Health effects of Charcoal Production as Perceived by the Rural Dwellers in Rainforest and Guinea Savannah Agro-ecological zones of Nigeria

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Authors' contributions

This work was carried out in collaboration between both authors. Author SOO designed the study, performed the statistical analysis, and wrote the protocol. Author POE managed the analyses of the study, the literature searches and wrote the first draft of the manuscript. Both authors read and approved the final manuscript.

ABSTRACT

Aims: The aim of this study is to access the health effects of Charcoal Production (CP) as perceived by the rural dwellers in the study area.

Study design: Survey study. Relevant quantitative data on charcoal production were used.

Place and duration of study: The study was carried out in the Rainforest (RF) and Guinea savannah (GS) zones of Nigeria between 14th February 2012 and 1st November 2013.

Methodology: Multiple stage sampling procedure was used to select a sample of 83 and 85 charcoal producers in the Rainforest and Guinea savannah zones respectively. Structured interview schedule data collected and analysed using descriptive and inferential statistics.

Results: The study noted that the modal ages of respondents were within the same age-range of between 35 and 44 years. Male respondents were 88.0% and 90.5% from RF and GS respectively. Respondents (59.0%) in RF zone had primary school leaving certificate, while, about 30.6% in the GS attended Koranic School. Eleven was the mean years of experience for CP in the RF zone and 14years for the GS zones. Hundred percent of the respondents used ancient earth mound method of CP and the respondents (36.1%.) from the RF zone had annual output of more than 128,000kg. Respondents perceived that CP may lead to skin and respiratory tract irritation/infection (72.3%, 57.6%.); CP may cause cut, crush and laceration of hand (78.3%, 69.4%.); burns (90.0%, 49.4%.); back and muscle pains (73.5, 70.6%.) and CP may lead to body wounds (73.5%, 58.5%.) in RF and GS zones respectively. Majority

(84.7%) in GS and 84.3%. in RF perceived that CP had negative effects on the health status of rural dwellers. Significant difference was predicted in the health status of charcoal producers between the agro-ecological zones (F=3.124). There is the need for awareness campaign on health consequences of CP.

Keywords: Charcoal production, diseases, earth mound method, rural dwellers

Introduction

In Nigeria, most rural dwellers have relied on CP as a means of livelihood since people have access to wood. Thus, this reliance has negatively impacted on the environment and the health of the producers (1). In the 1950's forest reservation had reached its peak in most parts of Nigeria especially in the Northern States where approximately 42,000 km^2 were reserved with the addition of an area of over 12,900 km^2 which was proposed for reservation between 1960 and 1972 in the Northern States. In the southern part of Nigeria, forest reservation has been at a standstill and the prospects of creating more reserves in the future are doubtful. In recent times, most of the forest reserves have been deforestated as a result of increase in population and economic expansion in other sectors of the economy.

Aside the environmental consequences of CP, there are also social, health and gender implications related to wood fuel consumption (2). Shortages of wood fuels for smallholder users are becoming more enormous, especially for the landless poor due to deforestation resulting from large scale CP, as well as reduced access to forests driven by the privatisation of resources for both cottage and industrial land users (3). These have reduced the livelihood potential for smallholder users dependent on forests. Hence, alternative means to procure products previously gathered from forests are sought through firewood collection activities. This has increased drastically the time spent searching for firewood, thereby preventing women and children from other more productive activities (2).

There are obvious health challenges concerning the use of wood fuels where incomplete combustion leads to various forms of accidents (4). Ellegard (1994) reported backache, heat, and cough among other ailments confronting charcoal producers. In a study from Brazil, charcoal producers reported many types of injuries with bad experiences of lumbar pain and muscle soreness as a result of heavy loads and repetitive movements of wood during CP. Ellegard (1993) opined that CP requires greater labour for the producer during felling of trees, cross cutting, log haulage, kiln building and management. There are also risks involved with a carbonising kiln particularly when repair work is being done. Sometimes, production accidents may lead to death. Charcoal producers also have health risk

such as exposure to gases and smoke and heat from the kiln. Carbon monoxide (CO) is the major health risk of all the gases emitted. The under listed the health risks associated with each stage of charcoal production are: Felling and cross-cutting which include backache, sore hands, general exhaustion and chest pains; Kiln covering which include cough, heat, burns, chest pains, exposure to smoke and gases; and Kiln breaking which entails heat and burns.

