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Petroleum Pollution and Decrease Neuroplasticity in Brain Development of the Ogoni Children in Rivers State, Nigeria

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Authors' contributions

This work was carried out in collaboration among all authors. Authors LKD and TB designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors LKD, TB and BGG managed the analyses of the study. Authors LKD and BGG managed the literature searches. Author TB revised the first draft. All authors read and approved the final manuscript.

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ABSTRACT

Background: Health and mental related illnesses has emerged as a new challenge in the rural and undeveloped areas in Ogoniland where petroleum exploration activities have devastated the entire ecosystem. Many of the school children are no longer zealous about their academic activities, as their performances in school are always very poor. It has been reported that the children's poor performance in school is closely linked with several health and mental challenges suffered by these children in the highly polluted areas.
Methods: The study comprises of 383 primary school teachers selected from 8 rural communities in the four (4) Ogoni Local Government Areas (Gokana, Tai, Eleme and Khana) in Rivers State where massive environmental pollution has been reported. Structured questionnaires were used to

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collect the data from the teachers on the children's exposure to oil pollution; self-rated mental illnesses and behavioural symptoms among the school children, perception to petroleum pollution and mental illnesses.

Results: The results revealed that the signs of mental illnesses like anxiety disorder, attention-deficit disorder, autism spectrum disorder, mood disorder, schizophrenia and eating disorder were noticeable among the school children. The children also exhibited behavioural challenges such as extreme fear, difficulty in concentrating, self-imposed injuries, aggressive behaviour, avoiding other classmates and poor academic performances. The field survey further revealed that mental illnesses and behavioural challenges were common in areas of massive petroleum pollution of the environment. Other causes of these illnesses were revealed to be poverty and psychoactive substance use.

Conclusion: It was concluded that constant exposures of the children to environmental pollution is associated with decreasing neuroplasticity of the brain.

Keywords: Brain; children; mental illnesses; petroleum; pollution, neuroplasticity.

1. INTRODUCTION

Pollution does not only destroy the ecosystem but it is also harmful to human health [1,2,3,4,5]. Previous studies have revealed that most mental illnesses and health related challenges have resulted from a polluted environment [6, [7,8,9,10,11]. It has also been reported that most cancerous terminal diseases are common in petroleum polluted environments [12]. The effects of pollution are on the children because their defence system is not fully developed to adapt or survive in such a corrosive environment. The effect of the polluted environment often results in many illnesses and deaths among children [13,12,14]. The consequences of a polluted environment could manifest in the form of poor academic, socio-economic and functional out-comes [15,16]; which reveals the developmental, behavioural and emotional problems in young children. Thus, early detection is necessary for appropriate treatment and referrals to counteract any future negative consequences.

Air pollution is one of the consequences of petroleum exploitation; which has enormous influences on human health [12,17]. Much of the world's population breathes air that hurts their health in so many ways [18] and causes an estimate of 7 million premature annual deaths [18,19]. As adults, our bodies maybe able to adapt or cope with our polluted environment; but our new born babies and children who are particularly more susceptible may not be that lucky [18]. In these young ones, air pollution can impair immune system development in uterus and impede children's cognitive development [18]. World Health Organisation reported that 93% of children under the age of 15 on the planet breathe air that is polluted enough to jeopardized their health [18]. Environmental pollution has also being linked with respiratory infections, cardiovascular diseases, throat inflammation, chest pain, ear infections and childhood obesity [18]. Bad air from petroleum exploitation activities can negatively affect the neurodevelopment of a child, which could result in lower cognitive test outcomes and the development of behavioural disorders [12,18,14].

Aside from the health challenges posed by the polluted environment, poverty is common in the study area; as other studies have described the condition of the Ogoni people as being pathetic, despite their enormous natural endowments [15], [13]. The level of poverty in the region is so high that the parents are not able to afford the cost of primary education, as they were often required to pay for books, admission fees, examination fees, sporting fees and every other chargeable fee. The Universal Basic Education (UBE) scheme was designed to provide elementary education (Basic 1-9) free of charge for these poor children, unfortunately the programme have failed in reaching its set goals and objectives. Most unfortunately, the teachers in this sector are the lowest paid in Nigeria, as they were placed on the poorest and specific scale, called Teachers Salary Scale (TSS). Thus, even when parents managed to put their children in schools, the available teachers are not motivated enough or are too hungry to inspire or impact on the children; resulting into dropping out of school by some children due to poor motivation and lack of resources.

