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Characterization of Dose Rates and Its Internal Fluctuation Using Frequency Distribution Function of Background Radiation Data

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Abstract The use of distribution function in characterization of data technique, to evaluate and estimate dose rates from background radiation in Akure informed this study. The mean and fluctuation in mean of possible exposure due to the members of the general public in Akure was deduced by statistically calculating the mean and fluctuation in mean of 166 sample points. Kindenoo blueGeiger PG-15 detector and Garmin GPSmap 62s were used for the research. The Dose Rate (DR) and its internal fluctuation range between $0.16 \pm 0.01\,\mu Sv/h$ - $0.37 \pm 0.04\,\mu Sv/h$ in air, and Annual Effective Dose Equivalent, AEDE between $0.31 \pm 0.02\,mSv/y$ - $0.71 \pm 0.08\,mSv/y$; the estimated mean outdoor AEDE $0.50 \pm 0.06\,mSv/y$ for members of the general public in Akure is below the UNSCEAR and ICRP recommended $1\,mSv/y$ annual exposure dose rate. All the estimated AEDE from measured dose rates at the chosen locations have values far lower than the $100mSv$ limit of admissible low-level radiation. The skewness and kurtosis of DR distribution is 0.134 and 0.251 with standard error 0.188 and 0.375. The predicted probability function of observing a specific count x in this study is $P(x) = 0.7826$.

Keywords: *background radiation, dose rate, radionuclide, distribution function, Akure*

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1. Introduction

Background radiation is emitted from both natural and human-made radioactive sources [1]. Humans are continuously irradiated by sources outside and inside our bodies [2]. Some naturally occurring radiation comes from the atmosphere as a result of cosmic radiation from outer space [3], some comes from the earth called terrestrial radionuclide [2,4], and some is even in our bodies from radionuclides in the food and water we ingest and the air we breathe [5]. Additionally, human-made radiation enters our environment from industries, consumer products and activities such as medical procedures that use radionuclides or x-rays and from nuclear power plants used to generate electricity [6,7]. The contributions from these components vary with local geology, altitude and geomagnetic latitudes [8].

Exposures from natural radiation are the largest component of all exposures for most people, and form the baseline upon which exposures from man-made sources are added [2]. The average annual effective dose from natural radiation is about $2.4mSv$, one third being due to external exposure and two thirds to internal exposure [2,9]. The main contribution to external exposure comes from gamma-emitting radionuclides present in trace amounts in the soil, mainly ^{40}K and the ^{238}U and ^{232}Th families [10,11]. Information on outdoor exposure comes from direct measurements of dose rate or from evaluations based on measurements of radionuclide concentration in soil [11].

Some forms of radiation data are voluminous in nature and therefore stressful to collate, most especially samples randomly measured in air; the need to statistically define the data and efficiently manage and/or organise it necessitates characterization of data. If radiation data(s) are adequately managed, estimation would be presented with better precision and minimal error [12]. The objective of this work therefore, was to describe the nature of sampled background radiation data from Akure, Southwestern Nigeria using characterization of data technique, with the aim of estimating its mean value and distribution model.

Akure is a prominent city in the Southwestern Nigeria. It lies within latitude 7° 05' 00''N and 7° 26' 11''N and longitude 5° 03' 06''E and 5° 29' 25''E. The temperature is usually between 21°C and 29°C, and relative humidity about 80%. The annual rainfall is about 1524mm [13]. The area is characterized by different rock formations such as porphyritic granite, biotite gneiss, pelitic schist, charnockites, quartzites, granite gneiss and migmatite gneiss [14,15,16].

2. Materials and Methods

An efficient technique for assessing background radiation is presented. It is a general method that utilizes

Radiation Detector Device, Global Positioning System and Counting Statistics.

The mean and fluctuation in mean of the background radiation reading for each sample point is calculated from six detectable stable logs measured by Geiger counter (Kindenoo blueGeiger PG-15 detector) at each spatial point; dose rate measurements were taken at 2 minutes interval after the first stable detection [17]. Thereafter, the mean and fluctuation in mean of possible exposure due to the members of the general public of Akure was deduced by statistically calculating the mean and fluctuation in mean of the 166 sample points. Characterization of data was used to accomplish this task [18]. The location code of each sample point in Appendix A and Figure 5 was used in Table 1 and Table 2 to group dose rates and fluctuations with common radiation measurement. This was achieved by reducing all radiation data to two decimal places (as shown in Appendix A) and frequencies noted.

Assume a collection of N independent measurements of the same physical quantity:

$$x_1, x_2, x_3, \ldots, x_i, \ldots, x_N.$$

And the two elementary properties of this data set are

$$Sum\ \ \Sigma \equiv \sum_{i=1}^{N} x_i \tag{1}$$

$$Mean\ \ \bar{x} \equiv \Sigma / N. \tag{2}$$

The notation Σ indicates a sum that is taken over the indicated values of the parameter with the subscript i.

The data set can be represented by its corresponding frequency distribution function $F(x)$. The value of $F(x)$ is the relative frequency with which the number appears in the collection of data [18].

$$F(x) \equiv \frac{number\ of\ occurrences\ of\ the\ value x}{number\ of\ measurements\ (-N)}. \tag{3}$$

The distribution is automatically normalized, that is,

$$\sum_{x=0}^{\infty} F(x) = 1. \tag{4}$$

Since the specific sequence of the numbers was not emphasized, the whole data distribution function $F(x)$ represents all the information in the original data set.

Using the data distribution function $F(x)$ to calculate the mean $\bar{x}$,

$$\bar{x} = \sum_{x=0} xF(x). \tag{5}$$

When the mean value $\bar{x}$ is “large,” the Poisson distribution can be approximated by the Gaussian distribution (also called the normal distribution). The equation describing the Gaussian distribution is

$$P(x) = \frac{1}{\sqrt{2\pi\bar{x}}} \exp\left(-\frac{(x-\bar{x})^2}{2\bar{x}}\right) \tag{6}$$

$P(x)$ = predicted probability distribution function of finding exactly x.

$\bar{x}$ = mean value.

The probability is peaked at a mean value, which is the true value for the measurement. The probability that a measurement will be “close to” mean value, $\bar{x}$ depends on the relative width, or dispersion of the frequency distribution curve [18,19,20,21].

