AN EPIDEMIOLOGICAL STUDY ON CASES OF UNUSUAL SKELETAL DISORDER IN PARTS OF DAMATURU TOWN OF YOBE STATE

BY

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DECLARATION

I hereby declare that this is an original work conducted by me under the supervision of professor P. Singha and had not been presented or published elsewhere by anybody.

Ahmad Abdulwahab

Signature

Date:

CERTIFICATION

This work entitled: An epidemiological study on cases of an unusual skeletal disorder in parts of Damaturu town of Yobe State meets the regulations governing the award of the Degree of Master of Public Health of Ahmadu Bello University Zaria.

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DEDICATION

This project is dedicated to my Wife Halimat and my two kids, Nasir and Abdulwahab.

ACKNOWLEDGMENT

I will begin by thanking the Almighty Allah subhanahu wata'ala for giving me His Supreme Guidance, Support and Strength to pursue this course to it's successful end.

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ABSTRACT

The study was carried out in Pawari and shehuri communities of Damaturu town, the Yobe State capital that were afflicted with an unusual skeletal disorder affecting the children (0 - 14yrs.) of the area.

The study was aimed at finding out the nature and magnitude of the disorder as well as the principal determinants of the occurrence of the disorder. It was also aimed at verifying the strength of the claim that the disorder was probably caused by certain abnormal constituents of their water.

The study design was that of a case control study. All the 63 affected households (i.e. households with at least a case of the disorder) formed the group of cases while the control households were randomly selected from the list of the remaining 109 households without at least a case of the disorder.

The findings were that 110 children, between 0 - 14yrs, out of the 557 children in that age group living in the area, representing 19.75%, were affected by the disorder. The prevalence was found to be more amongst males than females - 25.10% and 14.78% respectively. There was no case of an infant with the deformity while most of the cases were between the ages of 1 - 9yrs (91/110 or 82.73%), but the age specific prevalence with respect to the population of children in the affected households was highest in the 1 - 4yrs age group (56%).

About 61.36% and 79.55% of the affected children were found to be underweight and stunted respectively; this was significantly higher than the corresponding figures for their unaffected siblings within the same households ie. 33.33% and 44.44% respectively as well as that of the children of the control household i.e. 14.81% and 22.22% for underweight and stunting respectively. Similarly the proportion of all the under fives (both affected and unaffected) in the affected households with under weight and stunting i.e. 48.75% or 39/80 and 51/80 or 63.75% respectively are higher significantly than the corresponding proportions in the control households i.e. 4/27 or 14.81% and 6/27 or 22.22%.AIso the proportions were significantly higher in the unaffected children of the affected households(33.33% and 44.44%) than in the children of the control households(14.81%and 22.22%) for underweight and stunting respectively.

There were no evidences to support either a familial / genetic predisposition to the development of the disease. Similarly, epidemiological as well as laboratory analyses carried out did not support the claim that the disorder was associated with water or chemicals used in the households.

Clinical and laboratory evidences however supported the most likely diagnoses of the disorder being rickets, and relating this to the findings of the epidemiological analyses, concluded that the rickets was most likely nutritional in origin and most

probably due to inhibition of calcium and vitamin D absorption and reabsorption in the small intestine by some food constituents

Based on this conclusions, it was suggested that a further analytical study is required to confirm this conclusions; and that in the mean time, a nutritional intervention programme be commenced in the communities using the strategy of community level nutrition information system of action (COLNISA).

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CHAPTER ONE

INTRODUCTION

Most if not all the diseases we now know much about were at one time or the other not recognized or their characteristics not understood. Understanding of the disease usually begins with the identification of an individual or group of individuals with the condition e.g. what is now known as Burkitts Lymphoma, was first recognized in a boy named Africana, in Uganda in 1957; or the case of Legionnaires disease in-group of American Legions [1]. This was usually followed by a detailed investigation to find out the aetiological factors associated with the occurrence of the condition. All put together they provide the knowledge about the distribution and determinants of the disease available today. History has also shown that occurrence of cases of an unusual disease condition may be a forerunner to a larger problem e.g. the description by Gotilieb et-al in 1981 of unusual cases of a form of Pneumonia in 4 homosexuals is what metamorphosed into the global AIDS Pandemic [2]. Thus, cases of an unusual disease occurring anywhere need to be carefully investigated.

PROBLEM STATEMENT

For the past twenty years or so, the inhabitants of Pawari and Shehuri wards of Damaturu town, the Yobe State capital, have been faced with gradually increasing cases of a yet-to-be diagnosed skeletal disorder. This disorder mainly affects children

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causing different types of deformities of the skeletal system like those the limbs, skull, chest, spine and pelvis. Consequently, the affected children walk with different kinds of gaits while in extreme cases they cannot walk and so move around by crawling. The problem is quite enormous that one is tempted to conclude that every other child in the community is affected by the disorder. This may not be the exact estimate but is nevertheless very serious.

According to the elders of these two adjacent communities (they were actually the same community prior to the construction of the tarred road which now divided them), the problem started after the tarred road, which passed through the communities, was constructed. They believed that the disorder was due to the wrath of some Spirits (Supernatural forces) who resided in the huge baobab (Kuka Trees in Hausa) and tamarind (Tsamiya Trees in Hausa) trees that were uprooted and destroyed during the process of the road construction.

On the other hand, the state ministry of health opined that the problem may likely be traceable to their water source or that the problem might be attributable to the stream which passed by the area which might have been contaminated with chemicals used during the process of the said road construction.

All these are mere conjectures, which are yet to be ascertained, consequently the problem continues to grow day after day. Thus, it is right to conclude that there is a real problem facing the communities in particular and the whole state in general.

RATIONALE FOR THE STUDY

To date no study has been conducted to ascertain the true picture of the problem, thus no concrete interventional measures could be put in place. As a consequence of this, the people do not take their wards to the hospital but to the traditionalist who more often than not complicates the situation, either directly (child situation becoming worse) or indirectly (the parents becoming financially incapacitated and psychologically frustrated).

Secondly, I personally want to initiate an interventional programme, which will in the long run reverse the problem. But this cannot be done without a clear understanding of what the problem is really is.

OBJECTIVES OF THIS STUDY

The objectives of this study are divided into 2 main groups -- broad and specific objectives.

The broad objectives were

1. To assess the nature, magnitude, distribution and possible determinants of the disorder by the end of the study.
2. To test the hypothesis that the disorder has association with water or chemicals used by the inhabitants by the end of the study

The specific objectives were

1.1 To describe the salient health and demographic characteristics of both the affected and the unaffected households as at September, 2000

1.2 To determine the prevalence and estimate of the incidence of the disorder as at September, 2000

1.3 To outline the descriptive epidemiology of the children with the disorder as at September, 2000

1.4 To describe the clinical and relevant laboratory features of the disorder in affected children as at September, 2000,

2.1 To determine the association between water and the chemicals commonly available in the community and the development of the disorder.

2.1 To outline possible ways of prevention and control of the disorder.

SIGNIFICANCE OF THE STUDY

The findings is primarily aimed at benefiting the children already affected by the disorder and the other children too who are also potential candidates as it will attempt to provide affordable, accessible, applicable and acceptable ways of preventing and controlling the disorder in the community.

The findings will also benefit the medical community especially those dealing or concerned with problems of children.

CHAPTER TWO

INVESTIGATING CASES OF UNUSUAL DISEASES/EPIDEMIC

An epidemic {from Greek word, epi = upon and demos = people} according to Last [3], is the occurrence in a community or region of cases of an illness, specific health related behavior, or other health related events clearly in excess of normal expectancy. The community or region and the time period in which the cases occur, are specified precisely. The number of cases indicating the presence of an epidemic will vary according to the agent, size and type of population exposed, previous experiences or lack of exposure to the disease, and time and place of occurrence; *epidemic is thus relative to the usual frequency of the disease in the same area*, among the specified population, at the same season of the year. A single case of a communicable disease long absent from a population or 1st Invasion by a disease not previously recognized in that area requires immediate reporting and full field investigation; two cases of such a disease associated in time and place may be sufficient an evidence to be considered an epidemic.

Epidemics, which are usually produced by some special causes not generally present in the affected locality, have been a major concern of epidemiology from the earliest days of the discipline to the present.

As a consequence of the differential exposure to or presence of the causative factor(s) in the community, a particular pattern is often established which is directly or indirectly related to the presence or absence of the factor. The identification of the

pattern may eventually lead to or give a clue to the incriminating agent(s) or factor(s). A painstaking and meticulous search for the pattern is thus an essential component in investigating a disease.

A transient change in the apparent incidence of a disease may have any of several origins. It may be an artifact or chance phenomenon; alternatively it may be owed to a variation in the levels of known causes of the disorder. However, a third and most important possibility in a researcher's point of view, is that it may be owed to a temporary alteration in a previously unnoticed causal factor [4].

Over the years, the approach being used to investigate an epidemic either of a known disease or a previously unrecognized disease revolves round the principles of epidemiology. This could either be observational or experimental.

Observational study could be descriptive or analytic or both descriptive and analytical (mixed) [5]. The descriptive approach focuses on observing the distribution of diseases or health related conditions in human population and identifying the characteristics, which the condition is associated with, while the analytical approach aims at establishing causation.

A descriptive study is usually the 1st step towards the investigation of a disease or health related condition[2,5,6]may begin with the report of a case which is unusual; for instance Oyeneyin et-al (1999) [7] described the occurrence of a case of carcinoma of the penis in a 70 year – old Nigerian. This condition is said to be very rare in Nigeria but is the most commonly diagnosed carcinoma

in Uganda. When series of such cases are reported in parts of Nigeria, for instance, investigation may be required to find out the factor (s) associated with the sudden increase in the reported cases. A descriptive study can also be conducted in the form of a cross-sectional survey of a sample of the population. This gives the description of the disease or health related condition as to who is affected (person) where it occurs (place) and when does it occur (time). Such a study is employed to get a clear idea on distribution of the disease or health related condition in the population. From the data generated a hypothesis may be generated as to the factor (s) responsible for the distribution and based on this a control programme or necessary policy formulations can be instituted. For instance, in order to get a clearer *understanding of the distribution as well as the magnitude of childhood* behavioral disorders in Ilorin, Nigeria, Adelakan et-al (1999)[8] selected a sample of 846 parents in the area and questionnaire was administered to them, (self completed or administered by Interviewer depending on literacy level of respondent) after pre-testing of the questionnaire ;from the data collected ,and using the diagnostic /eligibility criteria for the study, they where able to describe the prevalence of childhood behavioral disorders as well as the clinical spectrum of the disorders. Also from the data they were able to outline the various risk factors like children from broken homes, those whose mothers suffered a major illness during the pregnancy & children who had had delayed

developmental milestones. Based on the findings they were able to recommend the need for a comprehensive child mental health package. This is one of the aims as well as advantage of a descriptive study of such nature. Knowledge attitude and practice (KAP) studies are a form of descriptive cross-sectional studies that also provide baseline data on the topic under study . This will then provide data for appropriate planning process. For example Ibrahim et-al [9] did a KAP study on women attending PHC clinics in Sokoto. A cross section of 600 women was randomly selected and a questionnaire administered to each of them. The study provided information on the prevalence of use of contraceptives as well as factors that favour approval or disapproval of contraceptive use. And from that, recommend the most appropriate strategies for the effective bridging of the barriers to effective family planning.

However, some of the limitations of descriptive studies include the fact that no data can be generated on incidence and are not effective in establishing causal association or otherwise between a suspected factor and a disease process, i.e only a hypothesis can be drawn from the results of a descriptive study.