Developing countries are adjudged as having the highest population of *"out of school children"* due to the different prevailing environmental factors; that may result in the brain damage of these children [12]. Recognising any possible challenges early enough in young children about their mental problems are crucial in improving

developmental trajectories and reduces any likely outcome that would result into an emotional and behavioural disorder [16]. Some of these health challenges may start early in a child even immediately after birth, but may not be easily identified at a glance. In most cases, as the child grows, some of these health challenges may begin to manifest unseen or silently except when observed closely.

Normally, parents should be the first to identify any possible health challenges in their children but their love for their children and their biased judgement usually blindfold them from the truth they are faced with. The teachers on the other hand, spend more quality time with the children and this exposes them to the basic essential information about them, giving the teachers the necessary skills needed to understand and develop the children mentally, emotionally and socially. The teachers do not only build skills in these children, but they can also cultivate the desired character into them. Thus, one can conclude that teachers play an important role in early problem detection in children [16]. Teachers can be more objective in observing children's development and measure their performance than their parents do. The teachers also have developed a broad knowledge about the children through their experiences with the many children that have passed through their tutelage. Thus, over time a teacher can correlate behaviours that are perceived to be out of place in a child and use such experience to identify health problems easily in another child.

Some of the notable consequences of mental challenges are anxiety disorder (attribute such as obsessive-compulsive disorder; post traumatic stress disorder; social phobia (which normally interferes with their daily activities); attention deficit/hyperactivity disorder (difficulty paying attention, hyperactivity and impulsive behaviour); autism spectrum disorder (child's inability to communicate and interact with others); eating disorders (a child eating in a manner that is disgusting or different from the usual manner); mood disorder (depression and bipolar disorder-the persistent feeling of sadness or extreme mood swings than the usual) and schizophrenia-psychosis (losing touch with reality) [20].

1.1 Aim of the Study

This study examines the relationship between petroleum pollution and the decrease neuroplasticity in brain development of the Ogoni children. To achieve this aim, the following specific objectives were considered:

i. Identification of children with mental and behavioural challenges;
ii. Determination of how petroleum pollution may influence brain development of children.

1.2 The Study Area

Ogoni is among the several ethnic minorities in River State Nigeria, which occupy a territory of approximately 404 square miles, which forms the part of the Eastern Niger Delta, between the Imo River on the East and North. The area lies between latitudes $4^{o}.05^{1}$ and $4^{o}.20^{1}$ North and longitudes $7^{o}.10^{1}$ and $7^{o}.30^{1}$ East [21]. Ogoniland is situated in the coastal plain of the eastern Niger Delta. Its topography is mainly characterized by rivers, lakes, creeks, lagoons and swamps of varying dimensions. Most water channels in the freshwater zone are bordered by natural levees that provide the basis for settlements and agriculture [22].

United Nations Environment Programs (UNEP) in 2011 reported that Ogoni communities were unprotected against petroleum pollutants in both outdoor air and drinking water which were always in high concentrations [13,23]. The massive pollution of the land has resulted to hydrological changes and groundwater pollution [23] that will require about 25-30 years of remediation to achieved complete restoration of the land [24]. During the environmental assessment of Ogoniland in 10 of the communities were sampling took place, 28 wells were detected to have been polluted with organic materials; 7 of these samples were 1000 times higher than the Nigeria drinking water standard. Communities in Ogoniland were reported to be using water from wells that were contaminated in excess of safe limit [15,12,23]. Despite the full awareness of the consequences of pollution [15,25]; the community dwellers still drink this contaminated water for survival because of lack of an alternative [26]. The people of Ogoni are already suffering the consequences of living in a polluted environment, as it has been reported that illnesses such as mental disorders, blood disorders, cancers of different organs, birth abnormalities, respiratory diseases, bad vision, asthma, skin rashes, heart attacks, ulcers, lung and throat infections, miscarriages and untimely menopause are now fully in manifestation in the communities [12,27,28,29]. Consequently, oil pollution has been blamed for a number of persisting public health challenges [15,23].

