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Microbial Load Burden of Solid Waste Biodegradable Microbes of Dumps In Relation to Economic and Health Implication of Waste Scavengers in Port Harcourt, Nigeria

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Abstract

Background: Background: This study investigates the health risks of waste scavengers (rag pickers) and the microbial burden of waste. Samples were collected from 8 dumpsites (7 dumpsites and 1 control) in different parts of Port Harcourt or locations and analyzed for total heterotrophic count.

Materials and Methods: 100 subjects (80 ragpickers and 20 students as control) were examined for some microbiological parameters. A well-structured questionnaire and oral interview were administered to the rag pickers. An aliquot (0.1ml) of the diluted samples from the dumpsites was inoculated on surface-dried media, yielding bacterial and fungal isolates. They include Proteus spp, Escherichia coli, Salmonella spp, Klebsiella spp, Bacillus species, Mucor spp, Penicillium mycelia, Aspergillus spp, and Candida albicans with a total microbial burden of 34.10 x 106cfu/g. All these organisms are potential human pathogens. The various risks associated with rag pickers were investigated to assess the health impact of waste on rag pickers.

Results: The culture result showed growth of Staphylococcus aureus on 26(32%) rag pickers and 2(25%) for the control; Klebsiella spp was isolated in 9(11.25%) rag pickers and 1(12.50%) control. Salmonella spp was isolated in 10(12.5%) rag pickers and 1(12.5%) control subject, Escherichia coli was isolated from 15(18.5%) rag pickers and 2(25%) control, Streptococcus spp was isolated from 12(15%) of the rag pickers and 1(12.5%) from the control, Pseudomonas aeruginosa was isolated in 3(3.7%) of the rag pickers and 1(12.50%) of the control subjects. In comparison, Candida albicans were found in 5(6.25%) of rag pickers and 0(0%) of control. In the final analysis, the microorganisms in waste dumps were also found in the samples collected from the rag pickers, where they caused disease.

Conclusion: These bacteria and fungi have severe health implications on rag pickers, waste workers, and the general public if adequate precautions are not taken as recommended in this work. Even though rag pickers make money from their business, the health implications are of great concern. It could as well be inferred that rag pickers or scavengers may serve as vehicles or carriers of these pathogens and later distribute them to other healthy individuals that come in contact with them.

INTRODUCTION

Microbial degradation of solid waste implies the breaking down of organic components of waste to inorganic form by microorganisms, which can readily serve as nutrient for various other organisms [1]. Waste is any substance, solution, moisture, or article for which no direct use is envisaged. Waste is any substance discarded after primary use or is worthless, defective, and of no use. [2]. Waste is a material that may no longer be needed but may become a feedstock or raw material elsewhere. [3]. The global waste problem is as old as man's existence [4]. Waste generation started from the early man who

used natural forest resources as food and shelter and discarded the remnants as food remains or human waste. These wastes come from municipal, domestic, industrial, mining, commercial, animal, and Agricultural sources basically [5]. These wastes are a severe health hazard and lead to the spread of infectious diseases to humans and animals living near the waste if improperly disposed of [6]. Over 150 tons of Solid Waste are produced daily in Port Harcourt [7].

The greatest threat facing us as a people is waste management. The implication is that soil, air, and freshwater pollution has become a serious and continuing threat to the health of humans and other species [8]. Although there are available waste disposal methods, such as composting, landfill, and incineration, open dumping remains the only method available in Nigeria vis-a-vis Port Harcourt. In this case, waste is left on the street (open dump) for weeks and, when collected for disposal, is either dropped along the roads on the way to the final dumpsites or relocated to open lands [5]**.** There is currently no accurate data on the impact of waste dumping in our environment in Port Harcourt. Benefits accruing from scavenging are enormous, but the health implications are devastating. There is a need for government and non-governmental organizations to enlighten waste scavengers through seminars and campaigns in a decent way and provide them with boots, gloves, wheelbarrows, etc. There is a need for dumpsites to be created out of the city to avoid indiscriminate dumping of waste in the ci**ty.** This study aimed to estimate the microbial load burden of solid waste biodegradable microbes in dumps with economic and health implications for waste scavengers in Port Harcourt, Nigeria.

