RELATIONSHIP BETWEEN LOW BIRTH WEIGHT AND MATERNAL PERIODONTITIS: A CASE STUDY OF KIAMBU COUNTY.

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DECLARATION

I declare that this research thesis is my original work and has not been presented in any other university.

Signed…… Date……

Rachel Njoki Gichuki
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This research thesis has been submitted for examination with our approval as university supervisors.

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DEDICATION

To the Almighty God, for His faithfulness and unmerited love for me. May His name be praised forever. To the very handsome Jesse Mbiu and Lucas Gichuki, my dear sweet sons, may you live to reach your full potential and to inspire many just as you have inspired me. I learn every day from your little innocent hearts. To my husband James Chege (Chei) thank you for the support and constant encouragement. May we achieve our dream of ending the stigma towards dental care during pregnancy. To my dear Papa (Lucas Gichuki) and Mama (Lydia Elizabeth Mumbi), I am forever indebted to you for your unconditional love, thank you for educating me and always being my greatest cheerleaders. I love you both immensely.

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ABSTRACT

Periodontitis is defined as a long-term inflammatory disease of the periodontal ligament and alveolar bone occurring as a response to bacterial plaque. Periodontal diseases are estimated to affect more than 95% of the adult population in Kenya. Low birth weight is defined by the World Health Organization as neonatal birth weight of 2500 g or less, regardless of gestational age. It is estimated to contribute 60 to 80 percent of all neonatal deaths The Kenya Demographic Health Survey (KDHS) of 2014 estimated low birth weight to be 7.6% countrywide and 9.2% in the Central region showing an increase in prevalence by 3.7% in 5 years. In addition, among all early childhood mortality rates in Kenya, neonatal mortality has showed the slowest rate of decline. With the high prevalence of periodontal diseases in females in Kenya and the increase in neonates born with low birth weight in central region, there was need to evaluate if there is a relationship between low birth weight and periodontitis. We further sought to determine the incidence of periodontitis in mothers delivering low birth weight neonates in Kiambu and to evaluate the relationship between low birth weight and oral hygiene practices in the same County. We carried out a cross sectional study using 384 post-partum mothers distributed across five hospitals in Kiambu between June and December 2019. Mothers who had delivered singleton low birth weight neonates within 48 hours, according to the medical records, were enrolled for clinical examinations and interviewed using a structured questionnaire. The incidence of maternal periodontitis in Kiambu was found to be 92% with 53% of the mothers having severe periodontitis. All oral hygiene practices were significantly associated with low birth weight ($P<0.001$). Incidences of maternal periodontitis are significantly associated with low birth weight with an $R^2 = 0.732$, $P < 0.001$ and a correlation of $r = 0.875$, $P < 0.001$. Statistically significant associations were found between age and maternal periodontitis ($p = 0.045$), highest level of education and maternal periodontitis ($p = 0.007$) and dental visits prior to pregnancy and maternal periodontitis ($p = 0.012$). In conclusion, there is a high incidence of periodontitis in mothers delivering low birth weight neonates in Kiambu County. Poor oral hygiene practices are a potential predictor of low birth weight. A positive relationship exists between low birth weight and maternal periodontitis in this population. The ministry of health should incorporate oral health preventive and curative services in antenatal programs in Kenya. Public health awareness on the importance of proper oral hygiene practices and routine dental care is required especially among expectant women. Large prospective cohort studies are required to investigate the relationship between low birth weight and periodontitis in different populations in the country. Further research is required on misconceptions surrounding dental care during pregnancy and barriers limiting utilization of dental services during pregnancy.

