KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ENGINEERING

DEPARTMENT OF BIOMEDICAL ENGINEERING

CENG 291: ENGINEERING IN SOCIETY

REDUCING THE EFFECTS OF DIABETES MELLITUS THROUGH EARLY DETECTION WITH A CONTINUOUS GLUCOSE METER IN THE NKWABENG NORTH COMMUNITY.

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ABSTRACT

Continuous glucose meter which is a major example of Continuous Glucose Monitoring systems is an emerging technology that allows frequent glucose measurements to monitor glucose trends in real time. Their use as a diagnostic tool is still developing and appears to be promising. Significant improvement in the treatment modalities that may prevent the progress of prediabetes to diabetes have been achieved recently and dictates screening of high risk patients for early diagnosis and management of glycemic abnormalities.

The use of CGMS in the diagnosis of early dysglycemia (prediabetes) especially in high risk patients appears to be an attractive approach. In this review we searched the literature to investigate the value of using CGMS as a diagnostic tool compared to other known tools, namely oral glucose tolerance test (OGTT) and measurement of glycated hemoglobin in high

risk groups. Just as the machine language for every computer is in binary codes so as the language in which the body gets its energy is Glucose. Glucose a sugar is a source of energy for the cells that make up muscles and other tissues. Sugar is absorbed into the bloodstream, where it enters cells with the help of insulin.

When your glucose levels are low, such as when you haven't eaten in a while, the liver breaks down stored glycogen into glucose to keep your glucose level within a normal range. When the pancreas do not produce enough insulin, or the cells of the body not responding properly to the insulin produced, it causes diabetes. It appears that the ability of the CGMS for frequently monitoring (every 5 min) glucose changes during real-life settings for 3 to 5 days stretches the chance to detect more glycemic abnormalities during basal and postprandial conditions compared to other short-timed methods. This in effect will help in the early detection of Diabetes Mellitus and to provide an appropriate cure before it becomes chronic and thus impose so many diverse problems on the individual.

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help of insulin.

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1.0 INTRODUCTION

1.1 PREFACE OF PROJECT:

As an up and coming engineer, a Biomedical engineer to be specific of the Nkwabeng North Community which is a sub community developing exponentially in the Sunyani East Municipality, it is meet and right to address one of the major challenges of the inhabitants of this community to make it worthwhile to write home about. This project seek to address the causes, effects and how to early detect Diabetes Mellitus(DM) using a Continuous glucose Meter as suggested solution.

1.2 BRIEF BACKGROUND OF THE COURSE:

Engineering in society officially set up by Professor S.K Ampadu, a two credit hour course is one of the key influence that connects the idea one acquires in a particular field of engineering to the society with its related applications. This in effect has helped students over the years to appreciate the practicality of engineering and also to help them address and solve societal problems using their field of study in Engineering. This enable students to do more research into a particular need of society and to come out with creative solutions to those societal problems. As we keep on handling issues which emerge with the resourcefulness increased through Engineering in society, the world will inheritably turn into a sanctuary forever.

1.3 AIMS AND OBJECTIVES OF THE COURSE:

1. To help students know the practicality of engineers in the society that is to enable them identify and solve societal problems.

2. To unsheathe the connection between students field of engineering to societal problems solving and to help have knowledge behind reasonable doubts about the course.

3. To unleash the creativeness and innovative ideas of students in societal problem solving. [1]

1.4 REPORT CONTENT

The report briefly describes how to reduce the effect of Diabetes Mellitus using a continuous glucose meter. This report perfectly describes in its nitty-gritties the articulating research niche, crannies of existed solutions and assumptions, followed by facts and data gathered precisely about this societal problem with respective to my field of study.

This report consists of;

- ✓ A well identified problem.
- ✓ Ways of collection of the data about the identified problem.
- ✓ Description of the Map.
- ✓ Nature and Structure of the identified problem.
- ✓ Biomedical Engineering and its branches.
- ✓ Solutions to the identified problem.
- ✓ Conclusion.
- ✓ Recommendation.
- ✓ Appendices.

2.0 METHODOLOGY

2.1 PROBLEM IDENTIFICATION AND DESCRIPTION:

In recent past years, there has been numerous cases and incidents of citizens of the Nkwabeng North Community being rushed to the hospital with symptoms of chronic Diabetes. The prolonged survival of these patients with diabetes mellitus has led to an increasing incidence of long term complications e.g. stroke, ulceration, and gangrene of the feet etc.

In April 2020, the president of the republic of Ghana declared a nationwide fast. The well trained doctors of Nkwabeng North decided to embark a major experiment to arrive at a solution why these diseases become very chronic before the inhabitants report cases to the hospitals and how to curb it.

During the fasting period we embarked on the fasting plasma glucose test (FPE), this was because every tom, dick and Harry was partaking in this nationwide fast. The screening was done for the entire populace of my community and it was crystal clear that very less number of people had their FPG to be less than 100mg/dl that is for a normal human being and greater amount of the populace had their FPG to be greater than 128mg/dl (implies abnormal and chronic). This diagnosis was predominantly observed in the students, headers and people in pension. The canker of patients reporting cases day-in and day out of the chronic diabetes mellitus in the Nkwabeng North without early detection and how to reduce it is a current day Nkwabeng North is being plagued by this menace.

Thinking back these pressing issues and events pressing hard on my community when the undertaking of recognizing in our society and proposing a remedy was given to me according to the course necessities of CENG 291 it was not troublesome discovering the topic reducing the effects of diabetes mellitus through early detection using a continuous glucose meter. Despite the fact that there are numerous approaches to address this using handling this from the perspective of a medical engineering a more proficient and yielding.

2.2 MAP PREPARATION AND REPRESENTATION:

Nkwabeng North is a small productive town to students in Sunyani. It is more specifically found in Nkoranza South District and the Sunyani East Municipal. The maps of the community was gotten from Google map. [2]

With regards to the preparation of the map of the Nkwabeng North Community, I took screenshots of the images using the 'windows' button and the 'print screen' button on my laptop and I saved the pictures to be later inserted in this report.

2.3 DATA AND INFORMATION ACQUISITION PROCESS:

These four primary strategies were found to be while in my endeavor to get information and data concerning this societal issue:

- The method of personal observation
- The use of verbal interviews
- The use of the internet
- The use of questionnaires

2.3.1 THE METHOD OF PERSONAL OBSERVATION

This approach brought to limelight pictures from what I personal observed in the market places, hospitals about patients with dislikes mellitus and what people go through to get the disease.

2.3.2 THE USE OF VERBAL INTERVIEWS

Pensioners talked about the stress they go through and how that affects their

blood glucose level. Also market woman were talked to, they channeled their challenges of prolong sitting and no amount of exercise to dislike Mellitus and also patients and student in the Municipal hospital near Nkwabeng North were talked to and significant information was deduced. These information were collated and analyzed during the data analysis stage of problem solving.

2.3.3 THE USE OF THE INTERNET

Through research was close into its nitty- gritties on the scratch issue after discovery. I got relevant information from articles and other discoveries made by other biomedical engineering which was also dived deeper into during the analysis stage.

2.3.4 THE USE OF QUESTIONNAIRE

I used Google forms to create questionnaire for the populace who could access and the internet to online. Simple copies were and given to the market women, retires and all the star members of the Nkwabeng North Community members available. Copies of these questionnaire and summary of the all the questionnaires used can be found in the Appendices section of the report.

2.3.5 MATERIALS EMPLOYED IN COLLECTING DATA

The materials involve:

- A copy of the letter of introduction which was given by the school to prove the credibility of the project.
- A camera for taking pictures.
- A questionnaire.
- A pen and a book for observation and the interview sections.

2.3.6 METHOD OF DATA ANALYSIS

After these information were collected they were cross- checked and give through thoroughly to validate the consistency of the information and how valid it is.

