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An Appraisal of the Volume, Potential Use and Disposal Methods of Spent Engine Oil Generated in Selected Mechanic Workshops in Imo State, South-East Nigeria

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Abstract

The study was carried out to appraise the volume, potential use, and disposal methods of spent engine oil generated in selected mechanic workshops in Imo State, South-East Nigeria. The study utilized a well-structured questionnaire, personal interviews, and field observations to generate relevant data on the mechanic workshops. Results obtained showed that the highest volume of spent engine generated was obtained from the Owerri zone (124,489.36 L), while the lowest was gotten from the Okigwe area (18,434.52 L). The total annual volume of spent engine oil generated (in liters) was 171, 354.88 from the entire study area. Both the frequency and percentage disposal methods were highest with those that dispose it in their immediate environment 168 (49.56%) while others used it for other purposes such as pest control 38 (11.21%), marking playground 25 (7.37%), treating roofing timber 43 (12.69) and pit latrine 18 (5.31%). The no knowledge of health, environmental risk, and training of disposal methods of spent engine oil were significantly higher ($P<0.05$) than the yes response of the study areas. The study concluded that there appear to be poor spent engine oil disposal attitudes among the mechanics in the state and that such a practice may lead to serious environmental pollution. The need for proper spent engine oil disposal methods among the mechanics is recommended.

Keywords: Engine oil, Volume, Disposal, Mechanic workshops, Imo state

1 Introduction

In most developing countries like Nigeria, automobile mechanic workshops are usually located in government-allocated areas known as mechanic villages [1]. Activities carried out in these areas include but are not limited to auto repairs and servicing of motor vehicles. The waste generated by automobile mechanics in these villages may include gasoline (petrol), diesel, spent engine oil, and paints among others [2]. These categories of wastes are generated and dumped by the mechanics, who may not know the potential environmental and human risks of exposure to such pollutants [3]. These wastes are therefore dumped indiscriminately in the vicinity, where there is no further treatment, and causes an environmental risk to humans, animals, and plants [1]. This has been attributed to the fact that most automobile mechanic activities in Nigeria are currently under the control of semi-literate individuals [4-6]. A study to assess the volume of spent oil generated in an auto mechanic village in Imo state, [7] reported about 1.4 million liters of spent engine oil being generated annually in Nekede mechanic village. Their study, though restricted to Nekede mechanic village, further revealed that a gross lack of knowledge of the environmental consequences of spent engine oil could be attributable to the indiscriminate dumping of spent engine oil on bare soil. According to [8] about 300 million liters of lubricating oil were being sold per year, and further estimated that about 150 million liters of used oil were being generated per year.

A related study, [9] reported that Nigeria accounts for about 87 million liters of spent engine oil annually and adequate attention has not been given to its proper disposal. In other words, the lack of adequate and sustainable disposal methods persists. Though this estimate of spent engine oil generation may appear very subjective, it gives an insight into the likely scale of the problem currently bedeviling the soil ecosystem [10]. This leads to the understanding that there is a need for proactive measures towards safeguarding the soil ecosystem in other to eschew alteration of ecosystem integrity for the benefit of man [11]. As opined by [12] lack of proper industrial waste management and disposal system is an unavoidable problem in Nigeria as a result of increasing population, rapid urbanization, industrialization, and lax environmental laws. This assertion is apt given the prevalent method of spent engine oil disposal system that generates hazardous pollutants of various kinds. The majority of these contain pollutants that subsequently pave their way into the soil resulting in the release of toxic elements into the environment [12]. Consequently, the soil ecosystem is continuously being polluted; resulting in an adverse effect on the terrestrial ecosystem and the biodiversity they support [13]. Several decades ago many Western nations raised environmental standards to reduce the contamination of soil [14]. Nevertheless, practices such as rampant dumping and

