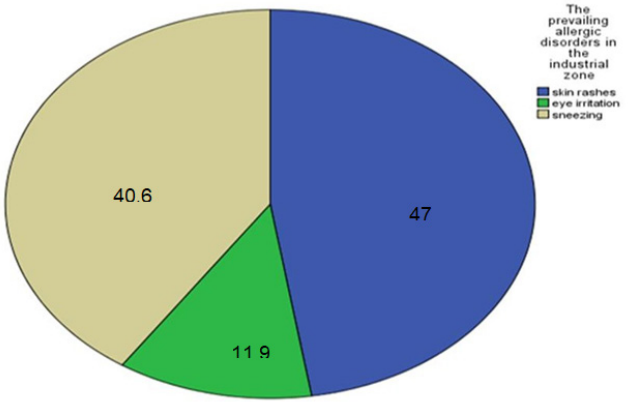

Fig. 1 The prevailing allergic disorders around industry park.

The prevailing allergic disorders based on proximity from Industry Park: In the section below, the prevailing allergic disorders based on the proximity the households have from industrial park were discussed.

As Fig. 2 presents, the majority 50.8% of the households within the proximity of below 1 km from industrial park encountered sneezing allergy. The rest 40.2% and 9.0% faced skin rash and eye irritation allergy respectively. On the other hand, the majority 56.4% of the residents within the proximity of 1-3 km from industrial park faced skin rash allergy. The remain 27.1% and 16.5% of dwellers within the proximity of 1-3 km from industrial park faced sneezing and eye irritation allergy respectively. The other, 52.6% of the town residents who inhabited within the proximity of 3-5 km encountered skin rashes allergy while the rest 36.8% and 10.5% residents faced sneezing and eye irritation allergy.

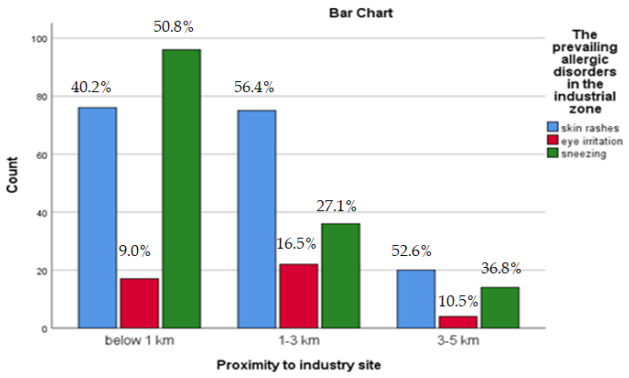

Fig. 2 The prevailing allergic disorders based on proximity from industry park.

This implies that the residents who inhabited below 1 km proximity were more susceptible for sneezing allergy while the majority of residents that dwelled within the proximity of 1-3 km and 3-5 km were more vulnerable for skin rash allergy. As people reside close to near industrial park they might be possibility to be affected by air pollution related diseases that emanate from industrial park. On the other hand, as people residing far from industrial park, there is still possibility to be affected by industrial dusts that blow to residents through wind. This might causes skin diseases.

The Ways Air Pollution Affect the Residents

As Fig. 3 presents, out of 360 respondents, the majority 50.8% of selected households responded that industrial air pollution affects them as health hazards. On the other hand, the rest 48.9% of the respondents said that the combined effects as health hazards and dirtiness of clothes impacting their life. A few number 0.3% of the candidates replied that industrial air pollution affect them as dirtiness of clothes.

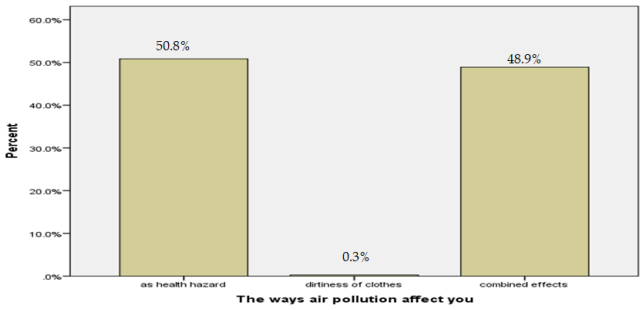

Fig. 3 The ways air pollution affects the residents.