After the formulation of an hypothesis, the type of study to be used to establish the existence or non existence of a relationship between a suspected

factor and a disease is an analytical study. The design of this type of study could be prospective or retrospective

The basic difference between the two is that a prospective study proceeds forward from cause to effect while a retrospective study proceeds backward from effect to cause i.e the disease process has already occurred in the study group before the start of the study. The choice of which of the two designs to choose depends on what is being investigated as well as the resources and time available to the researcher. For example, in Hungary, between 1975 and 1978,there was an increase in the occurrence of congenital limb reduction abnormalities (CLRA). This was said to have been preceded by the introduction of a new population policy for the country in 1974; involving restriction in abortion laws which resulted in a considerable decrease in the previously very; high number of induced abortions and slight increase in total births and there was growing suspicion on the relationship between these two events. Faced with this problem, Andrew Czeizel [10]and his colleagues designed a case control study to find out the most probable variable(s) associated with this increase. Study cases were identified from the Hungarian malformation registry and equal number of controls matched for age, sex and residence were also selected. The parents were interviewed and the information recorded on a printed data sheet. Among several factors investigated, they were able identify four variables as being slightly but significantly higher among the study group than in the control Similarly, a case control study was carried out in an area with a very high incidence of

schistosomiasis in Japan, to ascertain the role of schistosomiasis in liver cancer. The study was necessitated by the concomitant high incidence of of liver cancer in that area (higher than the national figure). To do this, Yutaka et-al[11] selected 62 cases of liver cancer from seven hospitals in the schistosomiasis endemic area. Equal number of controls were selected from the same area and matched for age and sex and were confirmed to have no liver disease at the time of the study. Apart from schistosomiasis, other aetiological factors were also considered. The findings were very firm in establishing a causal relationship between schistosomiasis and development of liver cancer with a percentage attributable risk of 89.5% and a population relatives risk of 3.55.

One of the limitations of retrospective analytical studies is the issue of recall bias by the respondents and this was pointed out by Andrew et-al in a study earlier cited.

Prospective studies, unlike retrospective studies, involve the selection of cohorts which are then followed for a desired period of time. They provide information on causation as in retrospective studies and have the added advantage of providing data on incidence. Some of the limitations of prospective studies include being more expensive, time consuming, high attrition rates and raises lot of ethnical issues. The Framingham heart study in 1948 by the U.S public health service is a good example of this type of studies.[2]

Another way of establishing causation/ effects of a factor is to carry out an experimental study in which the volunteers are exposed to the factor and followed for the desired period to observe the effects. The study subjects could be experimental animals in the lab as in the early stages of drug trials or a large field trials involving lot of human volunteers. For instance S.A Adigun [12] et-al carried out experiments on rat to observe the relationship between vitamin C and protection against hypertension. The rats were divided into groups, one group were give sodium chloride rich diet, while another received vitamin C in addition to the salty diet. The results showed that the 1st group developed hypertension while the 2nd group had a significantly higher blood pressure and using relevant analytical calculations concluded that vitamin C gives protection against the development of hypertension.

The limitation of this kind of study is finding human volunteers, the huge cost involved and lots of ethical problems.

CHAPTER THREE

BACKGROUND INFORMATION ON THE STUDY AREA [13]

Damaturu town is the local government headquarters of Damaturu L.G.A., which was created in 1976. Today, it now doubles as the capital of Yobe State, which was created in 1991. The local government has a population of about 104,475(projection for the year 2000). An estimate of about the 50,000(crude estimate) people live in Damaturu town. There are 4 political wards within Damaturu Township. The predominant tribes are Kanuri and Fulani and others like the Hausas as well as other tribes found in other parts of the State and Nigeria as whole. The major occupations are farming and trading with a significant population of civil servants.

There is a state specialist Hospital, 3 private hospitals, six PHC facilities and myriad of chemists within Damaturu town. The specialist hospital provides specialized surgical services but experienced general medical practitioners run other departments.

Educationally, there is school of nursing, a federal polytechnic, 2 government secondary schools, 2 private secondary schools and many private and government – owned primary schools.

There is a fair network of good roads passing through the town and connecting it to most of the other local government headquarters of the state and to neighbouring states. There is also telephone service available in the town.

Pawari and Shehuri lie towards the northern end of Damaturu town along Damaturu–Gashua road, with Pawari on the Western and Shehuri on the eastern sides of the northward road. The 2 communities represent what can be described as core–Damaturu inhabitants. One of the trees brought down during the process of the Damaturu–Gashua road construction was said to be referred to as Damaturu. The predominant tribe is Kanuri with few Fulanis and Hausas as well as very few other languages. Majority of the people are of low socio-economic status and the area could be said to be a sub-urban part of Damaturu town.

There is a health clinic/dispensary very close to the area and a fairly recently built maternal and child health center about 1–2km away. There are 2 primary schools that are accessible to the children of the community. There is a borehole within the vicinity of the communities that supplies them with fairly regular water supply as well as the government housing estates nearby.

The Topography is plain; there is a stream, which passes by the community. The temperature is mostly hot during the most part of the year.

METHODOLOGY

The study is a descriptive/analytic (i.e. mixed) case control study that was conducted within the month of September 2000 in Damaturu town of Yobe State.

In carrying out this study, some operational definitions were employed to define some variables used in the course of the study. Some of the key definitions are: -

1. "A case" of the disorder was defined as any child (0–14 Years) living in the study area as at September 2000, having visible skeletal deformation of any part of the body that developed spontaneously – not due to trauma or a known cause.
2. "A child" was defined as a person that was between the ages of 0 – 14 years as at September 2000. .
3. A household connotes a person or group of persons living under the same roof or in the same building or compound, share the same source of food and think of themselves as a unit [14].
4. An affected household was defined as a household within the study area with at least a case of disorder.
5. An unaffected household was defined as a household within the study area that had no case of the disorder as at September, 2000
6. A control household = A randomly selected house from the list of unaffected Households.
7. A new case was defined as any case whose onset of deformity was less than 12 months as at September 2000.
8. The head of household – an adult person (male/female) who the members of the household recognise as such. He/she is generally the one who bears the major responsibility of maintenance of the household and takes decision on its behalf.

9. Highest educational level – this was taken as the highest educational institution last attended or in case of young adults and children, the current institution they were in as at September 2000.

10. A cement house is that which the walls of the living rooms are made of cement bricks; if made of mud, zinc, or thatch then they are referred to as mud, zinc or thatched house as the case may be.

STUDY POPULATION

This was made up of all the children 0 – 14 years in Pawari/Shehuri communities of Damaturu town of Yobe State.

SAMPLING UNIT, SAMPLING SIZE AND SAMPLING METHOD.

The sampling units were households in both cases and control. A quick count of the households was done and total of number children/adults as well as their sex distribution noted All the 63 households having at least a case of the disorder constituted the affected households group; while 45 households were randomly selected as control households by simple random sampling out of the 109 unaffected households.

DATA COLLECTION TECHNIQUE

All the data collected were from primary source. The 1st stage consists of focus group discussions with elders of the community (males), group of mothers and a group of young adults in the area. Discussions were also held with the Director

PHC/Disease Control and International Health of the SMOH as well as staff of the Local Government Health Department. The designing of a questionnaire followed this with inputs from the various discussions earlier held. Pre-testing of the questionnaire on 10 households was carried out and necessary additions and subtractions were afterwards made before producing the final design of the questionnaire. This was then administered to the sampled households. A third tool employed in this study was careful observation of the general environment of the study area.

The questionnaire was in 5 parts (sections) with a total of 65 questions – made up of both open and close-ended questions.

Section 1 - Q 1 – 20 on the general characteristics of the household

Section 2 - Q 21 – 22 – vital events within the household in the last 12 months.

Section 3 - Q23 – 31 - Characteristics of the household members

Section 4 - Q32 – 42 – Characteristics of all the children (0–14 years) in the Household.

Section 5 - Q43 – 65 – Characteristics of the disorder (for affected child Only)

The questionnaires were administered with the help of 3 assistants and myself. A brief but thorough training season was conducted to acquaint the assistants (who were also field workers) before the actual commencement of the exercises. Briefing and discussions were normally done at the end of each day.

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COLLECTION OF BLOOD AND WATER SAMPLES

Samples of blood were collected from 8 children (7 cases and one control) and water samples were collected from the major sources of water in the area – namely – bore-hole and well for analysis. These procedures were conducted by a medical laboratory scientist (blood) and a water scientist (water) and taken to their respective labs for analysis. The blood samples were collected in plain containers (for electrolytes) and EDTA bottles for the remaining investigations.

MATERIALS

- Questionnaires
- Height/Length metres – locally made on a board to which a tape rule was attached. This was used for height/length measurement
- A bathroom weighing scale was used for weight measurement. For infants, the mother was weighed. 1st with out the baby and then with the baby. The difference is then recorded as the baby's weight.
- Needles/syringes – 2mls with size 23G needle
- Cotton wool
- Spirit
- Plain containers
- EDTA containers

- Sterile water containers
- Nutrient agar
- Microscope
- Counting chambers
- Microheamatocrit reader
- Calorimeter
- Photometer

LABORATORY PROCEDURES

The laboratory procedures carried out were on blood, urine, stool, water samples as well as X-rays. The blood, urine and stool examinations were done by two experienced medical laboratory scientist (one of them a chief lab scientist), the X-rays was done by a radiographer and interpreted by a radiologist while the water analysis was done by lab Scientist of the Yobe and Borno State Water Boards.

For the serum electrolytes, potassium and sodium were measured by flame photometry, chloride and bicarbonate by titration method, calcium, phosphate and alkaline phosphates by calorimetry. Blood genotype was by electrophoretic method, electrolyte sedimentation rate (ESR) was by Westergren method, Haemoglobin by calorimetry, packed cell volume by microhaematocrit reader and cell count by microscopy using the Neubauer chamber.

Stool and urine analysis were done by direct microscopy. Urine electrolytes were as for blood (only calcium and phosphate)

For water analysis, the most probable number of coliform was performed by growing on nutrient agar at 37oC for 48hrs, Dragen-Doff solution was used for determination of alkaloidal substances while photometry was used for the ions.

ETHICAL CONSIDERATIONS

Oral permission was obtained from the State Ministry of Health for the study to be conducted. Permission was also sought from the two community heads i.e. Bulamas of Pawari and Shehuri who gladly gave their approval. All efforts were made to respect the cultural practices of the area e.g. questionnaire was only administered only when the head was available and gave his blessing. There was happily no case of refusal or restriction during the whole process of questionnaire administration except during blood collection.

CONSTRAINTS

A very serious problem was the inability to conduct Vit D assay on the blood samples as both the Teaching Hospital, Maiduguri as well as the private Laboratories in the area were not doing the assay. Consequently, the plan of knowing the Vitamin D levels of the patients was not possible. However the other investigations were carried out and the results were used in analyses of the disorder.

Also the time available was also short to allow for more detailed collection / analysis of data on the foods especially to get institutions to help analyse the constituents of the foods e.g. phytate consumed by the people in the area.

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CHAPTER FOUR

RESULTS

This chapter is divided into three parts. Part one gives a description of the demographic, social, and environmental characteristics of the study population; the demography was based on the census of all persons in the study area, while the other characteristics were based on that of the persons in the sampled households. Part two describes the disease while part three gives the comparison of the different variables between the two groups of households.

PART ONE: DEMOGRAPHIC, SOCIAL AND ENVIRONMENTAL CHARACTERISTICS OF THE STUDY AREA.

DEMOGRAPHY: (these figures were obtained from a census of the study area which was conducted during the study.)

Table I: Table showing the population distribution of the study area by age and sex.

Indices	M	F	T
Children 0.14 yrs	263	294	557
Adults 15 – 59 yrs	221	305	526
Aged ≥ 60 yrs	53	31	84
Population	**537**	**630**	**1167**

Comments – the female male ratio is 1:0.85 in the general population. The ratios all favoured female in both the 0 – 14yrs and 15 – 59yrs age groups. But in the aged, males were higher with a ratio of 1.7:1. The total dependency ratio wais 1.22, made up of 1.10 (child dependency) and 0.12 (aged dependency).