3. Results and Discussion

Table 1. Data Distribution Function for Dose Rate (DR) in Air

Group Code	Location Code	Data $x(\mu Sv/h)$	Frequency (F)	Fx $(\mu Sv/h)$	Frequency Distribution Function, $F(x)$	$xF(x)$ $(\mu Sv/h)$
G1	A8	0.16	1	0.16	$F(0.16) = \frac{1}{166} = 0.006024$	0.000964
G2	A166	0.17	1	0.17	$F(0.17) = \frac{1}{166} = 0.006024$	0.001024
G3	A87, A55, A112	0.18	3	0.54	$F(0.18) = \frac{3}{166} = 0.018072$	0.003253
G4	A2, A10, A26, A54, A125	0.19	5	0.95	$F(0.19) = \frac{5}{166} = 0.030120$	0.005723
G5	A132, A135, A127, A14, A144, A5, A165	0.20	7	1.40	$F(0.20) = \frac{7}{166} = 0.042169$	0.008434
G6	A69, A51, A136, A88, A97	0.21	5	1.05	$F(0.21) = \frac{5}{166} = 0.030120$	0.006325
G7	A53, A99, A122, A13, A134, A61, A70, A9, A129, A37, A1, A50, A60, A124, A164	0.22	15	3.30	$F(0.22) = \frac{15}{166} = 0.090361$	0.019879
G8	A116, A77, A128, A71, A85, A36, A40, A63, A95	0.23	9	2.07	$F(0.23) = \frac{9}{166} = 0.054217$	0.012470
G9	A143, A6, A47, A118, A120, A4, A7, A25, A68, A89, A119, A123, A162, A163	0.24	14	3.36	$F(0.24) = \frac{14}{166} = 0.084337$	0.020241
G10	A98, A65, A109, A44, A92, A101, A141, A30, A52, A90, A33, A24, A67, A29, A78, A148,	0.25	21	5.25	$F(0.25) = \frac{21}{166} = 0.126506$	0.031626

Group Code	Location Code	Data $x(\mu Sv/h)$	Frequency (F)	$Fx\ (\mu Sv/h)$	Frequency Distribution Function, $F(x)$	$xF(x)$ $(\mu Sv/h)$
G11	A139, A23, A114, A130, A146 A22, A57, A91, A152, A76, A93, A138, A45, A113, A145, A38, A80, A100, A31, A126	0.26	15	3.90	$F(0.26)=\frac{15}{166}=0.090361$	0.023494
G12	A11, A151, A17, A58, A81, A107, A131, A142, A42, A79, A154, A35, A46, A75, A96, A133, A140	0.27	17	4.59	$F(0.27)=\frac{17}{166}=0.102410$	0.027651
G13	A19, A104, A150, A3, A12, A72, A159, A16, A62, A121, A66, A74, A149, A158, A160	0.28	15	4.20	$F(0.28)=\frac{15}{166}=0.090361$	0.025301
G14	A56, A137, A155, A103, A34, A73, A110, A27, A106, A39, A86, A32, A84, A105, A157, A108, A161	0.29	17	4.93	$F(0.29)=\frac{17}{166}=0.102410$	0.029699
G15	A41, A48, A153, A115, A18, A147	0.30	6	1.80	$F(0.30)=\frac{6}{166}=0.036145$	0.010843
G16	A59, A64, A43, A111, A49, A117, A28, A15	0.31	8	2.48	$F(0.31)=\frac{8}{166}=0.048193$	0.014940
G17	A20, A83	0.32	2	0.64	$F(0.32)=\frac{2}{166}=0.012048$	0.003855
G18	A82	0.33	1	0.33	$F(0.33)=\frac{1}{166}=0.006024$	0.001988
G19	A94	0.34	1	0.34	$F(0.34)=\frac{1}{166}=0.006024$	0.002048
G20	A102	0.36	1	0.36	$F(0.36)=\frac{1}{166}=0.006024$	0.002169
G21	A21, A156	0.37	2	0.74	$F(0.37)=\frac{2}{166}=0.012048$	0.004458
			$\sum F=166$	$\sum Fx=42.56$	$\sum_{x=0}^{\infty}F(x)=1.000000$	$\sum_{x=0}^{\infty}xF(x)=0.256385$