3.0 FINDINGS AND DISCUSSION OF RESULTS

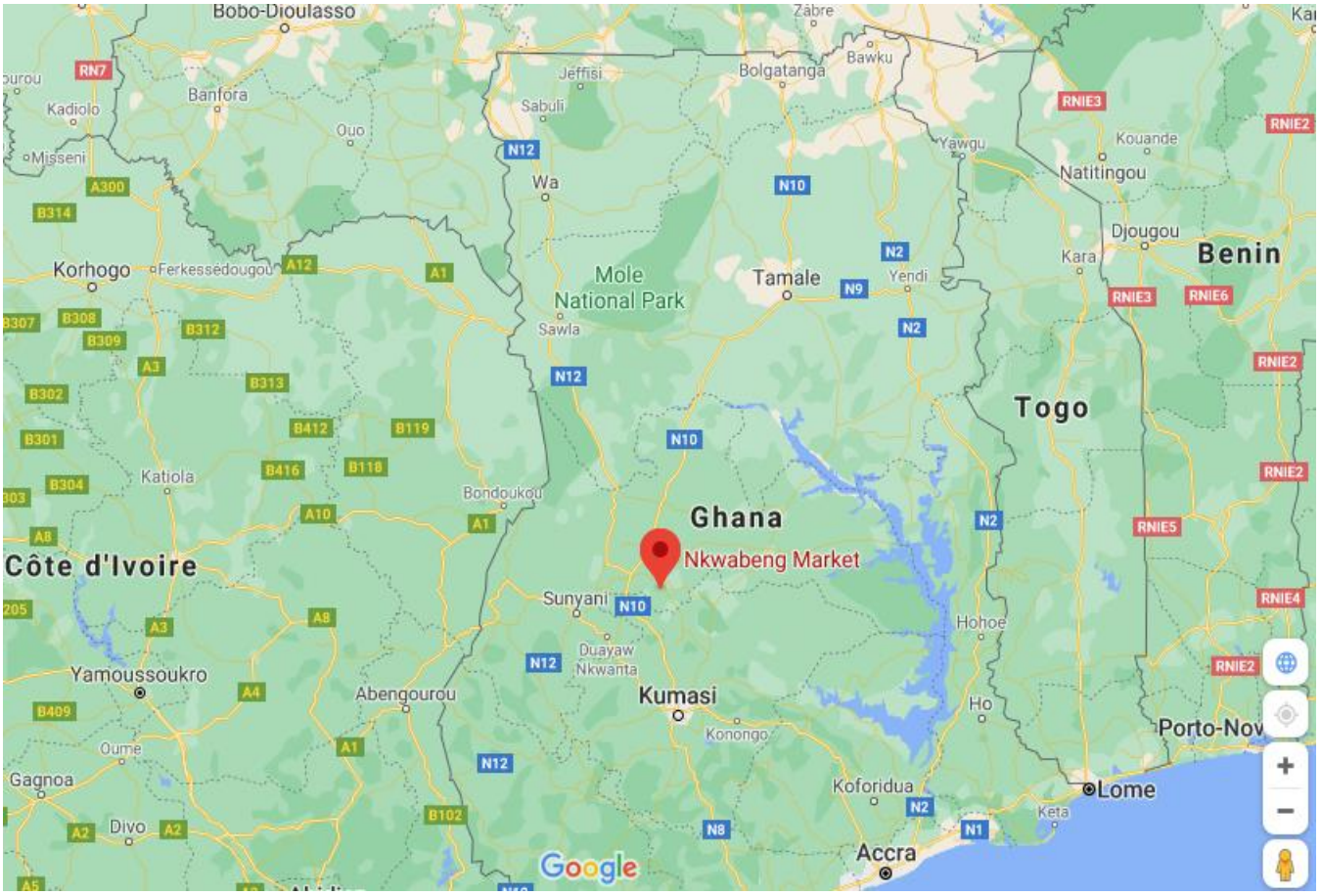

Figure 1: Location of Nkwabeng North on the map of Ghana

Figure 2: A street view map of Nkwabeng North

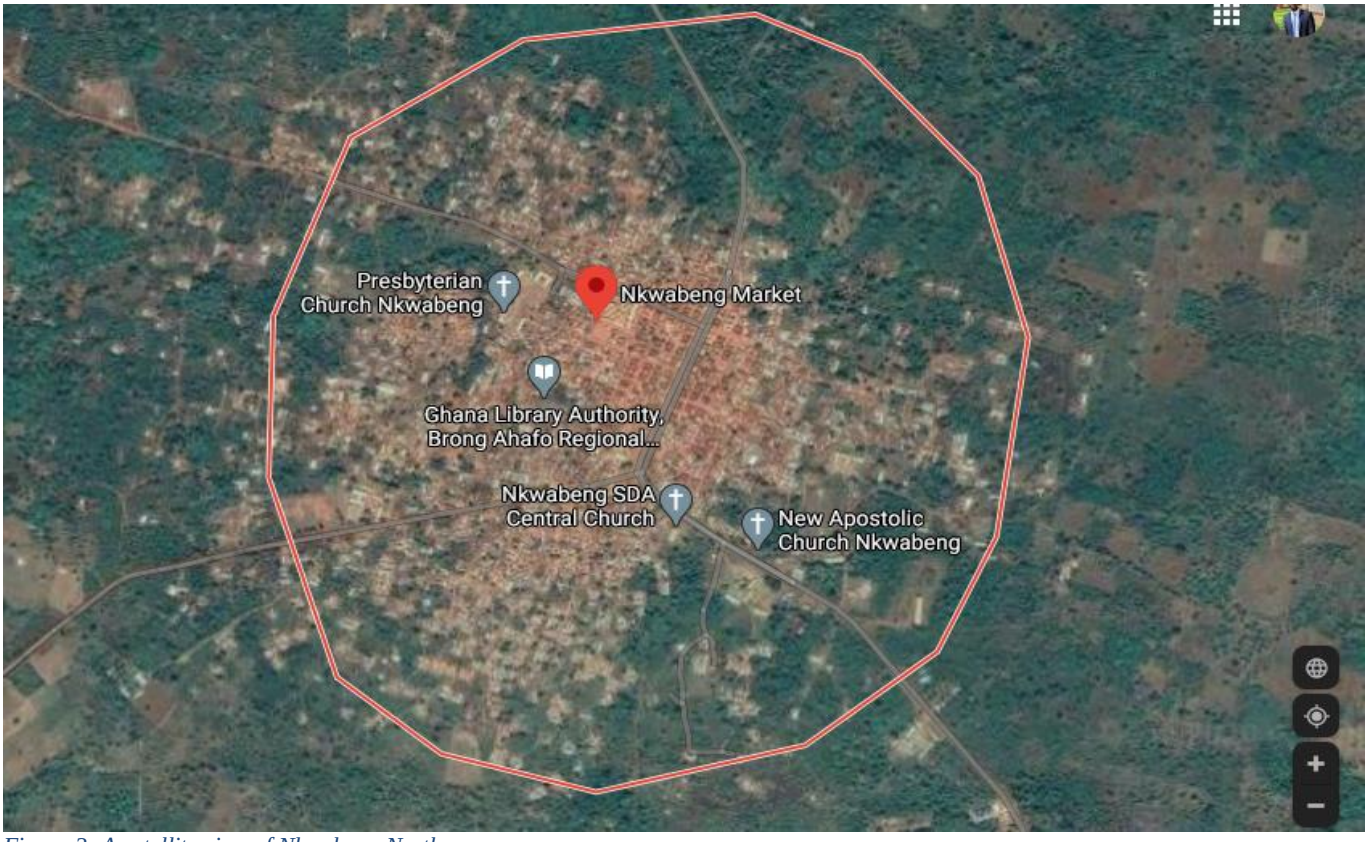

Figure 3: A satellite view of Nkwabeng North

3.1 DESCRIPTION OF THE COMMUNITY OF STUDY

Nkwabeng is a community of red or yellow forest. Akan history tells crystal clear that there was a war between the Nkoranzahene and Dumasihene. During the war, Kyere Bonse of the royal tribe of Dumasi took his father's stool and hid; this was because if their enemy took it, the Dumasi people would become slaves to Nkoranzahene. After the wall, he handed the stool to his father who rewarded him by giving him a piece of land. Kyere Bonse called the land of Nkwabeng because it was a virgin forest.

Nkwabeng North is a small town found in the Nkoranza South District, a suburb of the Sunyani East Municipality. Nkwabeng North is found in the Bono Region.

Nkwabeng North has a map quaze of D7 and a map link of 1M which is located on longitude -1.73^0 and latitude 7.5^0. It is a town surrounded by a Zongo community, it has a library for its populace, various religious churches, and a market, a municipal hospital which is a stone's throw away from the community, sole proprietor shops, forests, other menial job and large portion still being in the developing state. [3] The main shopping Centre is the Nkwabeng North market, where most of the indigenes go shopping for items and foodstuffs.

The people are very welcoming, hospitable with about 60% being illiterates yet very industrious.

