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Determination of Haematocrit, Erythrocyte Sedimentation Rate (ESR) and Methaemoglobin Levels in Municipal Solid Waste Collectors (Sanitation Workers) in Port-Harcourt, Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Aim: This study was carried out to ascertain whether or not occupational exposure affects the haematocrit, erythrocyte sedimentation rate, and methaemoglobin levels of municipal solid waste (MSW) collectors.
Methodology: A total of 60 male subjects were recruited for this study, out of which 30 subjects were apparently healthy and were used as the control subjects, while the other 30 subjects were municipal solid waste collectors (sanitation workers) randomly recruited during collection of solid wastes from three dumpsites in Port-Harcourt, Nigeria. Out of the 30 sanitation workers, 10 subjects made use of nose masks on routine basis during waste collection, while the remaining 20 subjects did not use nose masks. Both informed and written consent was obtained from each subject. The haematocrit (HCT) was analysed using the microhaematocrit method, the erythrocyte sedimentation rate (ESR) using the westergren method, and the methaemoglobin (metHb) using the colorimetric method by Lewis and Roper.

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Results: The results showed a significantly lower ($p<0.05$) HCT, but a significantly higher ($p<0.05$) levels of ESR and metHb in MSW collectors as compared to the control subjects. MSW collectors who never used nose mask during waste collection had a significantly lower ($p<0.05$) HCT, but significantly higher ($p<0.05$) ESR and Methaemoglobin levels compared to MSW collectors who use nose mask routinely during waste collection and transportation.
Conclusion: From the results of this study, it is evident that occupational exposure had a negative impact on MSW collectors by affecting their HCT, ESR and MetHb levels. Therefore, we recommend that these workers be provided with personal protective equipment such as protective clothing and particularly nose mask, to prevent or reduce the inhalation of the toxic and pungently foul smell emanating from these wastes.

Keywords: Municipal; haematocrit; methaemoglobin; Erythrocyte Sedimentation Rate (ESR).

1. INTRODUCTION

A municipal solid waste collector (also called sanitation worker) is someone employed by a private or public firm, whose job description is the collection and removal of solid waste (including recyclables) from residential, commercial, industrial or other collection sites for further processing and disposal. Specialized waste collection vehicles are usually deployed to waste collectors to assist them for easy and fast transportation of the waste.

Municipal Solid Waste (MSW) also referred to as refuse, trash, rubbish or garbage is a type of waste resulting from things that are discarded daily by the populace, which varies across countries; this waste changes significantly with time [1]. It may be classified into various groups: biodegradable waste (such as food and kitchen waste, green waste), recyclable waste, inert waste, electrical and electronic waste, composite waste, hazardous waste, toxic waste and biomedical waste.

Over the years and in recent times, there has been a rapid increase in the generation of municipal solid waste (MSW) in metropolitan cities. This upsurge in the generation of solid waste may be attributed to an increased population, production and consumption [2]. Waste dumping happens to be a global problem, and because these wastes are not properly disposed, they impose severe health challenges such as the transmission of infectious diseases to humans and animals residing within that vicinity [3], and is therefore a public health concern.

Waste when dumped on land, may result in the pollution of soil, air and fresh waters [4] through the action of microorganisms by breaking down the degradable materials in the waste [5]. Also, waste which has not been properly managed, has immensely contributed to flooding, breeding of insects and vectors which transmit diseases such as cholera, typhoid fever, lassa fever, diarrhoea, dysentery and schistosomiasis [6].

Various methods of disposing waste exist such as composting, landfill and incineration, and open dumping; however the latter seem to be the only available method in Nigeria [5]. The Environmental Protection Agency which is a United States Federal Government Agency developed a waste management hierarchy ranking strategy for municipal solid waste based on environmental friendliness, which is made up of four levels from the most to the least preferred methods which include: source reduction and reuse, recycling or composting, energy recovery, treatment and disposal. However, MSW management has become a major challenge in developing countries due to urbanization, industrialization, increasing population of animals and humans, and their increased demand for food [1].

Waste management in developing countries seems inefficient due to negligence from environmental stakeholders leading to poor funding of the sanitary agencies, and lack of organization [7].

Due to disposal of sharp objects such as syringes, scalpels and razor blades at the waste dumping sites, these waste collectors as well as scavengers are at risk of injuries [1], and are routinely exposed to pungent and offensive odour arising from the waste.

The Erythrocyte Sedimentation Rate (ESR) is the rate at which red blood cells fall or sediment in one hour. It is a non-specific test that provides information about the presence or absence of an inflammatory condition. It is raised in the

presence of elevated amount of acute phase reactants such as C-reactive protein (CRP) and fibrinogen in the blood in response to inflammation. Thus, the test is affected to a larger extent by a wide range of infectious diseases, inflammation, degenerative and malignant conditions, and to a smaller extent by anaemia, pregnancy, haemoglobinopathies, haemoconcentration and treatment with anti-inflammatory drugs [8].