Tzanakis *et al.* (2001) was of the opinion that workers are exposed to incomplete combustion of wood burning and noxious smoke gases for several hours per day during the burning period of charcoal production. They also experienced headache, drizzles, nose and acute eye problem, and throat irritation during the kiln management. Excessive heat exposed to was mainly from the task of unloading the kiln. However, during the dry season, charcoal production activities were subject to low humidity and high temperature. The harsh temperature of the working environment and the charcoal dust dispersed while unloading a kiln also affects the workers' eyes.

Thus, health effect of CP as perceived by the rural dwellers of RF and GS agro-ecological zones of Nigeria was examined.

1.1 Objectives of the Study

Basically, the study assessed health effect of CP as perceived by the rural dwellers of RF and GS agro-ecological zones of Nigeria

Specifically, the selected socio-economic characteristics of charcoal producers in the study area was identified; the study determined the methods used in CP; determine the level of CP in the study area; and accessed the perceived effects of CP on the health status of rural dwellers of the study area.

2. Methodology

2.1 Area of Study

The areas of study are the RF and GS zones of Nigeria (Fig. 1). Amidst the dry north and the wet south lies a GS zone with mean annual rainfall of 1200 mm. The zone predominantly supports arable such as maize, sorghum, millet, cassava, yams, and cowpeas, while rice form the main crop in some places. The southern middle belt's of the zone edge represents the lower limits of the northern grain-dominated economy. The main commercial crop of the middle belt is sesame. The RF zone has more rain than the guinea zone with 2000 mm during the pick period where the woodlands benefit from abundant precipitation and relatively short dry seasons. The southern zone mostly supports root crops such as cassava, yams, sweet potatoes and cocoyam. The main cash crops in the RF zone are tree crops, which

are grown on large scale viz: cacao, oil palm, and rubber. The mean monthly temperature in the RF zone is 26.5 ^{0}C. and sometime goes above 30 ^{0}C. in the GS zone (8).