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unregulated disposal [15] still typify the main disposal strategy for most developing countries like Nigeria. Though illegal, the poor strategies persist possibly due to weak law enforcement and needed research. This is unsustainable since such practices impact soil, land, and water bodies as well as the general well-being of host communities [16]. Obviously, a top-down approach is needed as a dire necessity to educate the public on the ecological implications of inappropriate discarding of spent engine oil into the environment by highlighting the damages due to such activities [17]. It is essential to point out that the environment is the nature capital from which man should organize and sustainably explore for good living. Issues and challenges associated with spent engine oil contamination are well documented in the literature [18]. This is not surprising considering the enormous environmental, health, and ecological related implications; and the increasing number of vehicles being serviced daily. In industrialized nations, [19] highlighted public health, environment, resource scarcity, climate change, public awareness, and participation as key drivers of spent engine waste management strategy. Engine oil is an indispensable component of every modern society because of its multifaceted functions. It is a major producer of petroleum products that helps the engine to function optimally [20]. The lubricant oil protects automotive components by forming a wear-resistant film between moving surfaces, transports various protective chemical additives, and inhibits corrosion [21]. However, engine oil performs under harsh conditions inside the engine with its combination of heat and high pressure, combustion activities, and generation of chemical residues. In this harsh operating system, the oil eventually gets dirty and additives and other chemicals break down and the oil requires regular changing [22]. Spent engine oil is oil that has been used and as a result, contaminated by chemical impurities which contribute to environmental degradation [23]. Available literature shows that spent engine oil is a very dangerous soil pollutant regarded to be more toxic than crude oil [24]. It is usually obtained after servicing and subsequent draining from automobile and generator engines [25]. As a result of its chemical composition, worldwide dispersion and effects on the environment spent engine oil is considered a serious environmental challenge that contributes to mutagenicity and carcinogenicity with global ramifications. Indiscriminate disposal of spent engine oil into gutters, water drains, open plots, and farms still typify most disposal methods among artisans in the business of auto repairs in Nigeria [26-27]. This has been attributed to the fact that most artisans know little about the deleterious effects of spent engine oil on the ecosystem [28]. The concerns over ecosystem disturbance by indiscriminate disposal of spent engine oil have led to the need to detect variations in the biotic and abiotic integrity of different trophic levels by assessing the potential risks to the ecosystem [29]. There are several reported cases of indiscriminate disposal of spent engine oil in the immediate environment. A survey of most cities in Nigeria showed that there are little or no organized disposal practices for waste engine oil [30]. [31] had estimated the total national used oil generating capacity in Nigeria to be over 200 million liters per annum in 2004. In a study to appraise the volume of spent engine oil generated in Nekede mechanic village, Udebuani, Chidiogo, Ifeanyi, Okoli, Harriet, Nwigwe & Patrick [32] reported a total of 1,469,678.08 liters. In a related study by [33], a total of 1628.50 liters of spent engine oil was recorded in the Portharcourt area of Rivers State. According to the Nigerian lubricant market report (2021), increasing drain intervals from automobiles dropped from an estimated 200 million liters per annum as a result of limitations occasioned by the Covid-19 pandemic in 2019, and it is expected to rise by 2026. This gives an insight into the volume of spent engine oil disposed into the environment [34]. This study aimed to appraise the volume, potential use, and disposal methods of spent engine oil generated in selected mechanic workshops in Imo State, South-East Nigeria. Such a study will help regulatory bodies to legislate against indiscriminate disposal of spent engines on the environment.

2 Materials and methods

2.1 Study Area

The study was conducted in Imo State southeast Nigeria. Imo State has a total of twenty-seven (27) Local Government Areas (L.G.A). The people of Imo State are basically of Igbo extraction having similar cultural activities to other Igbo communication and they speak the Ibo language. The state is influenced by urban sprawl whereby smaller communities merge. Several activities go on in the state, notable among them are automobile workshops scattered all over the nooks and crannies of the state from which spent engine oil and other effluents containing pollutants are deliberately or accidentally spilled on any available space by the mechanics in the business of auto repairs. To date, there is no regulation on the setting of the auto workshops; as a result, they are located at random or directly in front of residential or commercial areas. This exposes the soil ecosystem and residents to various kinds of pollutants. Imo State is divided into three Agricultural zones by the Imo state Agricultural Development Program (ADP) based on the agroecological and cultural characteristics of the state. The three zones are the Owerri zone, Okigwe zone, and Orlu zone. Based on the foregoing, study sampling was done to reflect the zones.