The haematocrit (HCT) also called packed cell volume (PCV), may be used to diagnose or rule out anaemia or polycythemia when the measurement of haemoglobin is not possible [8]. It may also be used to monitor the treatment of anaemia or polycythemia vera. The HCT is a reflection of the number of red blood cells, and thus the haemoglobin concentration. Therefore, a HCT value less than the lower limit of the reference range is diagnostic of anaemia, while a HCT value greater than the higher limit of the reference range is diagnostic of polycythemia vera; which may be due to increased oxygen supply or dehydration [9].

In humans, erythrocytes (red blood cells) contain several proteins, but the major protein constituting about 95 percent of the red blood cells is known as the haemoglobin, which is a respiratory pigment because it carries oxygen needed for aerobic respiration. Haemoglobin (Hb) binds reversibly with oxygen in the lungs (where there is high oxygen tension) to form oxyhaemoglobin, which is carried to the other tissues. Because the tissue capillaries are low in oxygen tension, the haemoglobin molecule in turn, releases the oxygen in these tissues [10]. The haemoglobin molecule also binds to carbon-dioxide in tissues and gets transported to the lungs for elimination.

Methaemoglobin (MetHb) is a metalloprotein derived from normal haemoglobin in which the iron in the haem moiety has been oxidized from the ferrous to the ferric state; due to this change in the ionic state of iron, it loses its ability to bind to and transport oxygen to the tissues. In normal red cells however, methaemoglobin is continually being formed by the auto-oxidation of haemoglobin, but it is reduced back to haemoglobin almost immediately it is formed, by the NADH-Methaemoglobin reductase system. The excessive accumulation of methaemoglobin in the red blood cell is called methaemoglobinaemia, which may induce symptoms of hypoxia [11]. Under normal condition, methaemoglobin constitutes about one to two percent of the total haemoglobin; with its concentration slightly higher in infants, particularly in premature infants, than in older children and adults [12]. Methaemoglobin is dark coloured [13], thus about ten to 15 percent of it in the blood can cause cyanosis.

The HCT, ESR and MetHb were analysed in this study because there is a strong relationship between them, such that when one parameter is affected, it may affect the other two parameters.

2. MATERIALS AND METHODS

2.1 Study Design

A total of sixty (60) male subjects were recruited for this study, out of which 30 subjects were apparently healthy and were used as the control subjects, while the other 30 subjects were municipal solid waste collectors (sanitation workers) randomly recruited during collection of solid wastes from three dumpsites in Port-Harcourt, Nigeria; these subjects have been in this occupation for a minimum of 5 years. Out of the 30 sanitation workers, 10 subjects made use of nose mask (as a Personal Protective Equipment) on routine basis during waste collection and transportation, while the remaining 20 subjects did not use nose mask. Relevant information about the subjects was obtained using well-structured questionnaires, and both informed and written consent was obtained from each subject. The control subjects were residents within the environment of the three dumpsites. Subjects working in companies, factories or workshops and are routinely exposed to fumes, gas flares, wood dust or any form of particulate matters or other environmental pollutants, and those on chemotherapy, were excluded from the study.

2.2 Blood Sample Collection and Analysis/Methodology

Using sterile hypodermic syringes and needles, five millilitre of venous whole blood was collected from each subject into EDTA-anticoagulant bottles and mixed together with several gentle inversions. The HCT was analysed using the Microhaematocrit method, the ESR was analysed using the Westergren method, while the Methaemoglobin was analysed using the Colorimetric method as described by Lewis and Roper [12].

2.3 Principles of the Methods Used

2.3.1 Haematocrit (Using the microhaematocrit method)

When a given volume of anticoagulated blood in a capillary tube (placed about three-quarter of the tube) is spun using a centrifuged at a constant speed and for a constant time, the heavier red blood cells fall to the bottom of the tube, while the lighter cells (platelets and white cells) and plasma precipitate out on top of the red cells. The space occupied by the packed red cells in relation to the height of the total blood volume is called the haematocrit or packed cell volume, measured with a haematocrit reader, and the volume expressed as a percentage.

2.3.2 Erythrocyte Sedimentation Rate (Using the Westergren method)

When citrated blood placed in a vertically positioned westergren tube is left undisturbed, red blood cells aggregate conjoin to form rouleaux and sediment via the plasma.

2.3.3 Methaemoglobin (Using the colorimetric method by Lewis and roper)

The wavelength at which methaemoglobin is maximally absorbed is 630nm. However, on addition of cyanide, this absorption band disappears, and the resulting change in absorbance is directly proportional to the concentration of methaemoglobin. On adding ferricyanide-cyanide reagent, the solution will be completely converted to cyanmethaemoglobin, where the total haemoglobin in the sample will then be measured.

