Onyejike *et al.*
Egyptian Journal of Forensic Sciences (2022) 12:29
https://doi.org/10.1186/s41935-022-00281-7

Egyptian Journal of Forensic Sciences

ORIGINAL ARTICLE

Open Access

Factors that influence decomposition timeline estimation in Anambra state, Nigeria

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Abstract

Background: Decomposition timeline estimation is one of the key tools used in homicide cases to unravel the mystery behind the time of death of a victim. Decomposition timeline is the time take for a carcass to decay from time of death to skeletonization. Several events occur during this timeline. These events are controlled by certain autolytic and putrefactive factors. Other factors also play a role in the determining the rate of decomposition. However, putrefactive factors aid the eventual breakdown of a carcass. The putrefactive factors are flora activities, fauna activities, soil physicochemical properties, nature of soil, and climatic factors. This study aimed at investigating the factors that play vital role in the estimation of decomposition timeline of *Sus scrofa domestica* placed on the soil surface in Anambra state, Nigeria.

Results: Findings from the study showed that the factors that statistically ($p < .05$) influenced the rate of decomposition includes atmospheric temperature, humidity, precipitation, and soil salinity. ANOVA demonstrated that the effect of the 6 predictors was significant for predicting time of decomposition F (6, 48) = 771.118, $p < .001$. There is a high degree of correlation between the predictors and time, $R = .995$. This prediction model can explain 9711.839 variables of all possible factors of decomposition but cannot explain 88.161 variables. Result from the prediction model for rate of decomposition showed a high degree of correlation between the predictors and rate of decomposition, $R = .986$. This model can explain 2438.799 variations in the variables of all possible factors of decomposition but cannot explain 70.334 variations in the variables.

Conclusions: The factors that affect the rate of decomposition include atmospheric temperature, humidity, precipitation, and soil salinity. The prediction model for time and rate of decomposition has a high goodness of fit. The six factors identified in this study should be considered when predicting time and rate of decomposition, so as to ensure accuracy. This implies that daily atmospheric temperature should not be the only data used for predicting the rate and time of decomposition in Anambra state, Nigeria.

Keywords: Post mortem interval estimation, Forensic taphonomy, Factors of decomposition timeline, Criminal investigation

Background

In recent times, there have been many accounts of clandestine deaths in Ekwulumili of Anambra State with no substantive proof of the actual time of death, and postmortem interval has presented to be the investigative limiting factor, as informed by the local security personnel. There have been several reports in the media on the discovery of clandestine deaths but without substantive investigation or outcome. Crime is on the increase on

This research article is an original article. It has not been submitted for review to another journal and has not been published in any journal or conference proceedings.

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daily basis in Nigeria and without proper detailed documentation on post-mortem interval; alibis cannot be accurately confirmed and criminals will not be accurately convicted.

The estimation of post-mortem interval in Nigeria is a problem that has plagued law enforcements, medical examiners, and forensic anthropologists for years. In Nigeria and Africa, forensic taphonomy is an emerging field, and very little has been researched and documented on timeline of decomposition in Nigeria. Most of the studies on decomposition timeline estimation focused on accumulated daily atmospheric temperature and insect/fly succession patterns as the only factors that influence decomposition rate (Comstock et al. 2015; Gelderman et al. 2017; Marais-Werner et al. 2018; McQuinn 2011; Megyesi et al. 2005; Sukchit et al. 2015; Tumer et al. 2013; Pope 2010).

Decomposition rates are influenced by climatic factors, and as such decomposition timeline vary across different climatic regions. Anambra state is one of the Nigerian states found in the Tropical rainforest vegetation of Nigeria. This vegetation is characterized by tall trees (30 to 70m), high rainfall, high humidity, and a varying temperature across the rainy and dry seasons. It experiences a double rainfall maximum characterised by two high rainfall peaks, with a short dry season. The type of soil in this vegetation varies from loamy, sandy, and clayey to humus (Ibenegbu 2018).

This study was carried out to investigate the factors that influence the decomposition timeline estimation in Anambra state using *Sus scrofa domestica*. It also developed a prediction model for estimating time of death for *Sus scrofa domestica* on soil surface using five factors of decomposition.