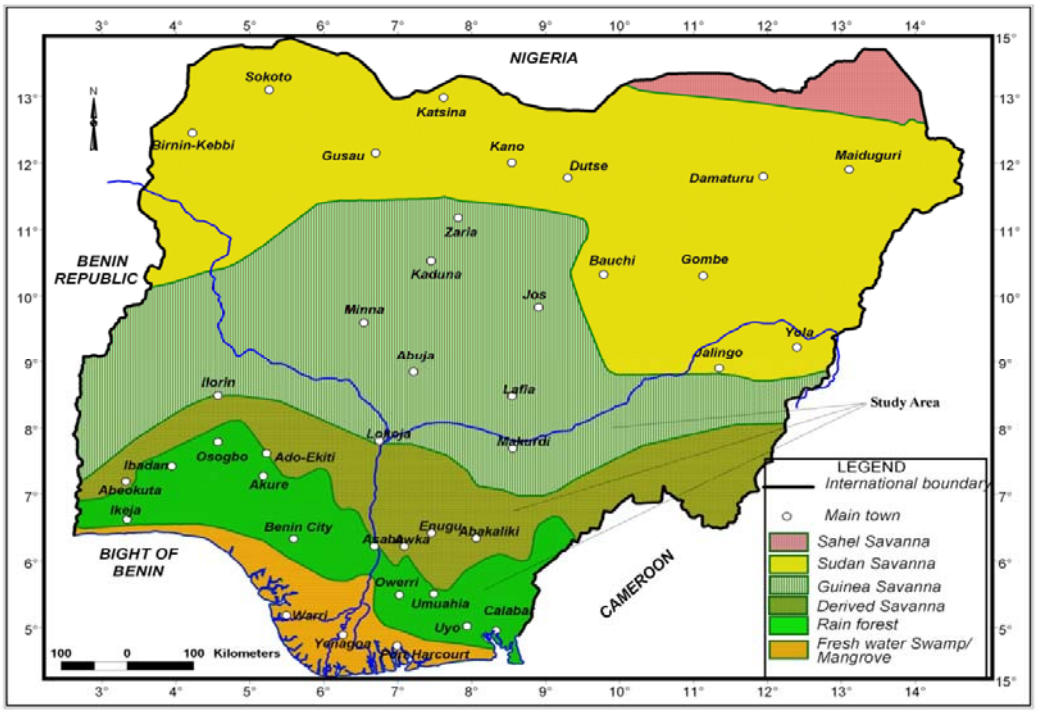

Fig. 1: Map of Nigeria showing the agro-ecological zones

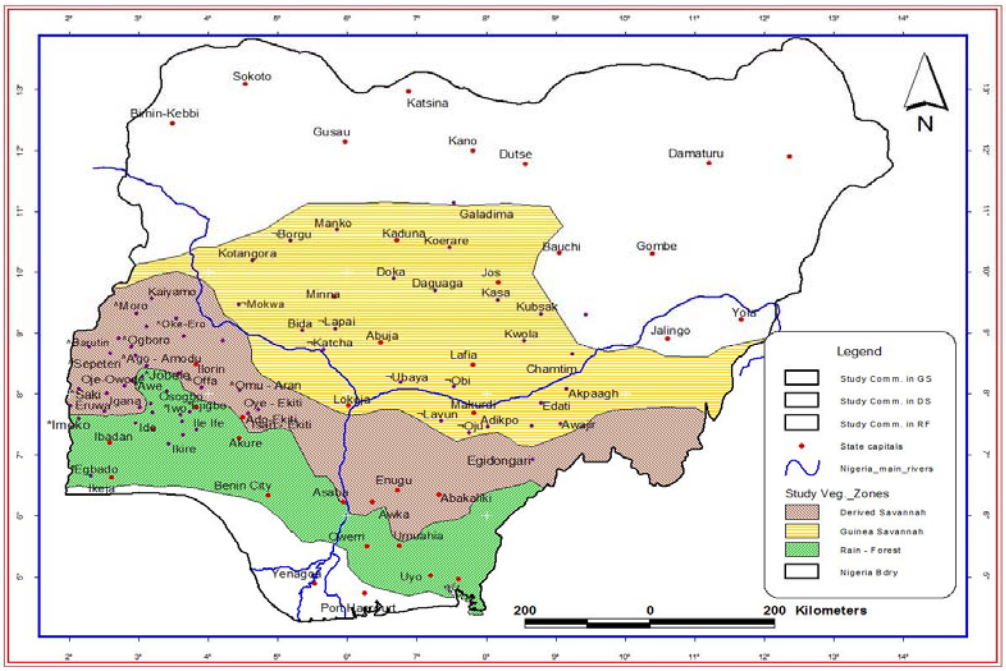

Fig.2: Map of Nigeria showing charcoal producing communities in RF and GS zone

2.2 Experimental Design

Multi-stage sampling procedure was used to select sample from the population of 277 and 284 charcoal producers in RF and GS zones respectively.

Stage one: The two zones were purposively selected from the six agro-ecological zones in Nigeria because of their potential for charcoal population. The informed consent of charcoal producers was received from the Chief and CP association's chairman in each community.

Stage two: High charcoal producing communities were identified and purposively selected which are as follows: Gbongan, Imeko, Ijaye, Awe, Iwo, Ilora, Ejigbo, Jobele and Egbado from the RF zone while, Edati, Borgu, Lapai, Bida, Katcha, Obi, Ubaya, Lavun, Oju, and Mokwa from the GS zone (Fig. 2).

Stage three: Among the rural communities in the zone, 50% were selected using simple random sampling technique.

Stage four: From the registered charcoal producers, and using simple random sampling technique, 30% were selected from the population of all registered charcoal producers available in each of the selected communities. In all, 83 and 85 charcoal producers in the RF and GS zones respectively were used as sample for the study. Likert-type rating scale of positively worded statements with scores 5-1 and 1-5 for negatively worded statements respectively), were used to solicit their opinion on each of the 30 selected (15 positive, and 15 negative) statements on perceived health effects of CP among rural dwellers in the study area.

To get the score for each respondent, the mean of each question was calculated by multiplying each frequency of the rating scale by the rating score and sum together. Then, divide the total by N, where N=83 for RF and 85 for GS zone. For validity and reliability test, the instrument was pre-tested in Kano State using split-half method. Correlation co-efficient of r = 0.78 was obtained and this was certified by professionals.

