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Concentration of Lead and Cadmium in the Fosu Lagoon and its Health Implications on Lagoon Fishermen

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Abstract
Many ecosystems around the world are encountering environmental problems as a result of man's activities. Such ecosystems include lagoons of which the Fosu lagoon is no exception. It has been asserted that the lagoon water is polluted with heavy metals such as lead and cadmium. Fish muscles are also polluted with lead and cadmium. This study sought out to investigate lead and cadmium effects of tilapia consumption on the health of fishermen who fished in the lagoon. It also looked at health effects resulting from standing in the lagoon for fishing purposes. Health conditions investigated include infertility, cancer, painful bones, Burton line, wrist drop, cognitive deficiency among respondents' children and skin diseases. Sixty fishermen were sampled for the study. The purposive and snowball sampling methods were used in the sampling process. Open and closed ended questions in a questionnaire were employed. Interview and observation techniques were also employed. The descriptive method of analysis was utilized using the SPSS software program. Results from the study revealed that fishermen who fished in the lagoon might be at risk of painful bone conditions and wrist drop due to lead and cadmium pollution of tilapia in the lagoon. While 28.3 percent had been diagnosed of wrist drop, over 33 percent had also been diagnosed of painful bones on more than one occasion. Fishermen might also be at risk of skin infections as a result of dermal contact with lagoon water. Thirty-five percent had at least, on one occasion or the other, been diagnosed of skin-related diseases. The study recommends that medical personnel, particularly doctors, should be involved in educating the fishermen concerning the risks involved in the consumption of tilapia from, as well as fishing in, the lagoon.
Keywords: diseases; environmental health; fishing; pollution; tilapia fish-muscle.

1. Introduction

The uncontrollable activities of man have resulted in environmental problems affecting many ecosystems (Essumang, Dodoo & Kendie, 2006). These ecosystem serve as habitats for various plants and animals and are therefore of great importance. Though ecosystems such as water bodies serve the interest of humans and his activities for livelihood, pollution, drying-up and loss of these precious systems appear to be of no concern. Water bodies including lagoons could be used for agricultural activities, recreational and sporting activities, religious purposes and fishing activities among others (Cunningham & Saigo, 1997; Mohammed, 1993). In spite of their importance, urbanization and modernization with their consequential human desire for higher standards of living persistently take their negative toll on these water bodies of which the Fosu lagoon is not excluded.

The importance of the Fosu lagoon cannot be taken for granted (Mohammed, 1993). Though the lagoon is rich with fresh water resources, it is being contaminated with all manner of waste (Essumang et al, 2006). This is affecting recreation, sports and the fishing industry in and around the lagoon (Mohammed, 1993). Fish caught from the lagoon are a great delicacy to many indigenes, including fishermen who fish in the lagoon, as well as strangers who troop to the Municipality during the *Fetu* festival. Among the fishes caught from the lagoon and the most preferred, is tilapia, locally referred to as *mpatoa* (Blay, Jnr. & Asabere-Ameyaw, 2007).

Currently the condition of the lagoon is not encouraging. The surface area has been reduced to a very large extent. The depth of the lagoon has also been reduced due to silting especially within the last thirty years. The unpleasant state of the lagoon is obvious as a result of pollution and current economic activities from and around its sphere of influence (Agyapong, 2008; Ahuahey 2007; Mohammed, 1993). The gradual extinction of the lagoon could also be attributed to unsustainable settlement planning. For example, the campus of St. Augustine's college, a second cycle institution, is located close to the lagoon. Effluent from the Cape Coast municipal hospital, also located near the lagoon, discharges wastes into the lagoon unpurified and uncontrolled. Domestic solid and liquid wastes from certain areas of Cape Coast Township are also discharged through Bakaano Township and Adisadel estate, suburbs of Cape Coast, directly into the lagoon (Mohammed, 1993).

The Nkanfoa, Esuekyir, Ankaful and Adisadel waste disposal sites all discharge leachates into the lagoon (Essumang et al, 2006). The Metro-mass garage, previously the omnibus services Authority garage, located very close to the lagoon also discharges oily, bituminous and other waste materials into the same sink. Run-off and leachates from the Siwdo automobile garages and workshops also flow directly into the lagoon with oils and paints (Ahuahey, 2007; Essumang et al, 2006). Garbage, night soil and metal scraps also find their way into the Fosu lagoon (Adjei, 1991).

It is known that sediments, water and fish in the lagoon are heavily infected with pollutants such as lead and cadmium (Akwansah-Gilbert, 2007; Dadson, 1996; Adjei, 1991; Tay 1988; Hagan 1986; Allen, Grimshaw, Parkinson & Quarnby, 1974). Through the food chain these metals could be translocated into humans who consume tilapia from the lagoon. Fishermen who fish in the lagoon could also be affected through physical skin contact with lagoon water. Lead and cadmium could be very toxic and therefore harmful to human beings when ingested in relatively very small amount. When accumulated they could be very harmful. They can cause various health problems including infertility, cancer, painful bones, Burton line, wrist-drop and skin diseases. They can also have effect on unborn children (Kumar, Abbas & Aster, 2013), causing cognitive-deficiencies.

Lead and cadmium pollutants that find their way into the lagoon may be part of the sediments or become dissolved in the water in solution. Whichever state in which they may be identified in lagoon water, aquatic plants translocate them into their tissues which are subsequently fed on by fishes in the lagoon. It is a fact that fishermen who fish in the lagoon feed on their fish catch, particularly the blackchin tilapia (Akwasah-Gilbert, 2007; Dadson , 1996; Adjei, 1991; Tay, 1988; Hagan,1986) which constitute over 90% of fish caught (Baffour-Awuah, 2014[a]; Abban, Asante & Falk, 2000). A recent report by Obodai, Okeyere, Boamponsem, Mireku, Aheto & Senu (2011) shows that higher concentrations of cadmium and lead exist in blackchin tilapia in the Fosu lagoon. Tilapia consumption and physical contact with lagoon water containing lead and cadmium may finally result in ingestion into fishermen.

1.1 Aim and Objectives of the study

The main aim of the study was to investigate the health implications of lead and cadmium in the Fosu lagoon and its health implications on fishermen who fish in it. The specific objectives, however, were as follows:

1. To investigate the health records of fishermen as to whether they have lead- and cadmium-related disease resulting from tilapia consumption;
2. To find out what effects fishing activity could have on the health of fishermen as a result of physical contact with lead- and cadmium polluted lagoon water;
3. To ascertain whether fishermen were prepared to stop consuming polluted tilapia;
4. To access fishermen's reaction to banning fishing activities in the lagoon.

1.2 Research questions

The following research questions guided the study:

1. How many fishermen have ever been diagnosed of infertility, cancer, painful bones, Burton line or wrist drop?
2. What is the number of fishermen who have cognitive-deficient children?
3. Have fishermen been diagnosed of skin-related diseases?
4. Would fishermen stop consuming tilapia from the lagoon if they knew they were polluted?
5. Would fishermen stop fishing in the lagoon if they knew it could have negative implications on their health?