3.2 DESCRIPTION OF THE NATURE AND CHARACTERISTICS OF THE PROBLEM:

Diabetes Mellitus (DM) has been undoubtedly proven beyond reasonable doubts to a group of metabolic disorders characterized by a high blood glucose level over a prolong period of time which often results in complex complications like stroke in the Nkwabeng North Community. DM is very alarming and chronic in this community. It appears that the populace of the Nkwabeng North Community have little or no knowledge on the instruments

that help in early detection of DM hence reducing its chronic and adverse effects on the people.DM does not only affect the individual but also disrupts the ability to work freely and to live a disease free and drugs free life

In a verbal interview with the Municipal endocrinologist, he made it crystal clear that most of the health facilities do lack these devices and it is very rare to come across people with these devices. He testified to the fact that on how it is very important for each and every one to have one of the device to help in early detection hence reducing Diabetes Mellitus.

He said a patient who had type 1 diabetes, and had to commute 60 minutes to work from our community. As recommended by him to the patient he was to check his glucose level immediately before getting into his car and heading home from work at 5pm in order to know the blood glucose (either 129mg/dl or 90mg/dl) and the number of calories to be consumed as well as the carbohydrates(fig 4). The patient didn't go along with his Continuous Glucose Meter (CGM) and so he took so many snacks and his blood glucose level was high and very detrimental and he was rushed to the hospital. If he had the CGM it would have helped him detect it early and to know the kind of foods to take as per the directives of the doctor.

In a questionnaire, it was observed that in Nkwabeng North Community DM is predominant among students, trader, pregnant women and those on pension (Fig 5).

Traders when personally interviewed led the bull by its horns saying they sit all-day at one very point in the market without any moving around and they become very stressed out and tired. Since they are all attending to their customers while seated, they tend to buy foods anyhow from people who sell them, they don't eat well, their diets are not balanced and there is no exercise but all day stress and fatigue. This is as a result of they been stationary at a point and as such their blood do not circulate well through their body and they don't even have the time to go to the hospitals and check their glucose level periodically (Fig 6 and Fig 7).

It was observed that DM in Nkwabeng North Community is also common in

students. When I visited the library, most students sit down for long hours to study without any break or nap. They sit at one very position for a longer time. Also, the students eat a lot of sweets including toffees, biscuits, drinks etc and they do not focus on eating balance diets. They do not even eat fruits and vegetables (fig 8) but take more of the sweets. Exercising is a headache for them (fig 9).

With regards to the aged, they find it difficult to exercise. An interview was made with one teacher on pension suffering from stroke as a result of DM, he made it known that he has a family history of diabetes (fig 10) but he did not take it serious and did not even detect it early, before he realized his blood glucose level had gone high and that left him with a chronic effect of diabetes which is stroke. Also, a made it clear that people do not come around him mostly to make him entertained, he is always lonely and stressed out and does not even have the strength to go the hospital as often as he should to check his blood glucose level (fig 11).

It is with respect to the challenges and predicaments the people are facing due to DM that is why I deem it necessary that the idea of reducing effects through early detection using a continuous glucose meter when brought into the limelight and made very accessible by every tom, dick and harry of the Nkwabeng North Community will make all these predicaments a chronic effects of DM a thing of the past.

Blood Glucose Level		What it means...			
		Excellent	Good	Acceptable	Poor
Before meal	mmol/L	4.0 – 6.0	6.1 – 8.0	8.1 – 10.0	>10
	mg/dl	72 – 109	110 – 144	145 – 180	>180
2 hrs after meal	mmol/L	5.0 – 7.0	7.1 – 10.0	10.1 – 13.0	>13
	mg/dl	90 – 126	127 – 180	181 - 234	>235

Figure 4: chart showing blood glucose level

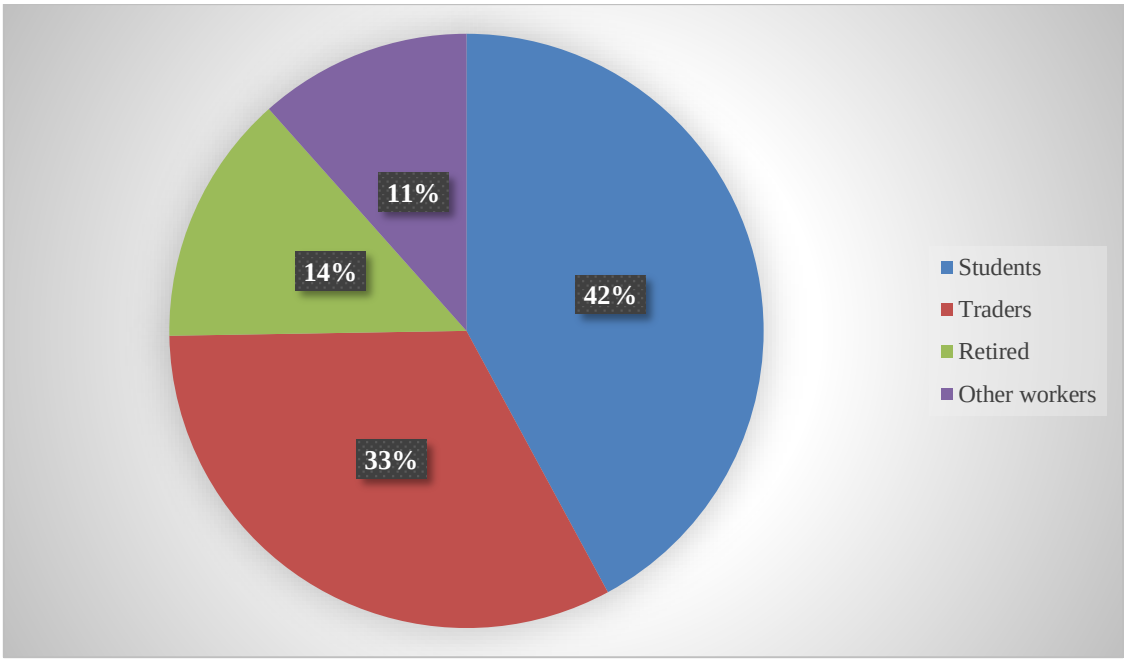

Figure 5: Chat showing the populace largely affected by DM

Figure 6: Traders of Nkwabeng North siting down for long hours.

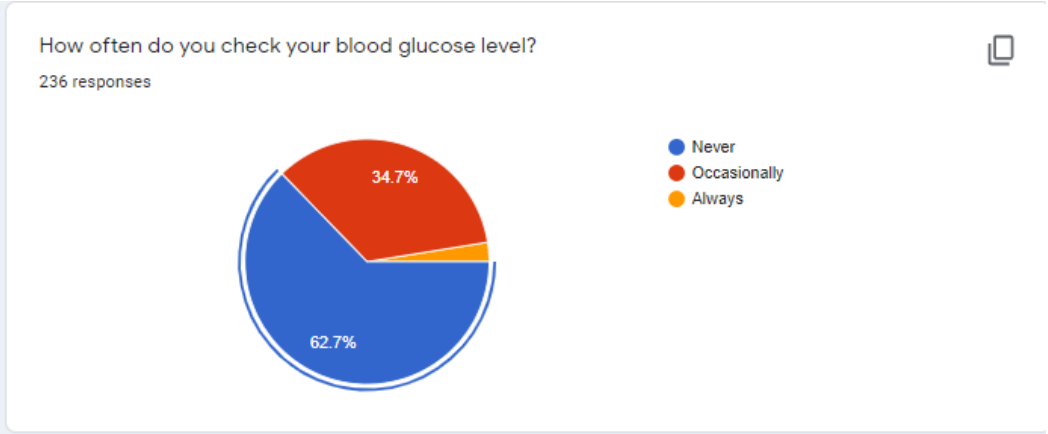

Figure 7: Questionnaire summary image on how often they check their blood glucose level.

