Environmental Factors and Cancer Prevalence in SW Nigeria: Impact of Toxic and Essential Elements in Soil

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ABSTRACT

In order to investigate possible contribution of the physical environment to cancer, levels of trace elements in soil samples taken from five Local Government Areas (LGAs) in Southwestern Nigeria with different cancer prevalence were determined. Using geo-spatial techniques on cancer prevalence data available at the Ife-Ijesha Cancer Registry and at the Medical Records Department of the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile-Ife, the entire southwestern Nigeria was classified into five class-interval groups. Soil samples were collected from five different cities/villages from each LGA representing a distinct class-interval of cancer prevalence. The soil samples were subjected to elemental analyses using Energy-dispersive X-Ray Fluorescence. Fifteen elements (K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Rb, Sr, Ba, Pb and Th) were simultaneously determined in some or all of the samples. Pb and Th were detected only in 40% of the soil samples, while Ba was detected in only 12%. A number of very high correlations were found among some of the elements in soil, probably reflecting chemical affinity. Notable correlations found included those between Zn-Ni, Zn-Rb, Ca-K and V-Cu all significant at $p < 0.001$. Fe and Cr were negatively correlated at $p < 0.02$ level. No significant correlations were found between levels of trace elements and prevalence of cancer in the study area as a whole. However when results from the city of Ondo, which quite unexpectedly had sharply varied cancer prevalence when divided into Ondo East (54 cases per million) and Ondo West (187 cases per million) were considered, the essential element Mn (and to a smaller extent, Cr, Ni, and V) were found to be significantly higher in soil samples from

Ondo East than those from Ondo West. The study concludes that levels of Mn (a well-known anti-oxidant) in soil is associated with cancer prevalence in Ondo city.
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Keywords: Cancer Prevalence. Environmental Factors. Toxic and Essential elements.

INTRODUCTION

Cancer is a public health problem world-wide affecting all categories of persons. It is the second common cause of death in developed countries and among the three leading causes of death in developing countries (Jemal *et al*., 2007). The World Health Organization (WHO, 2003) reported that about 24.6 million people live with cancer worldwide while 12.5% of all deaths are attributable to cancer. If this trend continues, it is estimated that by 2020, 16 million new cases will be diagnosed per annum out of which 70% will be in developing countries. (Brayand and Moller, 2006). Parkin *et al.* (2005) reported that in indigenous Africans, 650,000 people out of an estimated 965 million are diagnosed with cancer annually, and the lifetime risk of dying from cancer in African women is two times higher than in developed countries.

It is generally agreed that as much as 80% of cancers is preventable, being linked with environmental, diet, and lifestyle issues (Doll and Peto, 1981; Lichtenstein *et al*., 2000, Donato *et al*., 2006, Irigaray *et al.*, 2007, Ana *et al.* 2010, USDHHS, 2010). In Nigeria, where the health-care delivery system is still rather basic, outright cancer prevention is a far more attractive approach to cancer control than other measures such as surgery, radiotherapy, chemotherapy which involves high costs and advanced technology.

Toxic elements have been implicated in cancer and other human health problem in various parts of the world. Exposure to heavy metals continues, and is even increasing in some parts of the world, in particular in less developed countries, though emissions have declined in most developed countries over the last 100 years (Nair *et al*., 1994). Agencies such as the International Agency for Research in Cancer (IARC) and the Agency for Toxic Substances and Disease Registry (ATSDR), have published lists of several chemicals that are carcinogenic with

varying degrees of affirmation. (IARC, 1990, ATSDR, 1999, IARC, 2006). In its 2008-2009 Report, the US President's Panel on Cancer opined that the true burden of environmentally induced cancer has actually been grossly underestimated (USDHHS, 2010).

Soil is a very important natural resource to man. Without soil the earth would be as barren as the moon and hence lifeless (Misra and Mani, 2009). Despite its importance, soil is often contaminated by human activities. A variety of human activities including municipal waste disposal, industrial emissions, military testing and agricultural practices have left their impacts on soils in the form of elevated and high level of toxicants (Van, 1996). One of the commonest routes toxic elements get to humans is through soil (West, 1981, Merrington *et al.*, 2010), Minerals move up the food chain to humans following consumption of plants or herbivorous animals.

Literally hundreds of research papers have been published on the association of chemicals in the environment with cancer. Examples of such articles from Ile-Ife, include Durosinmi *et al.* (1994) and Alatise and Schrauzer (2010). However, the sources and pathways for these chemicals into man are largely unaddressed, hence very little evidence-based proposals could be suggested to remediate the situation. Pollutants in soil are easily transferred to man via all the possible exposure routes of inhalation (via air), ingestion (through food and water), and dermal (through direct contact with skin). In the current study, levels of toxic and essential elements that could significantly impact on the cancer burden, are investigated in soils from selected locations in SW Nigeria, based on cancer prevalence data obtained at the Ife-Ijesha cancer registry. This is essentially a preliminary/screening study which could be extended to other environmental media, and other geographical locations as may be considered necessary.