2.2 Activities at the study sites

At the various mechanic workshops, activities carried out by the artisans include but are not limited to the disassembly and assembly of machine spare parts, changing of oil in vehicles, car spraying, and general maintenance/repair of vehicle parts. Through these activities, spent engine oils and other solvents containing petroleum hydrocarbons are indiscriminately dumped or spilled on every available space [3]. Materials that are considered to be waste are either sold as scraps or burnt which exacerbates the emission of heavy metals, TPH, PAHs, and other pollutants.

2.3 Selection of sampling site

The study was carried out to cover the three zones of Imo State. Each zone was further subdivided into three sub-zones making a total of nine (9) sub-zones for sample collection. Before the commencement of the study, a reconnaissance visit was made within the three zones (Owerri, Orlu, and Okigwe) of the state in other to select suitable sites for the study. From each sub-zones, three (3) sampling sites were randomly selected making a total of twenty-seven (27) sampling sites (9 samples per zone). The study spanned from 2019 to 2021.

2.4 Estimation of disposal method, benefits, and perception of environmental risks of used engine oil generated in the study areas

For data collection, a multistage approach was employed that involved personal observation, face to face interaction. A modified version of the [8] questionnaire was used to elicit information from the respondents based on their willingness to participate in the study. The questionnaire survey elicited information on the age distribution, disposal method, benefits, volume of oil generated, and perception of environmental risks by the mechanics. A total of 350 mechanics made up the sample size.