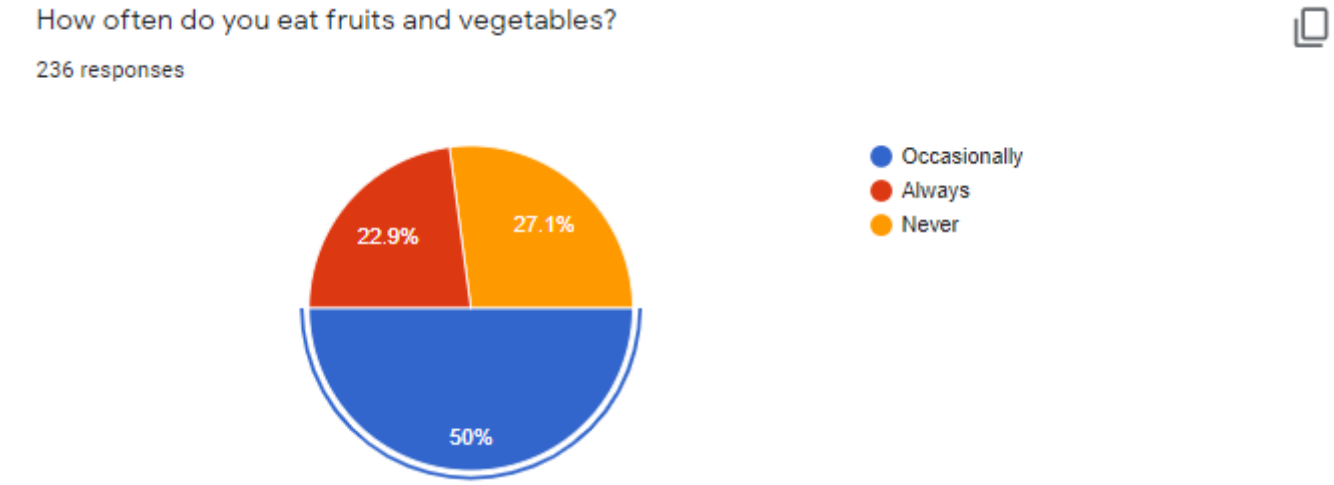

Figure 8: Questionnaire summary image on how often Nkwabeng North populace eat fruits and vegetables

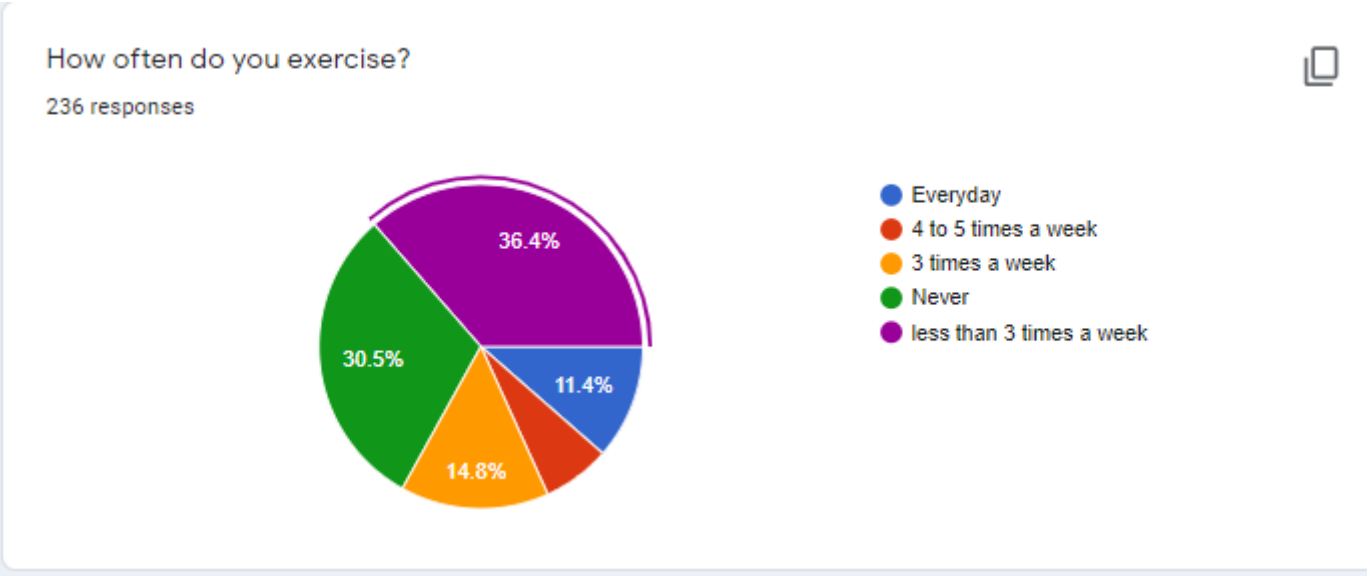

Figure 9: Questionnaire summary image on how often Nkwabeng North populace exercise

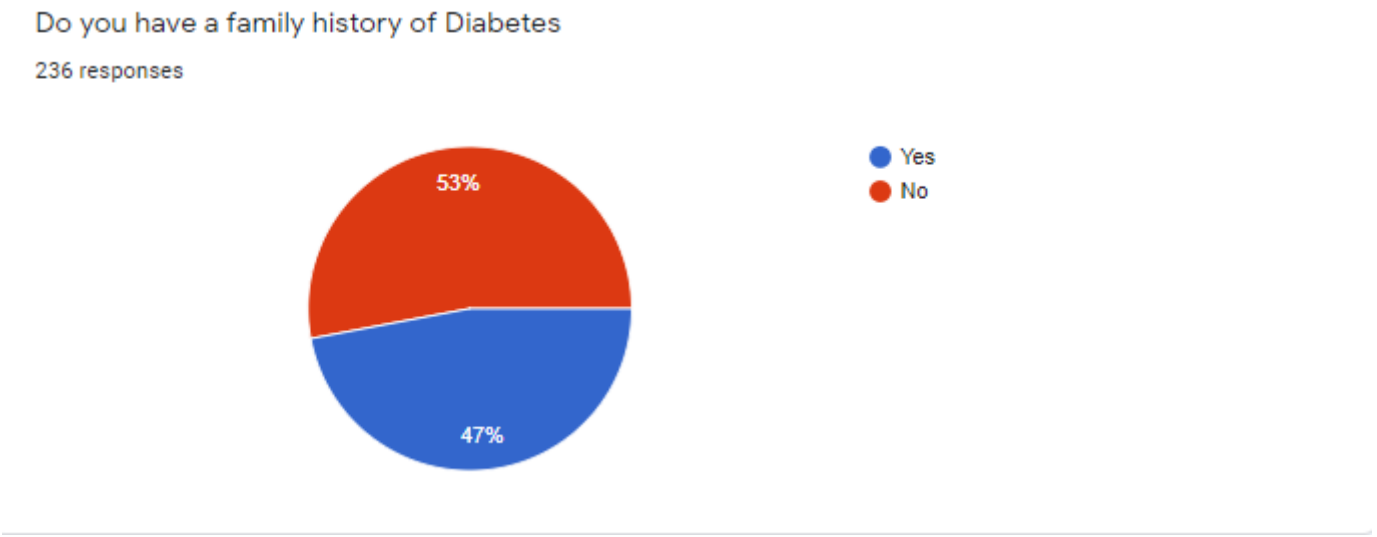

Figure 10: Questionnaire summary image on how Nkwabeng North populace have Family history of DM

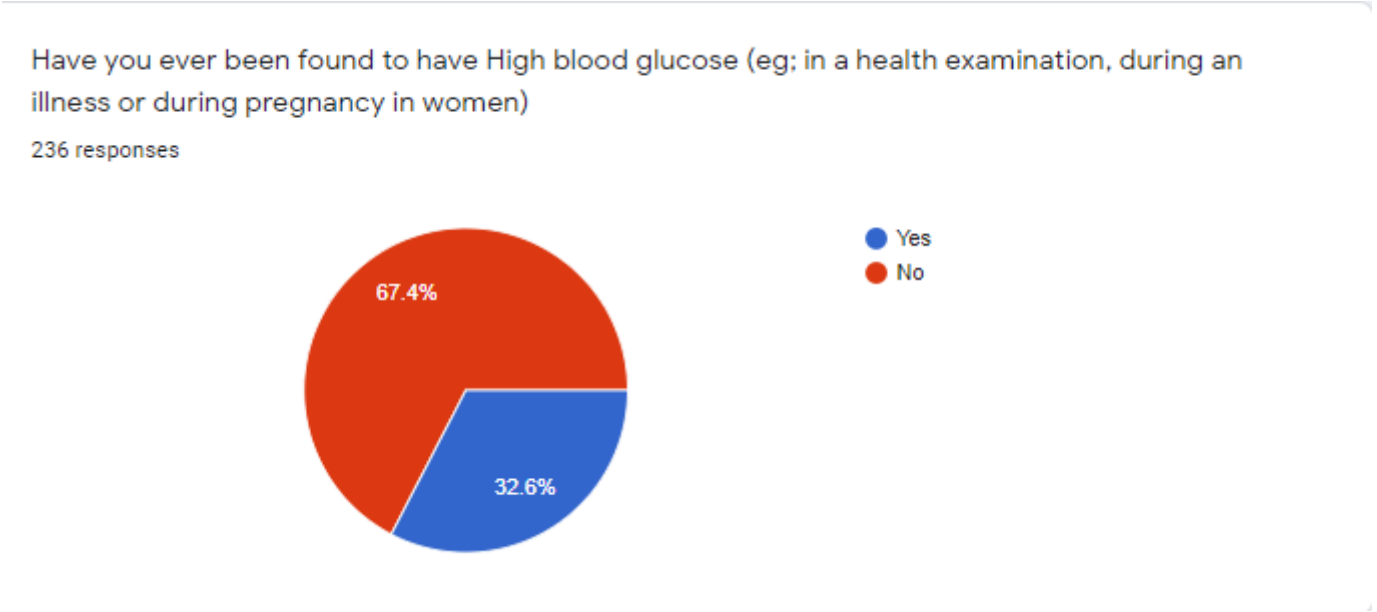

Figure 11 : Questionnaire summary image on how often Nkwabeng North populace check their glucose level