Methods

Materials for the study

The materials used for this study include digital indoor/outdoor thermo-hygrometer and digital body thermometer; digital camera, surgical hand gloves, rubber gloves, nose masks, safety rubber boots, laboratory coat, steel tape, and stadiometer.

Location of the study

The location was situated in a private fenced rural settlement located at the uplands of Enugwu community, Umudim village, Ekwulumili, in Nnewi South Local Government Area of Anambra State, Nigeria.

Animal acquisition

The animals for the study were adult *Sus scrofa domestica* weighing 40kg. They were procured from a pig farm located very close to the research location.

Sampling technique/method

The sampling technique used for this study was stratified random sampling. This was achieved via the assistance of the farmer. The farmer identified all matured animals (6 or 7 months in age) and separated the males from the females. The male group constituted 22 animals whereas the female constituted 18 animals. Animals in each group were numbered nominally via a neck-tag. Same numbering was assigned and ballots were randomly assigned into groups. Two domestic pigs (*Sus scrofa domestica)* were used for this experimental field study because of strict animal protection index laws on animal rights in Nigeria.

Study design

This study was a prospective cross-sectional experimental field study. Data were collected by the researchers by using standardized quantifiable methods such as daily atmospheric temperature, humidity, precipitation, soil temperature, and soil salinity, and the daily quantifiable decompositional changes on the animals were scored using modified Megyesi et al. (2005) scoring method (template).

Animal gender and body statistics (recumbent length, pre-mortem weight, and waist and chest circumference) were recorded. The pre-mortem and post-mortem rectal (body) temperatures of all the pigs were documented. The animals were sacrificed by strangulation so as ensure its forensic importance. Animal death was confirmed when no heart beat was recorded using stethoscope and observation of the pupillary reflex. The exact date and time of death was recorded. The early signs of decomposition (algor, pallor, livor, and rigor mortises) and marking autolysis were documented. The early signs of decomposition were monitored in a controlled environment where the room temperature was taken note of. The atmospheric temperature, humidity, precipitation, and soil temperature were recorded twice daily (morning and afternoon). The soil pH was recorded daily. The soil analysis was conducted to ascertain compounds that alter decomposition rates.

Animals were immediately moved to the research site at the end of the 8 h post mortem observation period. The decompositional changes were scored daily till the 49th day. The perimeter of the forensic site (9.39m in length and 3.38m in width) was secured and marked clearly with forensic tape and sign post to avoid any human interference.

Method of data collection for daily climate readings

The thermo-hygrometer was placed in a room (shed), and the wire plug (containing the mercury knob) was extended outside the room via its window. The liquid crystal display (LCD) of the equipment was taken far away from sun rays; then, the temperature scale was set to Celsius. The time was also set on the equipment to the Greenwich meridian time (GMT) of our location to ensure accuracy in documenting the readings. The lowest atmospheric temperature of the day was recorded between 3am and 7am, and the highest atmospheric temperature of the day recorded between 11am and 3pm. The lowest humidity of the day was recorded between 11am and 3pm, and the highest humidity of the day recorded between 3am and 7am.

The rain gauge display was placed in a dry area free of dirt, dust, and sun rays. The display and rain gauge must be within 30m (100ft) of each other. The rain gauge was installed at 0.9m above the ground on a flat level surface so as maximize wireless range communication and to ensure accurate rain measurement. In addition, the display and rain gauge were placed away from large metallic items, thick walls, metal surfaces, or other objects that may limit wireless communication, and both units were placed at least 0.9m away from electronic devices (television, computer, microwave, radio, etc.). We ensured that the rain gauge was not placed in a low spot that could become flooded or in an area where there are obstructions above it. We also ensured that the rain gauge base is fastened on a sturdy surface with screws using hand tools. At the completion of the installation, the rain gauge synchronized with the display and took daily readings daily automatically.

Method of data collection for soil salinity and temperature

The pH/°C yellow selector switch on the back of the instrument was pushed to either select pH or temperature position. The probe was vertically inserted into the soil and reading recorded. We ensured that the probe was not inserted too deep to avoid damage to the roots of the plant. We also ensured that we took multiple measurements to get the exact value needed. We recorded the lowest soil temperature of the day between 3am and 7am and also the highest soil temperature of the day between 11am and 3pm.