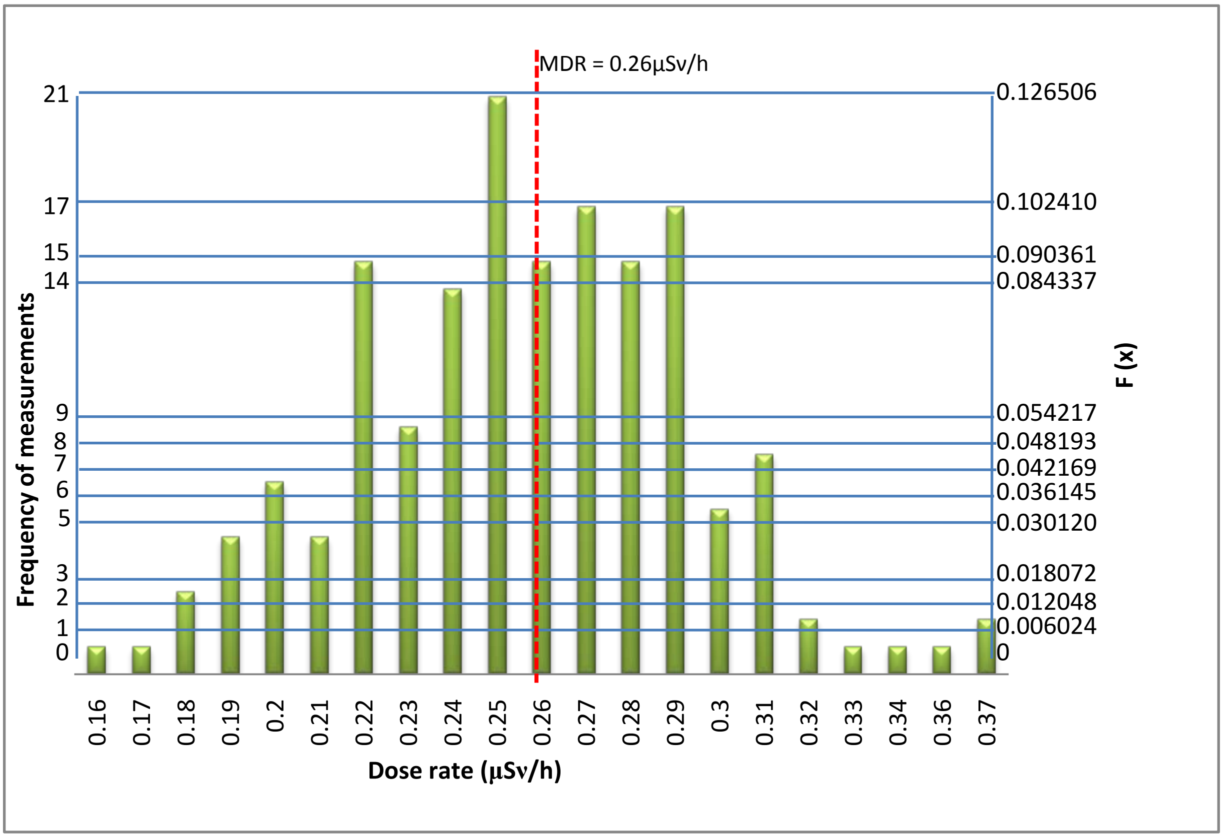

Figure 1. A plot of the data distribution function given in Table 1

Table 2. Fluctuation in Data Distribution Function for Dose Rate (DR) in Air

Group Code	Location Code	Data $x(\mu Sv/h)$	Frequency (F)	$Fx\ (\mu Sv/h)$	Frequency Distribution Function, $F(x)$	$xF(x)$ $(\mu Sv/h)$
B1	A8, A25, A33, A38, A48, A68, A74, A80, A95, A98, A103, A129, A150, A152, A158, A112, A117, A166	0.01	18	0.18	$F(0.01)=\frac{18}{166}=$ 0.108434	0.001084
B2	A1, A2, A3, A4, A9, A10, A13, A15, A17, A20, A28, A29, A30, A31, A35, A37, A42, A43, A44, A45, A47, A49, A57, A61, A62, A63, A64, A65, A66, A67, A69, A76, A83, A84, A85, A87, A92, A96, A97, A99, A100, A101, A102, A105, A106, A107, A108, A113, A116, A118, A121, A123, A125, A127, A130, A131, A132, A135, A145, A146, A151, A154, A155, A159, A160, A163, A164	0.02	67	1.34	$F(0.02)=\frac{67}{166}=$ 0.403614	0.008072
B3	A5, A7, A11, A14, A18, A19, A22, A26, A34, A36, A39, A40, A41, A46, A51, A53, A56, A58, A59, A71, A77, A78, A79, A82, A88, A89, A90, A91, A93, A104, A109, A111, A115, A119, A120, A126, A128, A133, A134, A141, A142, A143, A144, A147, A149, A156, A161, A162, A165	0.03	49	1.47	$F(0.03)=\frac{49}{166}=$ 0.295181	0.008855
B4	A6, A12, A21, A23, A24, A27, A50, A54, A60, A70, A72, A73, A81, A86, A94, A110, A114, A136, A137	0.04	19	0.76	$F(0.04)=\frac{19}{166}=$ 0.114458	0.004578
B5	A32, A52, A55, A75, A124, A138, A139, A140, A157	0.05	9	0.45	$F(0.05)=\frac{9}{166}=$ 0.054217	0.002711
B6	A16, A148, A153	0.06	3	0.18	$F(0.06)=\frac{3}{166}=$ 0.018072	0.001084
B7	A122	0.07	1	0.07	$F(0.07)=\frac{1}{166}=$ 0.006024	0.000422
			$\sum F=166$	$\sum Fx=4.45$	$\sum_{x=0}^{\infty} F(x)=1.000000$	$\sum_{x=0}^{\infty} xF(x)=0.026806$