1.3 Study area

The study sought to find out the linkage between concentration of lead and cadmium in the lagoon and the implication on the health of fishermen. The lagoon is located in the Cape Coast metropolis. Fishermen were also located in the Cape Coast Metropolis and conducted their business in and around the lagoon.

The lagoon is located in the Cape Coast Metropolis in the Central region of Ghana. It is bounded by Twifu/Hemang/Lower Denkyira District Gulf of Guinea, Abura/Asebu/Kwamenkese District and Komenda/Edina/Eguafo/Abirem District. Figure 1 shows the map of Fosu lagoon. In the background are the Cape Coast metropolis and Gulf of Guinea at the bottom edge.

The major settlements in the metropolis include Akotokyir, Abura, Amamoma, Ammisano, Siwdo, Antem, Ankaful, Pedu, Bakaano, Adisadel, etc. Economic activities that take place are agriculture, services and industry as well as fishing. Fishing activities are on fish-catch from the sea, rivers, streams, ponds and notably the Fosu lagoon. The major type of fish-catch in the lagoon is blackchin tilapia.

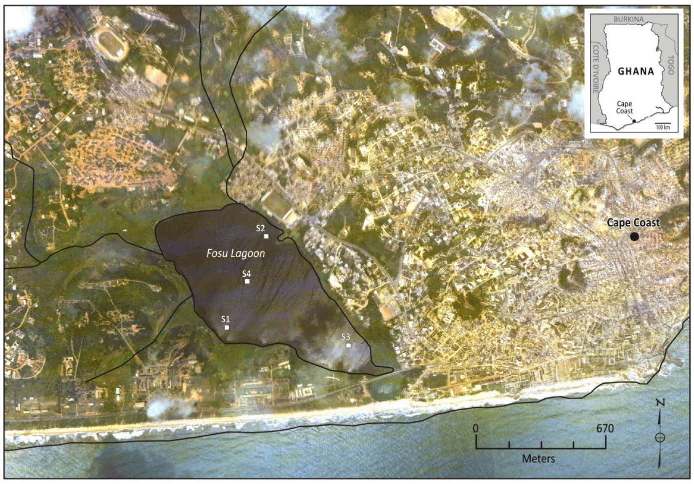

Figure 1: Map of Cape Coast metropolis showing the Fosu lagoon (Source: Armah, Luginaah, Kuitunen & Mkandawire, 2012)

2. Lead and cadmium ingestion

The term heavy metal is referred to any metal with relative density higher than 5, which at low concentrations could be toxic to biological matter (Bánfalvi, 2011). They may cause various dangerous non-communicable and non-infectious diseases. They may enter biological entities through air, water and food including fishes. Heavy metals could be toxic to plants, animals such as fishes and man through protein controlling biochemical reactions. They exhibit either immediate or long term manifestations when they enter human body through the food chain (Bánfalvi, 2011; Akwansah-Gilbert, 2007).

Some heavy metals referred to as trace metals are essential in small quantities for maintenance of food metabolism within biotic elements (Bánfalvi, 2011; Anukwah, 2007). For example zinc (Zn), iron (Fc), magnesium (Mn) and copper are very useful to biotic life since their limited quantities could result in dire biological dysfunction though excess intake could also have negative consequences. However, other heavy metals such as mercury Hg, arsenic (As), titanium (Ti), lead (Pb) and cadmium (Cd) can cause many negative medical conditions in the form of diseases. Lead and cadmium, for instance, may cause cancer, mental retardation among children and painful bones (Kumar, Abbas & Aster, 2013; Bánfalvi, 2011; Bellinger 2008; Kido, Nogawa, Honda, Tsuritani, Ishizaki, Yamada, & Nakagawa, 1990).

In aquatic environments lead and cadmium can easily and readily be taken up by plants and animals (Anukwah, 2007). Thus through the food chain humans could easily be exposed to these elements. They could be transported through roots and leaves, seeds and fruits of plants that habit close to aquatic environments. Whether water bodies act as habitat or waste disposal sinks, plants have the capacity to ingest chemical elements deposited in their environment. Eventually zoological animals such as fish in these habitats tend to find them accumulated in their cells, tissues and other organs when they consume these plants as food (Bánfalvi, 2011; Bellinger 2008; Anukwah, 2007; Kido, Nogawa, Honda, Tsuritani, Ishizaki, Yamada, & Nakagawa, 1990). When ingested into the human body through the food chain they are transformed by microorganisms to secondary toxic substances (Anukwah, 2007). The half life of cadmium, for instance, can be more than 20 years and this, for example, can accumulate in the human body in a continuous or continual manner either in a long time in one's life, or in a whole life time. For this reason, small ingestions through contaminated foods such as fish, is one of the main sources through which humans may be exposed to the metals (Hangi, 1996).

Studies done over the years show that the Fosu lagoon is polluted with Lead and cadmium; for example, Adjei (1991) recorded average concentrations of lead ranging between 0.040-1.12ppm in algae in the lagoon. A study conducted in 2007 by Akwansah–Gilbert confirms that the Fosu lagoon is polluted with cadmium concentrations of between 0.78mg/kg and 33mg/kg. Indeed the cadmium concentration was found to be higher than the 0.7mg/kg being the Interim Cadmium Marine/Estuarine Sediments Guideline for the protection of aquatic lives. One of the conclusions of the study was that maximum cadmium concentrations were found at where there were predominant industrial activities including a cluster of mechanical/automobile fitting shops and welding and spraying shops and at places close to where waste lead acid batteries were disposed off. Thus lead and cadmium eventually find their way into the lagoon.

The metals are extensively used in the production of vehicle body spraying chemicals. These chemicals are frequently used by vehicle body spraying workshops near the lagoon. Leaded fuels are also deposited by vehicles that visit the garages for repair and maintenance work and for other vehicle services. It is therefore no surprise that higher concentration of the metals find their way into water, algae and tilapia fish-muscle in the lagoon (Obodai et. al., 2011). They may eventually be ingested by fishermen who fish in the lagoon and also feed on the tilapia they catch.

2.1 Health implications of cadmium ingestion

Animals and humans may absorb cadmium into their bodies through the food chain (Bernard & Lauwerys, 1997). Thus through plants and animals, and contact with lagoon water, humans ingest cadmium. Consequently there is cadmium build up in their bodies. But biological and chemical effects of cadmium are manifold (Bernard & Lauwerys, 1986). For example, short term implications include choking attacks, persistent vomiting, salivation, abdominal pains, and loss of consciousness as well as spasm of the anal sphincter. While some amount of cadmium ingestion may be eliminated with time, a great fraction is trapped permanently in the body (De Cort, 2000). The trapped cadmium becomes progressively stored cumulatively (UNEP, 2010; Merian, 2000; Kazantzis, 1987).