Soil analysis methodology

Reagents

The reagents include distilled water and buffer/standard solutions of salinity. These buffers are prepared by dissolving standard buffer tablets or by diluting buffer concentrations as instructed by the suppliers. Distilled water free of CO_2 must be used.

Procedure

Put salinity in H_2O (1:1 soil to water ratio) to 20gm of air-dried soil (passed through 2-mm sieve) in a 50-ml beaker, add 20 ml of distilled water, and allow to stand for 30 min with occasional stirring with a glass rod. The electrodes were inserted into the buffer solutions having salinity values close to that expected of the soil and meter needle adjusted to read the buffer salinity. We took great care when inserting the electrodes into the solution as the electrodes are fragile and can easily break. They should extend at least 2cm into the solution. The electrodes were removed, rinsed with distilled water, and inserted into soil suspensions (1), (2), and (3) (with the calomel electrode into the clear supernatant solution and the glass electrode into the sediment if the electrodes are supplied separately), and the NaCl meter readings were recorded to the nearest 0.05 unit (electrodes should be rinsed between each reading). At the end of the experiment, the electrodes were cleaned with distilled water and a beaker of distilled water lowered to them.

Experimental precautions

We ensured that the experimental animals were healthy, and the food they took 2 weeks before the experiment did not contain any poisonous or alcoholic substances. Animals were procured from nearby farms to the research facility to ensure that there was no change in body thermal condition. Animals were procured very early in the morning between 5 and 6am and allowed to rest and acclimatize for a period of 1 h. All instruments were cleaned with methylated spirit and cotton wool to ensure accuracy in data collection.

Statistical tool and method of data analysis

Data were analyzed using the statistical package for social science (SPSS) IBM series version 25. The data were descriptively and inferentially analyzed and represented in tables. The body scores of animals were represented in tables. The accumulated days of the five factors of decomposition (atmospheric temperature, humidity, rainfall, soil temperature, and soil pH) studied were represented in tables.

The Pearson correlation was employed to determine the relationship between decomposition (dependent variable), and five factors affecting decomposition – ambient temperature, humidity, rainfall, soil temperature, and soil pH (independent variables). Prediction models and forecast equations (regression coefficients) for time and decomposition rate (TBS) were derived by regression analyses.

Duration of research

This study lasted for a period of 49 days (from October 2019 to November 2019).

Results

Decomposition body scores of animals

Results obtained from the body scores (BS) of the decomposing animals showed that there was an incomplete skeletonization as seen in Tables 1 and 2. The presence of adipocere delayed the complete skeletonization of the head, neck, and trunk regions of the female experimental animal (see Table 2) and also delayed the complete skeletonization of the trunk region of the male experimental animal (see Table 1).

A complete skeletonization for 49 days should present a total body score (TBS) of 1715. These results on decomposition body scores indicates that complete skeletonization of *Sus scrofa domestica* in Anambra state may not take place within 49 days (see Table 3).

Descriptive statistics of the variables

The result from the mean of the decomposition rate is reliable to describe the set of data. In addition, the mean of atmospheric temperature, soil pH, and soil temperature recorded in this study is reliable to describe the set of data. The mean of the data on humidity is strongly reliable to describe the set of data. However, the mean of precipitation recorded in this study is not reliable to describe the set of data. It only provides information on the central tendency of the data (see Table 4).

Effect of the five climatic factors on decomposition rate

There is a statistically significant very strong positive correlation ($r = .809$, $n = 49$, $p = .001$) between decomposition and duration of decomposition. There is a also a statistically significant strong negative correlation ($r = -.712$, $n = 49$, $p = .001$) between decomposition and precipitation, a statistically significant moderate positive correlation ($r = .500$, $n = 49$, $p = .001$) between decomposition and atmospheric temperature, a statistically significant moderate negative correlation ($r = -.470$, $n = 49$, $p = .001$) between decomposition and humidity, a statistically significant strong negative correlation ($r = -.739$, $n = 49$, $p = .001$) between decomposition and soil pH (salinity), and a statistically insignificant very weak positive correlation ($r = .184$, $n = 49$, $p = .204$) between decomposition and soil temperature (see Table 5).