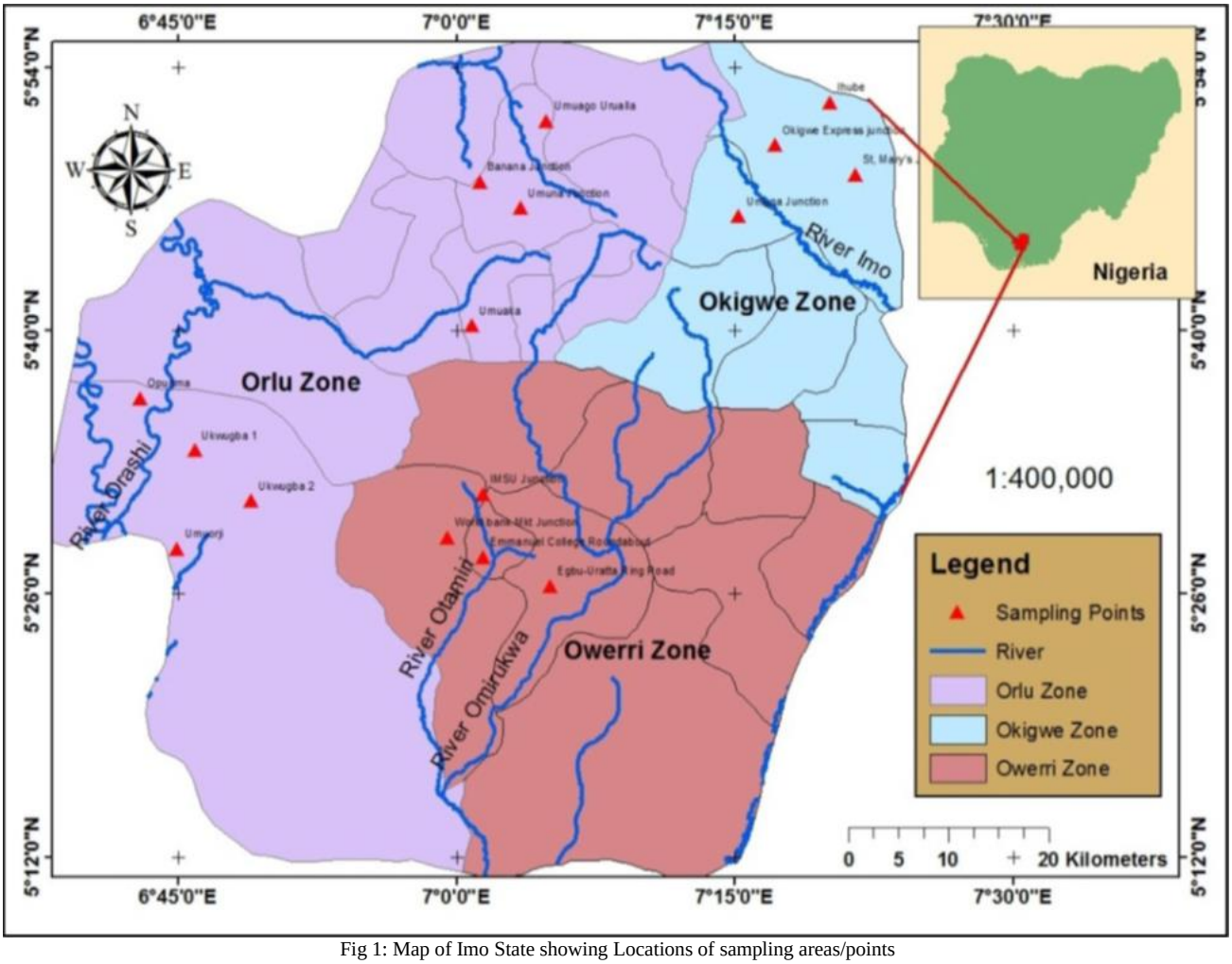

Fig 1: Map of Imo State showing Locations of sampling areas/points

3 Results

3.1 Age distribution of automobile mechanics in the study area

The age distribution of automobile mechanics in the study areas is presented in Table 1. The results obtained showed that the mechanics in the age group between 20 to 30 years are the highest number of mechanics participating in the job. The result further shows that mechanics between the age of 20 and 30 years were higher in number in all the sample areas compared to other age groups. This is followed by the age group between 31 to 40 years. The least values were obtained from the age group of 60 years and above. Results also showed that automobile mechanics in Owerri had the highest number of mechanics in the age group of < 20 years, 20 to 30, 31 to 40 years respectively. However, the lowest number of mechanics within the age groups <, 20, 20 to 30, and 31 to 40 years were obtained from Okigwe. The total number of mechanics and percentage participation were highest in the age group between 20 to 30 with a value of 173 (51.03%) while Owerri showed the highest number of mechanics and percentage age group participation with a value of 142 (41.29%) while the lowest percentage participation was obtained at Okigwe area with a value of 88 (25.96%). However, the number of mechanics and percentage age groups obtained in Owerri was significantly different from that of other study areas with a distribution of Owerri> Orlu> Okigwe respectively.

3.2 Number of vehicles serviced per day and the annual volume of spent engine oil generated in the study areas

The frequency and percentage distribution of mechanics according to the number of vehicles serviced per week and the annual volume of spent engine oil generated in the study areas are shown in Table 2. Results obtained showed that the number of vehicles serviced in Owerri, Orlu, and Okigwe mechanics is 42(46.7%), 27(30.0%), and 21(23.5%) respectively. The highest volume of spent engine generated was obtained from Owerri (124,489.36), while the lowest was gotten from the Okigwe area (18,434.52) respectively. The total annual volume of spent engine oil generated (in liters) was 171, 354.88 from the entire study area.

3.3 Frequency and percentage disposal methods of spent engine oil by automobile mechanics

The frequency and percentage disposal methods of spent engine oil by automobile mechanics in the mechanics' villages are presented in Table 3. The results obtained showed that a good number of mechanics dispose of the spent engine oil in their immediate environment 168 (49.56%). Both the frequency and percentage disposal methods were highest with those that dispose of in the immediate environment compared to others. This is followed by mechanics that give it out freely to end users 66 (19.47%).