The above stated data implies air pollution from industrial park is affecting the majority of residents through being as health hazards more than the combined effects as health hazards and dirtiness of clothes. This showed, people who resided around industrial park were encountering health problem more than other hazards.

The ways air pollution affects the residents with their age differences: In the following Fig. 4, the way air pollution affect residents based on their age differences were discussed.

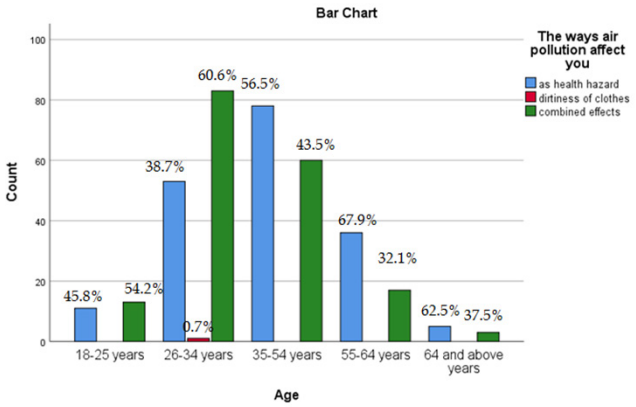

Fig. 4 The ways air pollution affects the residents based on their age level.

As Fig. 4 depicts, the majority of residents 54.2% who's their age ranges between 18-25 years accepted that air pollution from industrial park affected them through combined effects of making their clothes dirty and being as health hazards. The rest 45.8% of the town dwellers were affected by pollution from industrial park as health hazards.

On the other hand, the majority 60.6% of the town inhabitants who's their age ranges between 26-34 years believed that the combined effects of industrial air pollution as health hazards and dirtiness of clothes were affecting them. The remaining 38.7% and 0.7% of the respondents were affected by industrial air pollution as health hazard and dirtiness of clothes respectively.

The other 56.5% and 43.5% of the town dwellers who's their age ranges between 35-54 years were affected by industrial air pollution from Eastern Industrial Park as health hazards and the combined effects of health hazard and dirtiness of cloths.

The majority 67.9% and the rest 32.1% of the town inhabitants who's their age ranges between 55-64 years were affected by air pollution from industrial park as health hazards and the combined effects of dirtiness of clothes and health hazards respectively.

On the other hand, the majority 62.5% and the remain 37.5% of respondents whose their age ranges between 64 and above were affected by industrial air pollution from industrial park as health hazards and the combined effects respectively.

This indicates that, the majority of residents whose their age ranges from 18-25 believed that the combined effects of industrial air pollution affecting them. Similarly, the majority of inhabitants of the town who's their age range from 26-34 and 35-54 years accepted that the combined effects of industrial air pollution affecting them. However, the majority of residents of the town who's their age range from 55-64 years and above 64 years were affected by industrial air pollution as health hazards.

The place where air pollution affects the residents: In this section, the place where air pollution affected the residents described as in the following Fig. 5.

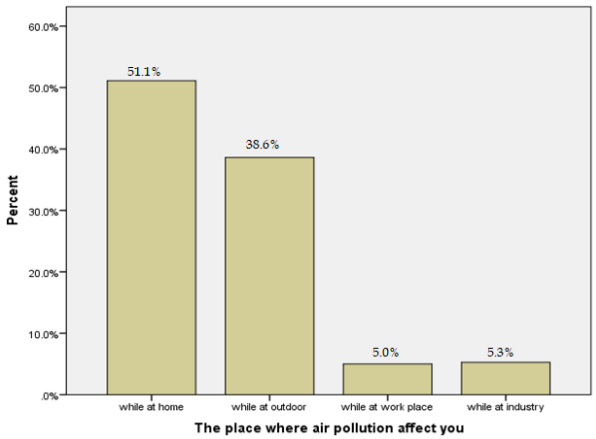

Fig. 5 The place where air pollution affects the residents.