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ABBREVIATIONS

BOP	Bleeding on probing
CAL	Clinical attachment loss
CPITN	Community periodontal index of treatment needs
DNA	Deoxyribonucleic acid
IUGR	Intra uterine growth restriction
KDHS	Kenya Demographic and Health survey
KOHS	Kenya oral health survey
LBW	Low birth weight
NICU	Neonatal intensive care unit
PD	Probing/pocket depth
PLBW	Preterm low birth weight
PPD	Periodontal probing depth
PPROM	Preterm premature rupture of membranes
PT	Preterm birth
SPSS	Statistical Package for Social Sciences
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Periodontal diseases comprise inflammatory diseases of the oral cavity caused by bacteria in dental plaque. Periodontal diseases cause discomfort, pain and eventually loss of teeth in adults. There are two broad classifications of periodontal disease, periodontitis and gingivitis. Periodontitis involves destruction of the ligament of the periodontium and alveolar bone, which support the teeth, damage to the periodontal fibers and migration of the ligament of the periodontium apically. Gingivitis is characterized by inflammation of the soft tissue around the teeth. Clinical characteristics of periodontitis are changes in gingival color, formation of pockets, movement of attachment of the epithelium and bleeding from the gingiva (Muwazi, 2014). Results of clinical studies by Folkers (1992) show that 30% to 100% of gravid women are diagnosed with gingivitis due to an increase in levels of four major hormones; progesterone, estrogen, human chorionic somatotropin and human chorionic gonadotropin.

The World Health Organization (WHO) defines LBW as neonatal birth weight below 2,500 g. According to Stanford Children's health, low birth weight is caused primarily by intrauterine growth restriction (IUGR) and premature birth (birth occurring prior to gestation week 37). Premature babies have less intrauterine time to grow and gain weight while in intrauterine growth restriction; the fetus fails to develop properly due to the mother's health, the fetus's condition or complications with the placenta. Low birth weight consists of a broad group of neonates: some are born growth restricted; others are born early while some are both growth restricted and early. LBW results in multiple short-term and long-term complications such as intraventricular hemorrhage, respiratory distress syndrome, problems in behavior and congenital anomalies. LBW has been constantly documented as a risk factor for neonatal morbidity and death. The survival of neonates with neonatal low birth weight at birth is influenced majorly by the neonate's weight with the smallest babies (less than 500 grams) having the lowest survival rate. Almost all low birth weight neonates need critical attention in the Neonatal Intensive Care Unit (NICU) till they have achieved weight gain.

Animal models have explored the association between pregnancy outcomes and maternal periodontitis. In a study of pregnant mice by Lin et al. (2003) using *Porphyromonasgingivalis (P. gingivalis*) - a major periodontal pathogen, it was found that *P. gingivalis* did not contribute to growth restriction in every fetus but in every litter. The DNA of P. *gingivalis* was demonstrated exclusively in placentae of involved fetuses, and these placentae had elevated pro-inflammatory cytokines and decreased anti-inflammatory cytokines.

Offenbacher (1996) carried out the landmark study that showed that maternal periodontitis was a statistically significant risk factor for preterm low birth weight (PLBW) due to preterm premature rupture of membranes (PPROM) or preterm labor. 124 postpartum or gravid ladies had a mouth examination conducted to establish the level of clinical attachment. Confounding factors in particular alcohol consumption, tobacco use, genitourinary infections and poor nutrition were eliminated. Results showed that primiparous and non-primiparous mothers of PLBW neonates had remarkably more severe maternal periodontitis than the controls- participants who delivered neonates with normal weight. Periodontitis in pregnancy was found to result in a seven-fold increase in risk of PLBW and approximately 18% of PLBW births were found to be attributable to maternal periodontitis.

Periodontal therapy such as full mouth scaling was found to reduce neonatal premature birth and low weight at birth rates by 68 percent in mothers diagnosed with periodontitis (López, 2002). They recommend that whenever possible ladies should conceive without periodontitis and periodontitis detected during the pregnancy period should be clinically attended to promptly to minimize the chance of neonatal low weight at birth or premature birth. Women should be informed and encouraged to maintain good oral hygiene and oral health prior to and throughout pregnancy.

Bansal (2013) recommends that women should be targeted before they conceive as periodontal therapy can be carried out more aggressively and a lengthier post-treatment maintenance phase carried out ensuring that any inflammation induced by periodontitis in the system is able to resolve completely.