2. METHODOLOGY

This study took place between September 11th, 2017 and July 27th, 2018 which covers one academic session. Primary school teachers were used as respondents for this study. The selected teachers were given one week comprehensive training by psychologists (experts trained to evaluate and diagnose mental illnesses but usually treat them through counselling or behavioural therapy) and psychiatrists (medical doctors who diagnose mental illnesses and write prescriptions for medications). The essence of the training was to enable the teachers to identify signs of mental illnesses among the school children in their custody. Thus, this study focused on identifying possible mental and behavioural illnesses in school children between the ages of 6 to 13 years old that maybe related to petroleum pollution of the environment. Structured questionnaires were used to collect that data from the respondents (the selected teachers) on the children's exposure to oil pollution; self rated mental illnesses and behavioural symptoms among the children and the perception to petroleum pollution and mental illnesses.

2.1 Population and Sample Size

The population of Ogoni is 1,302,455 (comprising 298,986; 358,418; 460,766 and 184,290 for Eleme, Gokana, Khana and Tai respectively) according to Bodo [4] projected population data as shown on Table 1.

Out of the four Local Government Areas (LGAs) in Ogoni, two oil bearing or petroleum impacted communities were selected from each of the LGA and four primary schools were chosen from these communities as shown in Table 2.

Table 1. Calculated projected population of Ogoni

LGAs	Population (2006)	Projected population (2016)
Eleme	218,200	298,986
Gokana	261,570	358,413
Khana	336,267	460,766
Tai	134,495	184,290
Total	950,532	1,302,455

2018 projected population of Ogoni [18]

Table 2. Selected communities

LGA	Chosen communities	No. of selected primary schools	Nature of primary school	
			Public	Private
Gokana	Bodo	4	3	1
	Bomu	4	2	2
Khana	Kpean	4	2	2
	Sii	4	2	2
Tai	Nonwa Tai	4	3	1
	Koroma	4	2	2
Eleme	Onne	4	3	1
	Akpajo	4	3	1

Source: Fieldwork, 2018

Table 3. Questionnaire distribution

LGA	Chosen communities	Questionnaire distribution	No.of retrieved questionnaires
Gokana	Bodo	50	48
	Bomu	50	46
Khana	Kpean	50	48
	Sii	50	47
Tai	Nonwa Tai	50	49
	Koroma	50	48
Eleme	Onne	50	48
	Akpajo	50	49
Total		400 (100%)	383 (95.75%)

Source: Fieldwork, 2018

The sample size was subsequently determined through the use of TARO YAMANE sample size determination formula [15]. Subsequently, the 400 questionnaires were distributed equally among the chosen communities since the population sizes were fairly the same as discovered from the reconnaissance survey.

3. RESULTS AND DISCUSSIONS

3.1 Socio-economic Characteristic of Respondents

The data in Table 4 showed that the teachers that participated in this survey, cut across the four LGAs in Ogoni with 24.54% (94), 24.28% (93), 25.32% (97) and 25.32% (97) from Gokana, Khana, Tai and Eleme respectively. 51.95% (199) of the teachers were male while 48.04 (184) were female. Majority of the teachers are educated with 61.61% (236) and 37.59% (144) having NCE/ND and B.Ed/BSc respectively while only 0.78(3) had a master's degree. Majority of teachers (74.4%) are married, with only 7.83% as singles and 17.75% as widows/widowers. All the teachers claimed that their financial status were low as shown on Table 4.

3.2 Children with Mental and Behavioural Challenges

In the selected schools, the teachers through their wealth of experience and the knowledge from the medical training; identified the children in their classes that have exhibited signs of mental and behavioural challenges as shown on Table 5.

The field data obtained in all Local Government Areas (LGAs) in Ogoni revealed that some of the children showed signs of mental and behavioural challenges with 14.89%, 8.60%, 16.49%, and 10.30% for Gokana, Khana, Tai and Eleme respectively as shown on Table 5.

Table 4. Socio-demographic characteristics of primary school teachers in Ogoni

Characteristics	Frequency (f)	Percentage (%)
Age		
21-30	50	13.05
31-40	150	39.16
41-50	103	26.89
51-60	80	20.88
LGA		
Gokana	94	24.54
Khana	93	24.28
Tai	97	25.32
Eleme	97	25.32
Sex		
Male	199	51.95
Female	184	48.04
Educational Qualification		
FSLC	0	0
SSCE(WAEC/NECO)	0	0
NCE/ND	236	61.61
B.Ed/BSc	144	37.59
MSc	3	0.78
PhD	0	0
Marital Status		
Single	30	7.83
Married	285	74.4
Divorced	0	0
Widow/widower	68	17.75
Perceived financial status		
High	0	0
Moderate	0	0
Low	383	100

Source: Fieldwork, 2018

The field data showed that some of the children were showing notable sign of these illnesses. The teachers in the selected schools revealed that some their children were suffering from mental illnesses such as anxiety disorder (2.08%), attention-deficit/hyperactivity (28.08%), autism spectrum disorder (10.44%), mood disorder (20.88%), schizophrenia (1.30%), and eating disorder (28.98%).