MATERIALS AND METHODS

Study area

The study was carried out in the city of Port Harcourt, which is the head quarter of oil and gas in Nigeria. Due to the importance of the town in Nigeria, there is a flow of people with accompanied commercial activity, thus giving rise to all forms of waste generation. Samples were collected from eighty waste scavengers (ten per dump site) from the following dump sites; A) Elikpokoodu, B) Mile 3 motor park dump site, C) Mile 1 dump site, D) Eagle Island dump site, E) Rumuokoro dump site, F) Town market dump site, G) Ogbunabali/ Nzimiro dump site and H) Ada George dump site, . In the course of the work, a structured questionnaire was prepared for the waste workers to analyze and ascertain the economic benefits and the health implications. Samples collected from scavengers include nasal swabs, sputum, and stool. Samples were also collected from twenty students as a control. The waste scavengers signed an informed consent form before samples were collected. Protective materials used include safety boots, nose and face masks, and hand gloves.

B. Examination of samples from waste scavengers & students as control.

1) Stool: The stool was collected for macroscopic and microscopic examination for intestinal worms and parasites using the formol ether method and cultured on Salmonella Shigella Agar (SSA), DCA, and MacConkey.

2) Nasal Swab: This was collected from the waste workers using swab sticks and cultivated onto MacConkey agar, Blood agar, and Chocolate agar plate**s.**

3) Sputum: This was collected from waste workers using a sterile sample container and cultured onto MacConkey Agar, Blood Agar, chocolate Agar, and Nutrient Agar.

C. Isolation, identification, and characterization of bacteria in the waste scavengers:

Pure bacteria cultures were obtained by streaking representative colonies of different cultural types, which appeared on the various plates on Nutrient agar and incubated at 37°C for 24 hours. These served as stock for subsequent tests.

The organisms were examined and identified, considering their cultural characteristics, Gram's staining reaction, motility test, and use of Biochemical tests such as the Coagulase test, Oxidase test, Indole test, Citrate test, Urease test, and sugar fermentation test [9].

D. Isolation and identification of fungi in waste dumpsites and waste scavengers:

Pure cultures of fungi were obtained by subculturing discrete colonies onto Sabouraud-dextrose agar and incubated at 28°C for 5 to 7 days. The identification was made based on a Macroscopic examination of fungal growth, slide culture, and microscopic examination using a mounted needle to a few drops of lactophenol cotton blue [10].

Then, observe sexual and asexual reproductive structures like sporangia, conidial head, arthrospores, and vegetative mycelium.

RESULTS

The results obtained from the rag pickers were compared with those of the coontrol subjects: as seen in Table

1, From the waste dumpsites, the bacteria isolated include (ten per dump site); *Proteus* spp 3(1.3%), *Klebsiella* spp 4(13.7%), *Salmonella* spp 5(17.2%), *Clostridium* spp 1(3.4%), *Escherichia* coli 7(24.1%), *Staphylococcus* aureus 7(24.1%), *Bacillus* spp 1(3.4%) and *Pseudomonas aeruginosa* 1(3.4%). The fungal isolates include *Mucor* spp 2(22.2%), *Aspergillus* spp 3(33.3%), *Penicillium* spp 1(11.1%), and *Candida* albicans 3(33.3%).

Viable heterotrophic count was highest in site D (6.7×10^6cfu/g), followed by site A (6.3×10^6 cfu/g), then site E (4.9×10^6 cfu/g), site B (4.8×10^6 cfu/g), site G (3.9×10^6 cfu/g) site F (3.8×10^6 cfu/g) and site C (3 .7 $\times 10^6$ cfu/g). All the sites gave a total of (34.10×10^6 cfu/g). The control site had a total colony forming unit of 1.0×10^6 cfu/g.

The most frequently encountered organism was *Staphylococcus aureus* (8.9×10^6 cfu/g), followed by *E.coli* (8.6×10^6 cfu/g) then *Salmonella spp* (7.6×10^6 cfu/g) *Klebsiella* (2.6×10^6 cfu/g), *Proteus* spp (1.7×10^6 cfu/g) *Pseudomonas aeruginosa* (1.1×10^6 cfu/g). The control site had only two bacteria namely *Clostridium* spp (0.8×10^6 cfu/g) and *Bacillus* (0.1×10^6 cfu/g). The colony forming unit for the fungi isolates include *Aspergillus* spp (1.2×10^6 cfu/g) and *Candida* albicans (2.4×10^6 cfu/g).