Cadmium in aquatic environments can accumulate in aquatic animals such as mussels, shrimps, lobsters, oysters and fishes. These polluted animals when consumed directly or indirectly can cause chronic diseases to humans. Such diseases include painful bones and wrist drop (Lentech, 2008).

In the long term occupational exposures to cadmium have also been associated with effects on bones (Kjellstrom, 1986). Cadmium can thus have health implications on bone directly by affecting calcium and vitamin metabolism (Kumar, Abbas & Aster, 2013; Kido, Nogawa, Honda, Tsuritani, Isahiziaki & Yamada, 1990). This may result in softening, bending and consequently painful bone structure (Kumar, Abbas & Aster, 2013; Nogawa, Tsuritani, Kido, Honda, Yamada & Ishizaki, 1987). The presence of such medical conditions may therefore serve as an indication of cadmium in the human body.

2.2 Health implications of lead ingestion

Lead has no physiological beneficial role in the human body; it rather produces enzymic ability to act as catalyst in enzymatic reactions supposed to be performed by zinc and iron in particular in the body (Kosnett, 2006). The removal of lead from the body takes a long time. For this reason, lead can accumulate in human cells, tissues and organs. About 95% of ingested lead in the body accumulates in bones as lead phosphate (ATSDR, 2011). Lead presence in the body may give rise to infertility, have negative implication on cognitive (intelligence) abilities in children, the peripheral and central nervous system and weakness of the exterior muscle of the hand (wrist drop), occurring after several weeks of exposure, (Kumar, Abbas & Aster, 2013; Bellinger, 2008; Patrick, 2006; Landrigan, Schechter, Lipton, Fahs & Schwartz, 2002). Generally, lead ingestion can lead to bluish line formation along the gums. This is referred to as Burton line (William, Berger & Elston, 2005). Lead can build up in aquatic and soil organisms. In seas, rivers and lagoons phytoplankton is an important source of food to aquatic animals such as fish. Thus through the food chain lead can be transported from aquatic environments into humans. Continuous consumption of fish from the Fosu lagoon by fishermen can therefore have negative implication on their health.

The human skin may rather ingest organic lead directly. Workers exposed to lead pollution in their working environments may therefore absorb lead through the skin. For example, it was found that between 0.5 and 1.5 million United States workers were exposed to lead at where they work (ATSDR, 2011). Fishermen working in lead-polluted aquatic environments may therefore be at risk in encountering dermal health implications resulting from direct interaction with the working environment.

3. Public attitude and environmental health

It is the duty of every government in various countries to monitor the environment, its pollution and the complex health implications associated with pollution of the environment. As an arm of government, the local government is concerned with minimizing risks to public health including monitoring water quality. It is therefore the onerous duty of the environmental health service to make sure that the environment is safe and that acceptable standards of hygiene are maintained for general public good (OSHA, 2012).

Though environmental health activities may go a long way to reduce the risk of pollution to public health, the activities and perception of people towards the environment also has a very prominent role to play in this regard. The pollution of the environment, including water bodies begin with attitude and perception of waste disposal to the environment (Kendie, 1999). Generally, attention has dwelt on government bodies such as the environmental health service in the design of waste management technologies and their availability to the population. However, attitudes and perceptions toward waste and public health issues concerning non-infectious diseases have not been given much attention (Kendie, 1999; Porter, Boakye-Yiadom, Mafusive & Teheko, 1997).

According to Agbola (1998), modern technology and drugs needed for treating such disease are beyond the reach of the majority of the population in developing countries. He continues that as a composite set of behavioral settings in which individuals within a community act with diverse consequences, the environment and its problems in many developing countries are rooted in cultural norms which are characterized by attitudinal patterns in relation to the environment. These attitudinal patterns, he explains, are originated from the interactions with one another as a group of people who have come to live together with a common objective and collective aspirations to have a common goal in life through communal and societal security. This therefore brings to the fore a dependency between man, on one hand, and environment and health on the other.

In spite of this relationship, the security of environmental health of society has always not been taken seriously since temporal and immediate satisfaction through the exploitation of the environment seems to be the first consideration of human beings (Convery & Tutu, 1999). This brings into view the problems associated with the connection between, man, environment and health on one hand and culture, technological advancement, level of education, poverty and observed presence and degree of existing health problems on the other. For this reason the individual's ability to observe the presence of a health hazard and the degree to which it can unleash its toll hinges on the intensity of planning, organization and arrangement, consciousness and the responsiveness to environmental health issues (Essumang, 2000). In Ghana this relationship seems to drift towards the American preference of command and control system. This attitude could be of great cost to the prevention and care of environmental health problems to the Ghanaian citizenry (Convery & Tutu, 1999).

According to Gale (1952), the sanitation problem arising from behavioral settings in Cape Coast dates back to the colonial regime. He explained that one of the reasons for relocating the national capital to Accra was sanitation, Accra being considered as the healthiest spot in Gold Coast soil at the time. He continues that various attempts to improve the sanitary conditions during the colonial era were frustrated by the inhabitants. Lack of funds by government authorities and lack of goodwill from the colonial government were other factors. This attitude has continued to this day (Essumang et al, 2006). As a result of this, various insanitary practices can be seen everywhere in Cape Coast, including the surroundings of the Fosu lagoon, even in this era.

4. The health belief model

As a theoretical framework to support the study, the health belief model (HBM) was visited as a psychological theory which tries to account for and forecast the behavior of the individual or society with regards to health threats. It was propounded by social psychologists Hochbaum, Rosenstock, and Kegels when working in the United States Health Services in the 1950's. Their observation of the reluctance of the public to react positively to a free tuberculosis health screening program resulted in the development of the theory (Rosenstock, 1974; Hochbaum, 1956).

The core theme of the theory is that an individual is likely to react to a health-related action (e.g. eating tilapia from a lagoon with water, sediments, algae and fishes polluted with lead and cadmium) provided;

1. The person has the feeling that a negative health condition does exist;
2. The person has the optimism that a negative health condition is avertable (for instance, by not eating fish from a polluted lagoon);
3. The person has the belief that recommended actions can be accomplished (by having confidence and being comfortable in exploiting the options from an authority).

Figure 2 shows the four basic constructs that represent the HBM. These are the perceived susceptibility, perceived severity, perceived benefits and perceived barriers. When one feels that there is the probability of an event occurring then that person is said to have susceptibility perception. Moreover people are not likely to act when they feel that they are not at risk. Furthermore when people can perceive the severity of a disease they are self-motivated enough to take preventive measures to affect their involvement in getting the disease in the first place. In addition to this people can be insulated by protecting their health when they have perceived benefits. Also all attempts by people to involve themselves in health risk activities will be restrained when the people have perceived barriers (Rosenstock, 1966).