Aside from the already noticed mental illnesses, the children were also exhibiting behavioural challenges through showing less concern for their safety (28.98%), poor school performance (78.32%), aggressive behaviour (65.27%), frequent complaints of headaches and stomach aches (2.61%), self imposed injuries (1.03%), difficulty concentrating (81.20%), neglecting decent appearances (83.28%), extreme fear (1.03%) and avoiding classmates (2.61%) as shown on Table 6.

More of the younger children within the ages of 6-7 and 8-9 years were suffering from mental and behavioural challenges as against children within the ages of 10-11 and 12-13 as shown on Table 7. This is a clear indication that the younger children were more prone to environmental influences or the consequences of environmental pollution; as they showed more visible signs of these mental illnesses as compared to their older counterparts.

3.3 Petroleum Pollution influences on Brain Development

The teachers in this study recognised the influences on petroleum pollution and other environmental factors on the developing brain of the children. The field data revealed that oil exploration is currently on-going in the chosen communities as 94% of the teachers agreed to this opinion, while 5.22% of the teachers believe

Table 5. General survey of children with and without mental and behavioural challenges in the selected communities

LGA	No. of retrieved questionnaires	No. of pupils suspected to show signs of mental and behavioural challenges (frequency & percentage)	No. of children free from mental and behavioural challenges (frequency & percentage)
Gokana	94	14 (14.89%)	80 (85.10%)
Khana	93	8 (8.60%)	85 (93.39%)
Tai	97	16 (16.49%)	81 (83.50%)
Eleme	97	10 (10.30%)	87 (89.69%)

Source: Fieldwork, 2018

Table 6. Multiple responses on the identification of children with mental and illnesses and behavioural challenges

S/N	Variables	Frequency (f)	Percentage (%)
1.	**Mental illnesses:**		
	a. Anxiety disorder	8	2.08
	b. Attention-deficit/hyperactivity (ADHD)	319	83.28
	c. Autism spectrum disorder(ASD)	40	10.44
	d. Mood disorder	80	20.88
	e. Schizophrenia	5	1.30
	f. Eating disorder	111	28.98
2.	**Behavioural challenges:**		
	a. Showing less concern for one's own safety	111	28.98
	b. Poor school performance	300	78.32
	c. Noncompliant or aggressive behaviour	250	65.27
	d. Frequent complaints of physical symptoms such as headaches and stomach aches	10	2.61
	e. Self imposed injuries	5	1.03
	f. Difficulty concentrating	311	81.20
	g. Neglecting decent appearances	319	83.28
	h. Extreme fear	5	1.03
	i. Avoiding other classmates.	10	2.61

Source: Fieldwork, 2018

Table 7. Prevalence of mental and behavioural illnesses among children of different age groups

LGA	No. of retrieved questionnaires	Ages of children	Frequency	Percentage
Gokana		6-7	7	7.44
		8-9	3	3.19
	94	10-11	2	2.12
		12-13	2	2.12
		Total	14	14.89
Khana		6-7	4	4.03
		8-9	3	3.22
	94	10-11	1	1.07
		12-13	0	0
		Total	8	8.60
Tai		6-7	6	6.18
		8-9	6	6.18
	97	10-11	2	2.08
		12-13	2	2.08
		Total	16	16.49
Eleme		6-7	4	4.12
		8-9	3	3.09
	97	10-11	2	2.08
		12-13	1	1.03
		Total	10	10.30

Source: fieldwork, 2018

Table 8. Multiple responses to petroleum pollution influences on the developing brain