METHODOLOGY

Archived data on cancer cases reported in the five-year period 2010-2014 in patients resident within SW Nigeria were retrieved from the Ife-Ilesha cancer registry at the Obafemi Awolowo University Teaching Hospital Ile-Ife. The data retrieved were taken to the hospital library to search out case notes of patients to retrieve other information such as geographical location,

occupation, age, etc. Data extraction was carried out/supervised by regular hospital personnel in charge of the data. Personal information such as names of patients and street addresses were not extracted, so as to protect the privacy of the subjects. A GIS-based package was used to graphically display prevalence of cancer (5 class intervals) on a physical map of the Southwestern Nigeria. Thereafter, five geographically-contiguous and culturally-identical Local Government Areas (LGAs) with cancer prevalence spanning the five class intervals were identified. These LGAs (Idanre, Akure South, Ondo West, Ifedore and Ondo East), purposively selected to fall within Ondo State, were chosen as the sites for soil sampling. These LGAs are shown on the map of SW Nigeria in Figure 1. The GPS locations of actual soil sampling were also noted.

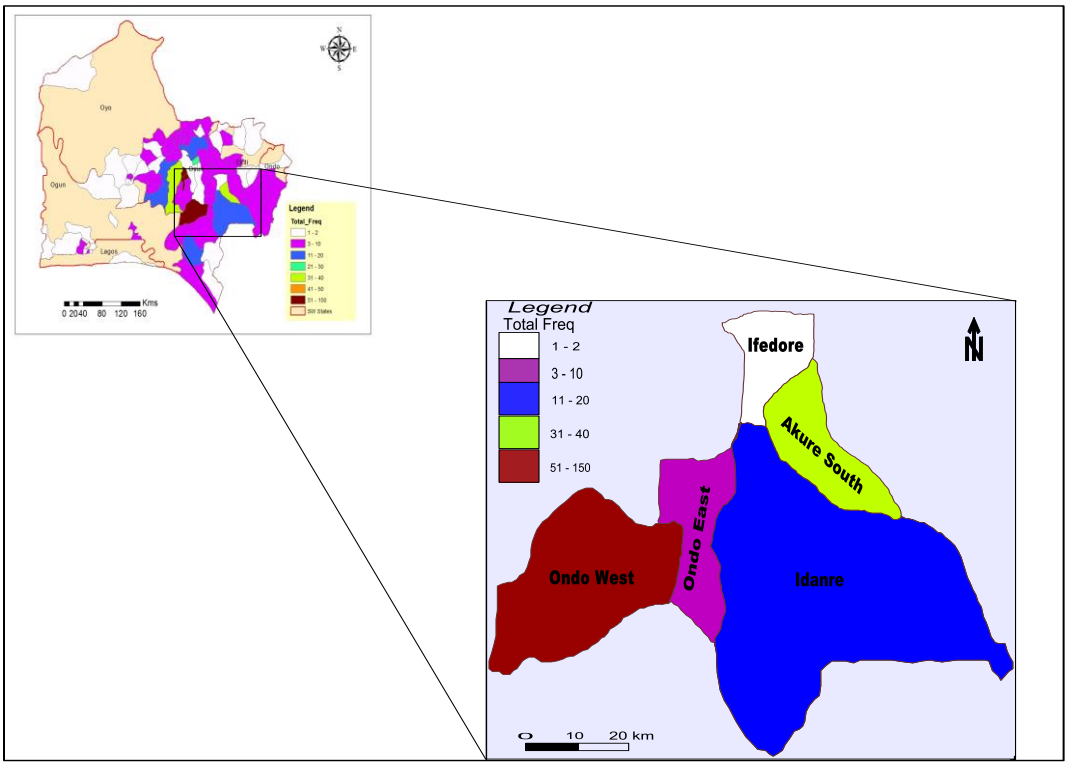


Fig 1. Map Showing the Prevalence of Cancer in SW and Sampling Sites for Soil.

Five sampling locations were chosen in each of the 5 LGAs, leading to 25 total sampling points. At each sampling point, approximately 0.5 kg of soil was collected from a depth of 0-10 cm using a stainless steel sampler. Soil samples along the roads were collected at a distance of one

metre from the edge of the road and within an area of one square metre. The samples were stored in polythene bags, and appropriately and carefully labelled at the point of collection.

The soil samples were taken to the laboratory where they were air-dried till constant weight was achieved. They were thereafter pulverized to fine powdery form using an agate mortar. For presentation to the ED-XRF facility, pellets were made for each sample using a CARVER model manual pelletizing machine at a pressure of 6-8 torr. This process further serves to pre-concentrate the elements in the samples before analyses.