1.2 Statement of the problem

A child's birth weight is an important indicator of the child's vulnerability to the risk of childhood illnesses and chances of survival. Every year, 40,000 neonates die in Kenya (Lawn et al., 2014). Neonates who weigh below 2,500 g are approximately 20 times more likely to die than heavier neonates and low birth weight is estimated to contribute 60 to 80 percent of all neonatal deaths (United Nations Children's Fund [UNICEF], 2018) The Kenya demographic health survey of 2014 found a 3.7% increase in neonates born with low birth weight in central region and neonatal mortality was found to exhibit the slowest rate of decline among all the early childhood mortality rates. The prevalence of gingival inflammation (the first stage of periodontitis) in adult females aged 35-44 years in Kenya is reported as 97.7 % (Ministry of Health, 2015). While there are many known risk factors for low birth weight and interventions exist to prevent many of these factors before and during pregnancy the prevalence of low birth weight in Central Kenya has not decreased. The contribution of periodontitis to low birth weight in Kenya is still unknown.

1.3 Purpose of the study

The purpose of this study was to establish whether there is an association between low birth weight and maternal periodontitis.

1.4 Objectives

1.4.1 General

To determine the relationship between low birth weight and maternal periodontitis in Kiambu county.

1.4.2 Specific

1. To determine the incidence of maternal periodontitis in post-partum women who have given birth to a low birth weight neonate within 48 hours of delivery in Kiambu County.
2. To determine the relationship between low birth weight and moderate maternal periodontitis in Kiambu County.
3. To determine the relationship between low birth weight and severe maternal periodontitis in Kiambu County.

4. To determine the relationship between low birth weight and oral hygiene practices in Kiambu County.

1.5 Research questions

1. What is the incidence of maternal periodontitis in post-partum women who have given birth within 48 hours of delivery to a low birth weight neonate in Kiambu County?
2. Is there any relationship between low birth weight and moderate maternal periodontitis in Kiambu County?
3. Is there any relationship between low birth weight and severe maternal periodontitis in Kiambu County?
4. Is there any relationship between low birth weight and oral hygiene practices in Kiambu County?

1.6 Null hypothesis

There is no relationship between low birth weight and maternal periodontitis in Kiambu County.

1.7 Justification of the study

Low birth weight contributes to 60 to 80 percent of all neonatal deaths (UNICEF, 2018). Among all the early childhood mortality rates in Kenya, neonatal mortality has showed the slowest rate of decline (Kenya National Bureau of Statistics [KNBS], 2015). The contribution of periodontitis to low birth weight in Kenya is unknown. With a reported prevalence of 97.7% of gum diseases in females aged 35-44years in Kenya (Ministry of Health, 2015) and a 3.7% increase in neonates born with low birth weight in central region (KNBS, 2015) there was need to establish if there is an association between maternal periodontitis and low birth weight. While antenatal oral health programs exist in other countries, the program is not part of antenatal care in Kenya. The information obtained from this research study can be used to advise changes in antenatal care and can also be used as a foundation for further research.

1.8 Limitations of the study

Lack of cooperation from study participants. To address this, the principal investigator ensured adequate information was given on the nature the proposed

examination and the benefits of the information to be obtained. All attempts were made to allay any anxiety and fear.

1.9 Delimitations of the study

Only post-partum mothers aged 18 to 50 years were enrolled in the study. This study was restricted to participants who were capable of giving informed consent. Only birth weight that had been measured within the first one hour of life was recorded. This was to ensure that significant post-natal weight loss had not occurred.

1.10 Significance of the study

The results of this study will aid in establishing whether maternal periodontitis is a risk factor for low birth weight and consequently the need for periodontal therapy in women with periodontitis. The information obtained can be used to advise changes in pre-natal care and can also be used as a foundation for further research.

1.11 Assumptions of the study

1. Sample selected was representative of the general population.
2. Reliability and validity of the measuring instruments.

1.12 Operational definition of terms

Multiparous- Having experienced one or more previous childbirths.

Neonatal mortality: Death occurring during the first 28 days of life

Periodontitis- Chronic inflammatory disease of the gum and alveolar bone resulting in resorption of the bone around the teeth, creation of periodontal pockets and damage to the supporting structures with loss or loosening of teeth.

Severe periodontitis- two or greater than two interdental areas with loss of clinical attachment ≥6 mm, not on the same tooth, and one or greater than one interdental areas with probing depth ≥5 mm.

Moderate periodontitis -two or greater than two interdental areas with loss of clinical attachment ≥4 mm, not on the same tooth, or two or greater than two interdental areas with probing depth ≥5 mm, not on the same tooth.

Pre term- neonates born alive prior to gestation week 37.