Table 1: Age distribution of automobile mechanics in the study area

Age groups (years)	Participant locations			
	Owerri	Orlu	Okigwe	Total
≤20	12(3.54)	10(.2.95)	4(1.18)	26(7.67)
20-30	76(22.42)	53(15.63)	44(12.98)	173(51.03)
31-40	43(12.68)	32(9.44)	28(8.26)	103(30.39)
41-50	9(2.65)	11(3.25)	10(2.95)	30(8.85)
≥60	2(0.59)	3(0.88)	2(0.59)	7(2.06)
Total	142(41.29)	109(32.15)	88(25.96)	339(100)

Table 2: Number of vehicles serviced per day and the annual volume of spent engine oil generated in the study areas

Treatments	Locations		
	Owerri	Orlu	Okigwe
The volume of SEO removed (L)	4	4	4
Mean NVS/mechanic/week	7.7	4.5	3.9
Mean volume of SEO generated/vehicle	3.95	3.95	3.95
NVS/day	53.90	20.25	15.15
NVS/week	323.4	121.5	90.9
NVS/annum	16816.80	6318.0	4726.80
SEO generated/day	212.91	79.99	59.84
The volume of SEO generated/week	1277.43	479.93	359.06
The volume of SEO generated /annum	124,489.36	28,431.0	18,434.52

Legend: L = Litre, V = Volume, SEO = Spent engine oil, NVS = Number of vehicles serviced

Table 3: Result showing Frequency and percentage disposal methods of spent engine oil by automobile mechanics

Methods of disposal	F	Percentage (%)
Sold	41	12.09
Poured into the immediate environment	168	49.56
Given out for free	66	19.47
Taken by car owners	64	18.88
Legend: F = Frequency		

Table 4: Result showing Frequency and percentage uses of spent engine oil by automobile mechanics

	Frequency	%
Lorries/trucks Reuse	74	21.83
Poured in a pit latrine	18	5.31
Mosquito	48	14.16
Timber cutting	51	15.04
Pest control	38	11.21
Marking playground	25	7.37
Treating roofing timber	43	12.69
Treating fencing post	42	12.39

The results also show that mechanics also sell spent engine oil to other people with a frequency and percentage disposal rate of 41 (12.09%). However, whichever way spent engine oil is disposed of, whether sold, given out freely, or taken by the owner, all may eventually land back in the environment.

3.4 Frequency and percentage use of spent engine oil by automobile mechanics

The various uses of spent engine oil by mechanics and people in mechanic villages are presented in Table 4. The result obtained showed eight (8) different uses of spent engines among the mechanics. The result showed that Lorry/Truck reuse of spent engine oil had the highest frequency and percentage use 74 (21.83%) compared to other uses. This was followed by Timber cutting 51 (15.04%) in which spent engine oil is bought and robbed on the Saw for easy cutting of the wood. The mechanics use spent engines specifically to control mosquitoes in the environment 48 (14.16%). The least frequency and percentage use of spent engine oil were obtained from those that pour it in a pit laterine 18(5.31%). Spent engine oil was also used in pest control 38 (11.21%), marking playground 25 (7.37%), and treating roofing timber 43 (12.69); the frequency and percentage of use are also significant. However, in all its use, spent engine oil eventually finds its way back into the environment.

3.5 Knowledge of health, environmental risk, and possible training on disposal methods of spent engine oil

The knowledge of health, environmental risk of spent engine oil, and possible training on disposal methods by the mechanics are shown in Table 5. The result obtained showed that three hundred and eighty-seven 387 (84.66%) of the mechanics do not have any knowledge of the health risk associated with exposure to spent engine oil compared to fifty-two 52 (15.34%) mechanics who said they are aware of the health risk associated with exposure to spent engine oil. Also, two hundred and forty-three 243 (71.68%) mechanics do not know the environmental risk of exposure to spent engine oil compare to ninety-six 96 (28.32%) mechanics that said they do not know of it. Fourteen mechanics 14 (4.12%) have been trained on the disposal methods of spent engine oil. However, three hundred and twenty-five 325 (95.87%) have been not trained on how to handle spent engine oil. The no knowledge of health, environmental risk, and training of disposal methods of spent engine oil were significantly higher ($P<0.05$) than the yes response of the study.