The Portable AMPTEK$^{(R)}$Energy Dispersive X-ray Fluorescence (EDXRF) at the Centre for Energy Research and Development of the Obafemi Awolowo University, Ile-Ife, was used for the elemental analyses. The EDXRF instrumentation included the X-ray source, Sample Holder, Detector, Current and Voltage Amplifier and Read out computer. The pelletized sample was inserted into the sample holder of the EDXRF system and was bombarded by X-ray generated from the silver anode of the facility at a voltage of 25 kV and current of 50 μA. The bombardment lasted till 1000 counts were registered on the spectrometer, lasting approximately 18 minutes. Characteristic X-ray of the sample was detected by the solid state Si-PIN detector system and spectrum acquisition was done using ADMCA^{R} software. K X-ray lines were used to evaluate the levels of the elements K, Ca, Ti, V, Cr, Mn, Fe, Ni, Cu, Zn, Rb, and Sr; while the heavier elements Ba, Pb and Th were evaluated using L-X ray lines. The spectrum analysis was done using the ADMCA plus Fundamental Parameter (FP-CROSS) Software which translates the peak areas into concentration values. IAEA Soil Standard (S-7) was used to calibrate the procedures.

RESULTS AND DISCUSSION

The concentrations obtained for 12 elements in IAEA Soil S-7 standard were compared with the certified values in Table 1. The results obtained were quite satisfactory. Table 2 presents the values for the elements from 25 locations in the 5 Local Government Areas of Ondo State representing different interval levels of cancer prevalence in Southwest Nigeria. The descriptive

statistics (minimum, maximum, mean, and standard deviation) of these values for the five local government areas are summarized in Table 3.

Table 1: Comparison of values obtained for various elements in IAEA-S7 Soil Standard and Certified Values

Elements	Concentration of elements (ppm except otherwise indicated)	
	Certified values	Analyzed values
K %	1.22	1.22
Ca %	16.3	16.4
Ti (%)	0.3	0.33
Cr	2	2
Mn	631	635
Fe %	2.57	2.59
Ni	26	28
Cu	11	9
Zn	104	108
As	13.4	14.0
Sr	108	116
Zr	185	100

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Table 2: Concentrations of 12 elements in various soil samples from 5 Local Government Areas in Ondo State with varying levels of Cancer Prevalence

SITES	K %	Ca %	Ti %	V %	Cr %	Mn %	Fe %	Ni %	Cu %	Zn %	Rb (ppm)	Sr (ppm)
Idanre Alade 1	0.433	0.272	0.368	0.108	0.052	0.424	7.255	0.251	0.085	0.207	557	494
Idanre Alade 2	1.050	0.398	0.310	0.064	0.052	0.411	6.834	0.259	0.057	0.140	361	466
Idanre Dam	0.434	0.511	0.332	0.105	0.066	0.307	6.988	0.447	0.096	0.216	384	118.9
Idanre Ayetoro	0.356	0.353	0.215	0.081	0.057	0.337	7.525	0.185	0.089	0.248	623	423
Idanre Atosin	1.660	0.610	0.324	0.052	0.024	ND*	6.208	0.140	0.034	0.117	400	353
Ifedore Igbara-oke 1	0.230	0.053	0.609	0.140	0.047	0.225	7.341	0.193	0.325	0.156	831	147
Ifedore Igbara-oke 2	0.241	0.074	3.866	0.207	0.005	0.300	4.831	0.008	0.069	0.028	50	49
Ifedore Ilara 1	0.319	0.124	0.326	0.106	0.079	0.198	7.832	0.273	0.056	0.151	504	363
Ifedore Ilara 2	0.682	0.074	0.235	0.127	0.085	0.201	7.460	0.386	0.077	0.025	375	456
Ifedore Ilara 3	0.343	0.109	0.282	0.089	0.033	0.180	7.816	0.336	0.064	0.185	404	410
Akure Ayedun	0.009	0.060	0.059	0.056	0.191	0.085	0.705	0.002	0.014	0.013	93	13
Akure Ajipomu	0.127	0.054	1.065	0.354	0.220	0.432	6.507	0.063	0.562	0.187	647	223
Akure Gbogi	0.075	0.012	0.701	0.061	0.021	0.199	8.340	0.585	0.110	0.068	110	7
Akure Ijomu	0.347	0.068	0.367	0.103	0.054	0.415	7.252	0.462	0.064	0.282	650	260
Akure Araromi	0.196	0.041	0.389	0.050	0.043	0.115	8.446	0.115	0.161	0.071	231	89
Ondo-West Surulere	0.401	0.590	0.177	0.049	0.039	0.195	7.655	0.227	0.093	0.183	231	257
Ondo-West Yaba	0.302	0.337	0.218	0.073	0.028	0.223	8.004	0.162	0.054	0.167	405	484
Ondo- West Saluwa	1.024	0.290	0.235	0.087	0.065	0.342	7.062	0.195	0.057	0.203	435	558
Ondo-West Station 4	1.196	0.272	0.213	0.066	0.004	0.330	7.072	0.205	0.044	0.185	284	433
Ondo-West Station 5	1.010	0.756	0.209	0.081	0.011	0.200	6.536	0.205	0.134	0.199	585	259
Ondo-East Oboto (GS) 1	0.126	0.080	0.130	0.110	0.098	0.300	7.527	0.582	0.152	0.278	517	456
Ondo-East Oboto (GS) 2	1.135	0.169	0.242	0.109	0.045	0.321	6.950	0.296	0.078	0.196	558	620
Ondo-East Oboto 1 SW	2.017	0.490	0.180	0.244	0.067	0.493	4.145	0.869	0.266	0.586	858	207
Ondo-East Oboto 2 SW	0.790	0.364	0.373	0.074	0.037	0.421	7.137	0.176	0.064	0.108	197	933
Ondo-East Ireje SW	1.155	0.428	0.396	0.202	0.123	0.380	5.296	0.650	0.162	0.391	836	329