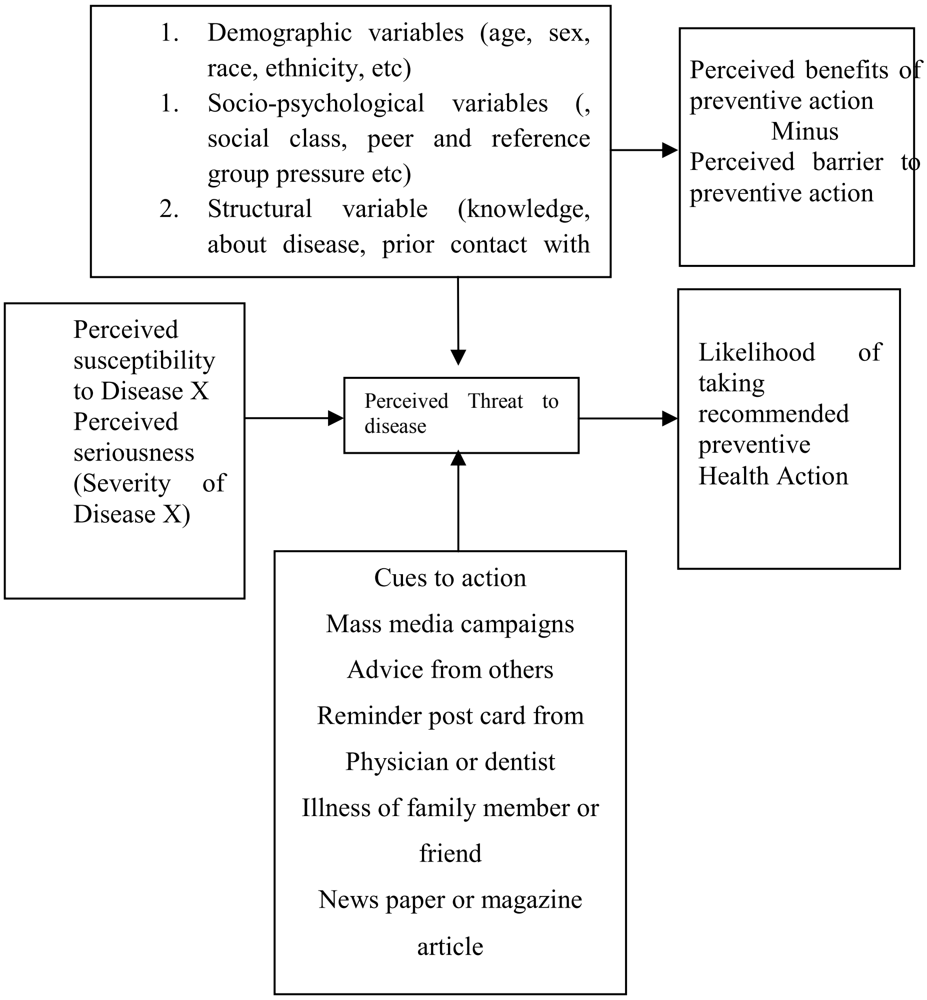

Figure 2: The health belief model as predictor of preventive health behavior (Source: Ghanze, Rimer, & Lewis, 2002).

Conner & Norman (1996) identify three broad areas in the health belief model as preventive health behavior, sick role behavior and clinical use behavior. There are two main aspects of preventive health behavior. These are health promotion behavior and health risk behavior. For the purpose of this study the health risk behavior is considered. The justification is based on the fact that both environmental health and public health fall under preventive health. Non-infectious diseases such as carcinogenic and reproductive problems which arise from environmental mismanagement are related to preventive health behavior. The sick role and clinical use behavior rather deal with curative situations (Agyapong, 2008).

5. Methodology

Sixty-two fishermen were involved in the study at a response rate of 96.7%. Kumar (2005) outlines the various types of sampling design methods and their applications, advantages and disadvantages. In this study the purposive and snowball sampling methods were employed. Various reasons were considered before choosing these methods. First, the information was to be obtained from a known population. Secondly, the respondents were willing to share the information the researcher was looking for. Thirdly, very little information about the fishermen concerning their health and medical conditions were not known to the public. Finally, the information required was confidential and therefore demanded one-on-one interaction. The study employed qualitative methods in gathering data using questionnaire. Both unstructured interview and observational guide were also employed when necessary. Open- and closed-ended questions were utilized to solicit information based on the objectives of study. The SPSS software program was employed for processing data while the descriptive technique was adopted in analyzing the data using frequencies, percentages, tables and charts.

6. Results and Discussion

The study showed that tilapia fishing in the Fosu lagoon is a predominantly male preserve with mean and modal age of 43 and 41.9 years respectively. Age was considered as a yardstick for a person's reproductive ability.

Since the ages ranged from 28 to 74, respondents were considered to have reached their child-bearing ages and therefore expected to be fertile (refer figure 3).

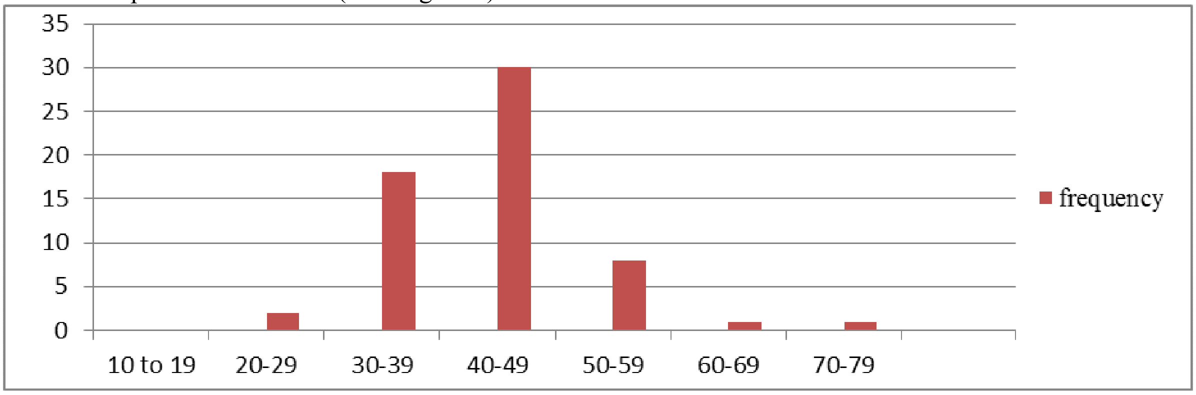

Figure 3: Age distribution of fishermen in years (Source: Field data, 2012)

The number of years of fishing ranged between 15 and 66 years. Mean value was 31.7 years while the mode was 27.5 years. About 83 percent, constituting majority had also practiced fishing between 20 and 39 years. Considering the fact that negative health implication of heavy metals takes over 10 to 15 years to manifest as a medical condition, the sample was a good representation of the population for the study. Figure 4 shows the distribution of number of years of fishing.