Primiparous-Giving or having given birth for the first time

Periodontal therapy- also known as scaling and root planning, is a procedure involving deep cleaning above and under the gum line to remove dental plaque and calculus and smoothing exposed surfaces of roots to aid in reattachment of the gum.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Following the landmark research study carried out by Offenbacher (1996) several studies have been conducted and they will be explored below. This review explores available published literature on the relationship between adverse outcomes of pregnancy and maternal periodontitis, in particular low birth weight. Unpublished literature was excluded.

2.2 Theoretical literature review

The theory that oral diseases may affect overall systemic health was first proposed by Miller in "focal infection theory" of 1891, where he stipulated that microorganisms or their waste products obtain entry to the organs system from the oral cavity. He further blamed oral bacteria for intrinsic diseases e.g. endocarditis and meningitis. As a result of this theory teeth ended up being extracted as prophylaxis against diseases (Miller, 1891). McGaw (2002) found that individuals diagnosed with illnesses as a result of foci of infection had no improvement once the foci were removed, in addition individuals with identical diseases had no evident focus of infection and such foci were as common in individuals who appeared to have good health as those found to have illnesses.

The supposition that remote infection sites may lead to neonatal low weight at birth has been backed by evidence through the pregnant golden hamster model. In a study by Collins et al., (1994) to examine the role of multiple, localized, non-disseminated provocations of Porphyromonas gingivalis on the production of inflammatory mediator and outcomes of pregnancy, organisms that were either live or heat-killed were inoculated in the hamsters on day 8 of gestation to establish their effects on fetal resorption, weight and viability. All porphyromonas gingivalis challenges caused a substantial increase in prostaglandin E2 and tumor necrosis factor alpha. Increasing levels of tumor necrosis factor alpha and prostaglandin E2 was found to cause retardation of fetal growth. These results show that infections with gram-negative periodontal bacteria can bring forth poor pregnancy outcomes like low neonatal

weight at birth and that the levels of prostaglandin E2 produced are proportional with how severe the fetal effect is.

Chambers et al., (1991) noted that a patient with an average set of 28 teeth with moderate or severe periodontitis has a surface area of infection and inflammation equivalent to the surface of two hands. According to Babu and Gomes (2011) three pathways have been postulated to show the possible ways in which infection can spread from the mouth and produce resulting effects in the body system:

i. Metastatic spread of infection from the mouth due to transient bacteremia.
ii. Metastatic injury due to circulating oral bacteria e.g. lipopolysaccharide. Lipopolysaccharide is released by periodontal gram-negative rods during growth, when it is introduced into the host and results in pathological manifestations
iii. Metastatic inflammation as a result of injury to the immune system caused by oral bacteria.

Several mechanisms have been postulated by Michaela and Milan (2011) on how periodontitis causes low birth weight :

1) The penetration of Bacteria and bacterial by-products (lipopolysacharride-toxins) in the fetoplacental unit

Porphyromonas gingivalis has been most associated in infecting the feto-placental structures, and inducing inflammatory processes. After infection, the resulting elevated release of pro-inflammatory cytokines and growth restriction of the fetus has been noted in animal models to cause low birth weight.

2) Genetic polymorphisms of immunologically active substance

Pro-inflammatory mediators that have undergone genetic polymorphism have been related with low neonatal weight and preterm birth. It has been suggested that alike polymorphisms bring about periodontitis. The pro-inflammatory mediators mostly associated with neonates with low weight at birth and premature birth are interleukin-1and their antagonists.

3) Increased oxidative substances and decreased antioxidants in the final pregnancy trimester

Gravid ladies in the last pregnancy trimester experience higher systemic and crevicular quantities of oxidative substances and reduced levels of antioxidants. The