3.3 BIOMEDICAL ENGINEERING AND ITS BRANCHES

3.3.1 DESCRIPTION OF BIOMEDICAL ENGINEERING:

Biomedical engineering is the application of the principles and problem-solving techniques of engineering to biology and medicine. This is apparent all through medical care, from finding and investigation to therapy and recuperation, and has entered the public soul however the expansion of implantable clinical

gadgets, for example, pacemakers and counterfeit hips, to more cutting edge advances, for example, undeveloped cell designing and the 3-D printing of natural organs. Biomedical engineers differ from other engineering disciplines that have an influence on human health in that biomedical engineers use and apply an intimate knowledge of modern biological principles in their engineering design process. [4]

3.3.2 BRANCHES OF BIOMEDICAL ENGINEERING:

Bioinformatics

Bioinformatics is an interdisciplinary field that develops methods and software tools for understanding biological data. As an interdisciplinary field of science, bioinformatics combines computer science, statistics, mathematics, and engineering to analyze and interpret biological data.

Bioinformatics is considered both an umbrella term for the body of biological studies that use computer programming as part of their methodology, as well as a reference to specific analysis "pipelines" that are repeatedly used, particularly in the field of genomics.

Common uses of bioinformatics include the identification of candidate genes and nucleotides (SNPs). Often, such identification is made with the aim of better understanding the genetic basis of disease, unique adaptations, desirable properties (esp. in agricultural species), or differences between populations. In a less formal way, bioinformatics also tries to understand the organizational principles within nucleic acid and protein sequences.

Biomaterial

A biomaterial is any matter, surface, or construct that interacts with living systems. As a science, biomaterials is about fifty years old. The study of biomaterials is called biomaterials science or biomaterials engineering. It has experienced steady and strong growth over its history, with many companies investing large amounts of money into the development of new products.

Biomedical Optics

Biomedical optics refers to the interaction of biological tissue and light, and how this can be exploited for sensing, imaging, and treatment.

Tissue Engineering

One of the goals of tissue engineering is to create artificial organs (via biological material) for patients that need organ transplants.

Genetic engineering

Genetic engineering, recombinant DNA technology, genetic modification/manipulation (GM) and gene splicing are terms that apply to the direct manipulation of an organism's genes.

Neural engineering

Neural engineering (also known as neuroengineering) is a discipline that uses engineering techniques to understand, repair, replace, or enhance neural systems. Neural engineers are uniquely qualified to solve design problems at the interface of living neural tissue and non-living constructs.

Pharmaceutical Engineering

Pharmaceutical engineering is an interdisciplinary science that includes drug engineering, novel drug delivery and targeting, pharmaceutical technology, unit operations of Chemical Engineering, and Pharmaceutical Analysis. It may be deemed as a part of pharmacy due to its focus on the use of technology on chemical agents in providing better medicinal treatment.

Bioinstrumentation

This is an *extremely broad category*—essentially covering all health care products that do not achieve their intended results through predominantly chemical (e.g., pharmaceuticals) or biological (e.g., vaccines) means, and do not involve metabolism. A medical device is intended for use in:

- the diagnosis of disease or other conditions
- In the cure, mitigation, treatment, or prevention of disease.

Some examples include pacemakers, infusion pumps, the heart-lung machine, dialysis machines, artificial organs, implants, artificial limbs, corrective lenses, cochlear implants, ocular prosthetics, facial prosthetics, somatic prosthetics, and dental implants.

Clinical engineering

Clinical engineering is the branch of biomedical engineering dealing with the actual implementation of medical equipment and technologies in hospitals or other clinical settings.

Rehabilitation engineering

Rehabilitation engineering is the systematic application of engineering sciences to design, develop, adapt, test, evaluate, apply, and distribute technological solutions to problems confronted by individuals with disabilities. Functional areas addressed through rehabilitation engineering may include mobility, communications, hearing, vision, and cognition, and activities associated with employment, independent living, education, and integration into the community. [5]

Biomechanics

Biomechanics is the science of movement of a living body, including how muscles, bones, tendons, and ligaments work together to produce movement. Biomechanics is part of the larger field of kinesiology, specifically focusing on the mechanics of the movement. It is both a basic and applied science, encompassing research and practical use of its findings. [6]

4.0 SOLVING THE PROBLEM BY THE APPLICATION OF KNOWLEDGE IN PETROLEUM ENGINEERING:

By the application of the insight and the knowledge well gotten in Bioinstrumentation, a field in Biomedical Engineering the proposed ways in reducing Diabetes Mellitus in the Nkwabeng North Community through early detection is by the use of Continuous Monitoring devices such as Continuous Glucose Meter. In the light of this chronic and prolong effects if Diabetes Mellitus will be a thing of the past.

First of all, in order to realize this idea, it must be taken into consideration:

- ✓ Source of Energy
- ✓ Pre diabetes
- ✓ Diabetes
- ✓ Continuous Glucose Meter

4.1 SOURCE OF ENERGY

4.1.1 Glucose

Our bodies convert food into energy. Although we get energy and calories from carbohydrate, protein, and fat, our main source of energy is from carbohydrate. Our bodies convert carbohydrate into glucose, a type of sugar. Our bodies convert food into energy. Although we get energy and calories from carbohydrate, protein, and fat, our main source of energy is from carbohydrate. Our bodies convert carbohydrate into glucose, a type of sugar.

Glucose — a sugar — is a source of energy comes from the Greek word for

"sweet" which is for the cells that make up muscles and other tissues. Glucose comes from two major sources: food and your liver. Sugar is absorbed into the bloodstream, where it enters cells with the help of insulin. The liver stores and makes glucose.

4.1.2 Insulin

Insulin is a hormone that comes from a gland situated behind and below the stomach (pancreas).

How the Insulin works:

- The pancreas secretes insulin into the bloodstream.
- The insulin circulates, enabling sugar to enter your cells.
- Insulin lowers the amount of sugar in your bloodstream.
- As the blood sugar level drops, so does the secretion of insulin from the pancreas.
- When your glucose levels are low, such as when you haven't eaten in a while, the liver breaks down stored glycogen into glucose to keep your glucose level within a normal range. [7]

4.2 PRE-DIABETES

Prediabetes is a condition in which blood glucose levels are higher than normal but not high enough for a diagnosis of diabetes. It is the state in which some but not all of the diagnostic criteria for diabetes are met. It is often described as the “gray area” between normal blood sugar and diabetic levels. Prediabetes includes impaired glucose tolerance (IGT) and/or impaired fasting glucose (IFG), depending on the test used to measure blood glucose levels. Having prediabetes puts one at higher risk for developing type 2 diabetes. People with prediabetes are also at increased risk for developing cardiovascular disease. However, discovering prediabetes gives the potential of early management and preventing the progress to full-diabetic state.

Impaired fasting glycaemia or impaired fasting glucose (IFG) refers to a condition in which the fasting blood glucose is elevated above what is considered normal levels but is not high enough to be classified as diabetes mellitus. It is considered a pre-diabetic state, associated with insulin resistance and increased risk of cardiovascular pathology, although of lesser risk than impaired glucose tolerance (IGT). IFG sometimes progresses to type 2 diabetes mellitus.