Variable	Frequency (f)	Percentage (%)
Knowledge of the environment		
(a) Oil exploration is going on in the communities.		
YES	363	94.7
NO	20	5.22
(b) The community environment is polluted.		
YES	383	100
NO	0	0
(c) Illnesses in the communities are linked with petroleum pollution.		
YES	375	97.9
NO	8	2.08
Perceived causes of mental illnesses and behavioural challenges		
(a) Polluted environment	363	94.7
(b) Poverty	45	11.74
(c) Heredity	0	0
(d) Psychoactive substance use	50	13.05
(e) Others, please specify	0	0
Common complaints from petroleum exposures		
(a) Headache	383	100
(b) Nausea	311	81.20
(c) Dizziness	343	89.55
(d) Respiratory diseases	111	28.98
(e) Skin rashes and irritations	311	81.20
(f) Others, please specify	0	0

Source: Fieldwork, 2018

that there are no current oil explorations in the communities. The results further revealed that the communities are massively polluted as a result of previous and current oil exploration activities with many associated mental illnesses. The field data revealed that root causes of the

mental and behavioural challenges among primary school children in Ogoni are petroleum pollution (94.7%), poverty (11.74%) and psychoactive substance use (13.05%) as shown on Table 7. The exposures of the children to petroleum pollution, which is the major causative factor of the mental illnesses in the communities (94.7%) has resulted into common complaints like headaches (100%), nausea (81.20%), dizziness (89.55%), respiratory diseases (28.98) and skin rashes and irritations (81.20%). Aside from the above findings, it was observed during field survey that a great number of children suffering from mental and behavioural challenges are from communities (like Bodo, Bomu, Kpean and Koroma) where the petroleum pollution has destroyed every natural system like streams, rivers and arable lands. The natives in these areas rely solely on their farm produce, streams and rivers for their food and sources of water supply for drinking and other domestic purposes. Hence, water and food contamination was also a contributing factor aside from the air pollution which is already a common denominator in Ogoniland [2,15,13,3,4].

4. CONCLUSION

There are links between petroleum pollution and decrease neuro-plasticity of the developing brain of the Ogoni children, as this study exposes that fact. Previous scholars have also acknowledged that the numerous mental challenges and illnesses in Ogoniland are linked with the petroleum pollution of the entire ecosystem [30,12,31]. Most of these mental challenges are always overlooked or may not be identified without close attention and that is why the teachers who built skills, knowledge and morals into these children, can play a key role in its detection. The teachers in primary schools reported to have often noticed signs like aggressive behaviour, poor hygiene, eating disorder, attention deficit and many other challenges in their children. Though, poverty and psychoactive substance use were also mentioned as some of the contributors of mental illnesses in these school children, but the main cause were said to be petroleum pollution of the environment. Previous scholars also asserted that psychoactive substance use, poverty and environmental pollution were the causative factors of mental illnesses in Ogoniland [13,12,32].

In this study, pollution has been recognised as the key causative factor of decrease neuro-plasticity of the developing brain of the primary school children in Ogoni. Exposure to pollution has adverse effects on the pulmonary and cardiovascular systems which have been well established in series of major epidemiological and observational studies [1,33]. Constant exposures of the younger children to environmental pollution can gradually lead to decrease neuroplasticity of the brain.

CONSENT

As per international standard or university standard, patient's written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Bandyopadhyay A. Neurological disorder from ambient (urban) air pollution emphasizing UFPM and $PM_{2.5}$. Current Pollution Reports. 2016;2(3):203-211.
2. Bodo T. Deep issues behind the crisis in the Niger Delta Region: The case of oil exploration in Ogoniland, Rivers State, Nigeria. Asia Journal of Geographical Research. 2019;2(1):1-12.
3. Bodo T, Bodo CB. The applicability of the rule in Rylands V. Fletcher to petroleum activities in Nigeria. Asian Journal of Advance Research Reports. 2019;3(1):1-10.
4. Bodo T, Gimah GB. Government programmes in checking the occurrence of habitat loss and their implications for maintaining sustainable environment in Ogoni, Rivers State, Nigeria. European Journal of Biomedical and Pharmaceutical Sciences. 2018;5(12):64-71.
5. Gimah BG, Bodo T. Creation of awareness through environmental adult education as a solution to the problem of habitat loss in Ogoni, Rivers State, Nigeria. International Journal of Advanced Research and Publications. 2018;2(12):8-15.
6. Nriagu J, Udofia EA, Ebuk G. Health risk associated with oil pollution in the Niger Delta, Nigeria. International Journal of Environmental Research and Public Health. 2016;13(3):346.