Table II. Table showing population distribution by age and sex of the affected and control household

Age group	Number of Persons						Total
	A HH			C HH			
	M	F	Sub Total	M	F	Sub Total	
0 – 14 yrs	129	139	268	56	32	88	356
15 – 59 yrs	88	97	185	47	56	103	288
≥ 60yrs	4	-	4	6	2	8	12
All ages	221	236	457	109	90	199	656

AHH=affected household ; CHH=control household

Comment – There were relatively more children in the affected households 58.64%(268/457) than in the control households 44.22%(88/199),and this is statistically significant (X^2=11.62;df=0.05:α<0.01) .The male female ratio was higher in the control households.(m:f 1.21:1) than in the affected households (f:m 1:0.94),while total and child dependency rates were higher in the affected households. (1.47 & 1.45) than in the control households (93% & 85%) but the aged dependency was slightly higher in the control households (8%) than in the affected households (0.02)

SOCIOECONOMIC AND ENVIRONMENTAL CHARACTERISTICS (these figures were based on the persons in the sampled households.)

Table III::Religion

Religion	No. of HHH	Percentages
Islam	101	95.28
Christianity	5	4.72
Total	106	100

Comment: the people were predominantly Muslims.

Table IV::Ethnicity

Ethnic group	No. of HHH	Percentages
Kanuri	75	70.75
Non-Kanuri	31	29.25
Total	106	100.00

Comment: the people were predominantly Kanuri.

Table V: Occupation.

Occupation	No. of HHH	Percentages
Farming	30	28.30
Civil servant	51	48.11
Trading	14	13.21
Artisan	9	8.49
Jobless	2	1.89
Total	106	100.00

Comment: about half of the people were civil servants with only two HHH being jobless.

Table VI: Highest educational level of mothers.

Level of education	No. of mothers	Percentages
Quranic	43	31.61
None	11	8.09
Adult education	11	8.09
Primary	42	30.88
Secondary	26	19.12
Tertiary education	3	2.21
Total	136	100.00

Comment: About 60.30% of the mothers had formal/non-formal education.

Table VII::Types of housing

Type of housing	No. of HH	Percentages
Mud	70	66.04
Thatched	6	5.66
Cement	30	28.30
Total	106	100.00

Comment: Two third of the households lived in mud houses while about 28% lived in cement houses..

Table VIII:Sources of water

Source	No. of HH	Percentages
Borehole	82	77.36
Tap	9	8.49
Dam	12	11.32
Well	3	2.83
Total	106	100.00

Comment: About 97.17% of the households had access to pipe-borne water while the remaining had access to well water..

Table IX:Sources of food

Source	No. of HH	Percentages
Market	29	27.36
Farm	2	1.89
Market and farm	75	70.75
Total	106	100.00

Comment: Most of the households got their foodstuffs from the market as well as from their farms...

Table X: Toilet facilities.

Source	No. of HHH	Percentages
Pit latrine	104	98.11
Water system	2	1.89
Total	106	100.00

Comment: All the households had toilet facilities.

PART TWO: DESCRIPTION OF DISEASE

Table XI: Prevalence and incidence of the disorder in shehuri and pawari.

Indices	Shehuri			Pawari			Total	
	M	F	Sub Total	M	F	Sub total	M	F
Popn of 0 –14yrs	115	105	220	148	189	337	263	294
Total cases	28	19	47	38	25	63	66	44
"New" cases	11	8	19	14	9	23	25	17
Incidence rate %	9.57	7.62	8.64	9.46	4.76	6.82	9.51	5.78
Prevalence	24.35	18.10	21.36	25.68	13.23	18.69	25.10	14.78

Comments: The overall prevalence is about 20% and it can be seen to be higher in males than in females in both communities. Prevalence of the disease is higher in Shehuri than in Pawari.

Table XII: Distribution by Sex amongst children in the study area.

Disorder	No. of Children		Total
	Male	Female	
Affected	66 (33.50%)	44 (14.97%)	110
Not affected	197 (66.50%)	250 (85.03%)	447*
Total	263	294	557

X^2 = 8.99, df = 1, 0.001 < P <0.1. * total population of all unaffected children in the community.

Comment: There is a statistically significant difference between the proportion of males with the disorder and the proportion of females with the disorder in the general population.

Table XIII Distribution by age amongst children in the affected households.*

Age Group	Diseased	No Disease	Total
0	0 (0%)	28 (100%)	28
1 – 4	41 (56.2%)	32 (43.8%)	73
5 – 9	50 (49.5%)	51 (50.5%)	101
10 – 14	19 (28.8%)	47 (71.2%)	66
All ages	110 (41%)	158 (59%)	268

*Data on age distribution of all children in the study area not available.

Comments: There was no single case in the infant, group. More than half of the children in the 1 – 4 age group were affected and the proportion decreases with increasing age i.e. 56% ► 50% ► 29%.

Table XIV: Age – Sex distribution of disease in the affected households.

Age	Male			Female			Total
	Affected child.	Normal Child	Sub. Total	Affected	Normal	Sub. Total	
0	0	9	9	0	19	19	28
1 – 4	18 (58%)	13 (42%)	31	23(55%)	19(45%)	42	73
5 - 9	34 (54%)	29 (46%)	63	16(42%)	22 (58%)	38	101
10 - 14	14 (39%)	22 (61%)	36	5 (17%)	25 (83%)	30	66
0 – 14	**66**	**73**	**139**	**44**	**85**	**129**	**268**

Comments: The trend was similar for both sexes i.e. Nil in infants, highest proportion in the 1 – 4 age group and lowest in the 10 – 14 age group. The corresponding proportions were higher in males than females in all the age groups.

Table XV :Area (Place) affected children were born

Area	No. of Children
Within the affected area	92
Outside the area	4
Unknown*	14
Total	110

*Information not filled in questionnaire.

Table XVI: Earliest Complaint Preceding deformity

Symptom	No. of Children
Bone pains	72 (65%)
Febrile illness	8 (7%)
Assymptomatic	16 (15%)
Unknown	14(13%)
Total	110

Comment: Three quarter of the children complained of bone pains for some time before the deformity sets in.

Table XVII: Site(s) of 1st Deformity

Site	No. of Children
Both Legs	74 (67%)
One Leg	19 (17%)
Head	3 (3%)
Unknown	14(13%)
Total	110

Comment: Most (84%) of the children had their 1st deformity in the legs.

Table XVIII: Affected Sites

Affected Sites	**No. of Children**
Lower Limbs only	60 (55%)
Upper & Lower limbs	21 (19%)
Limbs + Head	1 (1%)
Upper & lower Limbs + Head	7 (6%)
Lower limbs + pelvis	7 (6%)
Unknown	14(13%)
Total	110

Comment: All the children had at least the deformity affecting the lower limb. 19% had upper limbs deformities in addition, while 7% had involvement of the skull bone as well.

Table XIX: Duration between 1st symptom and development of deformity

Duration (Months)	No. of Children
1 –2	6(5%)
3 – 4	31(28%)
5 – 6	24(22%)
7 – 8	11(10%)
9 – 10	5(5%)
11 – 12	12(11%)
> 12	7(6%)
Unknown	14(13%)
Total	110

Comment: The median duration between 1st symptom and development of deformity was 5 – 6 months.

Table XX: Physical Examination findings performed on a sample of 20 affected children.

Physical Sign	No. of Children Positive
Hair Changes	11 (55%)
Skin changes	9 (45%)
Jaundice	1 (5%)
Pallor	3 (65%)
Keratomalacia	Nil (0%)
Lymphadenopathy (submandibular and axiliary)	2(10%)
Koilonychias	1 (5%)
Splenomegaly	2 (10%)
Hepatomegaly	Nil (0%)
Pedal Oedema	5 (25%)

Comment: The commonest physical anomaly was pallor seen in about 65% (11/20) of the children examined. About half had abnormal hair changes. 25% had oedema of the foot and no case of keratomalacia and hepatomegaly was seen.

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LABORATORY FINDINGS

Table XXI:

Investigation	1	2	3	4	5	6	7	8
Full blood count								
ESR mm/.hr	5	90	10	20	35	21	15	35
Heamoglobin (g/dl)	11.4	8.5	10.3	10.5	10.7	11.0	11.4	11.5
Packed cell volume	0.34	0.31	0.31	0.31	0.32	0.33	0.32	0.34
WBCCX10^9	3.6	5.8	5.8	4.8	3.2	5.0	4.6	60
Differentials								
Neutrophils (%)	56	49	43	51	62	62	51	56
Eosinophils (%)	4	5	6	3	3	3	2	1
Lymphocytes (%)	40	46	51	46	35	35	47	43
Monocytes (%)	—	—	—	—	—	—	—	—
Basophyils (%)	—	—	—	—	—	—	—	—
Genotype	AA	AS	AA	AA	AA	AA	AA	AA
Electrolytes								
Calcium (mm/l)	2.1	2.1	2.0	2.0	1.7	1.7	2.0	2.2
Alkaline phosphate	93	76	98	110	137	88	119	115
Organic phosphate	1.9	1.7	1.9	1.8	1.7	1.8	1.9	2.1
Sodium (mm/l)	146	125	138	130	125	136	121	133
Potassium (mm/l)	5	4.3	4.4	3.8	3.9	3.9	4.0	3.7
Chloride (mm/l)	110	86	90	89	88	97	89	97
Bicarbonate (mm/l)	18	20	18	22	17	21	18	20
Red blood cells								
Anisocytosis	—	+	+	+	+	—	—	—
Poikilocytosis	—	+	+	+	+	—	—	—
Hyphochromasia	—	+	—	—	—	—	—	—

Key: ESR=Erythrocyte sedimentation rate: WBCC =White blood cell count

Comments: Samples 1 – 7 were children with the disorder while number 8 was a normal child from the affected household. Taking a heamoglobin of 12g/dl as normal, then all the children were anaemic. The full blood count and differentials were within

normal ranges, while one of the affected children was a carrier of the sickle cell disease. The level of serum calcium of all the affected children was below 2.2mM/L (normal range 2.2 – 2.7) while that of the normal child was on the lower side of normal. The levels of phosphate for all the children fall within the normal range of 1.5 – 2.2mM/L. All the affected children had normal alkaline phosphates (normal range 56 – 190iu/L) as well as other serum electrolytes.

Water analysis. All samples were within normal range in terms of chemical constituents but the samples from well had coliforms. **See appendixes**.

PART THREE: COMPARISON OF SOME IMPORTANT CHARACTERISTICS IN THE AFFECTED (AHH) AND CONTROL (CHH) HOUSEHOLDS.

DEMOGRAPHIC, SOCIAL, AND ENVIRONMENTAL

Table XXII: Sex

	A HH	CHH	TOTAL
Male	221 (48%)	109 (55%)	330
Female	236 (52%)	90 (45%)	326
Total	457	199	656

Comments: There is no significant difference between the male - female proportions of the AHH and that of the CHH.(X^2 =2.282,df=1, P>0.05)

Table XXIII: Age

AGE (YRS)	A HH	CHH	TOTAL
0 – 14yrs	268 (59%)	88 (44%)	358
15 – 59	185 (40%)	103 (52%)	288
>60	4 (1%)	8 (4%)	12
Total	457 (100%)	199 (100%)	656

There is a significant difference between the age distributions of the AHH and that of the CHH.(X^2=17.23, df=2, P<0.001)

Table XXIV: Births and deaths within the last 12 months

	AHH			CHH			TOTAL
	M	F	Sub Total	M	F	Sub total	
Birth	9	19	28	14	5	19	49
Death	2	0	2	—	—	—	2

Comments: The crude birth rate was lower (28 / 457 = 61 / 1000) in the AHH than in the CHH (19 / 199 = 95 / 1000), while the overall crude birth rate 75 / 1000. No death

was recorded in the control household. The sex ratio at birth favoured females (m: f, 1:2.1) in the affected HH and favoured males (2.8.1) in the control households. However, combined the ratio is almost equal (0.96:1) in favour of females.