There is a 50% risk over 10 years of progressing to overt diabetes. Many newly identified IFG patient's progress to diabetes in less than three years. IFG is also a risk factor for mortality. IGT is also a pre-diabetic state associated with insulin resistance and increased risk of cardiovascular pathology. IGT may precede type 2 diabetes mellitus by many years and is also a risk factor for mortality.

4.2.1 Diagnosis of Prediabetes

Prediabetes is diagnosed when:

- Fasting blood sugar (glucose) level of 110 to 125 mg/dL (6.1 mmol/L to 6.9 mmol/L) - WHO criteria or 100 to 125 mg/dL (5.6 mmol/L to 6.9 mmol/L) - ADA criteria and/or
- Two hour glucose tolerance test after ingesting the standardized 75 gm glucose solution the blood sugar level of 140 to 199 mg/dL (7.8 to 11.0 mmol/L) and/or
- Glycated hemoglobin between 5.7 and 6.4%.

Levels above these limits would be a diagnosis for diabetes.

4.2.2 Prediabetes: Progression to diabetes

A major goal in the treatment of diabetes in youth is in the area of prevention. Because most of the morbidity and mortality in diabetes arises from long-term complications, early detection and prevention would be expected to have a tremendous beneficial human, social, medical and economic impact.

With these considerations in mind, it is logical to intervene early with measures targeted to reverse specific pathophysiological defects present in the prediabetes state and that ultimately lead to development of overt diabetes.

Approximately 40-50% of individuals with IGT will progress to type 2 diabetes over their lifetime. In addition, investigators in the Diabetes Prevention Trial of Type 1 Diabetes (DPT-1) have detected a group of subjects with type 1 diabetes who are asymptomatic, have normal (<6.1 mmol/l) or impaired fasting glucose (6.1-<7.0 mmol/l), but have 2-h glucose values >11.1 mmol/l on their oral glucose tolerance tests (OGTT) (Fig 13). [8]

4.3 DIABETES MELLITUS

Diabetes mellitus (DM), commonly known as diabetes, is a group of metabolic disorders characterized by a high blood sugar level over a prolonged period of time. Symptoms often include frequent urination, increased thirst, and increased appetite. If left untreated, diabetes can cause many complications. Acute complications can include diabetic ketoacidosis, hyperosmolar hyperglycemic state, or death. Serious long-term complications include cardiovascular disease, stroke, chronic kidney disease, foot ulcers, damage to the nerves, damage to the eyes and cognitive impairment. [9]

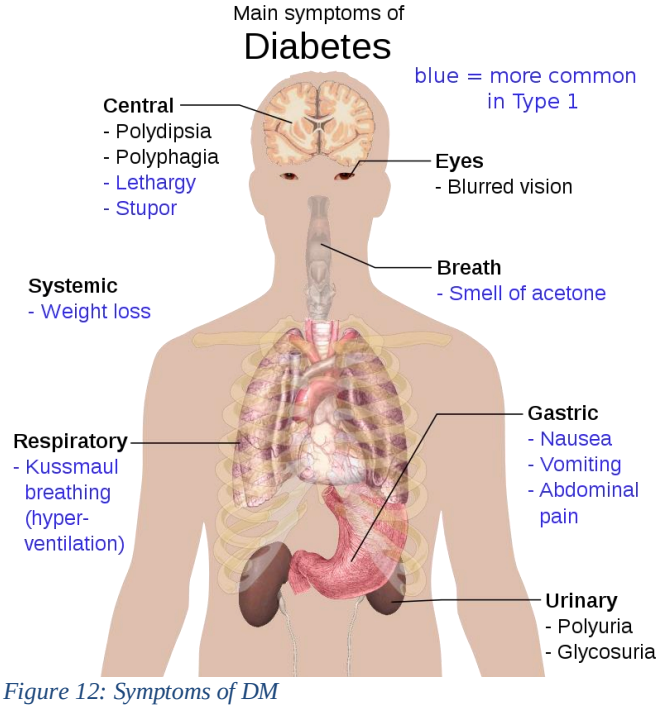

Figure 12: Symptoms of DM

4.3.1 Types of Diabetes

Type 1

Type 1 diabetes is characterized by loss of the insulin-producing beta cells of the pancreatic islets, leading to insulin deficiency. This type can be further classified as immune-mediated or idiopathic. The majority of type 1 diabetes is of the immune-mediated nature, in which a T cell-mediated autoimmune attack leads to the loss of beta cells and thus insulin.
Type 1 diabetes can be accompanied by irregular and unpredictable high blood sugar levels, and serious low blood sugar levels. Other complications include an impaired counter regulatory response to low blood sugar, infection, gastroparesis (which leads to erratic absorption of dietary carbohydrates), and endocrinopathies (e.g., Addison's disease).These phenomena are believed to occur no more frequently than in 1% to 2% of persons with type 1 diabetes. Type 1 diabetes is partly inherited, with multiple genes. Type 1 diabetes can occur at any age, and a significant proportion is diagnosed during adulthood.

Beta Cells

Beta cells are cells that make insulin, a hormone that controls the level of glucose (a type of sugar) in the blood. Beta cells are found in the pancreas within clusters of cells known as islets. In type 1 diabetes, the body's immune system mistakenly destroys the beta cells. Without beta cells, the pancreas can't make insulin.

Type 2

Type 2 diabetes is characterized by insulin resistance, which may be combined with relatively reduced insulin secretion. The defective responsiveness of body tissues to insulin is believed to involve the insulin receptor. However, the

specific defects are not known. Diabetes mellitus cases due to a known defect are classified separately. Type 2 diabetes is the most common type of diabetes mellitus. Many people with type 2 diabetes have evidence of prediabetes (impaired fasting glucose and/or impaired glucose tolerance) before meeting the criteria for type 2 diabetes. The progression of prediabetes to overt type 2 diabetes can be slowed or reversed by lifestyle changes or medications that improve insulin sensitivity or reduce the liver's glucose production.

Type 2 diabetes is primarily due to lifestyle factors and genetics. A number of lifestyle factors are known to be important to the development of type 2 diabetes, including obesity (defined by a body mass index of greater than 30), lack of physical activity, poor diet, stress, and urbanization. Continuous glucose monitors (CGMs) are increasingly accessible and effective for patients with type 2 diabetes. [10]

Gestational diabetes

During pregnancy, the placenta produces hormones to sustain your pregnancy. These hormones make your cells more resistant to insulin. Normally, the pancreas responds by producing enough extra insulin to overcome this resistance. But sometimes your pancreas can't keep up. When this happens, too little glucose gets into your cells and too much stays in your blood, resulting in gestational diabetes.

Gestational diabetes resembles type 2 diabetes in several respects, involving a combination of relatively inadequate insulin secretion and responsiveness. It occurs in about 2–10% of all pregnancies and may improve or disappear after delivery. It is recommended that all pregnant women get tested starting around 24–28 weeks gestation. It is most often diagnosed in the second or third trimester because of the increase in insulin-antagonist hormone levels that occurs at this time.

However, after pregnancy approximately 5–10% of women with gestational diabetes are found to have another form of diabetes, most commonly type 2. Gestational diabetes is fully treatable, but requires careful medical

supervision throughout the pregnancy. Management may include dietary changes, blood glucose monitoring, and in some cases, insulin may be required. [11]

SUGAR LEVEL	FASTING PLASMA GLUCOSE	2-HOUR PLASMA GLUCOSE POST (ORAL GLUCOSE TOLERANCE TEST; OGTT)
DIABETES	≥ 7.0 mmol/L (≥ 126 mg/dL)	≥ 11.1 mmol/L (≥ 200 mg/dL)
PRE-DIABETES	6.1 – 6.9 mmol/L (110 – 125 mg/dL)	7.8 – 11.0 mmol/L (140 – 199 mg/dL)
NORMAL	< 6.1 mmol/L (< 110 mg/dL)	< 7.8 mmol/L (< 140 mg/dL)

Figure 13: Progression of pre diabetes

4.4 CONTINUOUS GLUCOSE METER

More recently, engineering and scientific advances have allowed the development of continuous glucose meters that have proven useful for the day-to-day early detection of diabetes mellitus.

Continuous glucose meters represents a significant advance because it

- Provides real-time information about current blood glucose (or, more accurately, interstitial fluid glucose) concentrations.

- Provides short-term feedback about the effectiveness of diabetes interventions (such as insulin administration), and

- Provides warnings when blood glucose concentrations become dangerously high or low.