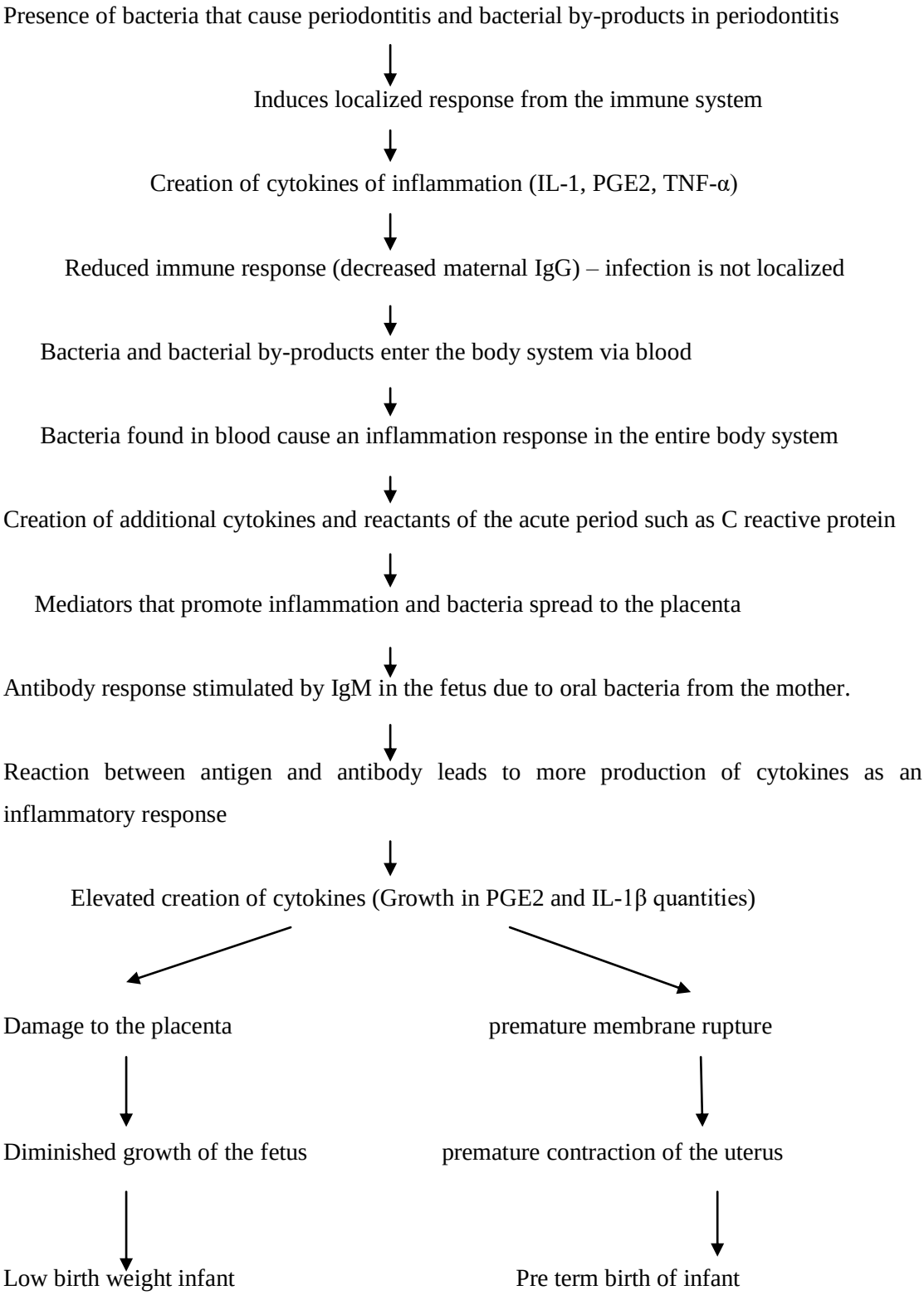
antibacterial process of breaking down and evacuation of periodontal bacteria produces strong oxidative substances. If the immune defense by the body is not able to stop the production of these oxidative substances, the oxidants damage tissues of the periodontium and migrate to the blood system where they affect peripheral organs.

4) Influence of hormones

The increased production of pregnancy hormones stimulates formation of prostaglandin E2, which is pro-inflammatory on periodontal tissue. If the pregnant woman had early stages of periodontitis, progression of the disease to more severe stages is possible. Due to increased permeability and blood vessel dilatation and subsequent exudation, periodontal bacteria can then penetrate the feto-placental unit.