Figure 5 summarizes tilapia consumption pattern of the respondents. The study showed, based on the findings of Obodai et al, (2011), that over 90 percent of the respondents consumed an average of 43.52g of tilapia by weight per meal. The remaining (6.7%) consumed an average of 27.2g of tilapia per meal. More than 90 percent of the subjects therefore consumed a minimum average of 289g of tilapia per week. This was an indication that tilapia is a major source of dietary fish to the fishermen. The sample therefore fairly represented the population.

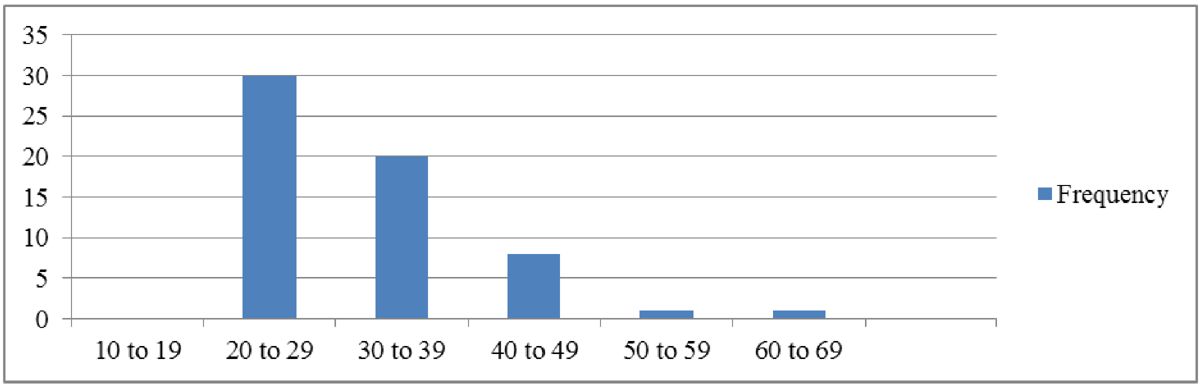

Figure 4: Years of fishing (Source: Field data, 2012).

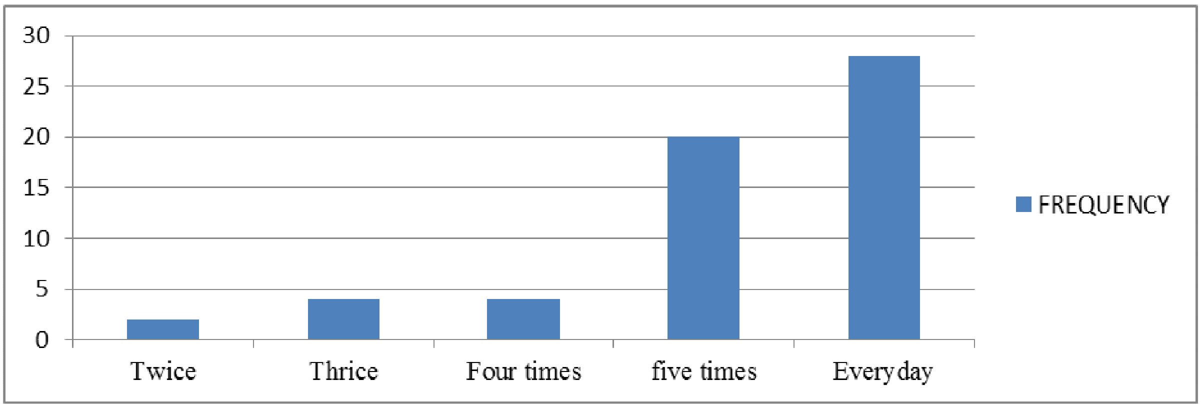

Figure 5: Tilapia consumption rate of Fosu lagoon fishermen (number of times per week (Source: Field data, 2012).

Family size was used as a measure of fertility among the respondents (refer figure 6). It does not include spouse of respondents. The study depicted that over 86 percent of respondents had between 1 and 9 children giving an average family size of 5 per fisherman. Over 96% of the respondents had more than one child per person; thus most of the respondents were fertile. It is to be noted that this distribution was consistent with populations that are involved in traditional occupations such as fishing and with low educational background up to the basic school level (Ghana Statistical service, 2000). Tilapia consumption therefore appeared to have no effect on fertility of respondents (Datz, 2006).

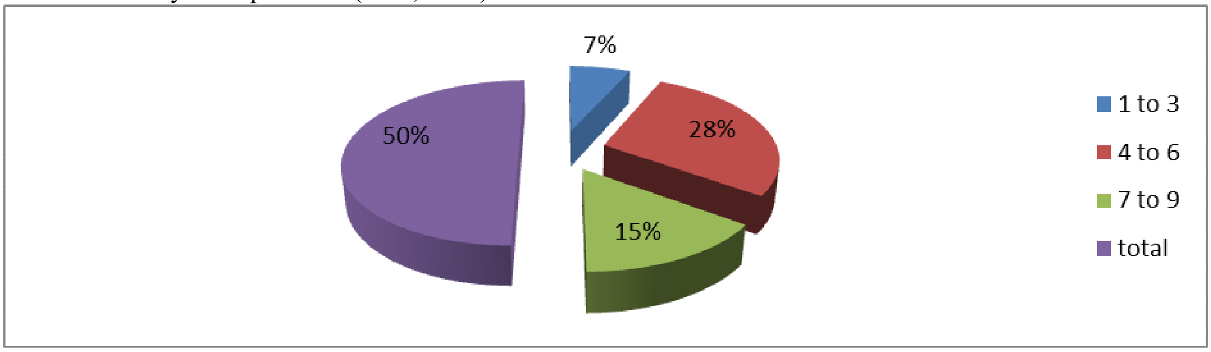

Figure 6: Family size distribution (Source: Field data, 2012)

The study depicted, from investigations of medical records that none of the respondents was diagnosed of cancer. This response appears to imply that cancer was not a health threat among the fishermen. According to the study, 33.3% of the respondents had been diagnosed of painful bones. The study also showed that 28.3 percent of the respondents had been diagnosed of wrist drop. Painful bones and writs drop therefore appeared to be a health threat among the fishermen. As an environmental health problem these medical conditions need to be given attention and consideration among fishermen who fish in the lagoon. Observations by the researcher during the study appeared to show no indication of Burton line among respondents. This finding may therefore appear to imply that Burton line is not a health threat among the fishermen. The study further indicated that only 5 percent of respondents agreed to have children with mental challenge. This indicates that tilapia consumption does not also appear to lead to adverse effects on the central nervous system of a substantial number of children born of the respondents (Bergeson, 2008).