Table 2 shows the bacteria and fungi isolated from the different sites kept in the laboratory for one week. The colony forming unit for site B (0.6×10^6 Cfu/g), site G (0.6×10^6 cfu/g), site D (0.5×10^6 cfu/g) site F (0.4×10^6 cfu/g), site A (0.4×10^6 cfu/g), site E (0.3×10^6 cfu/g) and site C (0.2×10^6 cfu/g). All the site gave a total of value of (3.0×10^6 cfu/g), while the control site had 0.2×10^6 cfu/g)

Also, the colony-forming unit of Staphylococcus is 1.5×10^6 cfu/g, Escherichia coli 0.7×10^6 cfu/g, Klebsiella 0.6×10^6 cfu/g, Proteus 0.1 x 106 cfu/g while Candida albicans (0.5×10^6Cfu/g) was for fungi. The control site showed a colony-forming unit of *Clostridium spp* (0.2×10^6 Cfu/g) and *Bacillus spp* (0.01×10^6 Cfu/g)

Table 3 shows the comparative analysis of the microbial degradation of samples from the waste Dumpsites and the waste kept in the laboratory for one week. From the final analysis, as can be deduced from the table, there is a significant difference in the rate of waste burden between samples from the waste dumpsites and the wastes kept in the laboratory for one week ($P<0.05$). The total heterotrophic count decreased from 4.26×10^6 cfu/g ……

(for samples collected directly from waste dump) to 0.60×10^6cfu/g (for samples kept in the laboratory for 1week)

TABLE 1: Bacterial and Fungi isolated from The Different Sites and Control Site

Bacteria/ Fungi	A cfu/g	B cfu/g	C cfu/g	D cfu/g	E cfu/g	F cfu/g	G cfu/g	Total	Mean	SD	H Control cfu/g
Proteus spp	1.4×10^6	-	-	-	-	0.6×10^6	-	1.7	0.57	0.72	-
Klebsiella spp	-	-	1.1×10^6	1.2×10^6	-	0.2×10^6	-	2.6	0.68	0.51	-
Salmonella spp	2.1×10^6	-	-	1.9×10^6	1.3×10^6	1.1×10^6	1.2×10^6	7.6	1.52	0.45	-
Clostridium spp	-	-	-	-	-	-	-	-	-	-	0.8×10^6
Escherichia coli	1.2×10^6	1.2×10^6	1.4×10^6	1.1×10^6	1.4×10^6	1.2×10^6	1.1×10^6	8.60	1.23	0.125	-
Staphylococcus aureus	1.4×10^6	1.4×10^6	1.2×10^6	1.4×10^6	1.1×10^6	1.2×10^6	1.2×10^6	8.9	1.27	0.125	-
Bacillus spp	-	-	-	-	-	-	-	-	0.1	0	0.1×10^6
Pseudomonas aeruginosa	-	-	-	-	1.1×10^6	-	-	1.1	1.1	0	-
Aspergillus spp	0.2×10^6	1.0×10^6	-	-	-	-	-	1.2	0.6	0.40	-
Mucor spp	-	-	-	-	-	-	-	-	-	-	-
Candida albican	-	1.2×10^6	-	1.1×10^6	-	-	0.1×10^6	2.4	0.8	0.608	-
Penicillum spp	-	-	-	-	-	-	-	-	-	-	-
Total	6.3×10^6	4.8×10^6	3.7×10^6	6.7×10^6	4.9×10^6	3.8×10^6	3.9×10^6	34.10	-	-	1.0×10^4
Mean	1.26	1.2	1.23	1.34	1.225	0.76	0.65	4.26	-	-	0.333
Standard Deviaton (SD)	0.68	0.16	0.15	0.34	0.15	0.56	0.57	3.46	-	-	0.40

Interpretation

A = Elikpokwodu Dumpsite
B = Mile 3 Motor Park
C = Mile 1 Dumpsite
D = Eagle Island Dumpsite
E = Rumuokoro DumpsitF = Town Market Dumsite G = Ogbunabali/Nzimiro Dumpsite H = A d a George Dumpsite