*ND means Not Detected

Table 3: Summary of Descriptive Statistics for 12 elements in soil samples from 5 Local Government Areas in Ondo State with varying levels of Cancer Prevalence

		K %	Ca %	Ti %	V %	Cr %	Mn %	Fe %	Ni %	Cu %	Zn %	Rb ppm	Sr ppm
ONDO.	MIN	0.302	0.272	0.177	0.049	0.004	0.195	6.536	0.162	0.044	0.167	231	257
WEST	MAX	1.196	0.756	0.235	0.087	0.065	0.342	8.004	0.227	0.134	0.203	585	558
	MEAN	0.787	0.449	0.211	0.071	0.029	0.258	7.266	0.199	0.076	0.187	388	398
	STD DEV	0.405	0.214	0.021	0.015	0.024	0.072	0.572	0.023	0.037	0.014	138	135
AKURE	MIN	0.009	0.012	0.059	0.050	0.021	0.085	0.705	0.002	0.014	0.013	93	7
	MAX	0.347	0.068	1.065	0.354	0.220	0.432	8.446	0.585	0.562	0.282	650	260
	MEAN	0.151	0.047	0.516	0.125	0.106	0.249	6.250	0.245	0.182	0.124	346	118
	STD DEV	0.129	0.022	0.382	0.130	0.092	0.165	3.202	0.261	0.219	0.109	281	117
IDANRE	MIN	0.356	0.272	0.215	0.052	0.024	0.307	6.208	0.140	0.034	0.117	361	118
	MAX	1.660	0.610	0.368	0.108	0.066	0.424	7.525	0.447	0.096	0.248	623	494
	MEAN	0.787	0.429	0.310	0.082	0.050	0.370	6.962	0.257	0.072	0.185	465	370
	STD DEV	0.563	0.133	0.057	0.024	0.016	0.057	0.497	0.117	0.026	0.055	117	150
ONDO	MIN	0.126	0.080	0.130	0.074	0.037	0.300	4.145	0.176	0.064	0.108	197	207
EAST	MAX	2.017	0.490	0.396	0.244	0.123	0.493	7.527	0.869	0.266	0.586	858	933
	MEAN	1.044	0.306	0.264	0.148	0.074	0.383	6.211	0.514	0.144	0.312	593	509
	STD DEV	0.685	0.174	0.117	0.072	0.036	0.078	1.436	0.279	0.081	0.185	270	282
IFEDORE	MIN	0.230	0.053	0.235	0.089	0.005	0.180	4.831	0.008	0.056	0.025	50	49
	MAX	0.682	0.124	3.866	0.207	0.085	0.300	7.832	0.386	0.325	0.185	831	456
	MEAN	0.363	0.087	1.063	0.134	0.050	0.221	7.056	0.239	0.118	0.109	432	285
	STD DEV	0.185	0.029	1.574	0.045	0.033	0.047	1.262	0.148	0.116	0.076	280	177
HIGH	MIN	0.126	0.029	0.057	0.024	0.005	0.047	0.497	0.008	0.026	0.025	50	49
REGION	MAX	2.017	0.610	3.866	0.244	0.123	0.493	7.832	0.869	0.325	0.586	858	933
	AVERAGE	**0.725**	**0.232**	**0.716**	**0.107**	**0.050**	**0.263**	**5.124**	**0.298**	**0.116**	**0.182**	**423**	**336**
	STD DEV	0.566	0.182	1.041	0.063	0.031	0.142	2.571	0.221	0.087	0.145	251	230
LOW	MIN	0.126	0.053	0.130	0.074	0.005	0.180	4.145	0.008	0.056	0.025	50	49
REGION	MAX	2.017	0.490	3.866	0.244	0.123	0.493	7.832	0.869	0.325	0.586	858	933
	AVERAGE	**0.704**	**0.197**	**0.664**	**0.141**	**0.062**	**0.302**	**6.634**	**0.377**	**0.131**	**0.210**	**513**	**397**
	STD DEV	0.563	0.157	1.075	0.054	0.033	0.099	1.281	0.243	0.090	0.162	259	238
ALL	MIN	0.009	0.012	0.059	0.049	0.004	0.085	0.705	0.002	0.014	0.013	50	7
REGIONS	MAX	2.017	0.756	3.866	0.354	0.220	0.493	8.446	0.869	0.562	0.586	858	933