Table XXV: Number of persons per household

No. of Persons/HH	No. of HH	
	A HH	CHH
1	—	—
2	2	2
3	10	13
4	7	9
5	6	11
6	3	6
7	8	3
8	8	1
9	6	—
10 – 19	—	—
≥ 20	11	—
TOTAL	61	45

Summary

	AHH	CHH
Mean No of Person / HH	8.26	4.42
Standard Deviation	5.91	1.42

$Z = 489$, $\alpha = 0.05$, $P<0.001$

AHH = affected households

CHH = Control households

Comment – there is a statistically significant difference in the average number of persons in the two groups with the average being much higher, almost twice (8.26) in the affected households than in the control households (4.42). Note however that there were eleven households in the AHH with twenty or more persons per household.

Table XXVI: Religion.

Religion	No. of HH		Total
	A HH	CHH	
Islam	57 (93.44%)	44 (97.78%)	101
Christianity	4 (6.56%)	1 (2.22%)	5
Total	61 (100%)	45 (100%)	106

$Z = 1.04$ and $= 0.05$, $P > 0.3$

Comment: Both groups were predominantly Muslims. There is no statistically significant difference between the differences in proportions of Muslims or Christians in the 2 groups of households.

Table XXVII: Ethnicity

Ethnic Group	A HH	CHH	Total
Kanuri	42 (69%)	33 (73%)	75
Non-Kanuri	19 (31%)	12 (27%)	31
Total	61 (100%)	45 (100%)	106

X^2 (without correction) $= 0.251$, df = 1 $0.5 < P < 0.7$

Comment: There is no statistically significant difference between the proportions of Kanuri and non-Kanuri in the AHH and CHH.

Table XXVIII: Highest educational level of mothers

Level of education	No of Mothers		Total
	AHH	CHH	
Quranic.	26 (33%)	17 (30%)	45
None	5 (6%)	6 (11%)	11
Adult education	7 (9%)	4 (7%)	11
primary school	23 (29%)	19 (33%)	42
Secondary school	17 (22%)	9 (16)	26
Tertiary education	1(1%)	2 (3%)	3
Total	79 (100%)	57 (100%)	106

Comment.: The level of education of both group was similar. The proportion of mothers with formal education was the same for both groups-52%.

Table XXIX: Occupation of HHH

Occupation	Frequency No of HHH		Total
	AHH	CHH	
Traders	8 (13%)	6 (13%)	14
Civil Servants	28 (46%)	23 (51%)	51
Farmers	18 (30%)	12 (27%)	30
Artisan	5 (8%)	4 (9%)	9
Jobless	2 (3%)	--- (0%)	2
Total	61 (100%)	45 (100%)	106

Comment; The main occupation of the HHH in both groups were civil service and farming and the proportions were comparable.

Table XXX: Types of Housing

	Frequency		
Type	**AHH**	**CHH**	**Total**
Mud	33 (54%)	37 (82%)	70
Thatched	4 (7%)	2 (5%)	6
Cement	24 (39%)	6 (13%)	30
Total	**61**	**45**	**106**

Comment: The proportion of those living in mud houses was significantly higher in the CHH than in the AHH ($Z = 3.01$, $\alpha = 0.05$, $P < 0.01$) while the proportion of those living in cement houses was significantly higher in the AHH than in the CHH .

Table XXXI: Number of living rooms per household

No. of rooms/HH	No. of Households		Total
	AHH	CHH	
3 or less	48	43	91
more than 3	13	2	15
Total	**61**	**45**	**106**

$X2 = 4.756$, $df = 1$, $0.01 < P < 0.05$

Comment: The proportion of households with 3 rooms or less was significantly higher in the CHH than in the AHH, while the reverse was the case for more than 3 rooms.

Table XXXII - length of stay in the area

Length of Stay in Yrs	No. of Households		Total
	AHH	CHH	
0 – 9	27	18	45
10 – 19	7)	6	13
20 – 29	12	11	23
> 30 years	15	10	25
Total	**61**	**45**	**106**

$X^2 = 0.7953$, df = 3, $0.8 < P < 0.9$

Comments: There was no significant difference in the length of stay of the affected HH from the CHH.

Table XXXIII: Major source of water

Water Source	No. of Households				Total	
	AHH		CHH			
Borehole	45 (74%)		37 (82%)		82	
Tap	51	6 (10%)	40	3 (7%)	9	91
Dam	7 (11%)		5 (11%)		12	
Well	10	3 (5%)	5	0 (0%)	3	15
Total	61		45		106	

Fischer's exact test 0.19, P = 0.38 (2 tailed test).

Comments: There is no significant difference between the proportion using the Borehole, Tap, and Dam water from those using well water in the 2 groups of household.

Table XXXIV: Source of food.

Food Source	No. of HH		Total
	AHH	CHH	
Market	19 (31%)	10 (22%)	29
Farm	1 (2%)	1 (2%)	2
Market and Farm	41 (67%)	34 (76%)	75
Charities	---	---	---
Total	61	45	106

Comment: Majority of the households in both cases purchase some of the food in the market to supplement what they produce in their family farm. The proportion being 67% and 76% for AHH and CHH respectively, but these proportions are not statistically different $Z = 0.32, \alpha = 0.05$ $P > 0.05$.

Table XXXV: Toilet facility within the HH

Toilet Type	No. of HH		Total
	A HH	C HH	
None	----	----	----
Pit latrine	59 (96.72%)	45 (100%)	104
Water system	2 (3.28%)	---	2
Total	61	45	106

Fishers exact test 0.33; P = 0.66 (2 tailed test)

Comment: Except for 2(3%) of the households in the AHH group, all the other households use pit latrine. This difference is however not statistically significant.

Table XXXVI: Methods of refuse disposal

Disposal Methods	No. of Households		Total
	A HH	C HH	
Open area within the compound	1 (2%)	0 (0%)	1
A dustbin, emptied periodically	2 (3%)	0 (0%)	2
In a heap, in front of the house	1 (2%)	2 (5%)	3
Specified collection point	57 (93%)	43 (95%)	100
Total	**61**	**45**	**106**

Comment: The mode of refuse disposal is similar in both groups and is mainly at a specified point outside the Household.

Table XXXVII: Presence of Pets in the Household

Pet	No. of Household		Total
	AHH	CHH	
Present	3 (6.67%)	0 (0%)	3 (2.91%)
Absent	58 (93.33%)	45 (100%)	103 (97.09%)
Total	61	45	106

Fishers exact test = 0.19; P = 0.38 (2 tailed test)

Comment: There is no significant difference between the proportions keeping/not keeping pets in the AHH and CHH. Mainly, both groups do not keep pets.

Table XXXVIII: Rearing of Animals

Animals	AHH	CHH	Total
Present	28 (45.90%)	22 (48.89%)	50
Absent	33 (54.10%)	23 (51.11%)	56
Total	61	45	106

X^2 =0.093; df =1 ;0.7<P<0.6.

Comments: There is no difference in the proportions rearing animals in the A HH and CHH.

NUTRITIONAL ASSESSEMENT/HISTORY

Table XXXIX - Duration of Breast Feeding

Duration	No. of Children	
	AHH	CHH
12 - 17	34 (31%)	26(30%)
18 – 23	68 (62%)	58(66%)
24 – 28	8 (7%)	4(4%)
Total	**110 (100%)**	**88(100%)**

Comment: No child was breast-fed for less than one year in both groups.. Similarly, the duration of breast feeding is comparable (similar) in both groups, with the majority being breastfed for 18-23months..

Table XIa : Proportions of underweight children 0 – 4yrs..

	AHH	CHH	Total
Underweight	39 (48.75%)	4 (14.81%)	43
Normal weight	41 (51.25%)	23 (85.19%)	64
Total	80	27	107

$X^2_{(Corrected)} = 8.95$, df = 1, $0.001 < P < 0.01$

Comments: There is a statistically significant difference in the proportion of underweight in the AHH and the CHH.

Table XLb: Proportion of underweight amongst unaffected children 0-4years in the AHH and children 0-4 years of the CHH.

	AHH unaffected children	CHH	Total
Underweight	12 (33.33%)	4 (14.81%)	16
Normal weight	24(66.67%)	23 (85.19%)	47
Total	36	27	63

$X^2 = 2.79$, df = 1, $P < 0.05$

Comment; the proportion of malnourished was higher among the unaffected children of the AHH and this is statistically significant.

Table XLc: Proportions of underweight children 0 – 4yrs within the AHH.

Weight	Affected children	Unaffected(normal) children	Total
Underweight	27 (61.4%)	12 (33.3%)	39
Normal Weight	17 (38.6%)	24 (66.1%)	41
Total	44 (100%)	36 (100%)	80

$X^2 = 6.23$ df = 1 $P < 0.05$

Comment: The proportion of underweight children was higher (61.4%) in the affected children's group than in their sibs in the unaffected group. This difference is statistically significant.

Table XLIc: Proportion of stunting in the AHH.

	Affected children	Unaffected (normal) children	Total
Stunted	35 (80%)	16 (44%)	51
Normal	9 (20%)	20 (56%)	29
Total	44 (100%)	36 (100%)	80

$X^2 = 10.56$, df = 1 $P < 0.001$

Comment: The proportion of stunting is higher (statistically significant) in the children with the disorder than in the unaffected group.

CHEMICALS IN THE HOUSEHOLD.

Table XLII: Use of chemicals in the HH.

Chemical usage	AHH	CHH	Total
Yes	36 (59%)	28 (62%)	64
No	25(41%)	17(38%)	42
Total	61	45	106

$X^2 = 0.1112$, df = 1, $P > 0.05$

Comment; there is no statistically significant difference in the proportion using/not using chemicals in the two groups of HH.

Table XLIII: Storage of chemicals in the HH.

Chemical storage	AHH	CHH	Total
Yes	2 (6%)	0 (0%)	2
No	34(94%)	32(100%)	66
Total	36	32	68

$X^2 = 0.1112$, df = 1, $P > 0.05$

Comment; there is no statistically significant difference in the two proportions using/not using chemicals in the two groups of HH.

CHAPTER FIVE - DISCUSSION

Socio- demographic and environment characteristics

The pattern of the population distribution of the communities is not too different from the normal with the proportion of females being higher than that of males except for the aged where the male proportion was higher. The reason for this is not clear but it may probably be due to the fact that the elderly women tend to return back to the villages after the death of their husbands to spend the rest of their lives there. Thus, this finding is not of much significance.

The total dependency ratio is about 122%; this is very similar to the National figure of 121% [13]. The average number of people per household in the community is about 6.78, which is higher than the National figures of both 5.6 (Rural) and 4.8 (Urban)[13]. This is not at all surprising because of Polygamous marriages and majority of the population being Muslims. The higher rate for Northern Nigeria was also noted in the National demographic health survey (NDHS) of 1990 [13]. The number of children 0-14yrs is about 47.73, which is also similar in the NDHS figures.

From the sampled population, the major occupations of the HHH in the community are public servants (48%) and farmers (28%) with about 2% being jobless. The major tribe is Kanuri (75/106 or 71%) and are mainly Muslims (95%) Majority of the people in the households sampled live in mud houses (70/106 = 66%) and about 28% live in cement houses and about 6% live in thatched houses. This is not surprising considering the fact that the areas are a suburb of the state capital and the

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level of sophistication and economic power cannot be comparable to the main city, hence some people are still living in thatched houses. Eighty five percent (85%) of the households have between 1-3 living rooms (Average 2.18 rooms /HH). This gives an average of 3.1 persons per living room in 85% of the households (Average persons /HH being 6.78). This is similar to the corresponding figure calculated for the country (From the NDHS data) of 3.2 persons / living room in rural areas: that of Urban being 3.4. This again is explainable by the fact that the communities are suburban part of the state capital that is still undergoing transformation to Urban lifestyles.