2.3 Data Analysis

SPSS (version 17.0) was used for descriptive, analysis of variance, Multiple regression and correlation coefficient $r = Cov(x, y) / \sqrt{S^2_x * S^2_y}$

Where:

r= indicate the direction and strength of the linear association between x and y variables.
x= independent variable
y= dependent variable
The data were analysed at 0.05 level of significance
Multiple regressions were used to determine the effects of the independent variables on the dependent variable. The model was expressed as:
$Y=a+b1X1\ldots+bnXn + e$
Where Y= Level of perceived health effects of CP (score value)
a=constant term
b1 b2….bn = Regression coefficients
e = error
X1, X2 …Xn= Regression parameters which are
X1= Age (in years)
X2= Sex (M=1, F=0)
X3= Marital status
X4= Educational attainment
X5= Primary occupation (score value)
X6= Secondary occupation (score value)
X7 = Farming system (score value)
X8= Income from charcoal production (score value)
X9= Years of experience

3. Results and discussion

3.1 Socio economic characteristics

Table 1 reveals that the modal ages were between 35 and 44 years with 35.1% for RF and 48.1% for GS zones. This implies that they are in their productive ages. This result is in line with the findings of (9), which opined that CP appears to be dominated by the active ages of between 35 and 45years. Most respondents from RF (88.0%) and GS (90.5%) were males. This may be as a result of the energy involved in the activities of CP. This agrees with (10), which revealed that males are prominent in CP. Across the agro-ecological zone, 90.4% and 90.6% of respondents in the RF and GS were married respectively. This indicates the fact that lot of money is got from the sale of charcoal, which assists the married among them to meet financial obligations of their families. Respondents (59.0%) in the RF zone possessed primary school certificate, while, 30.6% of respondents in the GS attended Koranic School. About 49.4% respondents in the GS zone are crop farmers, 35.3% as fisher folks and only 14.1% had CP as their primary occupation. Average (54.2%) respondents in the RF zone are crop farmers. Perhaps, inability of rural dwellers to produce charcoal all round the year may be difficult for them to take it as primary occupation. The findings was supported by (11), that those who have farming as their primary occupation have the tendency to produce charcoal since lands are cleared for farming which provide easy access to wood for CP.

While, (9) opined that only those with desirable vegetation take charcoal production as their primary occupation. Most respondents (81.9%) in the forest and 82.4% GS zone take charcoal production as secondary occupation. This suggests additional income. This has been complimented by the (12) who noted that charcoal is produced by the poor people who live in rural communities. According to UNDP (2008) and Barret *et al*. (2001) charcoal production is, notwithstanding, an activity for income diversification. Furthermore, (14) concluded that most households engage in multiple income-generating activities so as to meet their household needs. To reduce poverty, more than one source of income is required. The mean years of experience are 11 in the RF zone and 14 for the GS zones. This assertion was agreed with the study of (15), which put between 5 and19 as the years of experience of charcoal producers in some parts of Nigeria.

The annual mean income generated from CP ₦190,421.9 (1,269.5 dollars) in the RF and ₦135,929.4 (906.2 dollars) in the GS. Kalumiana (2000) inferred that 70.0% of the money accrued annually in Tanzania was realised in an area suitable for charcoal production. In addition, 96.6% practiced shifting cultivation and 38.8% practiced mono cropping in the GS zone, while in the RF, 49.4% practiced mono-cropping and 28.9% involved in shifting cultivation.

Table 1: Socio-economic characteristics of charcoal producers

Socio-economic characteristics	**RF zone Mean age =46 Std dev.=9.3**		**GS zone Mean age =43 Std dev.=8.0**	
Age (Years)	**Frequency**	**%**	**Frequency**	**%**
25-34	7	8.4	8	9.5
35-44	29	35.0	41	48.1
45-54	26	31.3	26	30.5
More than 54	21	25.3	10	11.9
Sex				
Male	73	88.0	77	90.5
Female	10	12.0	8	9.5
Educational Attainment				
No formal educ.	14	16.9	30	35.3
Koranic school	7	8.4	26	30.0
Pry. School	49	59.0	17	20.6
Secondary s	11	13.3	12	14.1
OND and above	2	2.4	-	-
Marital status				
Married	75	90.4	77	90.6
Single	5	6.0	5	5.9

Widow	3	3.6	3	3.5
Primary occupation				
Crop farming	45	54.2	42	49.4
Fishing	9	10.8	30	35.3
Charcoal production	11	13.3	12	14.1
Trading	14	16.9	1	1.2
Hunting	4	4.8	-	-
Secondary occupation				
Crop farming	10	12.0	14	16.4
Fishing	1	1.2	-	-
Charcoal production	68	81.9	70	82.4
Weaving	-	-	1	1.2
Hunting	4	4.9	-	-
Years of experience	Mean = 11 SD=4.3		Mean=14 SD=4.2	
less than 5years	9	10.8	6	7.1
6-10years	16	19.4	6	7.1
11-15years	51	61.4	39	45.8
more than15years	7	8.4	34	40.0
Income from CP	Mean=190,421.9 SD=99,71.4		Mean=135,929.4 SD=559,11.4	
≤100.000.00	-	-	20	23.5
100.001-200.000.00	38	45.8	48	56.5
200.001-300.000.00	40	48.1	16	18.8
300.001-400.000.00	5	6.1	1	1.2
Farming system				
Crop rotation	-	-	1	1.2
Mono cropping	41	49.4	33	38.8
Shifting cultivation	24	28.9	82	96.5
Total	83	100.0	85	100.0