	MEAN	0.626	0.264	0.473	0.112	0.062	0.293	6.749	0.291	0.119	0.183	445	336
	STD DEV	0.525	0.213	0.736	0.071	0.052	0.110	1.616	0.209	0.116	0.121	226	212

There are no discernible pattern in the distribution and levels of toxic and essential elements in soil and reported cancer prevalence in the region. To improve the data sizes involved, the sites were grouped into just two, designated simply as High Cancer Prevalence and Low Cancer Prevalence Groups, and the mean levels of the elements in the soil of both Groups compared. The High Prevalence Group comprised of Idanre, Akure South, and Ondo West LGAs with cancer prevalence of 93, 103 and 187 cancer cases per million people respectively, while Ifedore and Ondo East LGAs with 6 and 54 cancer cases per million people respectively constituted the Low Prevalence Group. The High Prevalence Group thus had a total of 383 cancer cases per million in the 5 year period under consideration, while the Low Prevalence Group had only 60 cancer cases per million in the same period. Even with this new re-grouping, there were still no statistically significant differences in the mean levels of the detected elements in the soil of both groups. The average levels (and standard deviation reflected by the error bars) of the elements in the two Groups are summarized in the bar charts in Figure 2.

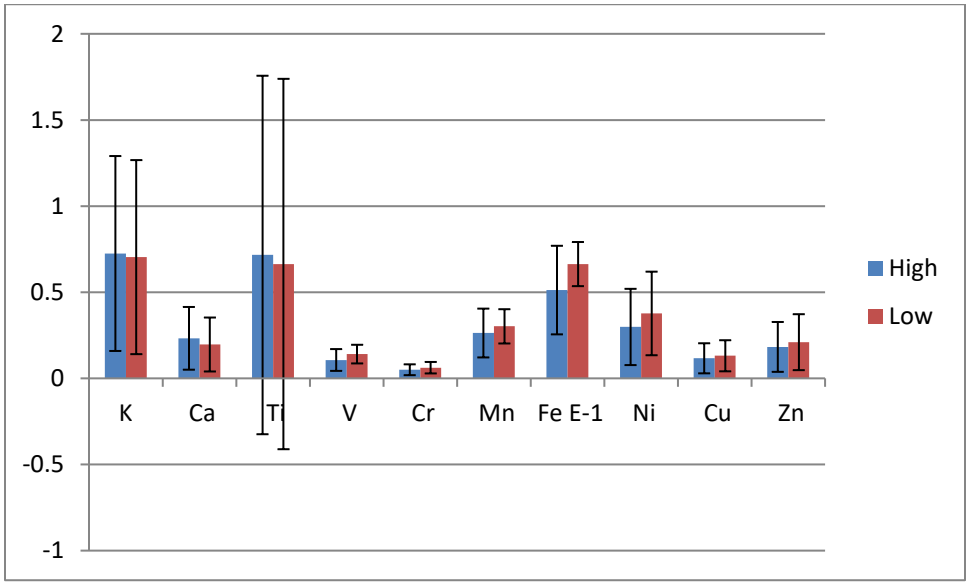


Figure 2: Average levels of the elements in the designated High (383 cancer cases per million population) and Low (60 cancer cases per million population) Cancer Prevalence Groups from Ondo State

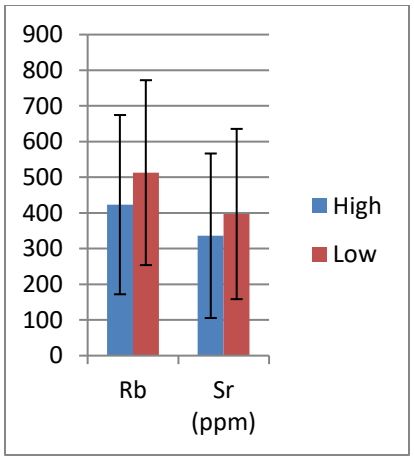


Figure 2 (continued): Average levels of the elements in the designated High (383 cancer cases per million population) and Low (60 cancer cases per million population) Cancer Prevalence Groups from Ondo State