TABLE 2: Bacteria and Fungi Isolated From The Different Sites and Control Kept in The Laboratory for One Week

Bacteria/ Fungi	A cfu/g	B cfu/g	C cfu/g	D cfu/g	E cfu/g	F cfu/g	G cfu/g	Total	Mean	SD	H Control cfu/g
Proteus spp	0.1×10^6	-	-	-	-	-	-	0.1	0.1	0	-
Klebsiella spp	-	-	0.1×10^6	-	-	0.1×10^6	-	0.6	0.1	0	-
Salmonella spp	-	-	-	-	-	-	-	-	-	-	-
Clostridium spp	-	-	-	-	-	-	-	-	-	-	0.2×10^6
Escherichia coli	0.1×10^6	0.2×10^6	-	0.1×10^6	0.1×10^6	0.1×10^6	0.1×10^6	0.7	0.12	0.64	-
Staphylococcus aureus	0.2×10^6	0.2×10^6	0.1×10^6	0.3×10^6	0.2×10^6	0.2×10^6	0.3×10^6	1.5	0.21	0.35	-
Bacillus spp	-	-	-	-	-	-	-	-	0	0	0.01×10^6
Pseudomonas aeruginosa	-	-	-	-	-	-	-	-	-	-	-
Aspergillus spp	-	-	-	-	-	-	-	-	-	-	-
Mucor spp	-	-	-	-	-	-	-	-	-	-	-
Candida albican	-	0.2×10^6	-	0.1×10^6	-	-	0.2×10^6	0.5	0.17	005	-
Penicillum spp	-	-	-	-	-	-	-	-	-	-	-
Total	0.4×10^6	0.6×10^6	0.2×10^6	0.5×10^6	0.3×10^6	0.4×10^6	0.6×10^6	3.00	0.43	0.15	2.0×10^4
Mean	0.133	0.2	0.1	0.17	0.15	0.13	0.2	0.60	-	-	0.105
Standard Deviation (SD)	0.6	0	0	0.12	0.07	0.06	0.08	0.57	-	-	0.13

Interpretation

A = Elikpokwodu Dumpsite
B = Mile 3 Motor Park
C = Mile 1 Dumpsite
D = Eagle Island Dumpsite
E = Rumuokoro Dumpsite
F = Town Market Dumsite
G = Ogbunabali/Nzimiro Dumpsite
H = Ada George Dumpsite
Cfu/g = Colony forming unit/Gram

TABLE 3: Comparative Analysis of Microbial Burden of Samples from Waste Dumpsite and Waste Kept in The Laboratory for one week

Bacteria/ Fungi	Samples from the Dumpsite	Samples from the Lab	df	t	P= Value
Proteus spp	0.1×10^6	-	98	2.9	>0.05
Klebsiella spp	-	-	98	5.07	>0.05
Salmonella spp	-	-	98	15.05	>0.05
Clostridium spp	-	-	98	-	-
Escherichia coli	0.1×10^6	0.2×10^6	98	35.79	>0.05
Staphylococcus aureus	0.2×10^6	0.2×10^6	98	22.66	>0.05
Bacillus spp	-	-	98	0	<0.05
Pseudomonas aeruginosa	-	-	98	0	<0.05
Aspergillus spp	-	-	98	6	>0.05
Mucor spp	-	-	98	-	-
Candida albican	-	0.2×10^6	98	4.60	>0.05
Penicillum spp	-	-	98	-	-
Total	0.4×10^6	0.6×10^6	98	0.5×10^6	>0.05 P<0.05

TABLE 4: Distribution of Bacteria/Fungi Isolates According to th6e Number of Rag Pickers Per Dumpsites