3.2. Methods of CP

Table 2 shows that all the respondents in the RF made use of earth mound method of charcoal production while 80.0% of the respondents in the guinea used the method. However, 20.0% made use of the pit method in GS zone. This implies that earth mound is very prominent in zones. This finding is in tandem with the study of (15), who concluded that earth mound method was found to be prominently used among charcoal producers in many parts of Nigeria.

Table 2. Distribution of respondents based on Methods of CP

Methods used in CP	RF zone		GS zone	
Earth mound	83	100.0	68	80.0
Pit method	-	-	17	20.0
Total	83	100.0	85	100.0

3.3: Annual output from CP

Table 3 depicts that average (52.9%) of respondents produced between 0 and 32,000kg of charcoal per annum while 41.2% had more than 32,000-64,000kg in GS. However, 36.1% of respondents produced more than 128,000kg/annum in RF zone. Eniola *et al*. (2012) inferred that the yield from charcoal production depends on vegetation, availability of water, season, types of wood, and occupation of the producer.

Table 3. Distribution of respondents' annual output from CP in the selected ecological zones

Kilogram of charcoal	RF zone		GS zone	
Total quantity per annum	F	%	F	%
0 – 32,000kg	11	13.3	45	52.9
More than 32,000– 64,000	13	15.6	35	41.2
More than 64,000– 96,000	25	30.1	-	-
More than 96,000-128,000	5	4.9	1	1.2
More than 128,000	30	36.1	4	4.7
Total	83	100.0	85	100.0

3.4. Health effects of Charcoal Production as Perceived by rural dwellers

Tables 4 and 5 showed the summary of results. SA, A, U, D, and SD are Strongly Agree, Agree, Undecided, Disagree, and Strongly Disagree, respectively.

Table 4 reveals that majority of the respondents in the RF zone strongly agreed respectively that CP may cause body wounds (#1: 73.5%), cut, crush and laceration of hand (#5: 78.3%), skin and respiratory tract irritation/infection (#9: 72.3%), lead to burns (#13: 90.0%), and that it is not hygienic for under age to get near the charcoal kiln or store (#25: 79.5%). Moreover, charcoal producers may not necessarily lead to spinal hernia (#4: 55.43%). Few respondents (#1: 21.7%) and (#3: 22.9%) agreed that CP may cause body wounds and respiratory diseases respectively. In addition, (#3: 26.5%, #8: 25.3% and #11: 47.0%) disagreed that CP may cause respiratory diseases, that dust from CP cannot cause asthma and that CP may aids malaria respectively. About (#8: 39.8%) respondents undecided that dust from CP cannot cause asthma.

However, most of the respondents strongly disagreed that falling and slipping are not common to charcoal producers (#12: 66.3%); fatigue is not prominent to charcoal producers (#14: 67.5%); poisonous bites has nothing to do with CP (#16: 69.9%); and that children can play with charcoal during production without any harm (#29: 65.1%). This connotes that the respondents in the RF zone perceived that CP could lead to various health challenges

Table 5 reveals that majority of respondents in the GS zone strongly agreed that CP is likely to lead to cut, crush and laceration of hand (#5: 69.4%); back and muscle pains may be associated with CP (#6: 70.6%). Furthermore, (#1: 60.0% and #9: 57.6%) of respondents strongly agreed respectively that CP is likely to cause body wounds and may cause skin and respiratory tract irritation infection. It is not also hygienic for children to get near the charcoal kiln (#25: 63.5%). Few respondents (#4: 34.1%, #12: 35.3%, #18: 37.6% and #19: 34.1%) disagreed that charcoal producers may not necessarily experience spinal hernia, falling and slipping are not common to charcoal producers, charcoal producers may not experience cold/flu and dizziness respectively. But (#8: 15.3%) undecided that dust from CP cannot cause asthma.