However when results from the city of Ondo, which quite unexpectedly had sharply different cancer prevalence when divided into Ondo East (54 cancer cases per million) and Ondo West (187 cancer cases per million) were considered, the mean levels of the essential element Mn were found to be significantly ($p < 0.05$) higher in soil samples from Ondo East than those from Ondo West. The mean levels of Cr, Ni, and V were also higher in the Low prevalence Ondo East group, but at a lesser level of statistical significance ($P < 0.1$). The p values for the two-tailed t-test comparing levels of the various elements in Ondo East and Ondo West are shown, together with the descriptive statistics for elemental distribution in soil, in Table 4. The significantly elevated level of Mn in the Low prevalence Ondo East region is very interesting since this element is well-known for its very strong anti-oxidant property which thus confers considerable protection against cancers. (Coassin *et al.*, 1992, Ercal *et al.*, 2001, Aguirre *et al.*, 2012).

The existence of patterns and association between the different elements detected in soils from each location was investigated using Pearson Correlation Analyses. A good number of significant correlations were found. These are shown in Table 5. For 25 data pairs, critical values required for Pearson correlation coefficients to be statistically significant are: $r = 0.337$ at $p < 0.10$ level; $r =$

0.396 at $p < 0.05$ level; $r = 0.462$ at $p < 0.02$ level; $r = 0.505$ at $p < 0.01$ level, and $r = 0.618$ at $p < 0.001$ level. The following pairs of elements are positively correlated at the indicated levels:

At $p < 0.001$: V-Cu, Zn-Rb, Zn-Ni, and Ca-K,

At $p < 0.01$: Zn-Mn, K-Mn, Zn-K, V-Cr, Cr-Cu, and Cu-Rb

At $p < 0.05$: Ti-V, V-Zn, V-Rb, Cr-Fe*, Mn-Rb, and Ni-Rb

At $P < 0.1$: K-Ni, Ca-Zn, and V-Zn

Fe and Cr were found to be negatively correlated (Significant at $p < 0.02$). Other negative correlations observed, were not statistically significant. All these significant correlations reflect chemical similarities/affinities and interactions among the pairs of elements involved. Their existence, also confirm that the values measured in this work were systematic to some extent, reflecting a measure of the goodness of the analytical protocols

Table 4: Descriptive Statistics for elemental levels in soils, and p values for t-test comparing levels from Ondo West and Ondo East

		K %	Ca %	Ti %	V %	Cr %	Mn %	Fe %	Ni %	Cu %	Zn %	Rb ppm	Sr ppm
ONDO. WEST	MIN	0.302	0.272	0.177	0.049	0.004	0.195	6.536	0.162	0.044	0.167	231	257
	MAX	1.196	0.756	0.235	0.087	0.065	0.342	8.004	0.227	0.134	0.203	585	558
	MEAN	0.787	0.449	0.211	0.071	0.029	0.258	7.266	0.199	0.076	0.187	388	398
	STD DEV	0.405	0.214	0.021	0.015	0.024	0.072	0.572	0.023	0.037	0.014	138	135
ONDO EAST	MIN	0.126	0.080	0.130	0.074	0.037	0.300	4.145	0.176	0.064	0.108	197	207
	MAX	2.017	0.490	0.396	0.244	0.123	0.493	7.527	0.869	0.266	0.586	858	933
	MEAN	1.044	0.306	0.264	0.148	0.074	0.383	6.211	0.514	0.144	0.312	593	509
	STD DEV	0.685	0.174	0.117	0.072	0.036	0.078	1.436	0.279	0.081	0.185	270	282
$P(T \leq t)$ two-tail		0.4961	0.2813	0.3718	0.0787	0.0550	0.0298	0.1876	0.0652	0.1373	0.2093	0.1820	0.4588

Table 5: Correlation between elements in soil samples from regions of different cancer prevalence in Ondo State

	K	Ca	Ti	V	Cr	Mn	Fe	Ni	Cu	Zn	Rb	Sr
K	1.000											
Ca	**0.620**	1.000										
Ti	-0.225	-0.272	1.000									
V	0.070	-0.175	0.421	1.000								
Cr	-0.249	-0.294	-0.136	0.524	1.000							
Mn	0.525	0.241	0.074	0.502	0.068	1.000						
Fe	-0.190	-0.061	-0.169	-0.258	-0.478	-0.026	1.000					
Ni	0.345	0.104	-0.294	0.194	-0.019	0.345	0.068	1.000				
Cu	-0.091	-0.166	0.118	**0.790**	0.506	0.281	0.002	0.089	1.000			
Zn	0.514	0.373	-0.290	0.398	0.077	**0.612**	-0.081	**0.717**	0.300	1.000		
Rb	0.338	0.176	-0.303	0.484	0.217	0.474	0.051	**0.459**	**0.512**	**0.761**	1.000	
Sr	0.325	0.195	-0.334	-0.187	-0.173	0.401	0.325	-0.033	-0.264	0.092	0.106	1.000

Lead is one of the major elements of interest in a study of environmental factors in cancer. (e.g. Alatise and Schrauzer, 2010). Unfortunately, the technique used is not sensitive enough to detect the low lead levels present in some of the samples. It was in only 10 out of the 25 samples (40%) that lead was detectable. As it were, we are not able to attempt any correlation between lead levels and prevalence of cancer due to too few data available. However, for the sake of adding to existing literature on this environmentally-important element, a descriptive summary of lead levels as found in this study is presented.