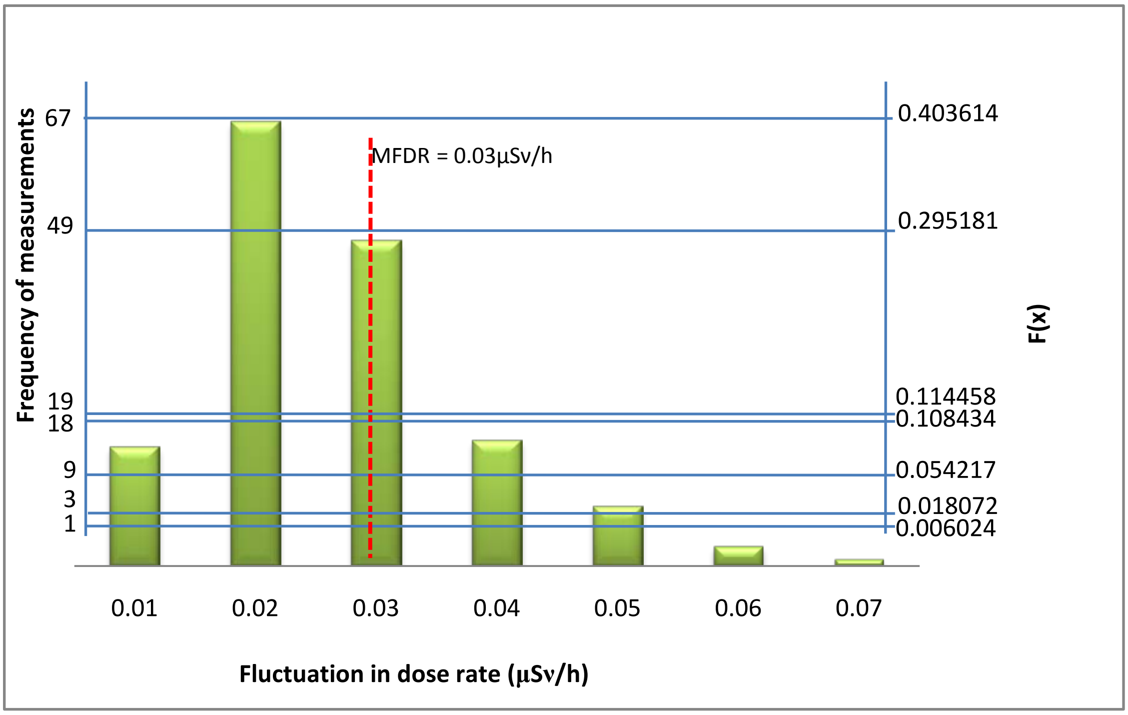

Figure 2. A plot of the data distribution function given in Table 2

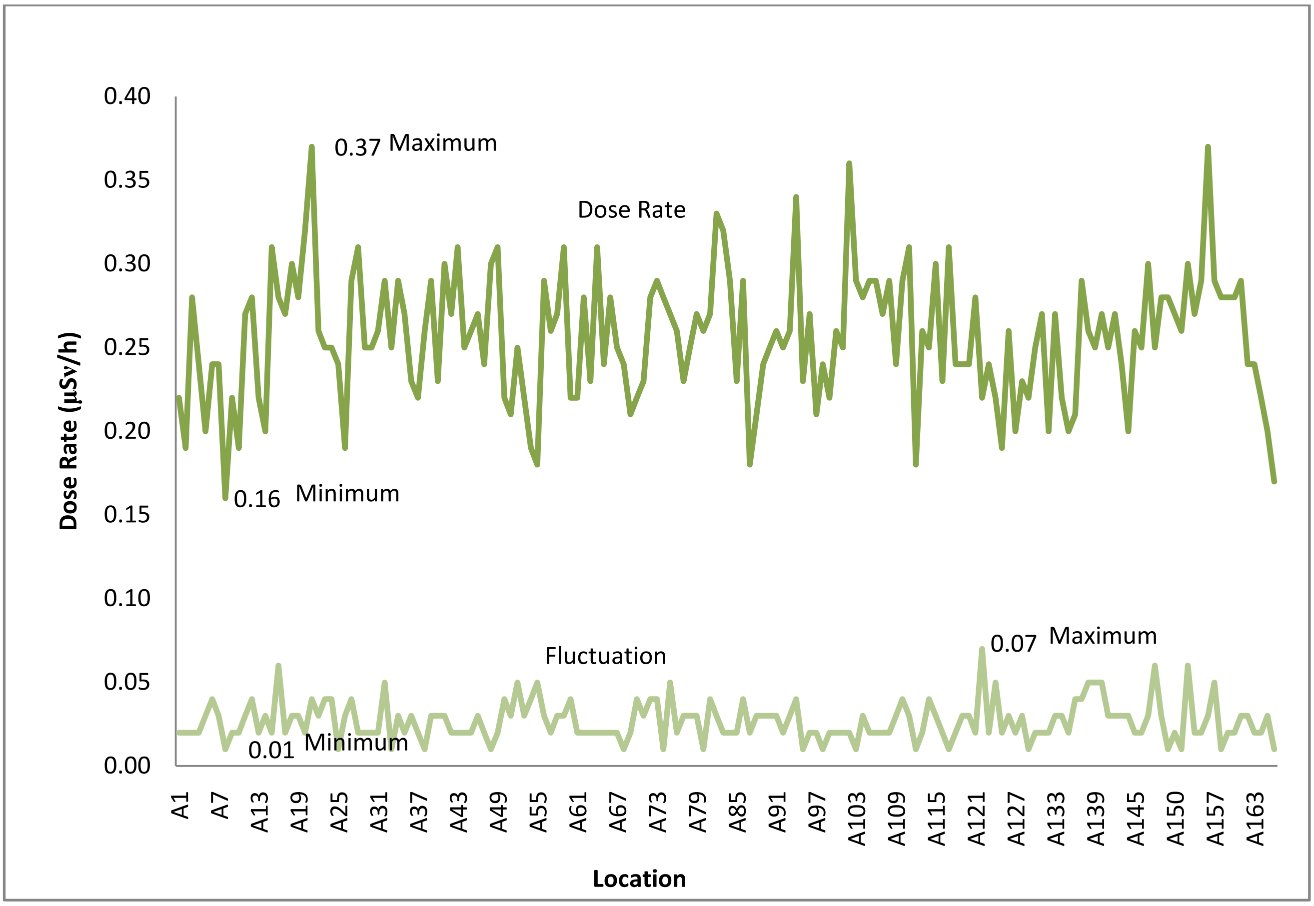

Figure 3. Trends of dose rate per location

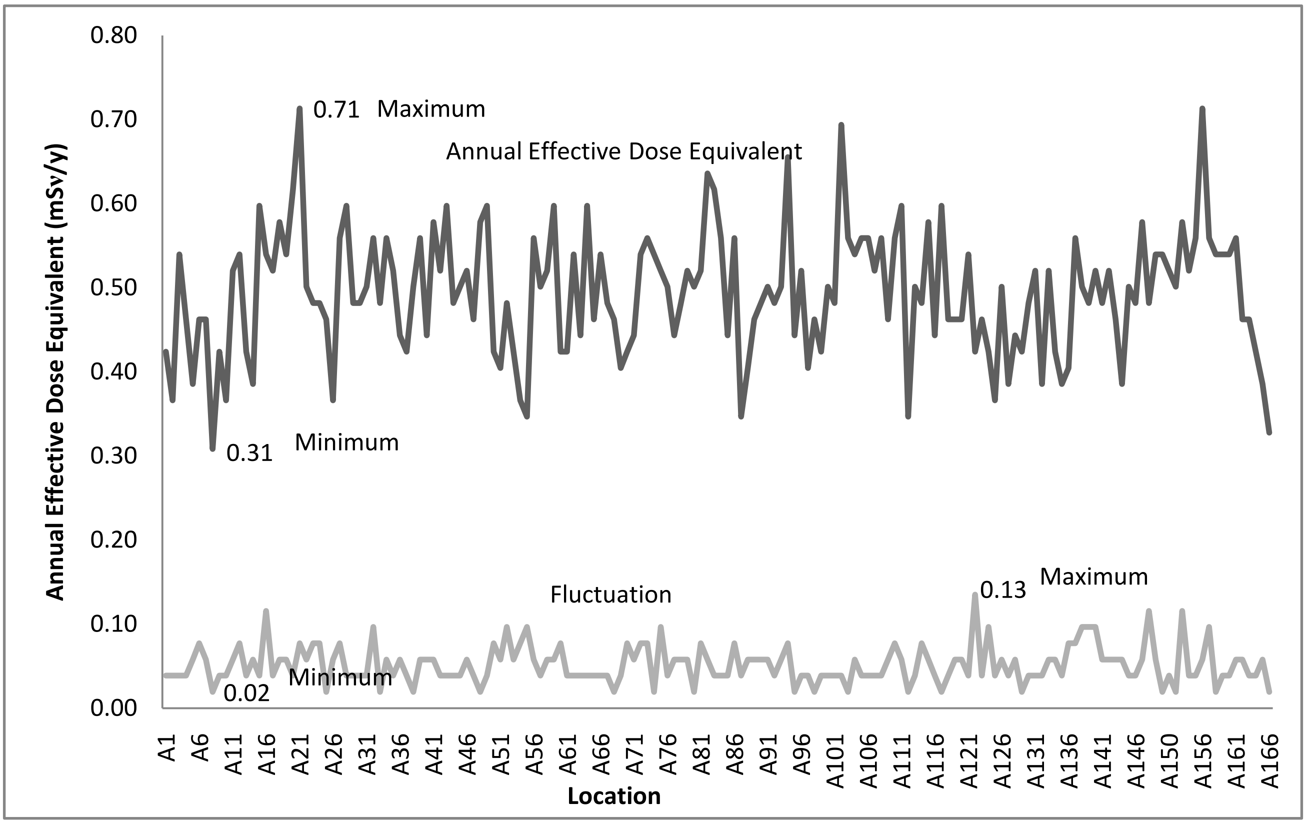

Figure 4. Trends of annual effective dose equivalent per location

The experimental mean is given by Equation (5) and is the value about which the distribution is centred. Therefore, the Mean Dose Rate (MDR) and its Mean Fluctuation in Dose Rate (MFDR) in air is $0.26 \pm 0.03\ \mu Sv/h$.