Figure 2.1

Theoretical framework



Adapted from Varadan & Ramamurthy (2015)

2.3 Empirical literature review

This section comprises of studies that found a positive relationship between low birth weight and periodontitis highlighting the incidence of periodontitis in particular studies. Studies that demonstrated an association between low birth weight and moderate or severe periodontitis are also explored. The role of periodontal therapy and oral hygiene practices in reducing adverse birth outcomes as well as studies that did not find periodontitis as a risk factor for low birth weight are presented.

2.3.1 Studies that found a positive relationship between maternal periodontitis and low birth weight.

The landmark study on periodontitis in pregnancy and poor pregnancy outcomes was carried out by Offenbacher et al., (1996). They clinically examined 124 gravid and postpartum women to establish the level of clinical attachment. Confounding factors in particular alcohol consumption, tobacco use, genitourinary infections and poor nutrition were eliminated. It was found that both primiparous and non-primiparous women who had delivered premature neonates with low weight at birth had significantly worse maternal periodontitis than the controls (women who delivered neonates with normal weight at birth). Periodontitis in gravid women was found to cause a seven-fold increase in chance of delivery of a preterm neonate with low weight at birth and approximately 18% of PLBW births are due to periodontitis.

All 232 participants in a research study by Vanka et al., (2013) were diagnosed with periodontal pocketing with 56% having shallow pockets (pockets of 4-5 mm). 134 of the participants diagnosed with deep periodontal pockets delivered a low birth weight neonate as opposed to 98 subjects who delivered normal weight neonates. Maternal periodontitis was established to be statistically significantly related with neonatal low weight at birth.

Periodontitis was found to be an independent risk factor for neonatal low weight at birth (Jacob & Nath, 2014) . They conducted retrospective research that was hospital based with the aim of evaluating if periodontal disease was among the risk factors for low neonatal weight at birth. The mothers who delivered neonates with low weight at birth had significantly severe periodontitis than mothers who had neonates with

normal weight at birth. Other factors found to be significantly related with delivery of neonates with low weight at birth were pre-eclampsia, vaginal type of delivery and preterm labor.

Three hundred and forty women carrying their first pregnancy with a singleton live pregnancy and of the age of between 20 and 35 years were recruited in the midst of their antenatal visits in a study by Kumar et al., (2013) to evaluate whether periodontitis diagnosed early in pregnancy was associated with adverse outcomes of pregnancy. All participants underwent full periodontal examinations upon enrollment which occurred between weeks fourteen and twenty of gestation. Outcomes of birth were identified after delivery and included low neonatal birth weight, intra-uterine growth restriction and premature birth. Of the three hundred and forty participants, 61 (17.94%) were diagnosed with periodontitis while 147(43.23%) were diagnosed with gingivitis. They concluded that periodontitis had a statistically significant association with all the adverse outcomes of birth.

The occurrence of neonates with low weight at birth was established to be 2.3 times more in primigravida women with maternal periodontitis than those in periodontal health Karimi et al., (2016). In addition, preterm labor was 12 times increased in participants found to have maternal periodontitis. They resolved that the more severe maternal periodontitis is, the greater the chance of low neonatal weight at birth and premature labor and an inverse association was found to exist between median birth weight and the potency of periodontitis in gravid ladies. They recommend that whenever possible ladies should conceive without periodontitis and periodontitis detected during the pregnancy period should be clinically attended to promptly to minimize the chance of neonatal low weight at birth or premature birth. Women should be informed and encouraged to maintain correct oral hygiene practices and good oral health prior to and throughout pregnancy.

A case control study involving one thousand three hundred and five women from different ethnic groups in Brazil was conducted by Siqueira et al., (2007) to assess whether there existed an association between periodontitis in pregnancy and poor outcomes of birth in particular low neonatal weight at birth, intrauterine growth restriction and premature birth . The participants were distributed into four categories,

a low birth weight group consisting of 235 participants who had delivered neonates with low weight at birth (below 2500g), an intrauterine growth restriction group made up of seventy-seven mothers who delivered neonates with fetal growth retardation and a premature birth group with two hundred and thirty-eight women who delivered neonates within a gestation period of less than thirty-seven complete weeks. Periodontitis in this study was defined as having at least four teeth with pocketing of equal to or greater than 4mm and loss of clinical attachment of greater than three millimeters on one or greater than one site. Following regression analysis periodontal disease was concluded as a risk component for low neonatal weight at birth, intrauterine growth restriction and premature birth.