Bacteria Species	A N=15	B N=10	C N=15	D N=15	E N=15	F N=10	G N=10	H N=10	Total
Staphylococcus aureus	7(38.35%)	5(12.5%)	4(40%)	2(15.38%)	2(18.8%)	2(28.5%)	4(40%)	2(25%)	28(32%)
Escherichia coli	3(14.29%)	2(25%)	3(30%)	2(15.38%)	2(18.8%)	2(28.5%)	1(10%)	2(25%)	17(19%)
Strept Spp	4(19.05%)	0(0%)	2(20%)	4(30.77%)	2(18.8%)	0(0%)	0(0%)	1(12.5%)	13(15%)
Klebsiella spp	2(9.52%)	0(0%)	1(10%)	1(7.69%)	2(18.8%)	1(14.29%)	2(20%)	1(12.5%)	10(11%)
Salmonella spp	4(19.05%)	0(0%)	0(0%)	3(23.08%)	1(9.09%)	1(14.29%)	1(10%)	1(12.5%)	11(13%)
Candida albican	1(4.76%)	1(12.50%)	0(0%)	1(7.69%)	0(0%)	1(14.29%)	1(10%)	0(0%)	5(6%)
Pseudomonas aeroginosa	0(0%)	0(0%)	0(0%)	0(0%)	2(18.8%)	0(0%)	1(10%)	1(12.5%)	4(4%)
Total	21(100%)	8(100%)	10(100%)	13(100%)	11(100%)	7(100%)	10(100%)	8(100%)	88(100%)

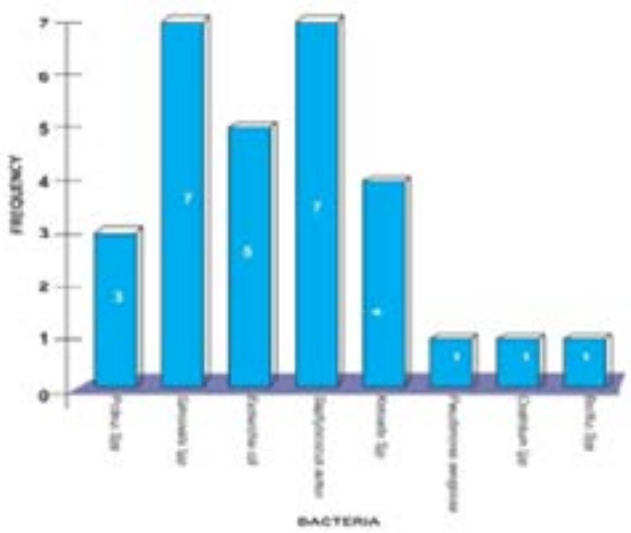

FIGURE 1: FREQUENCY OF THE DIFFERENT BACTERIA ISOLATED

Figure 1 shows a Bar chart showing the frequency of occurrence of the different bacteria genera according to the dumpsites. Proteus occurred in 3 dumpsites, *Escherichia coli* seven dumpsites, *Salmonella* 5 dumpsites,

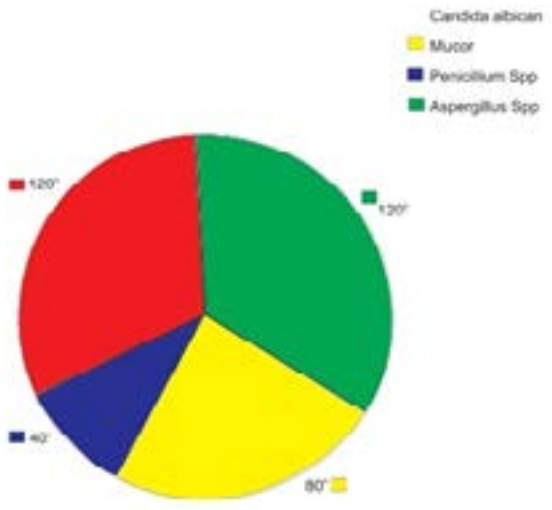

Figure 2 is a Pie Chart showing the percentage of occurrence of fungi isolated, which indicates that Aspergillus and Candida showed 120% each, Mucor 80%, and Penicillium 40%.

Table 4 shows the distribution of bacteria and fungi isolated according to the number of rag pickers per dumpsite and control site. From the result, Staphylococcus aureus was isolated from 26 (32%) of the rag pickers, while 2 (25%) were isolated from the control subjects.

Escherichia coli was isolated from 15 (18.5%) of rag pickers and 2 (25%) of the control. Streptococcus spp was isolated from 12 (15%) of the rag pickers while 1 (12.5%) from control. Klebsiella spp, 9 (11.25%) of rag pickers, 1 (12.50%) of control. Salmonella spp from 10 (12.5%) of rag pickers and 1 (12.50%) of control. Candida albican 5 (6.25%) of rag pickers and 0(0%) of control while Pseudomonas was found in 3 (3.7%) of rag pickers and 1 (12.50%) of control subject.