The mean levels of lead (in parts per million, ppm) in Ifedore, Idanre, Akure, Ondo East and Ondo West were 227.4±13.9, 210±31.6, 91.6±9, 90.2±16.8 and ND (not detectable) respectively. In Ifedore locality, the level of lead was determined in four out of five areas; Igbara oke 1, Igbara oke 2, Ilara 1, Ilara 3 with lead values of 216±9, 96±10, 366±55, 459±65 (ppm) respectively. In Idanre locality, lead was detected in only three areas; Alade 1, Atosin and Ayetoro with lead values of 253±48, 230±23 and 570±87 (ppm). Also in Akure, lead was detected in Ayedun and Ijomu with values of 24±2 and 434±43 (ppm) respectively. The gas station 1 in Ondo East had a lead level of 451±84 ppm. The lead values discussed above are summarized in Table 6. They are generally similar to values obtained from an industrially-polluted site in Nigeria (Inuwa *et al*,, 2007). These relatively high levels of lead recorded in agricultural area could be due to high soil organic matter

content. This soil component could possibly be responsible for higher soil lead retention (Mico *et al*., 2006). Lead could also be from the application of agrochemical and fertilizers in the agricultural area (Mico *et al*., 2006) e.g. urea and superphosphate, in addition to other anthropogenic sources.

Table 6: Lead levels in various soil samples from 5 Local Government Areas in Ondo State with varying levels of Cancer Prevalence

S/N	**Locations**		**Lead Levels** (ppm)
	ONDO WEST		
1	SALUWA	SA	ND
2	STATION 4	ST4	ND
3	STATION 5	ST5	ND
4	SURULERE	SU	ND
5	YABA	YA	ND
	Mean		ND
	AKURE		
6	AJIPOWO	AJ	ND
7	ARAROMI	AR	ND
8	AYEDUN	AY	24±2
9	GBOBI	GB	ND
10	IJOMU	IJ	434±43
	Mean		91.6±9
	IDANRE		
11	ALADE 1	AL1	253±48
12	ATOSIN	AT	230±23
13	AYETORO 1	AY1	570±87
14	ALADE 2	AL2	ND
15	DAM	DA	ND
	ONDO EAST		
16	GAS STATION 1	GS1	451±84
17	GAS STATION 2	GS2	ND

18	IREJE	IR	ND
19	OBOTO1	OB1	ND
20	OBOTO2	OB2	ND
	IFEDORE		
21	IGBARAOKE 1	IG1	216±9
22	ILARA1	IL1	366±55
23	ILARA2	IL2	ND
24	ILARA3	IL3	459±65
25	IGBARAOKE 2	IG2	96±10

CONCLUSION

This study has investigated levels of fifteen toxic and essential elements simultaneously determined in soil samples obtained from locations representing the five levels of cancer prevalence identified in southwestern Nigeria. No correlations were found between levels of either toxic or essential elements with the prevalence of cancer in the study area as a whole. The relatively small data size and the very many possible confounding factors involved could easily becloud any such correlations, if they at all exist. However the unexpected situation from the city of Ondo with very sharply varied cancer prevalence between the two component Local Government Areas (Ondo East and Ondo West) afforded us to keep constant, virtually all the confounding factors (including diet, culture, lifestyle, ethnicity, etc). It is therefore very interesting to find the essential element with well-known anti-oxidant property, manganese, being significantly elevated in the Low-Cancer Ondo East section of the city, than in the High-Cancer Ondo West section. It would be useful investigating the specific exposure pathways and routes of manganese from the environment into residents of the city.

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REFERENCES

Aguirre, J. Dafhne and Culotta, Valeria C. 2012. Battles with Iron: Manganese in Oxidative Stress Protection. *The Journal of Biological Chemistry 287, 13541-13548.*

Alatise O.I, and Schrauzer G.N. 2010. Lead exposure; a contributing cause of the current breast cancer epidemic in Nigerian women. *Biol. Trace Element Res*. 136 (2):127-39.

Ana, Godson R.E.E. Sridhar, Mynepalli K.C, and Asuzu, Michael C. 2010. Environmental risk factors and hospital-based cancers in two Nigerian cities. *Journal of Public Health and Epidemiology* Vol 2(8), pp 216-223.

