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Evaluation of Complete Blood Counts Parameters of Occupational Radiation and Non-Radiation Professionals from Three Teaching Hospitals in South-South Nigeria

Chikwendu Emenike Orji[1], Efe Omita[1], Kelechukwu B. Okeoma[1]

[1]Department of Physics, Federal University of Technology, Owerri, Imo State Nigeria

Corresponding Author: Efe Omita

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ABSTRACT

Background: The exposure of radiation workers to ionizing radiations, especially in medical field has increased due to the use of advance technological equipment in the diagnostic radiology and radiotherapy departments. This study is aimed at evaluating the effects of ionizing radiation on CBC parameters of medical radiation workers in South-South, Nigeria.
Materials and Methods: This comparative cross-sectional study was conducted in three teaching hospitals to include 39 radiation workers and 39 non-radiation workers with same year of working experience of one year to 10 years.
Results: The mean values for CBC in DSUTH are; radiation workers (WBC: 6.41, RBC= 5.47, Platelet = 240.28, Hb = 13.64 and Lymphocyte = 27.86) and non-radiation workers (WBC= 6.41, RBC= 5.47, Platelet = 250.75, Hb = 13.63 and Lymphocyte = 27.78). There were no statistically significance differences in the mean values of CBC in radiation and non-radiation workers in DSUTH ($p > 0.05$). There were no statistically significance differences in the mean values of CBC in radiation and non-radiation workers in NDUTH ($p > 0.05$).
Conclusion: Complete blood cells parameters only cannot be used as the most reliable indices for evaluating radiation biological risks associated with long term exposure, as we found that there was no statistically significant mean difference of CBC in radiation workers and non-radiation workers

Keywords: Blood cells, Health workers, Ionizing, Radiation.

INTRODUCTION

Ionizing radiation, especially X-rays and those emitted from radioactive sources, play crucial role in medical disciplines, both in the diagnosis and treatment of diseases[(1-2)]. However, these radiations accounted for the known occupational biological hazard, which might result from the deterministic effects and stochastic effects[(3)]. The occupational radiations effects are usually as a result of short time exposure to high doses of ionizing radiations above the occupational exposure limit (International Atomic Energy cited by Chinangwa et al[(3)] and Zare and Mortazari [(1)]. The exposure of radiation workers to ionizing radiations, especially in medical field has increased due to the use of advance technological equipment in the diagnostic radiology and radiotherapy departments [(4-10)]. According to UNSCEAR[(6)]. (2008), more than 75% of persons occupationally exposed to ionizing radiation were medical radiation workers. These categories of medical work force are inevitably exposed to long term low-dose ionizing radiation even if they apply the

normal personal protective equipment [1,11]. Previous studies have identified the connection between moderate to high-dose exposure to ionizing radiation and the potential of cancer development, such as leukemia, thyroid, lung, colon, breast and bladder cancers [4,12,13]. Although, there were controversial issues regarding the effects of ionizing radiations on humans as noted by Koptar and Garaj-Vrhovire[14], previous studies on the genetic changes due to ionizing radiation effects reported that the number of chromosomal aberrations in medical personnel working with ionizing radiations was higher than those of the general public[2,15]. The degree of ionizing radiation damage to the cells differs with hematopoietic cells being the most sensitive cells[1,16].

Currently, screening for different blood and non-blood related diseases is done using Complete Blood Component (CBC). This procedure is simple, cheap and can be use as point of care test. The prognostic and diagnostic values of the CBC cannot be overemphasized as it help to reveal the latent period of some diseases, especially chronic ones[17]. Nevertheless, different finding shave been reported on the effects of ionizing radiation on blood components such as white blood cells, monocyte and plasma immune-globulin, and was found that these blood components are usually lowered in radiation workers than the general population[11, 18]. Studies have shown that red blood cells did not show any significant changes in individuals occupationally exposed to ionizing radiation [19,20]. In a study done in Iran, they reported that regular periodic CBC tests are carried out on each radiation medical workers to determine their health status[1]. The amount of blood cells in any apparently healthy individual is relatively constant but changes in response to factors such as environmental and occupational hazards[17]. In another study carried out by Meo[21], in Saudi Arabia revealed the mean value of platelet count was significantly decreased in 40 X-ray technicians when compared to the controls. Good knowledge and adequate documentation of the effects of ionizing radiation on medical exposed workers using CBC parameters in the South-South region of Nigeria would help in planning and policy implementation of proper radiation safety measures in our radiology settings. There are scanty literature / and no documentation on the effects of ionizing radiation on medical exposed personnel in the settings of this study to the best of researcher's knowledge. Hence, this study is aimed at evaluating the effects of ionizing radiation on CBC parameters of medical radiation workers in South-South, Nigeria.