Table 5: Knowledge of health, environmental risk, and possible training on disposal methods of spent engine oil

Problem	Responses	Frequency	Percentage	Chi-Square	P-Value
Health Risk	Yes	52	15.34	11.37	0.121
	No	387	84.66		
Environmental risk	Yes	96	28.32	23.76	0.273
	No	387	71.68		
Training on hazards	Yes	14	4.12	0.235	0.104
	No	325	95.87		

Discussion

The auto-mechanics carry out numerous activities which expose the environment to pollution through indiscriminate disposal of wastes. The study showed that the majority of automobile mechanics are males between the ages of 20 and 30 years. This is not surprising as the job is physically challenging and strenuous which limits female participation. According to [34], males tend to do more strenuous jobs while females are assigned to less physically demanding jobs in Africa. This result is similar to the finding of [35] that reported the same age group among mechanics in the Kampala District of Uganda. A study by [34] documented 21-26 age groups among auto mechanics in Benin City which is in line with the observation made in this study. This observation could be ascribed to poverty as automobile service is one of the jobs used to alleviate poverty in Nigeria. Mechanics are recruited at a very tender age, especially those who are not willing to go to school/dropouts so that they will eventually grow into it. The finding that less number of people are involved in auto mechanic work at the age of 60 years corroborates with similar studies among automobile [35-36] This can be linked to the fact that mechanic work requires active people who can carry heavy loads, and work under the sun for a long period which people above 60 years may not find comfortable to do at that age [3]. Again, the study observed that more young mechanics was found in Owerri compared to other zones**.** In a rapidly urbanizing society, it is assumed that cities open more opportunities than rural areas. This observation may be attributed to the choice of working in a "happening city" and the possible class of clients that would pay them well [33].

It was established that on average, 3 to 9 vehicles are been serviced by the mechanics every week as seen in. This number is slightly higher than the 3 to 7 reported by [6] in a study at Nekede auto mechanic village but aligns with the findings of [33]. As opined by [37] the more vehicles serviced and spent engine oil generated, the higher the volume that accumulates and has to be disposed into the environment. These activities further pollute the environment thereby causing harm to the ecosystem. The study has also established the annual volume of spent engine oil generated in the study areas. Though the volume of spent engine oil generated in Owerri was greater than in other study areas, this could be a result of more anthropogenic activities taking place in this zone than in others. Owerri zone is more metropolitan than Okigwe and Orlu zones. This result compares well with the findings of [26] who reported 1628.50 liters generated at Porthacourt area of Rivers State Nigeria but lower than the value of 1,469,678.08 liters reported by [12] in Nekede mechanic village of Imo State. A study by [37] established that about 60 liters of spent engines are been generated annually in Kampala district in Uganda, which is lower than the values recorded in this study (Table 4.2). Similarly, [38] recorded 279.25 Litres as the volume of spent engine oil generated at an auto mechanic village in Enugu State which is lower than the volume obtained in this study. The low volume of spent engine oil generated in Okigwe and Orlu areas could be attributed to less number of cars in operation there; as such areas are semi-developed urban areas.