Also The use of CGM, both in research and clinical settings, has been documented to decrease blood glucose excursions, lower HbA1c values, and reduce hypoglycemic episodes, which together diminish the risk of complications associated with diabetes. In addition, use of CGM helps in reducing glucose variability. CGM can improve glycemic control, which may reduce both the micro- and macrovascular complications associated with diabetes, while not increasing the risk of hypoglycemia.

The purpose of this project is to review the benefits of the CGM in ways at which it helps reducing the effects of diabetes.

Continuous glucose meters are a developing innovation that permits successive glucose estimations (each 5 min) and the capacity to screen glucose patterns continuously. Despite the fact that these gadgets are right now costly and somewhat upsetting to use, there is huge potential for their utilization in both the examination and clinical domains.

Continuous glucose meters (CGM) gives maximal data about moving blood glucose levels for the duration of the day and encourages the creation of ideal treatment choices for the diabetic patient. For the treating clinician, CGM can possibly improve recognition of hyperglycemic outings just as asymptomatic hypoglycemia and the information to improve the board of glucose levels in diabetes patients.

4.4.1 Principle of the Continuous Glucose Meter

Continuous Glucose meters have two essential parts: an enzymatic reaction and a detector. The enzyme portion of the glucose meter is generally packaged in a dehydrated state in a disposable strip or reaction cuvette. Glucose in the patient's blood sample rehydrates and reacts with the enzymes to produce a product that can be detected. Some meters generate hydrogen peroxide or an inter-mediary that can react with a dye, resulting in a color change proportional to the concentration of glucose in solution. Other meters incorporate the enzymes into a biosensor that generates an electron that is detected by the meter. There are three principle enzymatic reactions utilized by current glucose meters: glucose oxidase, glucose dehydrogenase, and hexokinase. Each enzyme has characteristic advantages and limitations.

All meters are susceptible to heat and cold, because the enzymes are proteins that can denature and become inactivated at temperature extremes. Although packaged in a dry state, exposure of the enzymes to humidity can prematurely rehydrate the proteins and limit their reactivity when utilized for patient testing. The disposable reagents for glucose meters must therefore be protected from extremes of temperature and humidity. Such conditions could occur when transporting the reagents outside in the heat of summer or cold of winter.

Test strips should not be stored in closed vehicles for extended periods and must be protected from rain, snow, and other environmental elements. The detector portion of the meter is composed of electronics, so it must also be protected from extremes of temperature, humidity, moisture, and the elements (Fig 13).

Many meters now have internal temperature checks that prevent use of the meter outside of acceptable tolerance by blocking patient results or displaying an error code if the ambient conditions of temperature and humidity are outside manufacturer ranges. Continuous Glucose meters must also not be submerged in water when cleaning and must be protected from moisture, as with any electronic device. [12]

4.4.2 Technical Accuracy

Continuous Glucose meters vary in their method of analysis. There are meters on the market that use both types of correction. However, it is more common for manufacturers whose meters separate the cellular portion of the sample to set the calibration of the meter against a laboratory method in order to report a “plasma-calibrated” result. The differences between these various calibration and correction functions are one source of variability among the many glucose meter models when analyzing the same specimen. For accuracy determination, glucose levels from the same specimen would ideally be compared by analysis on the glucose meter and by a reference or comparative method.

Depending on the clinical situation, a variety of sample types may need to be analyzed by a glucose meter, including capillary, arterial, and venous specimens, particularly on hospitalized inpatients. Alternate collection sites,

including forearm, leg, and abdomen, have recently become popular, as patients claim these sites are less painful than finger stick collection given the abundance of nerve endings in the fingertips. Arterial blood has higher glucose levels compared to venous blood because arterial blood is being delivered to the tissues where glucose is absorbed as an energy source. In the fasting state, arterial glucose levels are only 5 mg/dl (0.27 mmol/liter) higher than capillary and 10 mg/dl (0.55 mmol/liter) greater than venous concentrations.[19] The difference can be amplified by perfusion difficulties, oxygenation, and pH differences between arterial and venous blood samples. Glucose levels also differ between fasting and postprandial states.

During fasting, capillary glucose may be only slightly (2–5 mg/dl) higher than venous glucose. In the postprandial state, however, capillary blood may be 20–25% or greater than venous levels. These differences become a significant concern if accuracy of a glucose meter is assessed using paired capillary and venous samples from a non-fasting individual. Perfusion is another consideration with capillary samples, as blood can pool in the extremities of patients with poor perfusion, such as those in shock, or in patients with disease in a specific limb. Poor perfusion can lead to capillary and venous differences in glucose results and should be a consideration when using paired capillary and venous samples to determine meter accuracy.

Figure 14: Various examples of the Continuous glucose meter

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION:

From the research conducted, it can be perceived that the improper plastic waste disposal is one problem which has posed great perils not only to the indigenes of the community but also to the Nkwabeng North Community but also chronic and complex complications on the populace of the community.

Due to the adverse effects such as damage to the blood vessels of the heart, brain and legs damage to the small blood vessels, causing problems in the eyes, kidneys, feet and nerves and so on, it was esteemed fit beyond reasonable doubts that Early Detection through the use of a Continuous Glucose Meter will help individuals to be on guard and to help cure the disease at its early stages.

The use of Continuous Glucose Meter in the diagnosis of early dysglycemia (prediabetes) and diabetes especially in high risk patients appears to promising and in many occasions superior to other known diagnostic modalities namely oral glucose tolerance test

It can therefore be concluded that Early Detection through the use of Continuous Glucose Meter will not only help curb the prevailing problem, but also provide the indigenes of the Nkwabeng North Community to go about their day to day activities freely without the fear of any chronic disease. Thus, the proposed solution should be implemented.

RECOMMENDATIONS:

- I highly recommend that the Assembly with the help of the National Commission on Civic Education (NCCE) to educate the entire public on the need for the use of the continuous glucose meter and the essence of it in helping in early detection and enabling curing of Diabetes Mellitus at its early stages.

- Also, I recommend that the well-to-do individuals in our community and beyond contribute their quota in the purchasing of the continuous glucose meter to be able to enable easy access by the members of the

fgyugdd

community.

- Also, exercising should be a normal routine that should be constantly done and occasional walks and joggings organized by the assembly, various institutions should be encouraged and well-practiced.

- I also recommend that the eating of a balanced diet is made a major necessity and eating of fruits and vegetables should be practiced.

- Lastly, I strongly recommend that the uses of the glucose meter should be used continuously and not intermittently.

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6.0 APPENDICES

6.1 QUESTIONNAIRE

REDUCING THE EFFECTS OF DIABETES MELLITUS THROUGH EARLY DETECTION WITH A CONTINUOUS GLUCOSE METER IN NKWABENG NORTH COMMUNITY.

My name is AMEYAW ARTHUR, a BSc. Biomedical engineering student of Kwame Nkrumah University of Science and Technology. This survey aims at gathering information about the problems facing our community i.e Nkwabeng North Community. This data is strictly for academic purposes and will be used to finish a project work assigned to me. The project work is to identify a problem in my community and use the concept of my field of study i.e Biomedical Engineering to attempt finding a solution to the problem identified.

* Required

1. What is your Age? *

Mark only one oval.

- ◯ under 16 years
- ◯ 16 - 25 years
- ◯ 26 - 49 years
- ◯ 50 - 65 yover 65 yearsears
- ◯ Option 5

2. Gender *

Check all that apply.

- ☐ Male
- ☐ Female
- ☐ Prefer not to say

Other: ☐ _____

3. Weight *

_____

4. Marital status *

Mark only one oval.

- ◯ Single
- ◯ Married
- ◯ Divorced
- ◯ Widow
- ◯ Widower

5. Occupation *

Mark only one oval.

- ◯ Student
- ◯ Retired
- ◯ Trader
- ◯ Teacher
- ◯ Other: _____

6. Do you have a family history of Diabetes *

Mark only one oval.

- ◯ Yes
- ◯ No

◯ Never
◯ Always
◯ Occasionally

Mark only one oval.

10. How often do you eat fruits and vegetables? *

◯ Never
◯ Always
◯ Occasionally

Mark only one oval.

9. How often do you take in alcohol ? *

◯ Less than 3 times a week
◯ Never
◯ 3 times a week
◯ 4 to 2 times a week
◯ Everyday

Mark only one oval.

8. How often do you exercise? *

◯ No
◯ Yes

Mark only one oval.