As Fig. 5 depicts out of 360 the majority 51.1% of the respondents replied that industrial air pollution affect them while they were at home. The other 38.6% of the participants said that industrial air pollution affects them when they were outdoor. The rest 5.0% and 5.3% of the participants accepted that industrial air pollution affect them while they were at work place and industries. This indicates that the majority of residents affected by industrial air pollution while they were at home. This might be due to the air pollution that emanates from industrial park blow to the residents house when it is open particularly during mid-night when the pollution released to the maximum level.

The place where air pollution affects the residents with their occupation: In the following Fig. 6 the place where air pollution affected the residents with their level of occupation presented. Accordingly, the place where industrial air pollution affected the residents such as at home, outdoor, work place and industry discussed in the next section based on households' occupation level.

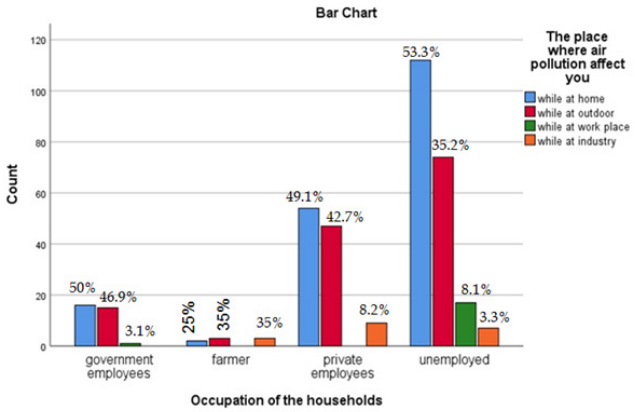

Fig. 6 The place where air pollution affects the residents based on their occupation level.

As the above Fig. 6 depicts, the majority 50.0% of the government employee respondents were affected by air pollution while at home. The other 46.9% and 3.1% of the government employee residents were affected by industrial air pollution while at outdoor and work place respectively.

On the other hand, the majority 75% of the town farmer dwellers were affected by industrial air pollution when they were both in the outdoor and industries proportionally. The rest 25% of the farmers respondents were affected by industrial air pollution while at home.

The majority 49.1% of the private employee respondents were affected by industrial air pollution when they were at home. The rest 42.7% and 8.2% of the private employees inhabitants were affected by industrial air pollution when they were in the outdoor and industries respectively.

Similarly, the majority 53.3% of the unemployed dwellers were affected by industrial air pollution when they were at home. The rest 35.2%, 8.1% and 3.3% of unemployed respondents were affected by industrial air pollution when they were at outdoor, work place and industries respectively.

This implies that the majority of government, private employees and unemployed residents of the town were impacted by industrial air pollution from industrial park when they were at home.

The More Respiratory Effect of Industrial Air Pollution

Under this section, the more respiratory effect of industrial air pollution described in the following Fig. 7.

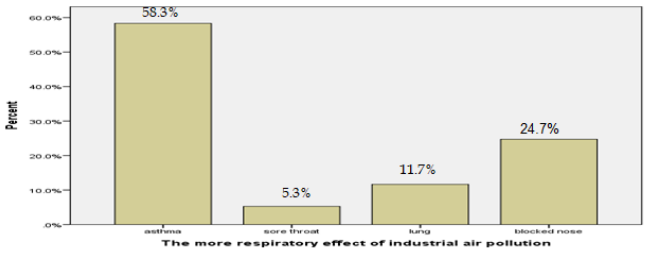

Fig. 7 The more respiratory effect of industrial air pollution.

Fig. 7 presents out of 360 respondents, the majority 58.3% of them replied that asthma was the more respiratory effect of industrial air pollution. The other 24.7% of selected participants said that the more respiratory effect of industrial air pollution around industrial park was blocked nose. The rest 11.7% and 5.3% of the candidates responded that lung and sore throat were the more respiratory effect of industrial air pollution respectively. The above stated data reveals that, the majority of the town residents believed that asthma was the more respiratory effect of industrial air pollution that affected the health of local residents.