MATERIALS AND METHODS

This comparative cross-sectional study was conducted in three teaching hospitals in south-south Nigeria, University of Port Harcourt Teaching Hospital, Port Harcourt. Rivers State, (UPTH) Niger-Delta University Teaching Hospital, Okolobiri, Bayelsa State (NDUTH) and Delta State University Teaching Hospital, Oghara. Delta State (DSUTH) between June 2020-June 2021. The study sample size comprised of exposure group (39 apparently healthy ionizing radiation workers such as radiologists, medical imaging scientists/ radiographers) and control group (39 non-radiation workers such as nurses, pharmacists, cleaners, medical laboratory scientist) in the aforementioned hospitals. All the participants included in this study, were those with same year of working experience of one year to 10 years for both the exposed and unexposed group respectively and have been working for 8 hours per day. Those with clinical history of gross anemia, diabetic, cardiovascular disease and smokers were excluded from this study. Ethical approval and permission to carry out this study were obtained from the Human Research Ethic Committee of UPTH (UPTH/ADM/90/S.II/VOL.XI/825), NDUTH (NDUTH/REC/ECC/240) and DELSUTH (HREC/PAN/2019/055/0307) .The consent of the participants was duly obtained after explanation of the aim of the

study using written informed consent form. The data collected were held in strict confidence. The sample size of 78 was selected using convenience sampling method.

Complete Blood Count consist of white blood cells (WBC), red blood cells (RBC), hemoglobin (Hb), hematocrit (Hct), mean corpuscular volume (MCV), mean corpuscular hemoglobin concentration (MCHC), mean corpuscular hemoglobin (MCH), platelets (PLT) and lymphocytes with normal values of (Hb- 11.0-16.0g/dl male,11-16.5g/dl female), (Platelet Count – 100,000-300,000mm3) , (WBC – 4000-11,000mm3) ,(RBC -4.5-6.6 X 10,6- male, 3.5-5.5 x106 - female), (MCV 80.0-100.0 fL), (Lymphocytes – 20.0 – 40.0 %), (MCHC 32.0 – 36.0 g/L), and (MCH 27.0 – 34.0 pg).

The hematological technique involves the collection of 2ml of blood from each participant by venipuncture in a disposable syringe and was transferred into a tube containing ethylene diamine tetra-acetic acid (EDTA) of 1.5mg/ml concentration. The method previous described by Lewis et al (2006) was adopted for blood preparation. Blood cell count was done using Mindray BC-5380 Automated analyzer. The differential count in the radiation workers was determined using cell counter (QBC Diagnostics Reader/Centrifuge) and compared with the normal values of the control group. The morphology of the cell was viewed at high power magnification (X 400) for the whole blood film slides. The complete blood counts were collected using proforma designed in line with the study objectives and simple questionnaire was used for collection of the participants' socio-demographic information.

The obtained data were analyzed statistically with a statistical package for social sciences (SPSS) version 21 ((IBM Corp, Amornk, NY, 2012). Statistical tools such mean, standard deviation, percentages, frequency and sample T-test. An independent-samples t-test was performed on the mean values of the hematological variables to determine the parameters that show a significant difference between the exposed group and the control group. The level of statistical significance was set at $p < 0.05$.

RESULTS

The majority 64 %(n=25) of the participants in the exposed group were males. Those within the age group of 35-39 years with > 10 years of working experience were highest 36% (n=16), followed by age group 40-44 years with work experience > 10 years 26% (n=10)(Table 1).