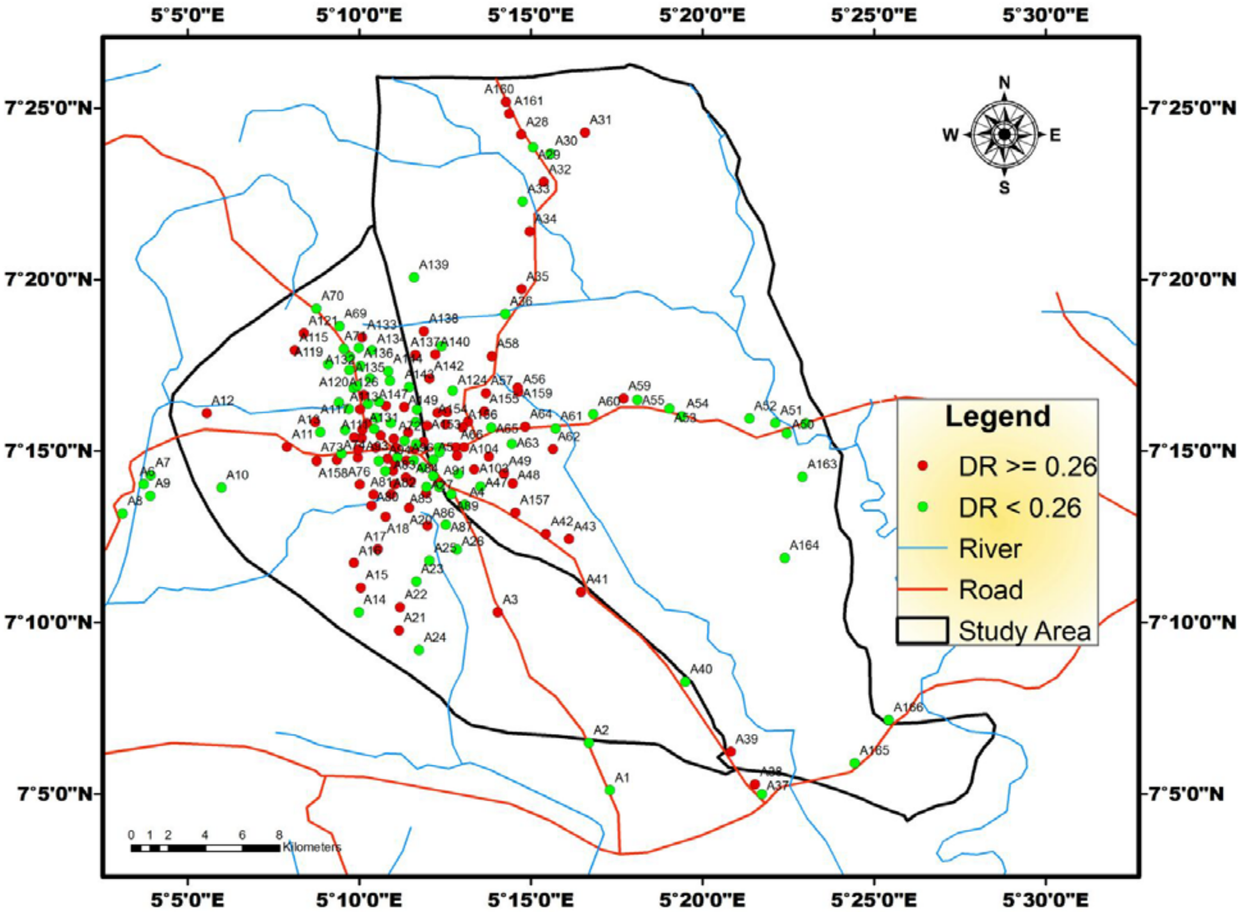

Figure 5. Sample points showing DR greater than or less than the $0.26\mu Sv$ average [22]

Table 3. Summary of Dose Rate around Sample Points

	Sample Points	Minimum Value	Maximum Value	Mean Value
Dose Rate, DR	166	$0.16\ \mu Sv/h$	$0.37\ \mu Sv/h$	$0.26\ \mu Sv/h$
DR >= 0.26 $\mu Sv/h$	85	$0.26\ \mu Sv/h$	$0.37\ \mu Sv/h$	$0.29\ \mu Sv/h$
DR< 0.26 $\mu Sv/h$	81	$0.16\ \mu Sv/h$	$0.25\ \mu Sv/h$	$0.22\ \mu Sv/h$