The proportion having access to portable water (Tap and Borehole) is about 97% and this is much higher than the National average of about 32%. (32%) The reason for this is that a borehole is within a walking distance of the community. Similarly the proportion of the households having a toilet facility (100%- 98% pit and 2% water carriage) is much more higher than the National average of about 67% - 63.3% pit and 3.5% water carriage). The reason for this high proportion may probably be partly due to high level of awareness (majority have one form of education or another) and partly because there is enough land space available for citing of pits.

Although 28% of the HHH are farmers only about 2% rely solely on their farm for their food source, while about 71% rely on both purchasing from the market and farming for their food source, the inference here is that some non- farmers also do some little farming. The reason for this is that the civil servant are mostly junior civil servants and the traders are mostly small scale traders, thus, their income is relatively

on the low side and thus, had to engage on subsistence farming to supplement their income. It is worth noting that about 47% of the house holds also rear animals (birds, sheep and cattle): the refuse disposal method in most (93%) of the households is at a central collection point within the community. This point is however an open area with is not a favoured but popular method of refuse disposal in the town.

5.1.2 COMPARISON OF SOME IMPORTANT CHARACTERISTICS OF THE AHH AND CHH.

The sex compositions of the people in the affected households do not differ statistically (table XXII) from that of the control households. This implied that the two groups are more or less the same in terms of sex composition. However, there is significant difference between the age composition (Table XXIII) of the AHH and that of the CHH. The proportion of children being higher in the AHH than in the CHH but proportion of the productive age group (15-59) is higher in the CHH than in the AHH. The implication of this is that the control households are significantly more productive than their control HH counterparts; similarly the average number of people per household (Table XXV) is significantly higher in the AHH (8.26) than in the CHH (4.42) -$P<0.001$. This further suggests more dependence on the side of the AHH, more so that the occupation (a very rough estimates of income) are similar for both groups.

The proportion of households with 3 rooms, (Table XXXI) or less is significantly higher in the CHH (43/45 or 96%) than in the AHH (48/63 = 76%). This is consistent with the finding that there are more people in the AHH than in the CHH, thus, more rooms are required to accommodate them. However the relevance or reason for the

significant difference between the house types (Table XXX) 82% of the CHH living in mud houses and only 54% of the AHH are living in same house type while 13% and 39% live in cement houses for the CHH and AHH respectively, could not be adequately answered by the data collected. But the observation made during the process of the data collection was that most of the houses labeled as cement were more of a glorified mud houses i.e. they are cement plastered mud houses.

The non-significant differences in some of the social characteristics especially religion (Table XXVI) and tribe (Table XXVII) in both AHH and CHH were also worthy of note for this in a way implied that the disorder is not restricted to a particular tribe (culture) or religion. Similarly the source of food (Table XXXIV) is similarly distributed in both groups, this in a way diminishes the strength of the thought that food source especially farming may be implicated as the farms are within the same area for both groups and the procedure /techniques too are similar.

Another significant finding is that the proportion of malnourished (underweight and stunting) using the reference values of national centre for health statistics (NCHS/WHO), and taking the cut- off point of less than minus two standard deviations as abnormal, is that the proportions of malnourished are higher in the children under 5 years in the AHH than in the control household.(Tables XL and XLI),this difference still remained significant when only the unaffected children of the affected households(Tables XLb and XLIb) were compared to the children of the control household. Among the children in the same households, the proportion of malnutrition

(stunting and under weight) is much higher in those with the disorder than those without the disorder (Tables XLc and XLIc). .

Although it is acceptable to say that the difference between the siblings in terms of nourishment may be that one group is sick while the other is well, it should be understood that the reason for the difference in nutritional status with particular reference to under weight goes beyond this simple grouping as the feeding habits of the children with the disorder have not been known to be remarkably affected negatively.

Since the major type of food consumed by the two groups of household are similar (mainly cereal based foods) ,the method of food preparation could be the major factor leading to the development of the disorder.

In terms of chemical usage, the proportion of those using chemicals (Table XLII) is much higher (71%) in the CHH than in the AHH (59%). Although this in itself does not completely rule out any association, however the type of the chemicals used by majority of the households are insecticides (which most of the households not just in the community but the town use commonly to fight the mosquito menace in the environment) and the fact that these chemicals were not stored as to give children access, makes the thinking that the disorder is associated with those chemicals very unlikely. It is worth to note that there was an epidemic of a skeletal disorder in India several decades back that affected children, and this was traced to the chemicals

used for preservation of their foodstuffs *.

As to the association with water, this too is very unlikely as the water the majority of the inhabitants use also goes to neighboring estates of which no case of the disorder was reported. In addition the results of the laboratory analysis of water gave the samples a relatively clean bill especially in terms of chemical constituents, only the samples from wells showed high number of coliforms, which though do not meet WHO recommendations in that respect, could not be said to be responsible for the occurrence of the disorder. More so, only a very few proportion of the affected. households (3/61 or 5%) rely on well water for their drinking water. With regards to contamination of stream water and the linkage of this to the disorder, the age at onset of the disease and the fact that none of the households use the stream water for drinking, make this thinking dissociative. A visit to the stream is enough to convince one that it is indeed true that nobody is drinking that water, at least intentionally, as it is very turbid and very dirty. Ironically, children go their to play and swim. This act cannot also be linked with the disorder as only older children (past the year of onset of disease) go their to swim i.e. the age at onset of the disease preceeds the age at which a child can be able to go the steam to swim.

The disorder was found to be significantly more in boys than girls. This difference is unlikely to be genetic and more probably due to environmental factors. It is known in this area that girls are more pampered than boys who

*Professor P. Singha MPH class discussion (2000)

thus, become adventurous. Other reasons are however possible.

No definitive explanation could be offered for the highest number of the cases among 1st born which decreases with increase in the order of birth. While it is known that the 1st child is usually over pampered especially among the educated so less incidence of malnutrition, this may not be true especially in the rural areas where these is a cultural belief that survival of the 1st child is based on luck" i.e. there is very high mortality among 1st children, this is usually due to there (mother's) inexperience with child care . This may probably be the case here.

Putting all these epidemiological findings together, there is a very strong suggestion that this disorder is almost certainly of nutritional origin as opposed to it being caused by chemical contamination of water or otherwise or that there is a familial or genetic predisposition to the development of the disease.

The laboratory results of the serum electrolytes suggest that this disorder is most likely rickets: The radiological findings also support this. The normal alkaline phosphatase is due to the fact that the children were malnourished. The serum phosphate is within the normal range but it can be seen to be lower than that of the normal child taken as control (Table 4.31)

DISCUSSIONS ON RICKETS

This is a disorder that arises as a result of a defective mineralisation of bone. Poskitt et-al (16) describes it as a clinical syndrome for there are a variety of causes.

The disease has been classified into two broad groups based on aetiological considerations. These are: Nutritional and Metabolic or non-nutritional Rickets.

NUTRITIONAL RICKETS

Epidemiology - This disorder was common in the temperate Europe until the 1950's [16] but now it is seen mostly among children with malabsorbtion, those on abnormal diets or in immigrants with customs and diet inappropriate for European climate. Most of the research on rickets where carried out on Asian immigrants in Britain [17]. A prevalence of clinical evidence of rickets has been described in 6% of children (5-16yrs) of Asian immigrants in school in Glasgow [18], others have reported clinical evidence in 5% and biochemical evidence in 50% of children of similar communities [18,19] It was being said that any Asian child (in the immigrant communities) complaining of bone pains should be considered as a case of rickets until proved otherwise. The disorder is not a public health problem in most countries of Asia, Africa (South of the Sahara) and Latin America, but prevalent according to clinical reports in most North African countries, the middle East, Iran and Pakistan [19]. It is said to be more common in the cities than the countryside most probably because of differential opportunities for sunlight exposure.

Neonatal rickets occurs in children born to mothers with o steomalacia who are on strict vegetarian Hindu diet, otherwise rickets is seen in infants and toddlers and usually resolves spontaneously as the infant grows without any residual deformity.

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This may be as a result of the child breaking away from the mother and joining other kids thus, benefiting nutritionally from the sun. On the other hand it is this period that the child is exposed to Malnutrition (Kwashiorkor). There are no enough evidence to support the argument that genetic factors play a crucial role in the development of the disease and unlike most nutritional disorders, rickets is mainly determined by cultural practices rather than socio-economic factors [19]. These cultural practices are those that relate to diet and exposure to sunlight, which are the two most important sources of Vit. D

SOURCES OF VIT D

The main sources of Vit. D is a diet and b) synthesis in the skin on exposure to sunlight. Since the work of Chick in 1919 (16) which showed that ricketts can be cured by either dietary or sunlight exposure, there has been considerable debate about which one of the two sources is more important in maintenance of Vit. D in the body. Poskitt et-al (1979) has found seasonal variations in temperate latitudes in the levels of Vit. D in the body and this they associate with sunlight exposure, as dietary intakes they opined could not have caused such variations. The dietary sources include mammalian and fish liver, egg yolk flesh of oily fish e.g. herring, mackerel sardine and salmon, foods fortified with Vit. D e.g. margarine, tinned milk and infant foods as well as diary products like fat and cheese to a lesser extent, butter and milk contain relatively small amount of Vit. D. Animal products contain the D3 form (Cholecalciferol) of Vit. D while plant products contain the D2 form (ergocalciferol) .

The Vit. D content of human breast milk is not high but together with skin production of Vit. D, meets the Vit. D requirement of the growing infant.

High levels of phytate as in some cereal preparations especially flour e.g. chapatis and unleavened bread has been known to inhibit calcium absorption as well as re- absorption of Vit. D secreted into the gut lumen at the jejunum and Ileum. Gluten has also been shown to affect calcium absorption. The rays from sunlight necessary for vit D production in the skin does not pass through ordinary glass thus, staying indoors all the time under such conditions can predispose to ricketts

VIT D SYNTHESIS AND CALCIUM/PHOSPHATE HOMEOSTASIS (20)

The precursor of vitamin D group is cholesterol. Cholesterol in the walls of the intestine is converted to 7- dehydrocholesterol, which on action by UV radiation in the skin is converted to cholecalciferol (Vit D3): similarly ergocalciferol (Vit D2) is produced in plants by the action of UV radiation on ergosterol. Both cholecalciferol and Ergocalciferol are converted in the liver to 25, hydroxy Vit D3 (calcifediol) which is the main circulating (storage) form of Vit. D in the body. 25 (OH) D3 is also converted to 1,25 (OH) D3 (Calcitriol) by the action of 1 alpha hydroxylase enzyme in the kidneys (other metabolites are also produced). The synthesis of calcitriol from calcifediol is regulated by parathyroid hormone and is also influenced by the phosphate concentration in the plasma and by the calcitriol concentration itself through a negative feed back mechanism. Calcitriol is the most important metabolite in the regulation of plasma calcium.

A fall in the plasma calcium concentration causes secretion of parathyroid hormone (PTH) from the parathyroid glands. PTH causes mobilization of calcium and phosphate from bone, converts 25 (OH) D3 to 1, 25 $(OH)_2$ D3 which increases intestinal absorption of calcium and also deceases the excretion of calcium by the kidney. All these result in a rise in the plasma concentration of calcium. An excess of plasma calcium conversely causes a fall in PTH secretion. PTH in addition, causes increase excretion of phosphate, those causing a decrease in serum phosphate level.