Prediction models for estimating rate of decomposition

There is a high degree of correlation in the prediction model for estimating decomposition which indicates that the model's goodness of fit is high. $R^2 = .972$ is the proportion of variance in the dependent variable which can be predicted from the six independent variables

Table 1 Body scores of male pig

Day	Head & neck	Trunk	Limbs	Total
1	1	1	1	3
2	1	4	2	7
3	2	5	3	10
4	3	6	5	14
5	4	6	6	16
6	5	6	6	17
7	6	6	6	18
8	7	6	6	19
9	8	6	6	20
10	9	7	7	23
11	10	7	8	25
12	11	7	8	26
13	12	7	9	28
14	12	7	9	28
15	12	8	10	30
16	12	9	10	31
17	12	9	10	31
18	12	9	10	31
19	12	9	10	31
20	12	10	10	32
21	13	11	10	34
22	13	11	10	34
23	13	11	10	34
24	13	11	10	34
25	13	11	10	34
26	13	11	10	34
27	13	11	10	34
28	13	11	10	34
29	13	11	10	34
30	13	11	10	34
31	13	11	10	34
32	13	11	10	34
33	13	11	10	34
34	13	11	10	34
35	13	11	10	34
36	13	11	10	34
37	13	11	10	34
38	13	11	10	34
39	13	11	10	34
40	13	11	10	34
41	13	11	10	34
42	13	11	10	34
43	13	11	10	34
44	13	11	10	34
45	13	11	10	34
46	13	11	10	34
47	13	11	10	34
48	13	11	10	34
49	13	11	10	34
Total	540	454	432	1426

Table 2 Body scores of female pig

Day	Head & neck	Trunk	Limbs	Total
1	1	1	1	3
2	2	3	2	7
3	2	4	3	10
4	4	5	4	12
5	7	6	5	18
6	8	6	5	19
7	8	6	5	19
8	8	6	6	20
9	8	6	6	20
10	9	6	7	22
11	10	6	8	24
12	10	6	8	24
13	10	6	9	25
14	10	6	9	25
15	10	6	10	26
16	10	6	10	26
17	10	6	10	26
18	10	6	10	26
19	10	6	10	26
20	10	7	10	27
21	10	7	10	27
22	10	7	10	27
23	11	7	10	28
24	11	7	10	28
25	11	7	10	28
26	11	8	10	29
27	11	8	10	29
28	12	9	10	31
29	12	9	10	31
30	12	9	10	31
31	12	9	10	31
32	12	9	10	31
33	12	10	10	32
34	12	10	10	32
35	12	10	10	32
36	12	10	10	32
37	12	10	10	32
38	12	10	10	32
39	12	10	10	32
40	12	10	10	32
41	12	10	10	32
42	12	10	10	32
43	12	10	10	32
44	12	10	10	32
45	12	10	10	32
46	12	10	10	32
47	12	10	10	32
48	12	11	10	33
49	12	11	10	33
Total	496	378	428	1302

Table 3 Cumulative body scores (CBS) and Average body scores (ABS)

Day	Male	Female	CBS	ABS
1	3	3	6	3
2	7	7	14	7
3	10	10	20	10
4	14	12	26	13
5	16	18	34	17
6	17	19	36	18
7	18	19	37	18.5
8	19	20	39	19.5
9	20	20	40	20
10	23	22	45	22.5
11	25	24	49	24.5
12	26	24	50	25
13	28	25	53	26.5
14	28	25	53	26.5
15	30	26	56	28
16	31	26	57	28.5
17	31	26	57	28.5
18	31	26	57	28.5
19	31	26	57	28.5
20	32	27	59	29.5
21	34	27	61	30.5
22	34	27	61	30.5
23	34	28	62	31
24	34	28	62	31
25	34	28	62	31
26	34	29	63	31.5
27	34	29	63	31.5
28	34	31	65	31.5
29	34	31	65	31.5
30	34	31	65	31.5
31	34	31	65	31.5
32	34	31	65	31.5
33	34	32	66	32
34	34	32	66	32
35	34	32	66	32
36	34	32	66	32
37	34	32	66	32
38	34	32	66	32
39	34	32	66	32
40	34	32	66	32
41	34	32	66	32
42	34	32	66	32
43	34	32	66	32
44	34	32	66	32
45	34	32	66	32
46	34	32	66	32
47	34	32	66	32
48	34	33	67	32.5
49	34	33	67	32.5
Total	1426	1302	2728	1342