Table 1: Occupational Radiation Professionals

No.	Workers Exposed to Radiation	Total	%
1	Radiologist	9	23
2	Radiographers	22	56
3	Medical Physicist	1	3
4	Radiology Resident Doctors	7	18
	Total	39	Radiation Workers

The mean values for CBC in DSUTH are; radiation workers (WBC: 6.41, RBC= 5.47, Platelet = 240.28, Hb = 13.64 and Lymphocyte = 27.86) and non-radiation workers (WBC= 6.41, RBC= 5.47, Platelet = 250.75, Hb = 13.63 and Lymphocyte = 27.78). There were no statistically significance differences in the mean values of CBC in radiation and non-radiation workers in DSUTH ($p > 0.05$). The results at NDUTH are; radiation workers (WBC = 5.02, RBC = 4.68, Platelet = 366.00, Hb = 11.66 and Lymphocytes = 37.00) and non-radiation workers (WBC = 8.42, RBC = 5.74, Platelet = 234.40, Hb = 14.76 and Lymphocytes = 32.94). There were no statistically significance differences in the mean values of CBC in radiation and non-radiation workers in NDUTH ($p > 0.05$). The mean values for CBC in UPTH are; radiation workers (WBC: 4.84, RBC= 5.44, Platelet = 234.00, Hb = 12.72 and Lymphocyte = 39.88) and non-radiation workers (WBC= 5.32, RBC= 4.94, Platelet = 214.83, Hb = 13.06 and Lymphocyte = 43.34) (Table 2).

Table 2: Distribution of participants Exposed to Radiation by Demographics

Variation	Category	Number	Percentage
Gender N = 39	Female: DSUTH = 6 NDUTH = 2 UPTH = 6	14	36
	Male DSUTH = 10 NDUTH = 3 UPTH = 12	25	64
Age/Experience	30-34 (<10) 30-34(>10) 35-39(<10) 35-39(>10) 40-44(>10) 45-49(>10) 50-54(>10)	4 2 2 14 10 3 4	10 5 5 36 26 8 10

DISCUSSION

The effects of ionizing radiation on humans can occur in low or high doses [22]. Exposure to low doses of ionizing radiation over a long period of time has been reported to be detrimental to the health of radiation workers and this effect may lead to hematological disorder [23,24].

We found in this study that in DSUTH, the RBC count showed no different in radiation workers and non-radiation workers. This finding is in keeping with the result of the studies done by Shafiee *et al* [25], Alnahhal *et al* [24] and Meo [21], which also reported that there was no different in the RBC count in both radiation and non-radiation workers. The WBC count in this present study shows no different in radiation workers and non-radiation workers in DSUTH. This is consist with the findings of the studies conducted by Joudoh *et al* [26], Shafiee *et al* [25] and Meo[21], which also reported that there was no mean difference in the WBC count of radiation and non-radiation workers. Contrary to the finding of this study, Omita *et al* [23], Dimitrovski *et al* [27]. (2018) and Davoudi *et al* [28], reported in their studies that there was slight difference in the WBC count in radiation workers and non-radiation workers. These differences in our findings could be attributed to the different sample sizes used in our various studies. In this present study, there was slightly higher mean value of platelets count in non-radiation workers than that of the radiation workers. This finding is in agreement with the findings of the studies carried out by Meo[21], Dimitrovski *et al* [27] and Davoudi *et al* [28] . However, Shafiee *et al*[25] and Alnahhal *et al* [24], reported that there was no different in the mean value of platelet in radiation and non-radiation workers.

The results at NDUTH and UPHTH shows that in almost all the hematological parameters there were statistical significance mean differences in the complete blood cell counts in both radiation and non-radiation workers with the exception of platelet counts in NDUTH and MCHC in UPTH radiation workers. These findings are harmony with the results of the studies conducted by [21,22,29], which equally reported no differences in the haematological parameters in radiation workers and non-radiation workers. Nevertheless, Zachariah *et al* [30] and Rozay *et al* [31], reported a contrast findings to the findings of the present study. The decrease the mean platelet count of radiation workers from NDUTH is in agreement with the study carried out by Meo 2004. These differences in our findings could be ascribed to the different sample sizes and geographical variations of the different studies. This study was conducted in three different teaching hospitals with different machines, technical issues, radiation protection strategies and parameters and different nature of radiation work which this study did not take into consideration, could be responsible for the differences in the findings noticed in this study, and these are the major limitations of this study.