7. Have you ever been found to have High blood glucose (eg: in a health examination during an illness or during pregnancy in women) *

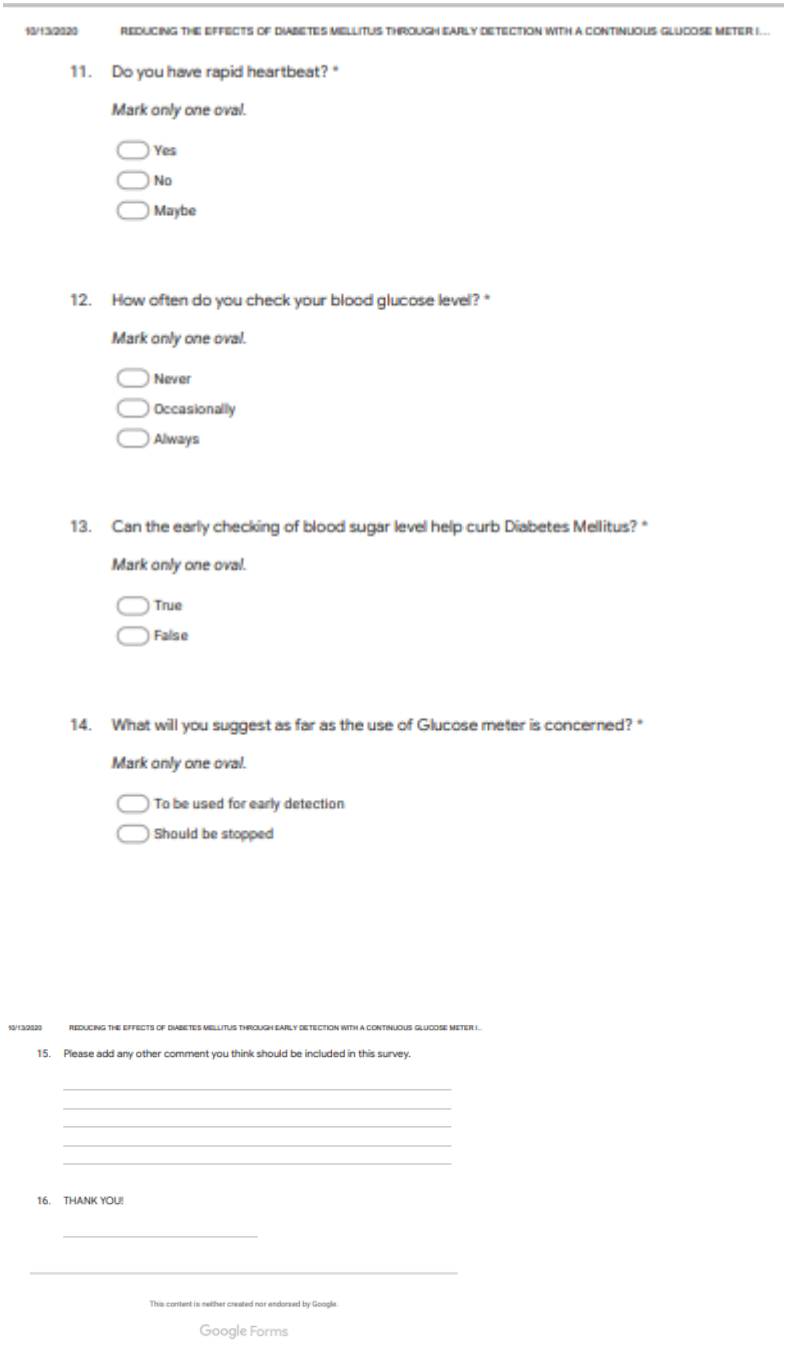
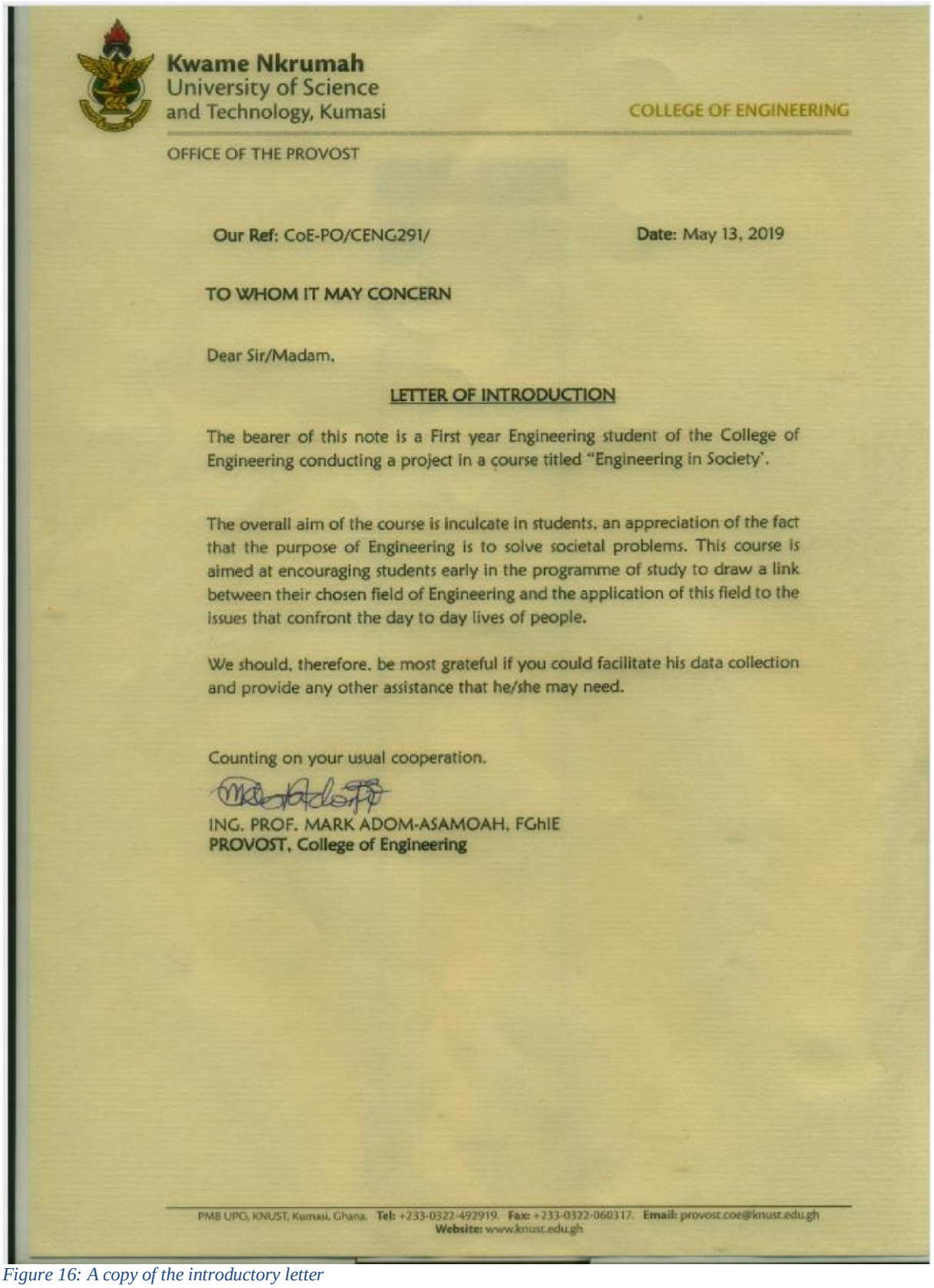


Figure 15: A copy of the questionnaire using Google forms

6.2 LETTER OF INTRODUCTION



Kwame Nkrumah
University of Science
and Technology, Kumasi

COLLEGE OF ENGINEERING

OFFICE OF THE PROVOST

Our Ref: CoE-PO/CENG291/ **Date:** May 13, 2019

TO WHOM IT MAY CONCERN

Dear Sir/Madam,

LETTER OF INTRODUCTION

The bearer of this note is a First year Engineering student of the College of Engineering conducting a project in a course titled "Engineering in Society'.

The overall aim of the course is inculcate in students, an appreciation of the fact that the purpose of Engineering is to solve societal problems. This course is aimed at encouraging students early in the programme of study to draw a link between their chosen field of Engineering and the application of this field to the issues that confront the day to day lives of people.

We should, therefore, be most grateful if you could facilitate his data collection and provide any other assistance that he/she may need.

Counting on your usual cooperation.

ING. PROF. MARK ADOM-ASAMOAH, FGhIE
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Website: www.knust.edu.gh

Figure 16: A copy of the introductory letter