Table 4 Descriptives of the variables

	N	Mean	Std. deviation	Std. error mean
Decomposition	49	27.3878	7.23005	1.03286
Precipitation	49	41.8367	43.79942	6.25706
Atm. temp.	49	30.2449	5.54632	.79233
Humidity	49	85.2041	5.47525	.78218
Soil temp.	49	29.6633	1.55251	.22179
Soil pH (salinity)	49	5.5306	.12111	.01730

N Duration of study

excluding the constant predictor. This means that this study can rely on 97.2% results obtained from this study (see Table 6). This model can explain 2438.799 variations in the variables of all possible factors of decomposition but cannot explain 70.334 variations in the variables of decomposition (see Table 7). This model is very reliable, and there is a statistically significant difference in the variations of the mean of the six independent variables. This prediction equation explains only five factors of decomposition (see Table 8).

Prediction model for estimating time of death

There is a high degree of correlation between the predictors and time of death, $R = .995$. R is the correlation between the observed and predicted value of the time. This is a high degree of correlation indicating that the model's goodness of fit is high (see Table 9). $R^2 = .991$ which is the proportion of variance in the dependent variable which can be predicted from the six independent variables excluding the constant predictor. ANOVA demonstrated that the effect of the 6 predictors was significant for predicting time of death F (6, 48) = 771.118, $p < .001$. This model can explain 9711.839 variables of all possible factors of decomposition but cannot explain 88.161 variables (see Table 10). This model is very reliable. The result from the prediction equation showed that humidity is the only predictor that has no significant effect on determination of time of death (see Table 11).

Discussion

Results from Pearson correlation analysis between decomposition rate and atmospheric temperature showed that there was a statistically significant moderate positive correlation ($r = .500$, $n = 49$, $p = .001$). This means that an optimum atmospheric temperature increases the rate of decomposition in Anambra state, Nigeria. This report supports the findings of Biswas (2012), Finley et al. (2014), Hanna and Moyce (2008), Pope (2010) and Rao (2013) that optimal temperature assists in the chemical breakdown of the tissue and promotes microorganism growth, but extreme temperatures (below 0 °C or above 48 °C) nearly halts decomposition process.

Results from Pearson correlation analysis between decomposition rate and humidity showed a statistically significant moderate negative correlation ($r = -.470$, $n = 49$, $p = .001$). This means that optimum humidity increases the rate of decomposition in Anambra state, Nigeria. This report supports the findings reported Biswas (2012), Hanna and Moyce (2008),

Table 5 Relationship between decomposition rate (TBS) and factors that affect decomposition

		TBS	Precipitation	Atmospheric temp.	Humidity	Soil temp.	Soil pH
Total Body Score (TBS)	Pearson Correlation	1	−.712**	.500**	−.470**	.184	−.739**
	Sig. (2-tailed)		.001	.001	.001	.204	.001
	5.2.1. *N*	49	49	49	49	49	49

Key to quality of relationship

0.80–1.00 Very strong positive

0.60–0.79 Strong positive

0.40–0.59 Moderate positive

0.20–0.39 Weak positive

0.00–0.19 Very weak positive

N Duration of study

** Correlation is significant at the .01 level (2-tailed)

* Correlation is significant at the .05 level (2-tailed)

Table 6 Regression model for decomposition rate

Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate
1	.986[a]	.972	.968	1.29407

R = .986 is the correlation between the observed and predicted value of the decomposition

[a] Predictors: (constant), days of decomposition (time), soil temperature, soil pH, humidity, precipitation, atmospheric temperature

[b] Dependent variable: decomposition rate (TBS)

Hyde et al. (2013), Rao (2013), and Stuart et al. (2002) that decomposition rates are highest in damp, moist conditions with adequate levels of oxygen for growth of microorganisms, but slows down (and may eventually halt) in hot, dry environment because the body can undergo a process called mummification where the body is completely dehydrated and bacterial decay is inhibited.

Results from Pearson correlation analysis between decomposition rate and precipitation (rainfall) showed a statistically significant strong negative correlation ($r = -.712$, $n = 49$, $p = .001$). This means that precipitation played a very significant role in the decomposition rate of the animals. This result also means that high rainfall slowed down the decomposition rate of the animals. This report supports the literature by Rao (2013) and Terneny (1997) that high rainfall leads to diminished exposure to air (oxygen) which slows the rate of decomposition.