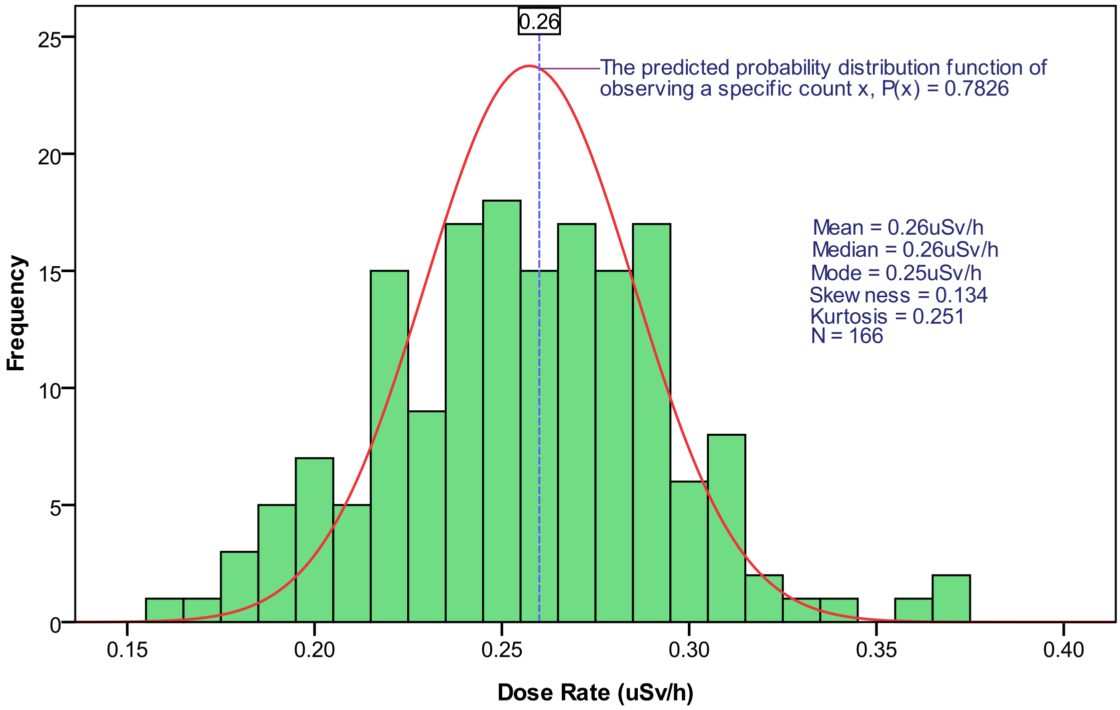

Figure 6. Histogram of Dose Rate, DR

Table 4. Descriptive Statistics

	N	Mean	Median	Mode	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Dose Rate (μSv/h)	166	0.26	0.26	0.25	0.03838	0.134	0.188	0.251	0.375
Valid N (listwise)	166								

Table 5. Annual Effective Dose Equivalent for Different Groups

Different Groups	Period Outdoor per Day	Occupancy Factor (O.F)	Work Days per Year	Work-Free Days per Year	$AEDE_{313}$ @ O.F a, b, c, d, e (mSv/y)	$AEDE_{52}$ @ O.F 0.22 (mSv/y)	$FAEDE_{313}$ @ O.F a, b, c, d, e (mSv/y)	$FAEDE_{52}$ @ O.F 0.22 (mSv/y)	$AEDE_{313+52}$ (mSv/y)	$FAEDE_{313+52}$ (mSv/y)
Commercial Cyclist	$14\frac{9}{10}hrs$	a = 0.62	313	52	1.21	0.07	0.14	0.01	1.28	0.15
Traffic Warden	7 hrs	b = 0.29	313	52	0.57	0.07	0.06	0.01	0.64	0.07
Huckster / Hawker	$9\frac{4}{5}hrs$	c = 0.41	313	52	0.80	0.07	0.09	0.01	0.87	0.10
Brick Layer / Vulcanizer	$9\frac{4}{5}hrs$	d = 0.41	313	52	0.80	0.07	0.09	0.01	0.87	0.10
General Public	$5\frac{1}{4}hrs$	e = 0.22	313	52	0.43	0.07	0.05	0.01	0.50	0.06
Continuous AEDE	24hrs	1	365		$AEDE_{365}$ 2.28 @ O.F 1		$FAEDE_{365}$ 0.26 @ O.F 1		2.28	0.26

$$AEDE = MDR\left(7512 \times O.F_{a,b,c,d,e} + 1248 \times O.F_{0.22}\right) \times 10^{-3} mSv/y \tag{7}$$

$$FAEDE = MFDR\left(7512 \times O.F_{a,b,c,d,e} + 1248 \times O.F_{0.22}\right) \times 10^{-3} mSv/y \tag{8}$$

where; MDR 0.26 $\mu Sv/h$ is the mean dose rate of all data obtained in Akure North and South,
MFDR 0.03 $\mu Sv/h$ is the mean fluctuation in dose rate of all data obtained in Akure North and South,
FAEDE is the fluctuation in Annual Effective Dose Equivalent.