However, the respondents strongly disagreed that fatigue is not prominent to charcoal producers (#14: 54.1%); one's hand, foot or limbs may not be affected during CP (#28: 55.3%) and children can play with charcoal during production without harm (#29: 60.0%),

283 It should be noted that respondents in the RF zone did not perceive spinal hernia (#4)
284 cold flu (#18), dizziness (#19) and regular medical check-up as health problems (#30).

285 **Table 4: Distribution of respondents according to perceived effects of Charcoal production on the health of rural dwellers**

S/N		RF zone N=83										
Statements on health related problems		**SA**		**A**		**U**		**D**		**SD**		**MEAN**
		***F**	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	%	
1	CP is likely to cause body wounds.	61	73.5	18	21.7	-	-	3	3.6	1	1.2	4.6
2	Charcoal producers may not experience sinusitis.	52	62.7	6	7.2	-	-	13	15.6	12	14.5	3.9
3	CP may result to respiratory diseases.	21	25.3	19	22.9	3	3.6	22	26.5	18	21.7	3.0
4	Charcoal producers may not necessarily experience spinal hernia.	46	55.4	1	1.2	-	-	14	16.9	22	26.5	3.4
5	CP is likely to lead to cut, crush and laceration of hand.	65	78.3	14	16.9	-	-	-	-	4	4.8	4.6
6	Back and muscle pains may be associated to CP.	61	73.5	17	20.5	-	-	-	-	5	6.0	4.6
7	Charcoal producers may likely experience frequent head ache.	20	21.4	10	12.0	4	4.8	10	12.0	39	47.0	2.4
8	Dust from CP cannot cause asthma.	4	4.8	5	6.0	33	39.8	21	25.3	20	24.1	2.4
9	CP may cause skin and respiratory tract irritation/infection.	60	72.3	16	19.3	5	6.0	-	-	2	2.4	4.6
10	CP is not likely to cause body irritation.	13	15.7	6	7.2	1	1.2	13	15.7	50	60.2	2.0
11	CP may aids malaria attack.	8	9.6	12	14.5	7	8.4	39	47.0	17	20.5	2.5
12	Falling and slipping are not common to charcoal producers.	6	7.2	3	3.6	-	-	19	22.9	55	66.3	1.6
13	CP may lead to burns.	49	90.0	19	22.9	-	-	4	4.8	11	13.3	4.1
14	Fatigue is not prominent to charcoal producers.	9	10.8	5	6.0	-	-	13	15.7	56	67.5	1.5
15	Eyes problem may be frequently encountered through CP.	22	26.5	12	14.5	-	-	2	2.4	47	56.6	2.5
16	Poisonous bites have nothing to do with CP.	7	8.4	1	1.2	-	-	17	20.5	58	69.9	1.6
17	Tuberculosis may not be contacted through CP.	47	56.6	25	30.1	-	-	2	2.4	9	10.8	4.2
18	Charcoal producers may not experience cold/flu.	45	54.2	3	3.6	-	-	21	25.3	14	16.9	3.5
19	Charcoal producers may not experience dizziness.	48	57.8	3	3.6	-	-	11	13.3	21	25.3	3.6
20	Involvement in CP may cause tetanus.	49	59.0	21	25.3	4	4.8	11	13.3	2	2.4	4.4
21	Traffic accidents are common during CP.	39	47.0	25	30.1	-	-	17	20.5	2	2.4	4.0
22	CP is likely to cause ill health.	44	53.0	22	26.5	-	-	5	6.0	12	14.5	4.0
23	One can still feel body pains with little involvement in CP.	20	21.4	14	16.9	-	-	15	18.1	34	41.0	2.7
24	None of my family members have experienced any form of disease as a result of CP.	17	20.5	13	15.7	-	-	9	10.8	44	53.0	2.4
25	It is not hygienic for children to get near the charcoal kiln or	66	79.5	13	15.7	-	-	3	3.6	1	1.2	4.7

	store.											
26	Fainting may not necessarily be associated to CP.	47	56.6	21	25.3	-	-	5	6.0	10	12.0	4.1
27	Pregnant women may be exposed to danger during CP.	46	55.4	19	22.9	-	-	4	4.8	14	16.9	4.0
28	One's hand, foot or limbs may not be affected during CP.	2	2.4	6	7.2	-	-	26	31.3	49	59.0	1.6
29	Children can play with charcoal during production without any harm.	5	6.0	3	3.6	-	-	21	25.3	54	65.1	1.6
30	Involvement in CP requires regular medical checkup.	18	21.7	26	31.3	4	4.8	30		5	6.0	3.3