Results from Pearson correlation analysis between decomposition rate and soil salinity (soil pH) showed a statistically significant strong negative correlation ($r = -.739$, $n = 49$, $p = .001$). This means that soil salinity played a very significant role in the decomposition rate of the animals. From this result, this study can infer that soil salinity negatively influenced the decomposition rate of animals in Anambra state, Nigeria. This report is line with the literature documented by Stuart et al. (2002) which noted that decomposition rates also tend to be slower in acidic soils.

Results from Pearson correlation analysis between decomposition rate and soil temperature showed a statistically insignificant very weak positive correlation ($r = .184$, $n = 49$, $p = .204$). This means that soil temperature did not play a significant role in the rate of decomposition. Results from the soil analyse showed that there were small insignificant deposits of salt in the soil. The amount of salt (NaCl) present in the soil did not significantly slow the decomposition rate.

Table 7 ANOVA of the regression model for decomposition rate

Model		Sum of squares	df	Mean square	*F*	Sig.
1	Regression	2438.799	6	406.466	242.722	.001[a]
	Residual	70.334	42	1.675		
	Total	2509.133	48			

[a] Predictors: (constant), days of decomposition (time), soil temperature, soil pH, humidity, precipitation, atmospheric temperature

[b] Dependent variable: decomposition (TBS)

Table 8 Coefficients of the regression model for decomposition rate

Model		Unstandardized coefficients		Standardized coefficients	*t*	Sig.
		B	Std. error	Beta		
1	(Constant)	129.946	13.642		9.525	.001
	Precipitation	.015	.010	.089	1.545	.130
	Atmospheric temp.	−1.413	.140	−1.084	−10.126	.001
	Humidity	−.077	.044	−.059	−1.742	.089
	Soil temperature	.808	.239	.173	3.377	.002
	Soil pH	−17.737	2.008	−.297	−8.835	.001
	Days of decomposition	.812	.058	1.604	14.104	.001

The regression equation is as follows:

$Y_{TBS} = 129.946 + .015_{Preci} - 1,413_{ATMOSTEMP} - 0.77_{Humidity} + .808_{SoilTemp} - 17.737_{SoilPH} - 17.737_{Time} + \varepsilon_x$

Predictors: (constant), days of decomposition (time), soil temperature, soil pH, humidity, precipitation, atmospheric temperature

Dependent variable: decomposition (TBS)

Table 9 Regression model for time of death

Model	*R*	*R* square	Adjusted *R* square	Std. error of the estimate
1	.995[a]	.991	.990	1.44882

[a] Predictors: (constant), decomposition rate (TBS), soil temperature, soil pH, humidity, precipitation, atmospheric temperature

[b] Dependent variable: days of decomposition (time of death)

The prediction model for decomposition rate and time of death estimation is a robust equation that factored six predictors. The models developed do not conform to the models developed in previous literature because the models developed from this study considered five factors of decomposition whereas other literatures considered only atmospheric temperature (accumulated degree days) and insect/dipteral succession patterns as factors of decomposition. The regression models are reliable. However, to accurately predict the time since death using the forecast equation, the regression model should be estimated with measurement data not less than 30 so as to obey the standard rule of normal distribution. This means that a minimum of 30 matured *Sus scrofa domestica* is required carry out this study so as to get an accurate robust prediction equation using five factors of decomposition.

Conclusions

The factors that influence the rate of decomposition of *Sus scrofa domestica* placed on soil surface in Anambra state, Nigeria, include atmospheric temperature, humidity, precipitation, and soil salinity. Since it has been proven by previous scholars that *Sus scrofa domesticus* has decompositional similarities as man, findings from this study can be applied to homicide cases resulting from strangulation in Anambra state, Nigeria.

In addition, the six predictors identified in this study should be used to estimate decomposition timeline in Anambra state, Nigeria. This will ensure the validity of the reports presented in the law court or the criminal investigation department of the Nigerian police.