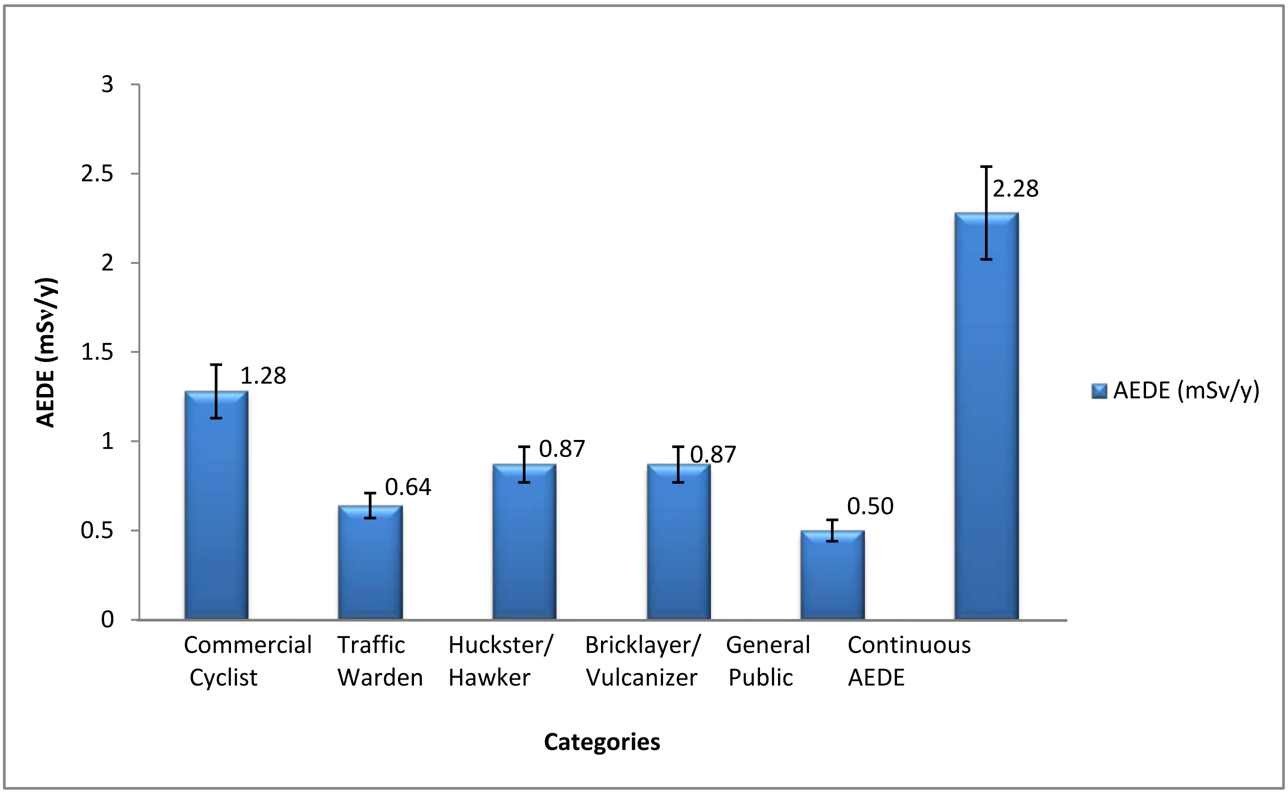

Figure 7. A plot of Annual Effective Dose Equivalent for Different Groups

Consider the groups in Table 5 amongst the members of the general public. The study believes they are more exposed to background radiation than other members of the general public. Equations (7) and (8) were used to calculate their respective AEDE and FAEDE in millisievert per year.

The least possible Dose Rate, DR of $0.16 \pm 0.01\,\mu Sv/h$ was recorded at coordinate 7.21972°N and 5.05168°E, with location code A8. The peak dose rate was recorded at location A21 with coordinate 7.16287°N and 5.18586°E; and location A156 with coordinate 7.26164°N and 5.21679°E, the two sites recorded DR $0.37 \pm 0.04\,\mu Sv/h$ and $0.37 \pm 0.03\,\mu Sv/h$, respectively. Figure 3 and Figure 4 above show the maximum and minimum DR and AEDE, including its associated internal fluctuations. The AEDE for the 166 sample points range from $0.31 \pm 0.02\,mSv/y$ - $0.71 \pm 0.08\,mSv/y$ with mean AEDE $0.50 \pm 0.06\,mSv/y$.

Characterization of data, a section under counting statistics was used to estimate the mean dose rate and fluctuation in mean dose rate of Akure as shown in Table 1 and Table 2. The uniqueness of this method is that it helps reduce the volume of data through data-group; gives objective classification of any data; and shows the mean around the data distribution chart. The plots in Figure 1 and Figure 2 simplify the data distribution function given in Table 1 and Table 2 by showing the relationship which exists in the distribution. Since the specific sequence of the numbers in data set doesn't matter, the complete data distribution function $F(x)$ will represent all the information contained in the original data set, and therefore helps summarize the entire data [18].

Furthermore, it is also possible to derive another parameter, called the sample variance, which will serve to quantify the amount of internal fluctuation in the data set, however, this research does not analyse sample variance from the 166 sample points altogether, but the fluctuation (standard deviation) in data recorded at each sample point; mean values are calculated. Therefore, the organization of real set of experimental data follows that: The frequency distribution function $F(x)$ gives complete description of any set of data, and the property of $F(x)$ of interest is the experimental mean.

Out of the total 166 sample areas, 85 points recorded dose rate greater than or equal $0.26\mu Sv$ mean dose rate of Akure; these represent 51.2% of all the sample points. And the other 81 points (48.8%) are areas where dose rate less than $0.26\mu Sv$ mean ambient radiation of Akure, Table 3. This was depicted in the geographical map of Akure as shown in Figure 5, some sample points marked red (i.e. $DR \geq 0.26\mu Sv$) while other points marked green (i.e. $DR < 0.26\mu Sv$). The skewness and kurtosis of DR distribution was determined via statistical models- skewness of 0.134 and standard error 0.188 shows that the AR distribution set in this study is 13% skewed, since the mean and median are identical the distribution is considered symmetric and approximately normal distribution. With kurtosis 0.251 and standard error 0.375, this is slightly leptokurtic: its peak is just a bit higher and sharper, and its tails are slightly longer and fatter than the peak of a normal distribution, Table 4 and Figure 6. The kurtosis is the statistical gap between the distribution model attaining normal distribution and predicted probability, P(x) close to 1.

The graph of DR and AEDE, regardless of scale and interval have similar steps, trends and shapes; this is because the same exposure period of $8760\,h/y$ and Occupancy factor 0.22 was used for all ambient radiation data input DR to compute AEDE as reported by UNSCEAR, Figure 3 and Figure 4 [11]. Figure 3 illustrates the graph of dose rates that were measured in air as shown in Appendix A, while Figure 4 shows the graph of AEDE for sampled points; the AEDE was calculated using equation 9. Although all calculated AEDE was not captured in this study but Figure 4 help denote the statistical range (i.e. minimum and maximum) of all computed AEDE. The difference between the internal fluctuation (standard deviation) of all dose rates in Table 1 and the collective average of individual fluctuation at each sample point of six logs of dose rate in Table 2 is 0.01; this is an indication of consistency and reliability of the data set.

The fraction of exposure experience by any member of the general public due to outdoor background radiation is usually determined by individual exposure period, which can be calculated by using occupancy factor, the use of other quantities will depend on the unit of the measured dose rate. The Occupancy Factor (O.F) is the proportion of the total time during which an individual is exposed to a radiation field. In the tropical environment such as Akure, Southwestern Nigeria, outdoor occupancy factors of 0.30 and 0.22 have been estimated for rural and urban dwellers, respectively [23]. However, some groups amongst the general public, such as commercial cyclist, traffic warden, huckster/hawker, bricklayer, vulcanizer, etc, whose nature of work have necessitated their exposure rate to varying outdoor radiation distribution in Akure will receive more doses of ionising radiation than other members of the public, Figure 7. The exposure of these groups to outdoor background radiation was captured in Table 5, and their expected AEDE and FAEDE was calculated using equations 7 and 8, which was compared with the general public as shown in Figure 7. Estimation of annual outdoor effective dose equivalent (AEDE) received by members of the public, is given by:

$$AEDE\left(mSv/y\right) = Dose\ Rate\left(\mu Sv/h\right) \times 24\left(h\right) \times 365\left(days\right) \times 0.22\left(O.F\right) \times 10^{-3} \quad (9)$$

where Occupancy Factor $(O.F) = 0.22$.