TABLE 4: Distribution of Bacteria/Fungi Isolates According to The Number of Rag Pickers per Dumpsite

Bacteria Species	A N = 15	B N = 10	C N = 15	D N = 15	E N = 15	F N = 10	G N = 10	H N = 10	Total
Staphylococcus aureus	7(38.35%)	3(12.50%)	4(40%)	2(13.38%)	2(18.8%)	2(28.5%)	4(40%)	2(25%)	26(32%)
Escherichia coli	3(14.29%)	2(25.00%)	3(30%)	2(15.38%)	2(18.18%)	2(28.57%)	1(10%)	2(25%)	17(19%)
Strept Spp	4(19.05%)	0(0%)	2(20%)	4(30.77%)	2(18.18%)	0(0%)	0(0%)	1(12.5%)	13(15%)
Klebsiella Spp	2(9.52%)	0(0%)	1(10%)	1(7.69%)	2(18.18%)	1(14.29%)	2(20%)	1(12.50%)	10(11%)
Salmonella Spp	4(19.05%)	0(0%)	0(0%)	3(23.08%)	1(9.09%)	1(4.29%)	1(10%)	1(12.50%)	11(13%)
Candida albicans	1(4.76%)	1(12.50%)	0(0%)	1(7.69%)	0(0%)	1(14.29%)	1(10%)	0(0%)	5(6%)
Pseudomonas aeruginosa	0(0%)	0(0%)	0(0%)	0(0%)	2(18.18%)	0(0%)	1(10%)	1(12.50%)	4(4%)
TOTAL	21(100%)	8(100%)	10(100%)	13(100%)	11(100%)	7	10(100%)	8(100%)	88(100%)

Figure 5 illustrates Bar Chart showing the classification of Disease according to ailment from Questionnaire completed by Respondents (rag pickers). From the Bar Chart: 10 of the rag pickers had cough/sore throat, 12 were hospitalized, 12 had typhoid, 20 had malaria, 8 suffered from stooling/vomiting, 14 had wound skin infection, 4 went for routine medical consultation and non had Tuberculosis.