Thirty five percent of respondents had been diagnosed of skin infections of one kind or the other since the last two years. However 70 percent disagreed that standing in the lagoon for several years during fishing activities could result in skin diseases. Some of the diseases include foot rot, rashes and pale and whitish skin around the lower legs. Medical experts interviewed were of the view that lead presence in the lagoon might not necessarily lead to all of these infections. However it could be a contributing factor to such conditions.

On the issue of banning tilapia consumption table 1 shows that majority of the fishermen who constitute 43.3 percent expressed their strong unhappiness should eating tilapia from the Fosu lagoon be banned. About 27 percent also said they would be unhappy if tilapia consumption is banned. Seventeen percent indicated that they would be very happy while about 10 percent expressed their happiness if eating tilapia from the lagoon is banned. Only two persons (3.3%) were indifferent about banning tilapia consumption. In summary, 70 percent of the respondents expressed general unhappiness should tilapia consumption be banned even if they knew it could cause diseases. This is inconsistent with the findings of Rosenstock (1974), Hochbaum (1956) and Ghanze et al (2002), that people will stop an action if they knew it will cause risks to their health. Major reasons cited include fish as a source of food (28.3 percent), delicacy (23.3 percent), cultural (12.7 percent) and proximity to the lagoon (6.7 percent).

Table 1: Banning tilapia consumption (Source: Field survey, 2012).

Response	Frequency	Percent
Very unhappy	26	43.3
Unhappy	16	26.7
Indifferent	2	3.3
Very happy	10	16.7
Happy	6	10.0
Total	60	100.0

Considering the skin diseases, though fishermen earned their living through fishing, 73.3 percent of those surveyed said they would generally not work in polluted water if they knew it could result in skin diseases. They were of the view that skin diseases could directly and easily be observed. On the other hand, the remaining 26.7 percent answered in the affirmative. This is because they thought it was their source of living and therefore could not earn any descent living if they stopped fishing. Economic factors thus appear to affect reaction of respondents to health threat (Ghanze et al, 2002). The percentage distribution is displayed in Figure 7. For those who answered in the affirmative however, life was worth living for and therefore 63.3 percent said they wished they did not fall sick when they consume tilapia from the lagoon while seven percent reasoned that a contaminated environment could create health problems in agreement with Ghanze et al, (2002), Rosenstock (1974) and Hochbaum (1956).

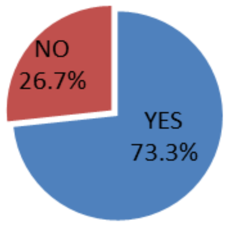

Figure 7: Fishermen's agreement to work in polluted environment (Source: Field survey, 2012).

The 26.7% respondents who answered in the affirmative had experienced skin disease within the last two years while 72.7 percent of them had experienced skin disease since the last 10 years. Skin diseases thus appear to be a health threat among the fishermen. Figure 8 gives the response to those interviewed. Though the majority (43.3 percent) explained that they did not know the cause of their skin diseases, they conjectured that they were as result of heat. However, 26.7 percent of them could not give reasons to the causes.

The study showed that 85 percent of the respondents were ready to stop fishing in the Fosu Lagoon in particular if they knew they could be infected with non-infectious environmental skin diseases. This is in agreement with Ghanze et al, (2002), Rosenstock (1974) and Hochbaum (1956). While 58.3 percent attributed their response to medical reasons the remaining 26.7 percent, were of the view that though they were ready, it would be difficult for them to stop fishing since it was a source of their livelihood in spite of the health risk.

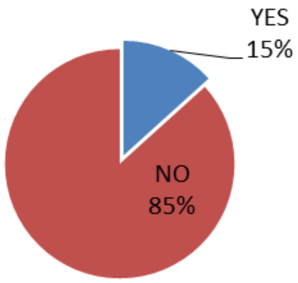

Figure 8: Reaction to occupational threat (Source: Field survey, 2012).

The minority (15%) indicated they would fish in the lagoon even if they knew fishing in the lagoon could result in skin diseases (see Figure 8) citing the reason that fishing is their source of livelihood. Thus 41.7 percent of the respondents were unwilling to stop fishing in the lagoon even if it could cause skin infections. The study has therefore shown that economic consideration is a major contributor to the respondents to work in the lagoon in particular even if there were environmental health risk. This is in disagreement with the health belief theory as explained by Campbell (2001) that a threat to disease would motivate and encourage people to take proactive action by not engaging in activities that would cause the disease. Banning tilapia fishing was therefore most likely to put an end to the tilapia fishing activity. The unemployment problem that this intervention may cause would be another economic problem that would have to be grappled with. Fishermen, in their endeavor to satisfy economic demands should however be mindful that fishing in the lagoon may have adverse effects on their health and that this could be more costly than the gains they might incur.

Figure 9 below indicates the responses as to how respondents would feel should tilapia fishing in the Fosu lagoon be banned. Seventy percent expressed their unhappiness should tilapia fishing be banned. Forty three percent of these respondents explained that they were unhappy because banning fishing would make them redundant. The remaining however gave conflicting reasons.

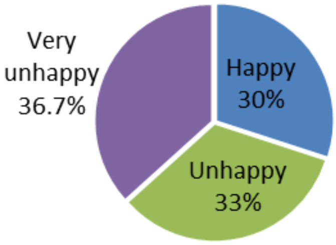

Figure 9: Reaction to banning fishing (Source: Field survey, 2012).

Out of the 30 percent who expressed happiness should fishing be banned, 51.7 percent gave fear of getting health problems as the reason, while the reasons given by the remaining were also conflicting. This finding appear to imply that when it came to banning tilapia fishing from the lagoon, the major factors that determined respondents reactions were economic and health. Figure 10 is a summary showing the factors that could influence Fosu lagoon fishermen's decision to take preventive measures towards the non-communicable and non- infectious environmental diseases investigated.

Primary independent variable → Primary dependent variable → Secondary dependent variable

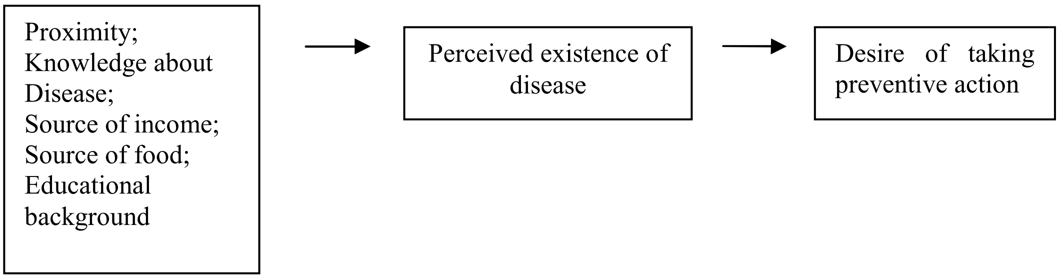

Figure 10: Factors influencing fishermen's perceived threat to disease caused by consuming lead-and cadmium-contaminated tilapia and fishing in the Fosu lagoon (Source: Baffour-Awuah, 2012).