The more respiratory effect of industrial air pollution with proximity from industry site: In this section, the respiratory effect of industrial air pollution such as asthma, sore throat, lung and blocked nose based on the proximity that the residents have from industry site described in the following Fig. 8.

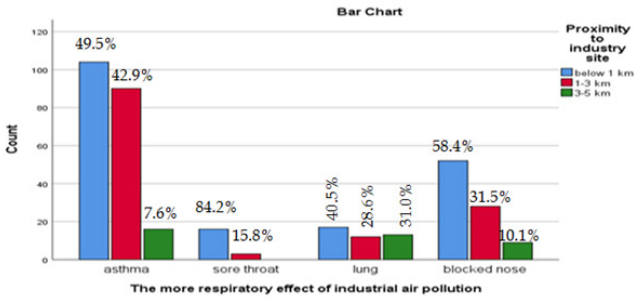

Fig. 8 Respiratory effect of industrial air pollution based on proximity from industry site.

As Fig. 8 indicates the majority 49.5% of asthma was respiratory effect of industrial air pollution within the proximity of below 1 km from industrial park. The rest 42.9% and 7.6% of asthma was respiratory effect of industrial air pollution within the proximity of 1-3 km and 3-5 km from industrial park respectively.

The majority 84.2% of sore throat was respiratory effect of industrial air pollution within the proximity of below 1 km from industrial park. The remaining 15.8% of sore throat was respiratory effect of industrial air pollution within the proximity of 1-3 km from industrial park (Mekonnen, 2012).

On the other hand, the majority 40.5% of lung was respiratory effect of industrial air pollution within the proximity of below 1 km from industrial park. The rest 28.6% and 31.0% lung was respiratory effect of industrial air pollution within the proximity of 1-3 km and 3-5 km respectively.

The majority 58.4% of blocked nose was respiratory effect of industrial air pollution within the proximity of below 1 km from industrial park. The remains 31.5% and 10.1% of blocked nose were respiratory effect of industrial air pollution within the proximity of 1-3 km and 3-5 km respectively.

This implies that, the majority of asthma, sore throat, lung, blocked nose were respiratory effect of industrial air pollution within the proximity of below 1 km from industrial park. As households reside very close to industrial park, there might be air pollution that released from industrial park and affected the health of local residents.

Air Pollution Related Sickness Based on Age Differences among Family Members of Residents within the Last Three Years

In this section, whether air pollution related sickness encountered the family members based on age differences such as below 1 year, 1-5 years, 6-10 years, 11-20 years, 21-29 years, 30-45 years, 46-69 years and above 70 years were described using Fig. 9 below.

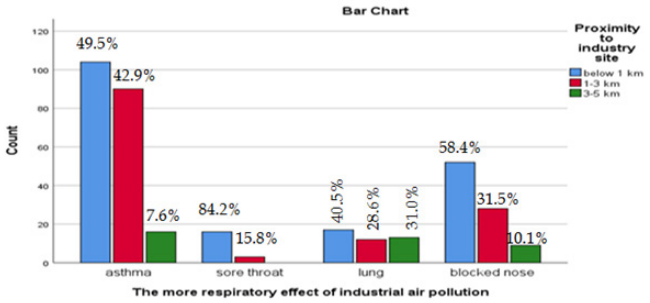

Fig. 9 Resident's family faced air pollution related sickness.

As Fig. 9 presents, the majority 99.7% of respondents accepted that in the last 3 years their family members faced air pollution related sickness while only 0.3% of the respondents rejected. Accordingly, the majority 48.9%) of the age of residents' family members that faced air pollution related sickness was below 1 year. The other 18.6% of the age of residents' family members that faced air pollution related sickness range between 1-5 years (Menbere, et al., 2019). 9.7% of the age of residents' family members that faced air pollution related sickness range between 6-10 years. On the other hand, 2.5% of the age of residents' family members that faced air pollution related sickness ranges between 11-20 years. 4.2% of the age of residents' family members that faced air pollution related sickness ranges between 21-29 years. The remain 6.1%, 5.3% and 4.4% of the age of residents' family members that faced air pollution related sickness ranges between 30-45 years, 46-69 years and above 70 years respectively.