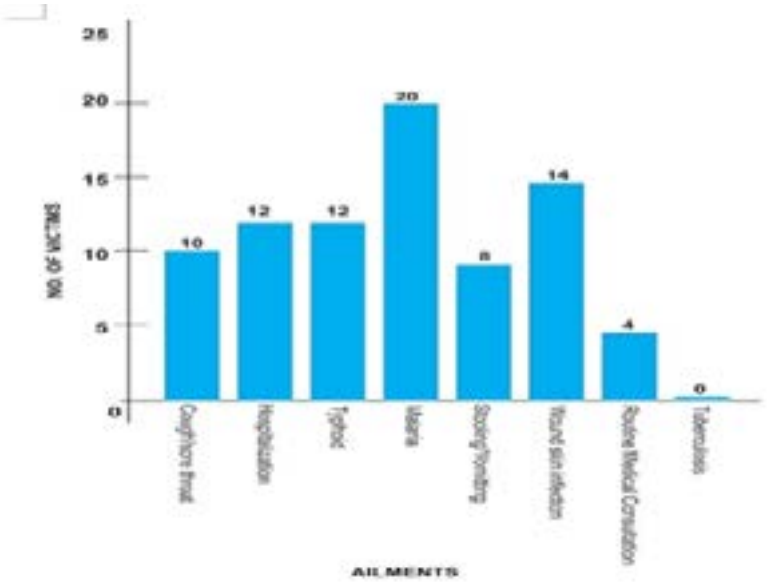

FIGURE 5: CLASSIFICATION OF DISEASES FROM RESPONDENTS

DISCUSSION

Most of the microbes isolated from the waste dumpsite were seen in the samples collected from the Rag pickers, which resulted in disease. This results from the work the rag pickers embarked upon without adequate protection. From the study carried out, the distribution of bacteria isolates according to the number of rag pickers per dumpsites suggests that Coagulase-positive *Staphylococcus aureus* was isolated from 26(32.0%) of the Rag pickers while it was isolated from 2(25%) of the control subjects. Though some Staphylococcus spp are members of the normal skin flora and Mucous membrane, Staphylococcus aureus is a major pathogen of humans causing minor skin infections amongst other diseases [11]. This explains why 10 of the rag pickers had sore throats. *Staphylococcus aureus* may also cause Pneumonia, endocarditis or sepsis, impetigo, and scalded skin syndrome [12]. *Escherichia coli* was isolated from 15(18.5%) of the rag pickers and 2(25%) of the control subjects. Though *Escherichia coli* forms part of the normal bacteria flora of the intestine, they are the major cause of urinary tract infections and wound infections [8]. Beta hemolytic Streptococcus spp was isolated from the sputum of 12(15%) of the rag pickers, while it was isolated from 1(12.5%) of the control. Streptococcus spp causes skin infections, erysipelas, and cellulitis when the portal of entry is in the skin and Streptococcal sore throat [13]. This explains why ten rag pickers had a cough/sore throat and 14 had skin infections. [13] reported that 20% of Streptococcal sore throat infections are caused by Streptococcus spp. Salmonella spp was isolated from 10 (12.5%) of the rag packers and 1 (12.5%) of the control subject. Similarly, Salmonella spp was isolated from the stool of 16(78%) of the rag pickers. This explains the high incidence of typhoid (enteric) fever. Where? The route of the disease is by ingestion of contaminated food & water.

Candida albicans was isolated in 5 (6.25%) of the rag pickers, while none was isolated from the control subjects. *Candida albicans* is an opportunistic fungal pathogen and causes deep mycoses. It's chief portal of entry is the respiratory tract. Candida albicans do not produce disease in healthy individuals because growth is suppressed by other microbiota. However, candida may multiply rapidly to produce candidiasis if anything upsets the normal microbiota. Thus, the incidence of candidiasis is on the increase [13].

CONCLUSION

Bacteria and fungi are basically present in waste dumps, and they are responsible for the decay of waste and cause diseases in people who come in contact with them. From the study, It was seen and observed that bacteria and fungi genera were isolated from most dumpsites. These further showed that these bacteria and fungi are pathogenic (disease-causing) when found in man. As such, this showed the health implications of these wastes, which can further affect those living around the waste dump and the rag pickers or scavengers. The diseases caused by these bacteria, helminths, and fungi can cause the death of persons, more especially the rag pickers who do not protect themselves or observe good personal hygiene during and after handling this waste, and therefore, their health presently and in the near future is at risk.

Scavenging represents an important survival strategy for the poor. Scavengers recover materials from waste in order to satisfy their needs. Scavengers respond to market demand and not to environmental and health considerations. The underlying factors that cause people to become scavengers are poverty resulting from under development, inability or unwillingness of individuals to obtain other forms of employment, existence by waste dumps, income earned and recyclable industrial demand for inexpensive raw materials. Scavenging has led to the production of sub – standard, fake and adulterated consumables in Nigeria as a whole as bottles are picked and sold to companies to repackage. Scavengers despite the monthly income they make have faced problems of informality and vulnerability to diseases, hence they need government assistance. Women are scared of getting involved in scavenging because of fear of being raped.

Recommendation

In reality, rag picking has posed a great threat to society at large. Therefore, the following are recommended:

- Indiscriminate dumping of waste around residential areas should be avoided. There should be adequate policies in this regard.

- Funds and vehicles should be adequate to encourage modern waste disposal technologies.
- The populace should be enlightened on the hazards of indiscriminate dumping of waste, hence, they should learn to minimize waste at source.

At the household level, proper waste segregation must be done, and it should be ensured that all organic matter is kept aside for composting so that it can be used as fertilizer.

- There should be a law prohibiting people from indiscriminate waste dumping, and defaulters should be arrested and prosecuted as done in Calabar, Cross Rivers State.
- Government and non-government organizations (NGOS) should assist in organizing rag pickers to form co-operatives so that they can pool their efforts and resources together and bargain collectively to bypass middlemen, dismantle the monopolistic market, and thus increase their earnings. Scavengers Co-operative can represent a perfect example of sustainable development and can promote grassroots development in an economically viable, socially desirable, and environmentally sound manner.

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