The mean outdoor exposure AEDE for Akure North and South Local Government Areas of Ondo State is $0.50 \pm 0.06\,mSv/y$; the value is within the range of values obtained by other researchers who have carried out similar environmental radiation assessment in Southwestern Nigeria [24,25], which is normal for public exposure to background radiation [2,26,27]. The result of the characterization method was compared with the result of the general method in equation 2; the MDR and MFDR have the difference of 0.00018 and 0.000001 respectively. The data in Appendix A is comparable with measurements received by other renowned researchers who have used different equipments, measuring units, and techniques to perform radiation assessment in air, soil, and vegetable in Southwestern Nigeria, although, there are slight variations which is primarily due to the geology of the sample area, however, the estimated mean of this study is in their range of value(s) [24,25,28,29]. The low-level radiation dose receive by the members of the general public in Akure and its environs is considered beneficial for human health [30] and act as a stimulant to accelerate DNA damage repair and enhance immune responses [31].

4. Conclusion

In this study, characterization of data technique was used to show that any set of data can be completely described by its frequency distribution function $F(x)$; the distribution function represents all the information contained in the original background radiation data set. The data set is considered a normal distribution being approximately symmetric. The dose rate and its internal fluctuation range between $0.16 \pm 0.01\,\mu Sv/h$ - $0.37 \pm 0.04\,\mu Sv/h$ in air, and AEDE between $0.31 \pm 0.02\,mSv/y$ - $0.71 \pm 0.08\,mSv/y$; the estimated mean outdoor AEDE $0.50\,mSv$ for members of the general public in Akure is below the UNSCEAR and ICRP recommended $1\,mSv$ annual exposure dose rate. The environmental radiation of the study area, as at the time of its assessment and evaluation poses no significant threat which may as a result lead to certain health challenges that could be ascribed to radiation. All the estimated AEDE from measured dose rates at the chosen locations have values far lower than the $100mSv$ limit of admissible low-level radiation.

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Appendix A. Background Radiation Data across Akure, Ondo State

Location Code	Dose Rate $(\mu Sv/h)$	Location Code	Dose Rate $(\mu Sv/h)$	Location Code	Dose Rate $(\mu Sv/h)$	Location Code	Dose Rate $(\mu Sv/h)$
A1	0.22±0.02	A43	0.31±0.02	A85	0.23±0.02	A127	0.20±0.02
A2	0.19±0.02	A44	0.25±0.02	A86	0.29±0.04	A128	0.23±0.03
A3	0.28±0.02	A45	0.26±0.02	A87	0.18±0.02	A129	0.22±0.01
A4	0.24±0.02	A46	0.27±0.03	A88	0.21±0.03	A130	0.25±0.02
A5	0.20±0.03	A47	0.24±0.02	A89	0.24±0.03	A131	0.27±0.02
A6	0.24±0.04	A48	0.30±0.01	A90	0.25±0.03	A132	0.20±0.02
A7	0.24±0.03	A49	0.31±0.02	A91	0.26±0.03	A133	0.27±0.03
A8	0.16±0.01	A50	0.22±0.04	A92	0.25±0.02	A134	0.22±0.03
A9	0.22±0.02	A51	0.21±0.03	A93	0.26±0.03	A135	0.20±0.02
A10	0.19±0.02	A52	0.25±0.05	A94	0.34±0.04	A136	0.21±0.04
A11	0.27±0.03	A53	0.22±0.03	A95	0.23±0.01	A137	0.29±0.04
A12	0.28±0.04	A54	0.19±0.04	A96	0.27±0.02	A138	0.26±0.05
A13	0.22±0.02	A55	0.18±0.05	A97	0.21±0.02	A139	0.25±0.05
A14	0.20±0.03	A56	0.29±0.03	A98	0.24±0.01	A140	0.27±0.05
A15	0.31±0.02	A57	0.26±0.02	A99	0.22±0.02	A141	0.25±0.03
A16	0.28±0.06	A58	0.27±0.03	A100	0.26±0.02	A142	0.27±0.03
A17	0.27±0.02	A59	0.31±0.03	A101	0.25±0.02	A143	0.24±0.03
A18	0.30±0.03	A60	0.22±0.04	A102	0.36±0.02	A144	0.20±0.03
A19	0.28±0.03	A61	0.22±0.02	A103	0.29±0.01	A145	0.26±0.02
A20	0.32±0.02	A62	0.28±0.02	A104	0.28±0.03	A146	0.25±0.02
A21	0.37±0.04	A63	0.23±0.02	A105	0.29±0.02	A147	0.30±0.03
A22	0.26±0.03	A64	0.31±0.02	A106	0.29±0.02	A148	0.25±0.06
A23	0.25±0.04	A65	0.24±0.02	A107	0.27±0.02	A149	0.28±0.03
A24	0.25±0.04	A66	0.28±0.02	A108	0.29±0.02	A150	0.28±0.01
A25	0.24±0.01	A67	0.25±0.02	A109	0.24±0.03	A151	0.27±0.02
A26	0.19±0.03	A68	0.24±0.01	A110	0.29±0.04	A152	0.26±0.01
A27	0.29±0.04	A69	0.21±0.02	A111	0.31±0.03	A153	0.30±0.06
A28	0.31±0.02	A70	0.22±0.04	A112	0.18±0.01	A154	0.27±0.02
A29	0.25±0.02	A71	0.23±0.03	A113	0.26±0.02	A155	0.29±0.02
A30	0.25±0.02	A72	0.28±0.04	A114	0.25±0.04	A156	0.37±0.03
A31	0.26±0.02	A73	0.29±0.04	A115	0.30±0.03	A157	0.29±0.05
A32	0.29±0.05	A74	0.28±0.01	A116	0.23±0.02	A158	0.28±0.01
A33	0.25±0.01	A75	0.27±0.05	A117	0.31±0.01	A159	0.28±0.02
A34	0.29±0.03	A76	0.26±0.02	A118	0.24±0.02	A160	0.28±0.02
A35	0.27±0.02	A77	0.23±0.03	A119	0.24±0.03	A161	0.29±0.03
A36	0.23±0.03	A78	0.25±0.03	A120	0.24±0.03	A162	0.24±0.03
A37	0.22±0.02	A79	0.27±0.03	A121	0.28±0.02	A163	0.24±0.02
A38	0.26±0.01	A80	0.26±0.01	A122	0.22±0.07	A164	0.22±0.02
A39	0.29±0.03	A81	0.27±0.04	A123	0.24±0.02	A165	0.20±0.03
A40	0.23±0.03	A82	0.33±0.03	A124	0.22±0.05	A166	0.17±0.01
A41	0.30±0.03	A83	0.32±0.02	A125	0.19±0.02		
A42	0.27±0.02	A84	0.29±0.02	A126	0.26±0.03		