Recommendations

Based on the findings from this study, the following are recommended:

1. To ensure accuracy in the precision of the prediction models for time since death, a minimum of 30

Table 10 ANOVA of the regression model for time of death

Model		Sum of squares	df	Mean square	*F*	Sig.
1	Regression	9711.839	6	1618.640	771.118	.001[a]
	Residual	88.161	42	2.099		
	Total	9800.000	48			

[a] Predictors: (constant), decomposition (TBS), soil temperature, soil pH, humidity, precipitation, atmospheric temperature

[b] Dependent variable: days of decomposition (time of death)

Table 11 Coefficients of the regression model for time of death

Model		Unstandardized coefficients		Standardized coefficients	*t*	Sig.
		B	Std. error	Beta		
1	Constant	−105.685	21.710		−4.868	.001
	Precipitation	−.035	.010	−.107	−3.666	.001
	Atmospheric temp.	1.805	.080	.701	22.658	.001
	Humidity	.089	.050	.034	1.782	.082
	Soil temperature	−1.278	.229	−.139	−5.587	.001
	Soil pH	14.470	3.075	.123	4.706	.001
	Decomposition rate	1.017	.072	.515	14.104	.001

$Y_{Time} = -105.685 - .035x_{precipitation} + 1.805x_{Atemp} + 0.89x_{Humidity} - 1.278x_{Soil\ temp} + 14.470x_{Soil\ PH} + 1.017x_{TBS} + \varepsilon_{Residual}$

Predictors: (constant), decomposition rate (TBS), soil temperature, soil pH, humidity, precipitation, atmospheric temperature

Variable: days of decomposition (time of death)

matured domestic pigs should be used to carry out this experiment, and adequate approval obtained from the animal protection index of Nigeria.
2. Experimental animals used for taphonomic studies should be acquired from the research vegetation (community) to ensure that the body temperatures are in conformity with the ambient temperature.
3. Local meteorological centers should be established in every state of Nigeria so as to reduce the hassles involved in taphonomic research in Nigeria.

Contribution to knowledge
Investigation on the factors that influence the rate of decomposition in Anambra state, Nigeria, provided these findings:

1. Total body score (TBS), accumulated degree days (ADD), accumulated humidity days (AHD), accumulated precipitation days (APD), and accumulated soil salinity days (ASSD) are very essential parameters for predicting decomposition timeline in Anambra state, Nigeria.
2. The prediction models developed in this are reliable tools (techniques) for estimating decomposition timeline in Anambra state, Nigeria.

Abbreviations
ABS: Average body scores; ADD: Accumulated degree days; AHD: Accumulated humidity days; APD: Accumulated precipitation days; ASSD: Accumulated soil salinity days; ANOVA: Analysis of variance; BS: Body scores; CBS: Cumulative body scores; GMT: Greenwich meridian time; HAT: Highest atmospheric temperature; HH: Highest humidity; HST: Highest soil temperature; IBM: International business machines; LAT: Lowest atmospheric temperature; LCD: Liquid crystal display; LH: Lowest humidity; LST: Lowest soil temperature; mg/kg: Milligram per kilogram; N: Duration of study; PMI: Post mortem interval; SD: Standard deviation; SPH: Soil pH; SPSS: Statistical package for social sciences; TBS: Total body scores; PREP: Precipitation.

Supplementary Information
The online version contains supplementary material available at https://doi.org/10.1186/s41935-022-00281-7.

Additional file 1: Table 1. Factors that affect the rate of decomposition. **Table 2.** Soil salt level that affect decomposition rate.

Acknowledgements
Not applicable.

Authors' contributions
This work was carried out in collaboration of all authors. The author ODN wrote the protocol, acquired the animals, carried out the experiment, and wrote the first draft of the manuscript. The author EUG designed the study and assisted author FVA to supervise the experimental study. The author FVA supervised the experimental study. The author NAT carried out the statistical analysis. The author OIM managed the literature searches. The authors read and approved the final manuscript.

Funding
None.

Availability of data and materials
The datasets generated during and/or analyzed during the current study are available within the text.

Declarations

Ethics approval and consent to participate
The ethical clearance (079PHY3321) was obtained from the ethical committee of the Faculty of Basic Medical Sciences, University of Calabar, Calabar, Nigeria. All the authors gave full consent to participate in the study.

Consent for publication
The authors enlisted in this draft article have given full consent for this draft article to be submitted under review in the Egyptian Journal of Forensic Sciences.

Competing interests
The authors declared that they have no competing interests.

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Received: 31 January 2022 Accepted: 2 May 2022
Published online: 20 June 2022

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