The alarming volume of spent engine oil generated in the study areas indicates that there could be serious spent engine oil pollution in the soils of the study areas which could eventually alter ecosystem integrity [1]; [4]. Spent engine oil contains toxic substances such as heavy metals and poly aromatics which when released into the environment, have the potential to affect flora and fauna, and contaminate water bodies through runoff [39]. When the spent engine gets to the soil, it physically coates the body of an organism, causing behavioral changes which in turn causes hypothermia. The study showed that a large number of mechanics disposed of spent engine oil within their immediate vicinity. This is in agreement with the report of previous authors [33]. The mechanics also acknowledged that they sell the oil off to other end users which may eventually be disposed into the environment. This is a major source of pollution of the environment. Toxic chemicals through these disposal methods enter the environment and alter the physical and chemical properties of the environmental components [40]. However, the study established other beneficial applications of spent engine oil in the study areas**.** The most common benefits of spent engine oil according to responses from auto mechanics were: as pest repellant, given out to lorry drivers(for reuse), poured in a pit latrine, road construction (where it is mixed with bitumen), timber cutting, pest control, marking playground, treating roofing timber, and treating fencing post respectively. Spent engine oil is robbed on building poles to prevent wood rot and termite infestation. Lumbermen also use spent engine oil during the felling of trees and in saws used for cutting trees. The oil is also used to mark lines on the timers and lubricates chain saws used for cutting wood into different sizes [23]. Most people prefer to use spent engine oil in marking playgrounds because it is cheaper than lime which is costly and not readily available. According to the responses from the mechanics, the spent engine is being poured into the laterine to kill maggots and flies, and also reduce the bad odor from the pits. In many urban poor areas, the management of pit laterines is very poor resulting in quick filling up of the pits. These cause offensive odor and the emergence of maggot from the pit onto the floor of the laterine, especially during the rainy seasons. This pit also acts as a breeding habitat for mosquitoes and other pests. The application of spent engine oil reduces pests and delays the fecal degradation process in the pit [23]. All of these many uses may result in the release of spent engine oil back into the environment with its attendant effects on the ecosystem. Upon release into the environment, the oil can seep into aquatic bodies causing harm to the living organisms that make up the food chain [11].

The study further established the health, environmental risk, and training on disposal methods of spent engine oil among mechanics. The result showed that most of the mechanics (84.66%) know nothing about the health risk and environmental hazards (71.68%) associated with indiscriminate disposal of spent engine oil (Table 4.5). This is similar to the finding of [11]. As knowledge of health, environmental risk and disposal methods are lacking; the mechanics are ignorantly exposed to toxic substances which

may have been inflicting some diseases and pain on them without their knowing it. As it was observed that no personal protective equipment (PPEs) is used by the mechanics to cover their bodies against the negative effects of these substances. Abdominal pains, coughing, irritating eyes, sore throat, and other musculoskeletal disorders had been reported among auto mechanics [41]. Harmful chemicals like heavy metals, aliphatic and aromatic hydrocarbons present in the spent engine can pose a serious health effect when accidentally ingested by the mechanics. These pollutants have been documented to cause hematological derangement, kidney damage, and skin cancer [35]. Health effects attributable to spent engine oil results from exposure to it [40-43]. A study by [42] opined that dermal contact is the most susceptible route of exposure among auto mechanics in Nigeria. Spent engine oil had been implicated to cause immunological, neurological, reproductive, genotoxic, and carcinogenic effects in humans.

4 Conclusion

The result from this study has shown that there are poorly spent engine disposal methods among mechanics in Imo State. Thus, environmental regulatory bodies should intensify awareness about the detrimental effects of spent engine oil exposure on the environment. Strict environmental laws should be enacted to prevent indiscriminate disposal of spent engine oil while recycling measures, and treatment measures for spent engine oil should be adopted and encouraged.

Ethical issue

Authors are aware of and comply with, best practices in publication ethics specifically about authorship (avoidance of guest authorship), dual submission, manipulation of figures, competing interests, and compliance with policies on research ethics. Authors adhere to publication requirements that the submitted work is original and has not been published elsewhere in any language. Also, all procedures performed in studies involving human participants were following the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards of the institution or practice at which the studies were conducted.

Competing interests

The authors declare that no conflict of interest would prejudice the impartiality of this scientific work.

Authors' contribution

All authors of this study have a complete contribution to data collection, data analyses, and manuscript writing.

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