ATSDR, 1999. Toxicological Profile for cadmium. Agency for Toxic Substances and Disease Registry. http://www.atsdr.cdc.gov/toxprofiles/tp5.html.

Brayand, F., and Moller, B. 2006. Predicting the future burden of cancer. *Nat. Rev. Cancer*. 6:63–74.

Coassin M, Ursini F, and Bindoli A. 1992. Antioxidant effect of manganese. *Arch Biochem Biophys*. 299 (2): 330-333.

Doll, R., and Peto, R. 1981. The causes of cancer: quantitative estimates of avoidable risks of cancer in the United States today. *J. Natl. Cancer Inst*. 66:1191–308.

Donato, F., Gelatti, U., Limina, R. M., and Fattovich, G. 2006. Southern Europe as an example of interaction between various environmental factors: a systematic review of the epidemiologic evidence. *Oncogene*. 25:3756–3770.

Durosinmi M.A., Ojo J.O., Oluwole A.F., Akanle O.A., Spyrou N.M. 1994. Study of trace elements in blood of cancer patients by PIXE analysis. *Biological Trace Element Research*, 43/44: 351-356.

Ercal N, Curer-Orhan H. and Aykin-Burns N. 2001. Toxic Metals and Oxidative Stress Part I: Mechanisms Involved in Metal Induced Oxidative Damage. *Current Topics in Medicinal Chemistry*, 1, 529-539.

IARC 1990. Overall evaluation of carcinogenicity, chromium III compound and chromium VI. International Agency for Research on Cancer, Monograph volume 49.

IARC 2006. Overall evaluation of carcinogenicity, lead compounds, organic. International Agency for Cancer *J. Clin.Research on Cancer*, Monograph volume 23, Suppl. 7, 87.

Inuwa, M., Abdulrahman, F.W. Birnin Yauri, U.A., and Ibrahim, S.A. 2007. Analytical Assessment of Some Trace Metals in Soils Around the Major Industrial Areas of Northwestern Nigeria. *Trends in Applied Sciences Research*, 2: 515-521.

Irigaray, P., Newby, J. A., Clapp, R., Hardell, L., Howard, V., Montagnier, L., Epstein, S., and Belpomme. D. 2007. Lifestyle-related factors and environmental agents causing cancer: an overview. *Biomed. Pharmacother*. 61:640–658.

Jemal A, Siegel, R., Ward, E., Murray, T., Xu, J., and Thun. M.J. 2007. *Cancer statistics*, 57:43–66.

Lichtenstein P., Holm N. V., Verkasalo P. K., Iliadou, A., Kaprio J, Koskenvuo M., Pukkala E., Skytthe A., and Hemminki K. 2000. Environmental and heritable factors in the causation of cancer—analyses of cohorts of twins from Sweden, Denmark, and Finland. *N. Engl. J. Med*.343:78–85.

Merrington, Graham, Saikat, Sohel and Grosso, Albania. 2010. Regulatory Limits for Trace Elements in Soils. In Hooda, P.S (Editor). Trace Elements in Soils. (Chapter 13) Blackwell Publishing Ltd ISBN: 978-1-405-16037-7 pg 293 -309.

Mico C., Peris M., Sanchez. and Recatala, L. 2006. Heavy metal content of agricultural soils in a Mediterranean Semiarid area: the Segura River Valley (Alicante, Spain). *Spanish Journal of Agricultural Research*; 4: 363-372.

Misra, S. and Mani, D. 2009. Soil pollution. New Delhi, India: S. B Nangia APH publishing corporation. 29-59.

Nair G., Parr R.M., and Castelino J. 1994. Health and the Environment: Examining Some Interconnections. *IAEA Bulletin* Vol 4, pg 10 – 15. [Citing Nriagu J.O. and Pacyna J.P. *Nature*, Vol 3, 33 (May 1984)]

Parkin D.M, Bray F, Ferlay J, Pisani P. 2005. Global cancer statistics. *Cancer J Clin* 55(2):74-108.

USDHHS 2010. U.S. Department of Health and Human Services. Reducing Environmental Cancer Risk What We Can Do Now. 2008–2009 Annual Report. President's Cancer Panel, Printed April 2010

Van, N. Krivolutsky. 1996. Bioindicator systems for soil pollution. Dordrecht, Netherlands: Kluwer Academic Publishers. Pp 1-8.

WHO 2003. Bernard W. Stewart and Paul Kleihues (editors). World Cancer Report. International Agency for Research on Cancer, IARC Press, Lyon 2003. ISBN 92 832 0411 5

West T.S. 1981. Soil as the source of trace elements. *Philos Trans R Soc Lond B Biol Sci*. Aug 14;294 (1071):19-39.