PATHOPHYSIOLOGY OF RICKETS [21]

The secretion of collagen initiates bone formation by osteoblast. This is followed by changes in the Polysaccharides, Phospholipids, alkaline phosphatase and pyrophosphatase, and mineralisation occurs in the presence of calcium and phosphate. In ricketts, the absence of calcium and phosphate lead to defective mineralization, cartilage cells fail to complete their normal cycle of proliferation and degeneration and subsequent failure of capillary penetration occurs in a patchy manner. The result is a frayed, irregular epiphyseal line at the end of the shaft: failure of osseous and cartilaginous matrix to mineralize in the zone of preparatory calcification, followed by the deposition of newly formed uncalcified osteod results in a wide irregular frayed zone of non-rigid tissue - the rachitic metaphysis. This zone, responsible for many of the skeletal deformities, becomes compressed and bulges laterally, producing flaring of the ends of the bones and rachitic rosary. Mineralisation is also lacking in subperiosteal bone, pre existing cortical bones are resorbed in the

normal way and are replaced by osteod tissue over the entire shaft which fails to mineralize . If this process continues, the shaft losses it's rigidity and the resultant softened and rarified cortical bone is readily distorted by stress, leading to deformities and fractures.

As a result of the increased osteoclastic activity, serum alkaline phosphates is raised, while phosphate is low because of the effect of PTH on kidney which decrease it's absorption. Low serum phosphate is also essential to the development of ricketts as it is almost impossible to make rats develop ricketts in the lab unless they are both deficient in Vit.D and phosphate [16]

CLINICAL FEATURES

Rickets can appear at any age in childhood [22]. The infant in restless and fails to thrive, older children complain of bone pains and there is delay in developmental milestones. The skull bone are soft and easily depressed (Craniotabes) this can be elicited early in the disease . Bossing of the skull (Caput-quadratus) is also seen in some cases and there is delayed closure of the fontanelles. In the chest rachitic rosary and Harrison sulcus (grooves) is seen, giving a pigeon chest shape. Muscles are poorly developed and lack tone, ligaments are relaxed and help to produce deformities and partly account for knock knees, over extension of knee joint, weak ankles, scoliosis and kyphosis. In the long bones, bowing, knocked knees etc can be seen.

Female patients with lordosis often have a narrowed pelvis Tetany may be seen especially when serum calcium has fallen considerably.

LABORATORY FEATURES AND DIAGNOSIS

Rickets is suspected when the earlier mentioned clinical manifestations are present. This is further confirmed by the characteristic laboratory findings of rickets. Serum calcium is usually within normal range (2.20 - 2.70m M/L) Serum Alkaline phospatase is raised markedly. (Expect in malnourished children). Serum phosphate is low.

The typical x-ray findings are seen on an antero-posterior radiograph of the wrist, which shows loss of definition of epiphyseal line with flaring and cupping of the ends of the radius and ulna.

Immuno assay of Vit. D level in the blood is a very sensitive test to detect Vit. D deficiency but is not readily available. Rentography is also of immense value in the diagnosis of rickets

TREATMENT

Exposures to sunlight have been found to produce evidence of cure in some infants. [22] Oral administration of Vit. D as well as parentral Vit. D have been used in some cases. Cod liver oil has been used in uncomplicated cases. Surgical corrections of severe cases of deformities can be performed.

PREVENTION

The principles of prevention are

1. Health education against practices that prevent exposure to sunlight
2. Fortification of foods with Vit. D
3. Vit D prophylaxis but care must be taken to avoid overdosage and the consequent renal damage.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

It can be concluded here that the disorder affecting the children of the two communities is actually nutritional ricketts, which is most likely due to interference with calcium and Vit. D absorption in the small intestine. More so, there was no evidence to suggest that the children were being poorly exposed to sunlight but it was found that the main food consumed were cereals (Maize, Millet, Guinea Corn and Wheat). It has been documented that exposure to sunlight (16) is the more important source of vit D and since there was no restriction to exposure: the Vit D requirement would have been provided by this source. Cereal based preparations have been known to contain phytate [16, 19], which inhibits calcium and Vit. D absorption / reabsorption. Thus, The food is a very likely suspect. This however remains to be proved by further analytical study.

RECOMMENDATIONS

1. There is an urgent need to start a Nutritional programme in that locality using the Community Level Nutrition Information System of Action (COLNISA)

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2. There is need to carry out a further analytical study to test the veracity of the aetiological conclusion made at the end of this study.

3 The study should as much as possible analyze the components of the major foods consumed in the community as well as liaising with an institution where Vit. D assay can be done.

4 A study design in which four groups of children with the disorder are used with one group on milk, another on calcium supplements, another on any local food with high Vit. D contents and the last on restricted and improved dietary regimen. This will help find the best treatment protocol.

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BORNO STATE WATER CORPORATION MAIDUGU
WATER TREATMENT PLANT

Water Quality Laboratory

Report on Bacteriological Examination of Water

Name and address of sender

N | S · W · B

Nature of Sample

SAMPLE A DA | 2 GAJ ani Borehole

Date and Time of Examination

22|5|2020

Date and time of Collection

18|5|2020 · 2.00 Pm

Colonies per cc 10^1 + 10^2

(Growing on Nutrient Agar at 37° C in 48 hours)

- Most probable number of coliform/E.Coli organisms
  Per 10ml 18 Coliforms | 10ml
- Most probable number of coliform/E.Coli organisms
  Per 100ml 2 Coliforms | 100ml.
- P. H of Samples

Remarks. The WHO Organisation guidelines for Coliform in any water intended for drinking is 0 Coliform in 100ml, but these is just an ideal, not onle it is not easy to obtain that in the 3rd World. However this water shows tremendous quality with as low as 20 Coliform counts per 100 ml, the water is Bacteriologically Safe drinkable.

BORNO STATE WATER CORPORATION MAIDUGURI
WATER TREATMENT PLANT

Water Quality Laboratory

Report on Bacteriological Examination of Water

Name and address of sender

C.S.W.B

Nature of Sample

SAMPLE(B) DA/2/ (Alau Bore hole)

Date and Time of Examination

22/5/2020

Date and time of Collection

18/5/2020. 2.00 p.m

Colonies per cc 10^1 10^2

(Growing on Nutrient Agar at 37° C in 48 hours)

- Most probable number of coliform/E.Coli organisms
  Per 10ml ALOE/Arms/10 mL
- Most probable number of coliform/E.Coli organisms
  Per 100ml ALOE/Arms/100 ml
- P. H of Samples

Remarks. Shows tremendous quality very ~~free~~ low Oliforms. Good for Human Consumption.

BORNO STATE WATER CORPORATION MAIDUGURI
WATER TREATMENT PLANT

Water Quaiity Laboratory

Report on Bacteriological Examination of Water

Name and address of sender
7 | S · W · P.

Nature of Sample
WELL WATER (SAMPLE C)

Date and Time of Examination
22/5/2000

Date and time of Collection
18/5/2000 | 2.00pm

Colonies per cc ... 10^1 ... 10^2 ...
(Growing on Nutrient Agar at 37° C in 48 hours)

- Most probable number of coliform/E.Coli organisms
  Per 10ml ... 278 Colioms | 10ml
- Most probable number of coliform/E.Coli organisms
  Per 100ml ... 201 Colioms | 100ml
- P. H of Samples

Remarks. Highly polluted. It should be thoroughly disinfected.

BORNO STATE WATER CORPORATION MAIDUGURI
WATER TREATMENT PLANT

Water Quality Laboratory

Report on Bacteriological Examination of Water

Name and address of sender
S.W.B

Nature of Sample
SAMPLE D (WELL WATER)

Date and Time of Examination
22/5/2020

Date and time of Collection
18/5/2020/ 2.00 P.M

Colonies per cc 10 10²

(Growing on Nutrient Agar at 37° C in 48 hours)

- Most probable number of coliform/E.Coli organisms
  Per 10ml 287 Organisms/10ml
- Most probable number of coliform/E.Coli organisms
  Per 100ml 122 Organisms/100ml
- P. H of Sampies

Remarks. Highly polluted, should be adequately chlorinated with a Hypochlorite Solution.

BORNO STATE WATER CORPORATION MAIDUGURI
WATER TREATMENT PLANT

Water Quality Laboratory

Report on Bacteriological Examination of Water

Name and address of sender

W.T.P. B

Nature of Sample

SAMPLE E (WELL WATER) PAWAI

Date and Time of Examination

22/5/2000

Date and time of Collection

18/5/2000 2.00 pm

Colonies per cc 10^1 10^2

(Growing on Nutrient Agar at 37° C in 48 hours)

- Most probable number of coliform/E.Coli organisms
  Per 10ml 112 Col forms / 10 ml

- Most probable number of coliform/E.Coli organisms
  Per 100ml 15 Col forms / 100 ml

- P. H of Samples

Remarks. Although the pollution level is low, there water in well needs to be disinfected thoroughly to prevent the proliferation of the indicator organis

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BORNO STATE WATER CORPORATION MAIDUGURI
WATER TREATMENT PLANT

Water Quality Laboratory

Report on Bacteriological Examination of Water

Name and address of sender
N.S.W.B

Nature of Sample
SAMPLE F (WELL WATER) GARDEN AGADI

Date and Time of Examination
23/5/2022

Date and time of Collection
18/5/2022 2:00pm

Colonies per cc 10^{1} 10^{2}

(Growing on Nutrient Agar at 37° C in 48 hours)

- Most probable number of coliform/E.Coli organisms
  Per 10ml 1 Colonies/10ml

- Most probable number of coliform/E.Coli organisms
  Per 100ml 1 Colonies/100ml

- P. H of Samples

Remarks. Polluted, should be disinfected before consumption.

BORNO STATE WATER CORPORATION
WATER TREATMENT PLANT
WATER LABORATORY

Report on Physico- Chemical Analysis of Water Sample

Lab. Ref. No: BSWC|WL|	Sender's Ref. No.: Y·S·W·B|5|70
Name and Address of Sender	Date of Collection: 18|5|2080
Y·S·W·B DAMATURU	Date Received: 18|5|2080
	Date of Analysis: 19|5|2080
	Source of Sample: (DA|2) AJNAI BORE HOLE DAMATURU (A)

Temperature (at time of analysis)	28·3	°C
Colour	N·D	Pt/Co
Turbidity	N·D	NTU
pH	8·0	
Total Dissolved Solids (TDS)	0·325	~~mg/l~~
Electrical Conductivity	0·65	mS/cm
Total Hardness	37·4	mg/l
Total Alkalinity		
CATIONS		
~~Sodium~~		mg/l
~~Potassium~~ Phosphate	0·73	mg/l
Calcium	35·0	mg/l
Magnesium	N·D	mg/l
Iron	0·09	mg/l
Cromium	0·08	mg/l
ANIONS		
Chloride		mg/l
Sulphate	17·0	mg/l
Nitrates	3·1	mg/l
Bicarbonate		mg/l
Flouride	0·09	mg/l

Water Analyst

Name:_____

Sign _____

Date:_____

Water Chemist

Name: ABBA A.-Attmts

Sign: ~~7-11-77~~

Date: 20th|5|2080

mg/l = milligrams/litre
NTU = Nephelometric Turbidity Units
S/cm = micro Siemens/cm
Pt/Co = Units of Platinum Cobalt
= Degrees Celsius

BORNO STATE WATER CORPORATION

WATER TREATMENT PLANT

WATER LABORATORY

Report on Physico- Chemical Analysis of Water Sample

Lab. Ref. No: BS WC/WL	Sender's Ref. No.: Y.S.W.B/S/70/Vol I
Name and Address of Sender:	Date of Collection: 18-May-2088.
Y.S.W.B DAMATURU.	Date Received: 18-May-2088.
	Date of Analysis: 19-May-2088.
	Source of Sample: (DA/2) AJari Borehole Damaturu (B)

Temperature (at time of analyses)	28.6	°C
Colour	ND	Pt/Co
Turbidity	ND	NTU
pH	7.5	
Total Dissolved Solids (TDS)	030 g/L	~~mg/l~~
Electrical Conductivity	0.61	µS/cm
Total Hardness	37.6	mg/l
Total Alkalinity		
CATIONS		
Sodium		mg/l
Pollasium Phosphate	0.76	mg/l
Calcium	36.1	mg/l
Magnessium	ND	mg/l
Iron	006	mg/l
Cromium	0.07	mg/l
ANIONS		
Chloride		mg/l
Sulphate	ND	mg/l
Nitrates	3.3	mg/l
Bicarbonate		mg/l
Flounde	0.05	mg/l