Table 3: Radiation Protection Strategies applied in the three Hospitals

HOSPITALS	USED OF LEAD APRON	X-RAY CUBICLE	USED OF LEAD GOGGLE	DISTANCE FROM THE X-RAY SOURCE	RADIATION SAFETY OFFICIER
DELSUTH	√	OUTSIDE THE X-RAY ROOM	√	MORE THAN 2m	√
NDUTH	√	INSIDE THE X-RAY ROOM	√	LESS THAN 2m	NIL
UPTH	√	OUTSIDE THE X-RAY ROOM	√	LESS THAN 2m	NIL

Table 4: T-test Analysis of Comparison of Blood parameters or Radiation Workers and Non-radiation Workers in the same Hospital.

	Hospital	Blood Parameters								
		WBC	**RBC**	**PLT**	**Hb**	**HcT**	**McV**	**McH**	**McHc**	**Lymphocytes**
DELSUTH	$\bar{X}_R$	6.41	5.47	240.28	13.64	37.71	81.04	31.58	35.9	27.86
	S_R	2.33	1.21	90.69	1.72	4.5	11.016	4.541	0.922	11.4
	$\bar{X}_N$	6.41	5.47	250.75	13.632	37.79	82.6	31.65	35.94	27.46
	S_N	2.33	1.21	71	1.708	4.45	5.8	4.573	0.965	11.782
	t-value	0	0	-0.364	0.01	-0.051	-0.5	-0.043	-0.112	0.096
	df	30	30	30	30	30	30	30	30	30
	P	1	1	0.719	0.992	0.959	0.62	0.966	0.911	0.924
	Remark	***Not sig.***	***Not sig.***	***Not sig.***	***Not sig.***	***Not sig.***	***Not sig.***	***Not sig.***	***Not sig.***	***Not sig.***
NDUTH	$\bar{X}_R$	5.02	4.68	366	11.66	31.96	80.76	26.66	33.06	37
	s_R	0.482	1.42	99.005	3.798	8.431	4.744	1.717	0.783	15.831
	$\bar{X}_N$	8.42	5.74	234.4	14.76	40.62	82.26	31.26	34.72	32.94
	s_N	4.114	0.21	50.86	31.96	5.421	5.1	8.631	1.427	9.01
	t-value	-1.836	-1.651	2.644	-1.655	-1.932	-0.439	-1.169	-2.28	0.498
	df	8	8	8	8	8	8	8	8	8
	p	0.138	0.171	0.039	0.152	0.096	0.673	0.303	0.06	0.635
	Remark	**Not sig.**	**Not sig.**	**Sig.**	**Not sig.**	**Not sig.**	**Not sig.**	**Not sig.**	**Not sig.**	**Not sig.**
UPHTH	$\bar{X}_R$	4.84	5.44	234.94	12.72	40.15	80.92	25.99	32.73	39.88
	s_R	0.972	1.096	72.57	1.923	5.29	6.599	1.96	2.37	11.057
	$\bar{X}_N$	5.32	4.94	214.83	13.06	37.91	77.66	27.44	35.69	43.34
	s_N	1.204	0.856	55.815	1.618	4.777	9.855	3.266	1.765	12.887
	t-value	-1.31	1.525	0.932	-0.572	1.333	1.165	-1.615	-4.25	-0.87
	df	34	34	34	34	34	34	34	34	34
	p	0.19	0.137	0.358	0.571	0.192	0.253	0.118	0.000	0.393
	Remark	**Not sig.**	**Not sig.**	**Not sig.**	**Not sig.**	**Not sig.**	**Not sig.**	**Not Sig**	**Sig.**	**Not sig.**
	$\bar{X}_R$ Mean blood parameter for radiation workers									
	$\bar{X}_N$ Mean blood parameter for non-radiation workers									
	s_R Standard deviation from the mean blood parameter for radiation worker									
	s_N Standard deviation from the mean blood parameter for non-radiation workers.									
	df = degree of freedom									
	p = p-value									

CONCLUSION

Complete blood cells parameters only cannot be use as the most reliable indices for evaluating radiation biological risks associated with long term exposure, as we found that there was no statistically significant mean difference of CBC in radiation workers and non-radiation worker

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