2.4 Statistical Analysis

Data generated from the analysis were expressed as Mean ± Standard deviation, and analysed using Microsoft Office Excel 2007 and Graph Prism Pad version 6.2. Comparisons of mean and standard deviation values were made for the various parameters for test and control subjects using the independent student's t-test. Results were considered statistically significant at 95% confidence interval ($p<0.05$).

3. RESULTS

3.1 Comparison of the HCT, ESR and MetHb Levels of MSW Collectors and Control Subjects

Details of the comparison of the mean HCT, ESR and MetHb Levels of MSW Collectors and Control Subjects are shown in Table 1. It shows that the mean HCT level of the MSW collectors was significantly lower ($p<0.05$) than that of the control subjects, while the mean ESR and MetHb Levels of the MSW collectors were significantly higher ($p<0.05$) than those of the control subjects.

Table 1. HCT, ESR and MetHaemoglobin (MetHb) levels of MSW collectors and control Subjects

	HCT (%)	ESR (mm/hr)	MetHb (%)
MSW Collectors (N=30)	32 ± 1.70	48.50 ± 15.85	6.10 ± 1.36
Control Subjects (N=30)	42.76 ± 1.57	3.93 ± 1.62	1.60 ± 0.72
P-Value	<0.0001	<0.0001	<0.0001

p<0.05 is considered significant

Table 2. HCT, ESR and MetHaemoglobin (MetHb) levels of MSW Collectors using nose masks, and those not using nose masks

	HCT (%)	ESR (mm/hr)	MetHb (%)
MSW collectors with NM (N=10)	34 ± 0.82	33 ± 6.02	4.70 ± 0.67
MSW collectors without NM (N=20)	31 ± 0.97	56.25 ± 13.28	7.35 ± 1.46
P-Value	<0.0001	<0.0001	<0.0001

NM = Nose Mask, p<0.05 is considered significant

3.2 Comparison of the HCT, ESR and MetHb Levels of MSW Collectors Using Nose Masks, and Those not Using Nose Masks

Details of the comparison of the mean HCT, ESR and MetHb Levels of MSW collectors using nose masks, and those not using nose masks are shown in Table 2. It shows that MSW collectors not using nose masks had a significant lower ($p<0.05$) mean HCT level, but significantly higher ($p<0.05$) mean ESR and MetHb levels than MSW collectors not using nose masks.

4. DISCUSSION

The elevated methaemoglobin levels in the MSW collectors may be attributed to the frequent inhalation of aromatic compounds from the wastes, which may have caused an increased auto-oxidation of haemoglobin. Liu et al. [14], stated that aromatic compounds are major components of volatile organic compounds which are emitted from MSW landfills. Among others, paints and paint containers, and other lead-coated containers, batteries and pesticides are part of MSW, which contain and emit aromatic compound; inhalation of these chemicals however, may induce increased auto-oxidation of haemoglobin in the red blood cells [15]. Obeagu [11] also stated that the cause of occupational toxic methaemoglobinaemia (elevated methaemoglobin in the blood) in industries is mostly due to the absorption of nitro and amino aromatic derivatives through the respiratory tract or skin.

The decreased haematocrit levels in MSW collectors may be attributed to the increased auto-oxidation of haemoglobin, producing elevated methaemoglobin levels; the methaemoglobin level is inversely proportional to the haemoglobin level, thus since the methaemoglobin level is increased, the amount of haemoglobin decreases, and therefore the resultant decrease in haematocrit level (in the absence of haemoconcentration, the haematocrit level is a reflection of the haemoglobin level); this result agrees with the statement of Obeagu [11], that ‘‘chemicals capable of inducing methaemoglobinaemia is also capable of causing haemolysis’’, which in turn, causes low haemoglobin and haematocrit levels. The result obtained from this study is also in agreement with that from a similar study carried out by Wachukwu et al. [5] stating that a significant decrease in haemoglobin and haematocrit levels occurred in waste scavengers when compared to the control subjects.

The increased ESR in MSW collectors may be attributed to the decreased haemoglobin and haematocrit levels, as these factors affect its estimation. ESR is significantly raised in anaemia due to any cause [8]. ESR is also raised in inflammatory conditions which have triggered the release of plasma proteins in response to the inflammation [8], thus the elevated ESR in these MSW collectors may also be attributed to an inflammatory condition in these subjects.

5. CONCLUSION

The generation of solid waste in metropolitan cities is rapidly on the increase. Municipal solid waste collectors play a major role in waste management by collecting and transporting these wastes for proper processing and disposal. However, in a bid to salvage the environment from waste-induced pollution, they become victims by being exposed daily to several aromatic and non-aromatic compounds capable of posing several health challenges on them.

From the results of this study, it is evident that occupational exposure had a negative impact on MSW collectors by affecting their HCT, ESR and MetHb levels. Therefore, it is highly recommended that these workers be provided with personal protective equipment such as protective clothing and other types of PPE, particularly nose mask to prevent or reduce the inhalation of pungently foul odour emanating from these wastes.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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