286 **Table 5: Distribution of respondents according to perceived effects of CP on the health of rural dwellers**

S/N	**N= 85**	**GS zone**										
Statements on health related problems		**SA**		**A**		**U**		**D**		**SD**		**MEAN**
		F	**%**	**F**	**%**	**F**	**%**	**F**	**%**	**F**	%	
1	CP is likely to cause body wounds.	51	60.0	29	34.1	-	-	5	5.9	-	-	4.5
2	Charcoal producers may not experience sinusitis.	27	31.8	6	7.1	-	-	23	27.1	29	34.1	2.8
3	CP may result to respiratory diseases.	39	45.9	25	29.4	-	-	7	8.2	14	16.5	3.8
4	Charcoal producers may not necessarily experience spinal hernia.	26	30.6	1	1.2	1	1.2	29	34.1	28	32.9	2.6
5	CP is likely to lead to cut, crush and laceration of hand.	59	69.4	22	25.9	1	1.2	3	3.5	-	-	4.6
6	Back and muscle pains may be associated to CP.	60	70.6	20	23.5	2	2.4	-	-	3	3.5	4.6
7	Charcoal producers may likely experience frequent head ache.	22	25.9	38	44.7	8	9.4	3	3.5	14	16.5	3.6
8	Dust from CP cannot cause asthma.	14	16.5	19	22.4	13	15.3	23	27.1	16	18.8	2.9
9	CP may cause skin and respiratory tract irritation/infection.	49	57.6	26	30.6	3	3.5	3	3.5	4	4.7	4.3
10	CP is not likely to cause body irritation.	14	16.5	8	9.4	2	2.4	24	28.2	37	43.5	2.3
11	CP may aids malaria attack.	16	18.8	15	17.6	4	4.7	25	29.4	25	29.4	2.7
12	Falling and slipping are not common to charcoal producers.	7	8.2	6	7.1	-	-	30	35.3	42	49.4	1.7
13	CP may lead to burns.	42	49.4	21	24.7	-	-	4	4.7	18	21.2	4.6
14	Fatigue is not prominent to charcoal producers.	5	5.9	8	9.4	1	1.2	25	29.4	46	54.1	1.8
15	Eyes problem may be frequently encountered through CP.	34	40.0	24	28.2	-	-	5	5.9	22	25.9	3.5
16	Poisonous bites have nothing to do with CP.	11	12.9	6	7.1	-	-	31	36.5	37	43.5	2.1
17	Tuberculosis may not be contacted through CP.	32	37.6	18	21.2	1	1.2	19	22.4	15	17.6	3.4
18	Charcoal producers may not experience cold/flu.	20	23.5	4	4.7	1	1.2	32	37.6	28	32.9	2.5
19	Charcoal producers may not experience dizziness.	21	24.7	6	7.1	-	-	29	34.1	29	34.1	2.5
20	Involvement in CP may cause tetanus.	42	49.4	30	35.5	2	2.4	6	7.1	5	5.9	4.2

21	Traffic accidents are common during CP.	43	38.8	35	41.2	3	3.5	9	10.6	5	5.9	4.6
22	CP is likely to cause ill health.	40	47.1	24	28.2	3	3.5	5	5.9	13	15.3	3.9
23	One can still feel body pains with little involvement in CP.	15	17.6	11	12.9	-	-	27	31.8	32	37.6	2.4
24	None of my family members have experienced any form of disease as a result of CP.	19	22.4	12	14.1	3	3.5	17	20.0	34	40.7	2.6
25	It is not hygienic for children to get near the charcoal kiln or store.	54	63.5	21	21.7	1	1.2	6	7.1	3	3.5	4.4
26	Fainting may not necessarily be associated to CP.	36	42.4	22	25.9	-	-	13	15.3	14	16.5	3.6
27	Pregnant women may be exposed to danger during CP.	38	44.7	26	30.6	-	-	10	11.8	11	12.9	3.6
28	One's hand, foot or limbs may not be affected during CP.	9	10.6	2	2.4	-	-	27	31.8	47	55.3	1.8
29	Children can play with charcoal during production without any harm.	6	7.1	5	5.9	1	1.2	22	25.9	51	60.0	1.7
30	Involvement in CP requires regular medical check up.	26	30.6	39	45.9	-	-	12	14.1	8	9.4	3.7

***F=Frequency**

3.5. Level of perceived effects of CP on health of rural dwellers

Table 6. reveals that 84.3% of respondents in the RF and 84.7% in GS zone had negative perception on effects of CP on the health of rural dwellers. This implies that respondents' experience several health problems during CP. Eniola, *et al.* (2018), (18), (4) & (12) noted that health problems, ranging from mild to chronic problems, result from involvement in CP.