This implies that children at lower age and adults were more vulnerable for air pollution related sickness than other age groups.

Recommendation

Based on the main finding of the study, the following recommendation forwarded:

• Since there were poor policy implementation practices in the selected companies, in each company there should be regular inspection and follow up on their policy implementation by the internal and external bodies.

• There should be local and national government intervention in the enforcement of industrial park policies that formulated to safeguard the environment.

• The existing solid waste reusing and recycling practices in the sampled companies were not that much satisfactory, hence, the companies recommended the advancement of reusing and recycling of wastes in order to reduce environmental pollution and resource efficiency.

• The existing temporary waste disposal site in each company was not efficient, the companies recommended to have well designed temporary waste disposal.

• There were large volumes of liquid wastes production from sample industries of Eastern Industrial park hence each companies recommended to have efficient treatment plant that help them treat the liquid wastes that discharged to the communal treatment plant.

• Each company recommended making sample test regularly from the effluents discharged to the communal treatment plant and its outlet.

• The existing communal treatment plant of Eastern Industrial park was not efficient in treating liquid wastes discharged from industries of Industrial park, therefore, the Industry Park recommended to plant efficient treatment plant with sufficient facilities in order to avoid environmental degradation due to pollution of liquid wastes.

• The industries recommended using modern and efficient technologies that reduce liquid waste pollution.

• Some of the chemicals that have been used in the treatment plant was not labelled either in English or local language rather labelled with Chinese language which was difficult to read and identify the expire date by local experts, hence, the chemicals that have been used in the treatment plant should be labelled either in English or local language so that appropriate evaluation and monitoring will be made by local experts.

• The existing regulatory framework that were related with liquid waste management in the Industrial Park need to be implemented in the sampled industries and the communal treatment plants.

• The companies recommended using efficient water use mechanism through reducing the amount of water used in the company and increasing the amount of waste water reusing.

• The majority of sampled industries of industrial park have been using fossil fuel in addition to electric power as source of energy, hence, the companies recommended to rely on renewable energy such as hydroelectric power, air force, water steam and solar energy.

• The companies recommended having energy audit systems, written energy policies and strategies.

• There should be regulatory measure on industries that violate the standard set by legal and pollute the environment.

CONCLUSION

Output from multinomial logistic regression revealed, air pollution was the dominant type of pollution that affects the health of local community.

On the other hand, based on likelihood ratio tests gender, income and occupation of the households are not statistically significant since p=0.857, 0.862 and 0.681 respectively which is greater than 0.05. However, age and proximity to industry site variables are statistically significant since p=0.003 and 0.004 respectively which is less than 0.05. Hence, both variables have significant impact on the dependent variable the kind of industrial

pollution that affects the health of local people more.

Output from multinomial logistic regression indicated, Acute Respiratory Infection (ARI) was the prevailing disease that affects the health of local people.

On the other hand, based on Likelihood Ratio Tests, gender, age and income of the households are not statistically significant since p=0.484, 0.720 and 0.486 respectively which is greater than 0.05. However, proximity to industry site and occupation of the household variables are statistically significant since p=0.039 and 0.000 respectively which is less than 0.05. Hence, both variables i.e. proximity to industry site and occupation of the households has significant impact on the dependent variable the prevailing diseases around Industry Park.

Based on output from descriptive statistics, the majority of residents believed that skin rashes and sneezing were the major allergy treat that impact their health. On the other hand, the majority of the town residents believed that asthma was the more respiratory effect of industrial air pollution that affected the health of local residents. On the other hand, the majority of asthma, sore throat, lung, blocked nose were respiratory effect of industrial air pollution within the proximity of below 1 km from industrial park. Children at lower age and adults are more vulnerable for air pollution related sickness.

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