7. Conclusion

The main aim of the study was to find out whether consumption of tilapia from the Fosu lagoon had negative health implication on the fishermen who fished in the lagoon as a result of the presence of lead and cadmium in tilapia muscle and other organs. Lead and cadmium may be ingested into the bodies of fishermen through the food chain and through physical contact with lagoon water due to pollution of the lagoon.

Medical conditions investigated include infertility, cancer, painful bones, wrist drop, skin disease, Burton line, mentally-retarded child-birth and skin related diseases. The study concludes that none of the respondents had cancer, infertility or Burton line effect; it appears consumption of tilapia resulting from lead and cadmium ingestion could be responsible for painful bones and wrist drop; lead ingestion through the skin could contribute to skin diseases among fishermen; only five percent of fishermen had only one child being mentally-challenged; it therefore appears that lead and cadmium presence in tilapia had no effect on cognition of children born by fishermen; majority of respondents would not stop eating tilapia even if they knew could result in negative health implications; majority of respondents would however stop fishing in the lagoon if they knew it could cause non-infectious skin disease. Proximity, knowledge about disease, source of income, source of food and educational background could influence, or otherwise, fishermen's desire to take preventive action from disease that may arise from eating lead- and cadmium-polluted tilapia from, or fishing, in the lagoon.

8. Recommendations

The study has demonstrated that consumption of tilapia in the Fosu lagoon could have some negative health implications among fishermen who fish in the lagoon. Upon this basis it is recommended that fishermen need to be educated on the possible negative health implications in consuming tilapia from the lagoon and also standing in the lagoon for fishing. Since most of the fishermen had educational background not higher than basic education (and even some being illiterates) the local vernacular should be used in the education process; radio and television should be used as communication media against the backdrop that most of them cannot read nor understand simple English (Baffour-Awuah, 2014[a]; Mohammed, 1993). Fishermen had confidence in health officials, particularly medical officers; for this reason medical doctors should be used to champion educational campaigns directed at fishermen (Baffour-Awuah, 2014[a]). Fishermen must be educated on the presence of lead and cadmium in tilapia in the lagoon, health implications of lead and cadmium ingestion as well as the food chain concept (Baffour-Awuah, 2014[b]) bearing in mind that lack of knowledge in these areas or the attitude of disregarding the knowledge acquired will not have any impact on the educational agenda. As environmental health problems, painful bones, wrist drop and skin diseases among fishermen who fish in the lagoon should be particularly given a serious consideration.

References

Abban, E. K., Asante, K. A. and Falk, T. M. (2000) Environment of blackchin tilapia, *saratherodon melanotheron*, and their potential effects on the genetic structure of stocks in Ghana, p 14-16. In: Abban, E. K., Casal, C. M. V., Falk, T. B. M. and Pullin, R. S. V. B. (Eds.) *Biochemistry and sustainable use of fish in the coastal zone.* ICIARM Conf. Proc. Pg.63-71.

Adjei, C. A. (1991) *Determination of copper and zinc levels in the sediments of the Fosu lagoon Cape Coast*, University of Cape Coast, Cape Coast, Ghana.

Agbola, T. (1998) A review of environmental component in Nigerian national development plans. In: Odomerho, S. (ed), *Environmental issues in management*, Evans brothers, Ibadan.

Agyapong, J. F. (2008) *Public perception on the degradation of fresh water bodies-A case study of the Fosu lagoon in Cape Coast, Ghana.* Department of Geography and Tourism, University of Cape Coast, Cape Coast, Ghana.

Ahuahey, C. Y. (2007) *The effects of Siwdo workshops and its surroundings on the Fosu lagoon in Cape Coast*. A project report submitted to the Mechanical Engineering Department, Cape Coast Polytechnic, Cape Coast, Ghana.

Akwansah-Gilbert, E. (2007) *Distribution of Polycyclic aromatic hydrocarbons and heavy metals in the Fosu lagoon of Cape Coast Ghana*. Thesis submitted to the Department of Chemistry. University of Cape Coast, Cape Coast, Ghana.

Allen, S. E., Grimshaw, H. M., Parkinson, J. A. and Quarnby, C. (1974) *Chemical analysis of ecological materials*. Stewarte Allen (ed). Blackwell Scientific Publications, Oxford, p 159.

Anukwah, G. D. (2007) *Levels of mercury, zinc and Cadmium in leafy vegetables of Agona Nkwanta, Aboso, Bogoso, and Huni Valley mining communities*. M Phil Thesis, Department of Chemistry, University of Cape Coast, Cape Coast, Ghana.

Armah, F. A., Luginaah, I., Kuitunen, M. and Mkandawire, P. (2012) Ecological Health Status of the Fosu Lagoon, Southern Ghana II: Environmental and Human Health Risk Assessment, *Journal of ecosystems and Ecograghy,* 2:107, doi:10.4172/2157- 7625.1000107. 30/05/14.

ATSDR (2011) *Agency for Toxic Substances and Disease Registry*, 4770 Buford hwy NE, Atlanta, G.A. 3034 www. Atsdr. Cdc. Gov/ substances/ toxorganlisting. Asp? Sysid= 2 18/04/12.

Baffour-Awuah, E. (2012) *Perception of concentration of lead and cadmium in tilapia in the Fosu lagoon and its health implications.* M. A. dissertation submitted to the Center for Development Studies, University of Cape Coast, Cape Coast, Ghana.

Baffour-Awuah, E. (2014[a]) Health implications of polluted tilapia consumption – the perception of Fosu lagoon fishermen in Cape Coast, Ghana. *Journal of Environment and Earth Science*. Vol. 4, No.10. Pp 78-86.

Baffour-Awuah, E. (2014[b]) Perception of Fishermen on Heavy Metal Pollution of the Fosu Lagoon in Cape Coast, Ghana. *Industrial Engineering Letters*, Vol. 4, No. 5. Pp 9-16.

Bánfalvi, G. (2011), Heavy metals, trace elements and their cellular effects; In G Bánfalvi (ed.), *Cellular Effects of Heavy Metals,* Springer, Dordrecht, pp. 3–28.

Bergeson, L. L. (2008) The proposed Lead NAAQS. In: Consideration of cost in the Clean Air Act's future, *Environmental Quality Management*, 18:79.

Berlinger, D. C. (2008) Very low lead exposures and children neurodevelopment. *Convent opinion in pediatrics* 20(2) 172-7.

Bernard, A. M. and Lawerys, R. R. (1997) Dose response relations between urinary cadmium and tubular proteinuria in adult workers. *AM Jnl of Med*; 31:116-8.

Blay Jnr, A. and Asabere-Ameyaw, J. (2007) Assessment of the fisheries of a stunted population of the cichlid, sarotherodon melanotheron (Rappel) in a "closed" lagoon in Ghana. *Journal of Applied Ichthyology*. Vol 4, Issue 1, pp1-11.