Table 6. Perception of respondents on the effects of CP on health of rural dwellers

		RF n=83		GS n=85	
Health related problems	**Scores**	**Mean score=98.5 Std. dev.=9.9**		**Mean score=94.1 Std. dev.=11.1**	
		F	**%**	**F**	**%**
Positive effects	30-98.5	13	15.7	13	15.3
Negative effects	98.6-150.0	70	84.3	72	84.7

3.6. Regression analysis showing health effects of CP in RF zone

Table 7. reveals that marital status (β= 0.301), and age (β= 0.316) in RF positively influence the health status of charcoal producers. This implies that age and marital status influence the level of health hazards they perceived.

The r^2 value of 0.372 connotes that all the socio-economic characteristics considered in the study area contribute 37.0% of the variance of perceived health effect of CP.

Table 8. depicts that years of experience (β= -0.319) of respondents is negatively significant to perceived health effects of CP in the GS zone. The implication is that the less the years of experience, the higher the level of perceived health effects of CP. For that of the GS, the coefficient of determination is 0.390 which implies that all the socio-economic characteristics considered for the study contributed only 39.0% to perceived health effects of CP.

Table 7. Regression analysis showing health effects of CP in RF zone

Variables	B	β	t-ratio	Significant
(Constant)	92.177	-	6.378	0.000
Age	0.341	0.316*	2.212	0.030
Farming system	0.784	0.121	0.775	0.632
Sex	3.446	0.107	0.823	0.414
Marital status	0.319	0.301*	2.160	0.024

Educational attainment	-0.078	-0.009	-0.073	0.942
Primary occupation	0.342	0.077	0.630	0.531
Secondary occupation	1.837	0.187	1.597	0.115
Years of experience	-2.602	-0.202*	-0.887	0.036
Income from CP	-3.153E-5	-0.175	-1.040	0.302

Coefficient of Determination (r^2) = 0.372

Table 8. Regression analysis showing health effects of CP in the GS zone

Variables	B	β	t-ratio	Significant
(Constant)	96.323	-	6.612	0.000
Age	0.178	0.129	1.032	0.306
Farming system	-3.547	-0.295	-1.298	0.339
Sex	5.468	.0145	1.289	0.202
Marital status	0.049	0.002	0.022	0.983
Educational attainment	0.966	0.092	0.819	0.415
Primary occupation	0.294	0.035	0.198	0.844
Secondary occupation	-0.575	-0.063	-0.496	0.622
Years of experience	-4.150	-0.319*	-2.049	0.044
Income from CP	3.794E-6	0.019	0.176	0.861

R^2 =0.390

3.7. Significant difference in the perceived health effects of CP across the agro-ecological zones

Table 9 revealed a significant difference in the perceived health effects of CP across the agro-ecological zones (F=3.124). The RF zone with high mean (98.18), perceived that CP have more negative effects on the health status of rural dwellers. This could be as a result of the fact that more respondents are educated in the zone which makes them to understand the health implications of CP.

Table 9. Differences in the level of perceived health effects of CP across the agro-ecological zones

Parameter	Statistical tool	df	Sum of square	Mean square	F value	p value	Decision
Health	Analysis of variance	1	921.020	460.010	3.124	0.00	Significant

Duncan's Multiple Range Test

Duncan Grouping Mean N Zone

	94.36_a	85	GS
	98.18_b	83	RF

Letters that are the same are not significantly different

4. Conclusion and Recommendations

The study concludes that CP is dominated by male who are in their active age and married. CP constitutes several health challenges to the producers. The health status of charcoal producers may likely continue to get worse if they continue to produce charcoal.

The study therefore recommends that more foresters/environmental extension agents should be employed and equipped to control the activities of rural dwellers in the forest. Forest licensing and fees collection must be re-orgarnised and increased to prevent illegal logging. There is the urgent need for the government to quickly work on other available and affordable alternative household energy sources such as solar energy, gas, and uninterrupted electricity. The rural dwellers need regular training and workshop on proper management of the forest and its future implications on the health and human lives which will enhance people's participation in forest management. Promotion of livelihood activities which are health friendly such as bee-keeping, fishery and snailery and mushroom production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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