Water Analyst

Name:_____

Sign:_____

Date:_____

Water Chemist

Name: ABBA A. ATTMT

Sign:_____

Date: 30/5/2000

mg/l = milligrams/litre
NTU = Nephelometric Turbidity Units
µS/cm = micro Siemen /cm
Pt/Co = Units of Platinum Cobalt
°C = Degrees Celsius

BORNO STATE WATER CORPORATION

WATER TREATMENT PLANT

WATER LABORATORY

Report on Physico- Chemical Analysis of Water Sample

Lab. Ref. No BSWC/WL/	Sender's Ref. No: Y.S.W.B/S/70
Name and address of Sender	Date of Collection: 18/5/2000
Y.S.W.B DAMATURU	Date Received: 18/5/2000
	Date of Analysis: 22/5/2000
	Source of Sample: HAND DUG WELL (C) AJARI

Temperature (at time of analysis)	28.5	°C
Colour	2.0	Pt/Co
Turbidity	1.0	NTU
pH	7.0	
Total Dissolved Solids (TDS)	0.22	mg/l
Electrical Conductivity	0.43	µS/cm
Total Hardness	36.0	mg/l
Total Alkalinity	—	
CATIONS		
Sodium	—	mg/l
Calcium		mg/l
Magnesium	0.1	mg/l
Iron	NIL	mg/l
Cromium	0.08	mg/l
ANIONS		
Chloride		mg/l
Sulphate	11.0	mg/l
Nitrates	6.0	mg/l
Bicarbonate	—	mg/l
Fluoride	0.07	mg/l

Water Analyst

Name:_____

Sign:_____

Date:_____

Water Chemist

Name: ABBA A. AHMED

Sign:

Date: 30th/5/2000

mg/l = milligrams/litre
NTU = Nephelometric Turbidity Units
µS/cm = micro Siemens/cm
Pt/Co = Units of Platinum Cobalt
°C = Degrees Celsius

BORNO STATE WATER CORPORATION
WATER TREATMENT PLANT
WATER LABORATORY

Report on Physico-Chemical Analysis of Water Sample

Lab. Ref. No. BSWC/WL/	Sender's Ref. No. Y.S.W.B/S/70
Name and Address of Sender	Date of Collection 18/5/2022
Y.S.W.B. DAMATURU	Date Received 18/5/2022
	Date of Analysis 22/5/2022
	Source of Sample HAND DUG WELL (S.D) AJARI

Temperature (at time of analysis)	29.0	°C
Colour	NIL	Pt/Co
Turbidity	NIL	NTU
pH	8.0 - 7.5	
Total Dissolved Solids (TDS)	0.16	mg/l
Electrical Conductivity	0.37	uS/cm
Total Hardness	411.0	mg/l
Total Alkalinity	—	
CATIONS		
Sodium	—	mg/l
Potassium Phosphates	0.26	mg/l
Calcium		mg/l
Magnesium	0.1	mg/l
Iron	NIL	mg/l
Cromium	0.12	mg/l
ANIONS		
Chloride	—	mg/l
Sulphate	6.0	mg/l
Nitrates	55.07	mg/l
Bicarbonate	—	mg/l
Flounde	NIL	mg/l

$(CaCO_3)$

Water Analyst

Name: _____

Sign _____

Date _____

Water Chemist

Name: ABBA A. ATTAHIRU

Sign: _____

Date: 30th/5/2022

mg/l = milligrams/litre
NTU = Nephelometric Turbidity Units
uS/cm = micro Siemens/cm
Pt/Co = Units of Platinum Cobalt
°C = Degrees Celsius

474625

BORNO STATE WATER CORPORATION
WATER TREATMENT PLANT
WATER LABORATORY

Report on Physico-Chemical Analysis of Water Sample

Lab. Ref. No. BSWC/WL/	Sender's Ref. No.: Y.S.W.B/S/70
Name and Address of Sender	Date of Collection: 18/5/2020
Y.S.W.B DAMATURU	Date Received: 18/5/2020
	Date of Analysis: 23/5/2020
	Source of Sample: KANKARE WELL SAMPLE @ PAWARI

Temperature (at time of analysis)	28·7	°C
Colour	1·0	Pt/Co
Turbidity	N/D	NTU
pH	5·5	
Total Dissolved Solids (TDS)	0·16	mg/l
Electrical Conductivity	0·32	µS/cm
Total Hardness	43·1	mg/l
Total Alkalinity	—	
CATIONS		
Sodium		mg/l
Potassium phosphate)	0·85	mg/l
Calcium	36·3	mg/l
Magnesium	0·6	mg/l
Iron	0·12	mg/l
Cromium	0·11	mg/l
ANIONS		
Chloride		mg/l
Sulphate	9·0	mg/l
Nitrates	11·02	mg/l
Bicarbonate		mg/l
Flouride	N/D	mg/l

Water Analyst

Name:_____

Sign:_____

Date:_____

Water Chemist

Name: ABBA A. AHMED

Sign:_____

Date: 30-[5-]2020

mg/l = milligrams/litre
NTU = Nephelometric Turbidity Units
µS/cm = micro Siemens/cm
Pt/Co = Units of Platinum Cobalt
°C = Degrees Celsius

BORNO STATE WATER CORPORATION

WATER TREATMENT PLANT

WATER LABORATORY

Report on Physico-Chemical Analysis of Water Sample

Lab. Ref. No: BSWC/WL/	Sender's Ref. No: Y.S.W.B/S/70
Name and Address of Sender	Date of Collection: 18/5/2022
Y.S.W.B DAMATURU	Date Received: 18/5/2022
	Date of Analysis: 23/5/2022
	Source of Sample: HAND DUG WELL (f) GARDAN AJARI

Temperature (at time of analysis)	28.3	°C
Colour	25	Pt/Co
Turbidity	5.0	NTU
pH	8.0	
Total Dissolved Solids (TDS)	0.14	mg/l
Electrical Conductivity	0.29	µS/cm
Total Hardness	43.1	mg/l
Total Alkalinity		
CATIONS		
Sodium		mg/l
~~Potassium phosphate~~	0.44	mg/l
Calcium	34.3	mg/l
Magnesium	0.4	mg/l
Iron	0.01	mg/l
Cromium	0.10	mg/l
ANIONS		
Chloride		mg/l
Sulphate	2.0	mg/l
Nitrates	22.01	mg/l
Bicarbonate		mg/l
Fluoride	0.05	mg/l

Water Analyst

Name:_____

Sign _____

Date:_____

Water Chemist

Name: ABBA A. AHMED

Sign: [signature]

Date: 30/5/2022

mg/l = milligrams/litre
NTU = Nephelometric Turbidity Units
µS/cm = micro Siemens/cm
Pt/Co = Units of Platinum Cobalt
°C = Degrees Celsius

BORNO STATE WATER CORPORATION
WATER TREATMENT PLANT
WATER LABORATORY

Report on Physico- Chemical Analysis of Water Sample

Lab Ref. No. BSWC/WL/	Sender's Ref. No.: Y.S.W.B/S/70/
Name and Address of Sender	Date of Collection: 18/5/2022
Y.S.W.B DAMATURU	Date Received: 18/5/2022
	Date of Analysis: 23/5/2022
	Source of Sample: HAND DUG WELL (G)

Temperature (at time of analysis)	29.4	°C
Colour	NIL	Pt/Co
Turbidity	NIL	NTU
pH	7.5	
Total Dissolved Solids (TDS)	0.16	mg/l
Electrical Conductivity	0.31	µS/cm
Total Hardness	40.2	mg/l
Total Alkalinity		
CATIONS		
Sodium		mg/l
Potassium Phosphate	0.88	mg/l
Calcium	37.5	mg/l
Magnesium	0.1	mg/l
Iron	NIL	mg/l
Cromium	0.10	mg/l
ANIONS		
Chloride		mg/l
Sulphate	5.0	mg/l
Nitrates	23.3	mg/l
Bicarbonate	—	mg/l
Flouride	0.02	mg/l

Water Analyst

Name:_____

Sign:_____

Date:_____

Water Chemist

Name: ABBA A. AHMED

Sign:_____

Date: 30th May 2022

mg/l = milligrams/litre
NTU = Nephelometric Turbidity Units
µS/cm = micro Siemens/cm
Pt/Co = Units of Platinum Cobalt
°C = Degrees Celsius

BORNO STATE WATER CORPORATION
WATER TREATMENT PLANT
WATER LABORATORY

Report on Physico-Chemical Analysis of Water Sample

Lab. Ref. No BSWC/WL	Sender's Ref. No. YSWB/S/70
Name and Address of Sender	Date of Collection 18/5/2022
Y.S.W.B DAMATURU	Date Received 18/5/2022
	Date of Analysis 25/5/2022
	Source of Sample: HAND DUG WELL (H) AJARI

Temperature (at time of analysis)	29.1	°C
Colour	ND	Pt/Co
Turbidity	1.0	NTU
pH	8.0	
Total Dissolved Solids (TDS)	0.16	mg/l s/c
Electrical Conductivity	0.32	µS/cm
Total Hardness	56.0	mg/l
Total Alkalinity	—	
CATIONS		
Sodium	—	mg/l
Potassium Phosphate,	0.49	mg/l
Calcium		mg/l
Magnesium	0.2	mg/l
Iron	0.02	mg/l
Cromium	0.10	mg/l
ANIONS		
Chloride	—	mg/l
Sulphate	10	mg/l
Nitrates	44.0	mg/l
Bicarbonate	—	mg/l
Flounde	NA	mg/l

N (AlO_3)

Water Analyst

Name: _____

Sign: _____

Date: _____

Water Chemist

Name: ABBA A. AHMED

Sign: _____

Date: 30/5/2022

mg/l = milligrams/litre
NTU = Nephelometric Turbidity Units
µS/cm = micro Siemens/cm
Pt/Co = Units of Platinum Cobalt
°C = Degrees Celsius

BORNO STATE WATER CORPORATION
WATER TREATMENT PLANT
WATER LABORATORY

Report on Physico-Chemical Analysis of Water Sample

Lab Ref No: BSWC/WL/	Sender's Ref No: YS/WB/S/90
Name and Address of Sender:	Date of Collection: 18/5/2020
YSWB DAMATURU	Date Received: 18/5/2020
	Date of Analysis: 29/5/2020
	Source of Sample: HAND DUG WELL (I) AJARI WARD

Temperature (at time of analysis)	29.5	°C
Colour	NIL	Pt/Co
Turbidity	NIL	NTU
pH	5.0	
Total Dissolved Solids (TDS)	0.19	mg/l
Electrical Conductivity	0.38	mS/cm
Total Hardness	30.1	mg/l
Total Alkalinity	—	
CATIONS		
Sodium		mg/l
Potassium phosphate	1.15	mg/l
Calcium	33.2	mg/l
Magnesium	0.2	mg/l
Iron	0.06	mg/l
Cadmium	0.09	mg/l
ANIONS		
Chloride		mg/l
Sulphate	10.0	mg/l
Nitrates	35.0	mg/l
Bicarbonate		mg/l
Fluoride	NIL	mg/l

Water Analyst

Name: _____

Sign: _____

Date: _____

Water Chemist

Name: ABBA A. AHMED

Sign: _____

Date: 30/5/2020

mg/l = milligrams/litre
NTU = Nephelometric Turbidity Units
uS/cm = micro Siemens/cm
Pt/Co = Units of Platinum Cobalt
°C = Degrees Celsius