Campbell, C. (2002) Health education behavior models and theories: a review of the literature - part I. *Health Curriculum Research*, Mississippi cooperative extension services, Mississippi State University. Hppt//msucares.com/health/health/apppa1.html. 16/02/11.

Conner, M. and Norman, P. (1996) *Predicting health behavior; search and practice with social cognition models.* Open University Press: Baltimore; Buckingham.

Convery, F. J. and Tutu, K. A. (1990) Estimating the cost of environmental degradation in Ghana, Accra, Ghana. In Kendie, S.B. (ed) *Do Attitudes Matter? Waste Disposal and Wetland Degradation in Cape Coast Municipality,* Development Project Planning Centre, University of Bradford (Discussion Paper Series 2, No. 21), 1999.

Cunningham, W. P. and Saigo, B. W. (1997) *Environmental Science: A Global Concern*, McGraw-Hill Inc, pp 272,422,425.

Dadson, F. A. (1996) *Analysis of micro-pollutants in lagoon fish muscle*, University of Cape Coast, Cape Coast, Ghana.

Datz, T. (2006) Fish intake, contaminants and human health: evaluating the risks and benefits. *Journal of the American Medical Association*. Vol. 296, no.15. Hsph Harvard.edu 28/12/12.

De Cort, F. (2000) *Environmental Chemistry*. 4^{th} Edition. New Age International Ltd Publishers, New Delhi Health, vol.2, pp 21-09.

Essumang, D. K. (2000) *The effects of leachates from solid waste disposal sites in the Cape Coast municipal environment*. M. phil. thesis submitted to the University of Cape Coast, Cape Coast, Ghana.

Essumang, D. K., Dodoo, D. K. and Kendie, S. B. (2006) The effects of leachates from solid waste disposal sites on the Cape Coast municipality environment, *Ghana Journal of Chemistry*, 7(1), pp 20-26.

G. S. S. (2000) *Population and housing census*, Ghana Statistical Service, Accra, Ghana.

Gale, T. S. (1952) The struggle against diseases in the Gold Coast; early attempts at urban sanitary reform. *Transactions of the historical society of Ghana*, XVI, II: 185-203

Ghanze, K., Rimer, B. K. and Lewis, F. M. (2000) *Health behavior and health education, theory and practice*. San Francisco; Wiley and sons.

Hagan, S. (1986) *Determination of the levels of pollution of trace-heavy metals in Cape Coast Fosu lagoon*, University of Cape Coast, Cape Coast, Ghana.

Hangi, A.Y. (1996) *Environmental impacts of small scale mining: A case study of Merelani, Kahama, Nioga, Geita and Musoma*. The Centre of Energy, Environment, Science and Technology (CEEST), 1:46 – 52

Hochbaum, G. M. (1956) *Why people seek diagnostic X-ray?* Public health reports 71:377-380.

Kido, T., Nogawa, K., Honda, R., Tsuritani, I., Isahiziaki, M., and Yamada, Y. (1990) The association between renal dysfunction and osteopenia in environmental cadmium-exposed subjects, *Environmental Research* 51:71-82.

Kido, T., Nogawa, K., Honda, R., Tsuritani, I., Isahiziaki, M., and Yamada, Y. (1989) Osteopenia in inhabitants with renal dysfunction induced by exposure to environmental cadmium, *Int. Arch. Occ. Environ. Health*. 61: 271-276.

Kosnett, M. J. (2006) “lead.” In: Olson, K.R. *Poisoning and dry overdose*, (ed.) McGraw- Hill professionals p:238.

Kumar V., Abbas A. K. and Aster, J. C. (2013) Environmental and nutritional diseases; In Kumar, V. Abbas, A. K. and Aster J. C. (eds), *Robbins Basic Pathology,* 9th ed., Elsevier, Philadelphia, PA.

Kumar, R. (2005) *Research methodology, a step by step guide for beginners,* 2^{nd} ed. Sage publications, pp 169-180.

Landrigan, P. J., Schechter, C. B., Lipton, J. M., Fahs, M. C. and Schwartz, J. (2002) Environmental pollutants and disease in American children, *Environmental health perspectives* 110(7):721-8 PMC1240919 04/12/12.

Lentech (2008) *Water treatment and air purification*, Holding B.V., Rotterdamsseiveg 402m 2629 HH Delft, the Netherlands.

Merian, E. (2000) Environmental chemistry and biological effects of cadmium components, *Toxicological and Environmental chemistry,* Vol 26. Issue 1-4, pp 27-44.

Mohammed, H. (1993) *Lagoon pollution: A case study of Fosu lagoon*, Dissertation submitted to the Geography and Tourism Department, University of Cape Coast, Cape Coast, Ghana.

Nogawa, K., Tsuritani, I., Kido, T., Honda, R., Yamada, Y., and Ishizaki, M. (1987) Mechanism for bone disease in inhabitants environmentally exposed to cadmium-decreased serum, 1A 25-Dihydroxyvitamin D level, *Int. Occ. Environ. Health*, 59:21-30.

Obodai, E. A., Okyere, I., Boamponsem, L. K., Mireku, K. K., Aheto, D.W. and Senu, J. K. (2011) *Comparative study of Tilapine populations from two contrasting habitats of Ghana* der chemica sinica. 2(5):200-210.

OSHA (2012) *Occupational Safety and Health*. An article redirected from Occupational Health, Wikipedia. en.wikipedia.org/wiki/occupational_health. 14/12/12.

Patrick, L. (2006) lead toxicity, review of the literature. Part 1: Exposure, evaluation and treatment. Alternative medicinal review. *Journal of clinical therapeutic* 11(1) 2-22 PMID 16597190 04/12/12.

Porter, R. C., Boakye-Yiadom, L., Mafusive, A. and Teheko, B. O. (1997) The economics of water and sanitation in three African capitals. In Kendie, S. B. (ed) *Do attitudes matter? Waste disposal and wetland degradation in the Cape Coast municipality of Ghana,* Ashgate, Aldershot, England, pg. 9.

Rosenstock, I. M. (1966) *Why people use health services.* Milbank Memorial Fund Quarterly 44:94-124.

Rosenstock, I. M. (1974) *Historical origins of the health belief model*. Health education monographs, vol. 2, 328-335

Tay, C. A. (1989) *Preliminary studies on the levels of inorganic pollution in Fosu lagoon (Cape Coast)* B.Sc. Lab. Tech, Dissertation. University of Cape Coast, Cape Coast, Ghana.

UNEP (2010) United Nations Environment Programme, Chemicals Branch, PIITE, *Final review of scientific information of cadmium*, pp 40-50.

William, J., Berger, T. and Elston, E. (2005) Andrews'disease of the skin, *Clinical Dermatolody*, (10^{th} ed) Saunders.

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