7. Levy BS, Nassetta WJ. The adverse health effects of oil spills: A review of the literature and a framework for medically evaluating exposed individuals. Int J Occup Environ Health. 2011;17(2):161-7.
8. Aguilera F, Mendez J, Pasaro E, Laffon B. Review on the effects of exposure to spilled oils on human heath. J Appl Toxicol. 2010;30(4):291-301.
9. Berkmann C, Schulte-Mark M. Prevalence of emotional and behavioural disorders in German children and adolescents: A meta-analysis. J. Epidemiol Community Health. 2012;66:194-203.
10. Costella EJ, Erkanli A, Angold A. Is there an epidemic of child or adolescent depression? J Child Psychol Psychiatry. 2006;54(12):1263-74.
11. How are mental illnesses in children. Available:www.kidsmentalhealth.org/how-is-mental-illness-in-children-diagnosed/ (Retrieved 10th January, 2019)
12. David LK, Bodo T. Environmental pollution and health challenges of the Ogoni People, Rivers State, Nigeria. International Journal of Advanced Research and Publication. 2019;3(2):28-32.
13. Bodo T, David LK. The petroleum exploitation and pollution in Ogoni, Rivers State, Nigeria: The community perspective. European Scientific Journal. 2018;14(32): 197-212.
14. O'Callaghan-Gordo C, Orta-Martinez M, Kogevinas M. Health effects of non-occupational exposure to oil extraction. Environ Health. 2016;15:56.
15. Bodo T. Community understanding of the environmental and socio-economic consequences of petroleum exploitation in Ogoni, Rivers State, Nigeria. International Journal of Advanced Research and Publications. 2018;2(11):51-55.
16. Desta M, Deyessa N, Fish I, Maxwell B, Zerihun T, Levine S, Fox C, Giedd J, Zelleke GT, Alem A, Garland AF. Empowering preschool teachers to identify mental health problems: A task-sharing intervention in Ethiopia. Mind, Brain and Education. 2017;11(1):32-42.
17. Latton B, Pasaro E, Valdiglesias V. Effects of exposure to oil spills on human health: Updated review. J. Toxicol Environ Health B Crit Rev. 2016;19(3-4):105-28.
18. Zoe Schlanger. Air pollution is impeding our children's brain development. Available:http://www.google.com/amp/s/qz.com/1446353/air-pollution-is-making-our-children-dumber/amp/ (Retrieved February 16th, 2019)
19. Barron MG. Ecological impacts of the deepwater horizon oil spill: Implications for immunotoxicity. Toxicol Pathol. 2012;40(2): 315-20.
20. Some notable consequences of mental challenges. Available:https://www.mayoclinic.org/health-lifestyle/children-health/in-indepth/mental-illness-in-children/art-2004657 (Retrieved February 16th, 2019)
21. Agbonofo J. Development as conflict: Ogoni movement, the state and oil resources in Niger Delta, Nigeria, doctoral thesis; 2009. Available:http://repub.eur.nl/res/pub/32647/90-423-03808_DOK%5B1%5D (Retrieved on the 5th June, 2018)
22. UNEP. Environmental Assessment of Ogoniland. Nairobi, Kenya: United Nations Environment Programme; 2011.
23. Udoh IA. Public health emergency, UNEP environmental assessment and the clean-up of Nigeria's Niger Delta. Arts and Humanities Open Access Journal. 2018; 2(6):386-389.
24. United Nations Environment Program. Environmental Assessment of Ogoniland; 2011. Available:http://postconflict.unep.ch/publications/OEA/UNEP_OEA.pdf (Accessed on 29 December 2018)
25. Yakubu OH. Addressing environmental health problems in Ogonil and through implementation of United Nations Environment Program recommendations: Environmental management strategies. Environment. 2017;4(28):1-19.
26. Bodo T, Ukpong IE. Community participation in the remediation of petroleum impacted sites in Ogoni, Rivers State, Nigeria. Multi-disciplinary Journal of Research and Development Perspectives. 2018;7(3):97-104.
27. Daiz JH. The legacy of the Gulf oil spill: analyzing acute public health effects and predicting chronic ones in Louisiana. Am J Disaster Med. 2011;6(1):5-22.
28. Nriagu J. Oil industry and the health of communities in the Niger Delta of Nigeria. In Encyclopedia of Environment Health; Jerome, O.N., Ed.; Elsevier:

Burlington, NJ, USA. 2011;240-250.
29. Frynas JG. Oil in Nigeria: Conflict and litigation between oil companies and villages communities; LIT Verlag: Hamburg, Germany; 2000.
30. Beauchaine TP, Gatzke-Kopp L, Mead HK. Polyvalgal theory and development psychopathology: Emotion dysregulation and conduct problems from preschool to adolescence. Biological Psychology. 2007; 74(2):174-184.
31. Ozonoff S. Editorial: Early detection of mental health and neurodevelopment disorders: The ethical challenges of a field in its infancy. Journal of Child Psychology and Psychiatry. 2015;56:933-935.
32. Vidona WB, Wadioni A, Okeke SN, Bodo T. Evaluation of psychoactive substance use and its risk factors among Public School Students of Rivers State, Nigeria. Asian J. Pharm. Res. 2017;7(3):175-182.
33. Genc S, Zadeoglulari Z, Fuss SH, Genc K. The adverse effects of air pollution on the nervous system. Journal of Toxicology. 2012;Article ID 782462:23.
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APPENDIX QUESTIONNAIRE

(For Primary School Teachers Residing in Oil Bearing Communities in Ogoni)

We are researchers from the Department of Anatomy, University of Port Harcourt, Rivers State; Department of Geography and Natural Resource Management, University of Uyo, Akwa Ibom State; and Department of Curriculum Studies and Instructional Technology, Ignatius Ajuru University of Education, Rivers State.
This questionnaire is designed to obtain information on the topic-

Petroleum Pollution and Decrease Neuroplasticity in Brain Development of the Ogoni Children in Rivers State, Nigeria

We assure you that the information provided will be used strictly for academic purpose and kept confidential.

Kindly complete the blank spaces and put marks in the appropriate boxes as applicable.
Thank you.

Dr. Lekpa Kingdom David, Dr. Tombari Bodo and Mr Batombari Gbidum Gimah

July, 2017.

Part I: Demographic Data

1. Gender:

(a) Male [ ]
(b) Female [ ]

2. Age:

(a) 21-30 [ ]
(b) 31-40 [ ]
(c) 41-50 [ ]
(d) 51-60 [ ]

3. Highest Academic Qualification:

(a) FSLC [ ]
(b) SSCE (WAEC/NECO) [ ]
(c) NCE/ND [ ]
(d) B.Ed/BSc/HND [ ]
(e) MSc [ ]
(f) Ph.D [ ]
(g) Others [ ]

4. LGA:

(a) Gokana [ ]
(b) Khana [ ]
(c) Tai [ ]
(d) Eleme [ ]

5. Marital Status:

(a) Single [ ]
(b) Married [ ]
(c) Divorced [ ]
(d) Widow/Widower [ ]

6. Perceived Financial Status:

(a) High [ ]
(b) Moderate [ ]
(c) Low [ ]

7. Part II: Identification of Children with mental and behavioural challenges

Mental illnesses identified	Tick (as many as applicable)
a. Anxiety disorder	
b. Attention-deficit/hyperactivity (ADHD)	
c. Autism spectrum disorder (ASD)	
d. Mood disorder	
e. Schizophrenia	
f. Eating disorder	
g. Others (please specify)	

7.

Behavioural challenges identified	Tick (as many as applicable)
a. Showing less concern for one's safety	
b. Poor school performance	
c. Noncompliant or aggressive behavior	
d. Frequent complaints of physical symptoms such as headaches and stomach aches	
e. Self imposed injuries	
f. Difficulty concentrating	
g. Neglecting decent appearances	
h. Extreme fear	
i. Avoiding other classmates	
j. Others (Please specify)	

8. General survey of children with and without mental and behavioural challenges

Ages of children in class	No. of children with mental challenges	No. of children without mental challenges
6-7		
8-9		
10-11		
12-13		

Part III: Petroleum Pollution Influences on Brain Development

9. Oil exploration is going on in the communities (a) YES (b) NO

10. The community environment is polluted (a) YES (b) NO

11. Illnesses in the communities are linked with petroleum pollution (a) YES (b) NO

12. Perceived causes of mental illnesses and behavioral challenges

(a) Polluted environment
(b) poverty
(c) Heredity

(d) Psychoactive substance use
(e) Others, please specify……

13. Common complaints from petroleum exposures
    (a) Headache
    (b) Nausea
    (c) Dizziness
    (d) Respiratory diseases
    (e) Skin rashes and irritations
    (f) Others, please specify……

14. Any other contribution (Write expressly)…….....

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