BORNO STATE WATER CORPORATION

WATER TREATMENT PLANT

WATER LABORATORY

Report on Physico Chemical Analysis of Water Sample

Lab Ref. No	Sender's Ref. No: YSWB/5/70
Name and Address of Sender	Date of Collection: 18/5/2020
Y.S.W.B DAMATURU	Date Received: 18/5/2020
	Date of Analysis: 22/5/2020
	Source of Sample: HAND DUG WELL (J) AJARI

Temperature (at time of analysis)	27.7	C
Colour	NIL	Pt/Co
Turbidity	NIL	NTU
pH	7.0	
Total Dissolved Solids (TDS)	0.22	~~mg/l~~
Electrical Conductivity	0.45	mS/cm
Total Hardness	47.2	mg/l
Total Alkalinity		
CATIONS		
Sodium		mg/l
~~Potassium~~ phosphate	0.51	mg/l
Calcium	30.1	mg/l
Magnesium	NIL	mg/l
Iron	NIL	mg/l
Cromium	0.09	mg/l
ANIONS		
Chloride		mg/l
Sulphate	17.0	mg/l
Nitrates	22.04	mg/l
Bicarbonate		mg/l
Flounde	0.007	mg/l

Water Analyst

Name:_____

Sign _____

Date _____

Water Chemist

Name: ABBA A. AHMED

Sign. _____

Date 30th/5/2020

mg/l = milligrams/litre
NTU = Nephelometric Turbidity Units
µS/cm = micro Siemens/cm
Pt/Co = Units of Platinum Cobalt
°C = Degrees Celsius

BORNO STATE WATER CORPORATION
WATER TREATMENT PLANT
WATER LABORATORY

Report on Physico- Chemical Analysis of Water Sample

Lab Ref No: BSWC/WL	Sender's Ref No: YSWB/S/70
Name and Address of Sender:	Date of Collection: 18/5/2020
YSWB DAMATURU.	Date Received: 18/5/2020
	Date of Analysis: 26/5/2020
	Source of Sample: HAND DUG WELL (K)

Temperature (at time of analysis)	29·4	°C
Colour	17·0	Pt/Co
Turbidity	3·0	NTU
pH	8·0	
Total Dissolved Solids (TDS)	0·13	mg/l
Electrical Conductivity	0·27	µS/cm
Total Hardness	73·0	mg/l
Total Alkalinity		
CATIONS		
Sodium	—	mg/l
~~Potassium~~ phosphate	0·76	mg/l
Calcium	52·5	mg/l
Magnesium	0·4	mg/l
Iron	0·03	mg/l
Cromium	0·11	mg/l
ANIONS		
Chloride		mg/l
Sulphate	18·0	mg/l
Nitrates	40·0	mg/l
Bicarbonate		mg/l
Flounde	ND	mg/l

Water Analyst

Name: _____

Sign _____

Date _____

Water Chemist

Name: ABBA A. AHMED

Sign: _____

Date: 30th/5/2020

mg/l = milligrams/litre
NTU = Nephelometric Turbidity Unit
µS/cm = micro Siemens/cm
Pt/Co = Units of Platinum Cobalt
°C = Degrees Celsius

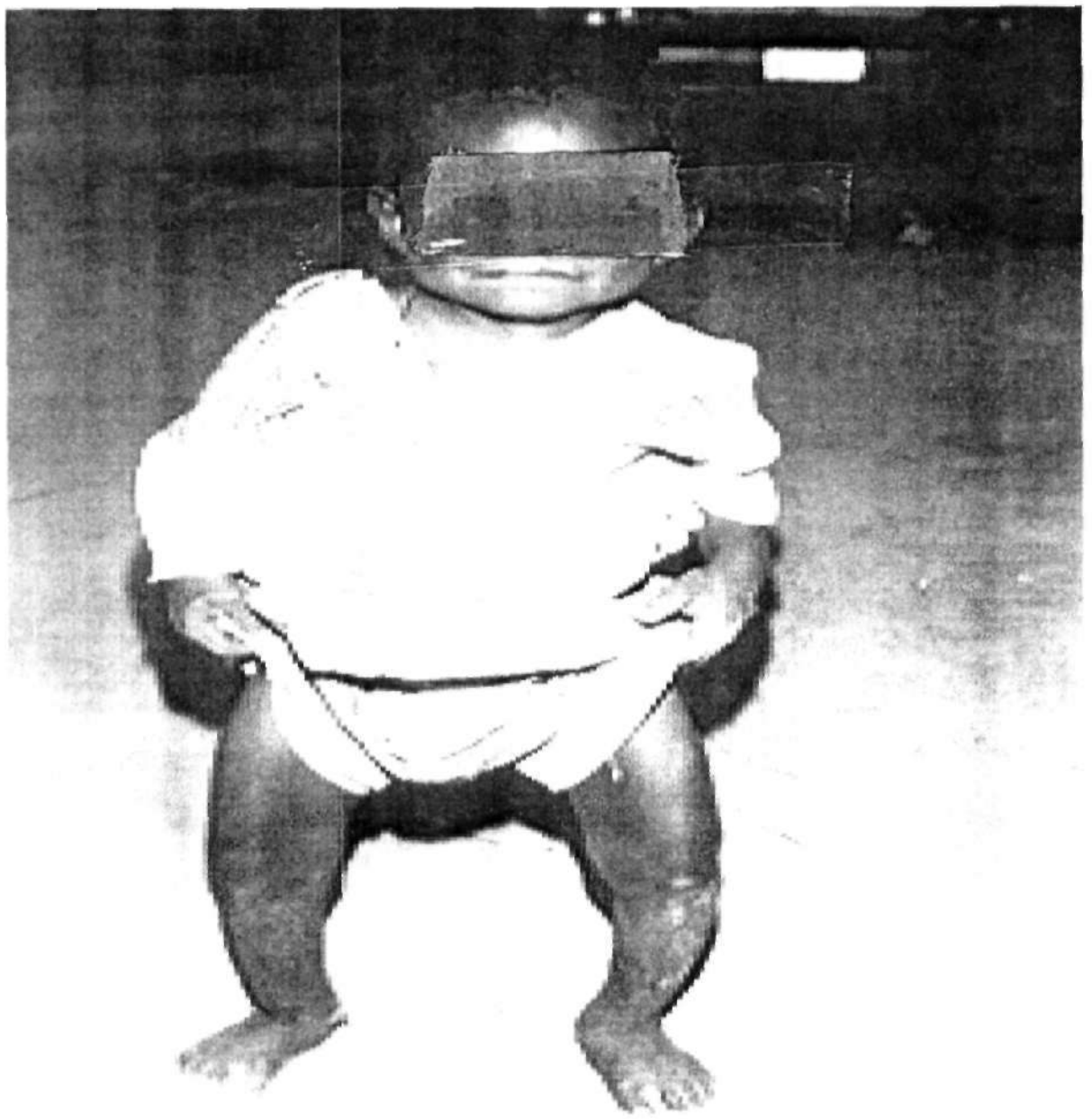


Picture showing one of the affected children with severe bone deformities.

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A picture showing an eight (8) years old Girl with both upper and lower limb involvement, and cannot walk.



Picture showing one of the affected children: malnourished, with both skin and hair changes as well as bowing of the legs.

QUESTIONNAIRE ON THE EPIDEMIOLOGY OF AN UNUSUAL SKELETAL DISORDER

S/no of Questionnaire----------

SECTION ONE: HOUSEHOLD

1. Household identification number: No---- street---------- ward---------- 2. Name of household head ----------

3. Length of stay in the area ---------- 4. Religion ---------- 5. Ethnicity ----------

6. Type of household

□ Thatch house □ Mud house □ Zinc house □ Cement house □ Others (specify)----------

7. Size of (No. in) household---------- (M=----- : F:-----) 8. No of rooms----------

9. Occupation of Household head (Tick as appropriate) ----------

10. Major source of water

□ Borehole □ Tap □ Dam □ Well □ Stream □ Water vendors □ Others (specify)----------

11. Mode of storage of water for drinking----------

12. Toilet facility within the household

□ None □ Water system □ Pit latrine □ Others (specify)----------

13. Refuse disposal method

□ An open area within the compound □ A dustbin, emptied periodically □ In a heap, in front of the house □ Specific collection point, outside.

14. Presence of pets in the household: □ None □ Yes (specify type)----------

15. Rearing of animals within the household: □ None □ Yes (specify type)----------

16. a) Do you use (Have you ever used) any form of chemical substance in the household? □ No □ Yes

b) If yes, specify type and for what purpose----------

17. a) Do you store (Have you ever stored) any form of chemical substance in the house? □ No □ Yes

b) If yes , specify, and where is it stored? ----------

c) Who are those accessible to the chemicals? ----------

18. Source of food for the household

□ Market □ Family farm □ Family farm and market □ Charities □ Others (specify)----------

19. Main foods consumed in the family----------

20. List cultural practices being done in the household with respect to children.

1. ---------- 2. ---------- 3. ----------

4.---------- 5. ---------- 6. ----------

SECTION TWO: VITAL EVENTS IN THE HOUSEHOLD

21. a) Any birth(s) recorded in the household within the last 12 months? □ No □ Yes

b) If yes, fill the table below

S/no	Name of child	Age	Sex	Mother's age at Child's delivery	Place of delivery	Delivery Attendant
1						
2						
3						
4						

22. a) Any death(s) within the household within the last 12 months? □ No □ Yes

b) If yes, fill the table below

S/no	Name of deceased	Date of death	Age at death	Place of death	Cause of death S (if known)
1					
2					
3					

SECTION 4: CHARACTERISTICS OF CHILDREN (4 YRS & BELOW) OF THE HOUSEHOLD

31 Child s/no from Q22 above	32 Mother's s/no from Q22 above	33 Ht In cm	34 Wt In kg	35 Immuni-zation status C=completed I=incomplete N=none	36 Weaning diet	37 Additional or any special supplementary diet during (or after) weaning	38 Cultural practices done specify s/no from Q20 above	39 History of accessibility to chemicals Yes or No	40 History of Usage of stream water Yes or No	41 History of Usage of well water Yes or No	42 Treatment of water before usage	
											Yes or No	If yes how

SECTION 3

CHARACTERISTICS OF HOUSEHOLD MEMBERS

22 S/no	23 Name	24 Relation ship with household head	25 Age	26 Sex	27 Marital Status	28 Highest educational level	29 History of disorder Y =Yes N =No Hs =Has presently	30 Present state of health Aw=Apparently well Au =Apparently unwell U= Unsure

SECTION 5 (FOR THE AFFECTED CHILD ONLY)

43) S/no from Q32---------- 44) Father's S/no from Q22---------- 45) Mother's S/no from Q22----------

46) Earliest complaint preceding deformity----------

47) Age at unset of deformity---------- 48) Duration between 1st symptom and deformity---------- (months/years)

49) Site of 1st deformity----------50) Affected sites (in order of occurrence)

1).----------2)----------3)----------4)----------5)----------6)----------

51) Treatment received

□ None □ Chemist □ Health centre □ Hospital □ Traditional

52) Duration of treatment----------

53) Progress of disease

□ Improved □ Worsening □ Unchanged □ Unsure

54) Duration of pregnancy----------month(s)

55) Attendance of ANC: □ None □ Irregular □ Regular

56) History of illness during pregnancy

□ No □ Yes (describe)----------

57) Drugs taken during pregnancy----------

58) Place of delivery/delivery attendant)----------

□ Home by self or untrained midwife or TBA □ Home by trained TBA □ Hospital □ others (specify)----------

59) Was the child born in the area? Yes ----or No----

60) Birth order------- out of -------- 61) Duration of breastfeeding ----------62) Mother's age at child's delivery----------

63)Any family member not necessarily within the household with similar problem? Yes---or No----

64 a)) Does the child have a playmate with similar problem? Yes or No

b) If yes, Name----------Father's name----------S/N of Q/naire (if known)----------

65) Any child in neighbouring household (i.e. within the same compound or next house in all directions) with similar problem? Yes---or No---

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