Ren and Du (2017) carried out a cross-sectional study with the objective of investigating the association between growth of the fetus and periodontitis particularly in gravid ladies who had undergone periodontal therapy. The results demonstrated that periodontitis was positively associated with length of the neonate at birth, femur length of the fetus and weight at birth. Bleeding on probing had a negative correlation with length of the neonate at birth. Participants with severe periodontitis had significantly lower length of the fetus at birth, lower femoral length and lower weight at birth than those with mild periodontitis. The rate of delivery of neonates with low weight at birth was significantly higher in the severe periodontitis category than the mild periodontitis category.

A study conducted by Vogt et al., (2010) among gravid mothers in brazil diagnosed with periodontitis and categorized as low risk for adverse outcomes of pregnancy found that maternal periodontitis is a risk factor for premature rupture of membranes ,premature birth, low neonatal weight at birth but not for neonatal small for age of gestation. The prospective study done with the goal of evaluating the role of periodontitis in pregnancy in contributing to adverse outcomes of pregnancy involved three hundred and twenty-seven participants divided into two categories, a no periodontitis group and a periodontitis one, The participants received a complete examination of the periodontium conducted at below gestation week 32 and periodontitis was diagnosed by presence of loss of clinical attachment, periodontal pocket depth, bleeding on probing and gingival recession.

Mesa et al., (2013) found that a diagnosis of periodontitis was more often found and more aggressive periodontitis in mothers who delivered preterm neonates and neonates with low weight at birth. The research with the aim of determining whether inflammatory infiltrate in placental chorionic villi, periodontal clinical parameters and periodontitis bacterial profiles are related with adverse outcomes of pregnancy found that the controls had significantly lower clinical indicators of periodontitis than the cases. The anaerobic bacteria profiles were the same in both groups.

Wang et al., (2013) enrolled pregnant ladies receiving antenatal care between the ages of 22-40 in research to evaluate to examine the association between periodontitis in pregnancy and premature neonates with low neonatal weight at birth. The women were classified into a gingivitis group, a healthy group and a periodontitis group and upon delivery; neonatal birth weight was recorded. Statistically significant contrasts in median neonatal weight at birth occurred in all three categories. Low neonatal weight at birth was found to be significantly related to periodontitis in pregnancy but non-significant relationship existed between periodontitis in pregnancy and delivering prematurely.

Mathew et al., (2014) conducted a case control research study with the aim of determining whether a relationship existed between low neonatal weight at birth and periodontitis. The cases comprised mothers of the age group 18-35 years of age who had a minimum of 18 teeth. The mothers must have given birth to a singleton live infant to be included in the study. Mothers with medical conditions such as valvular heart disease, pregnancy induced hypertension, viral infections and those who had undergone periodontal treatment within the past 6 months were excluded. Periodontitis was established as an independent risk factor contributing to low neonatal weight at birth and women who were diagnosed with periodontal disease being 5 times more susceptible in delivering low birth weight neonates.

Chakki et al., (2012) found periodontitis in pregnancy to be significantly related to reduced weight at birth. In this research with the aim of evaluating if maternal periodontitis was an independent factor associated with low neonatal weight at birth; the birth weight was regressed against the periodontal community index, plaque index and age.

In a cohort study by Agueda et al., (2008) with the objective of establishing whether periodontitis in pregnancy is a risk factor for poor outcomes of pregnancy, 1334 pregnant women had full clinical oral investigations, ultrasounds and medical interviews conducted at gestation week twenty. Periodontitis was classified as presence of greater than four teeth with more than one site with pocket depth greater than 4 mm and loss of clinical attachment greater than or equal to 3 mm at same site. 73.9% of the participants were not diagnosed with periodontal disease and of the 26.1% diagnosed with periodontitis, 50 participants delivered a low birth weight neonate while 54 delivered pre term. It was resolved that a modest association exists between adverse outcomes of pregnancy and maternal periodontitis.

Periodontitis in gravid women was established as an to be risk factor for both premature birth and low neonatal weight at birth among middle class women (Pitiphat et al., 2008). 96.2 % of the 1635 ladies recruited in trimester two of pregnancy did not have maternal periodontitis and from this group 6.4% delivered PLBW neonates. 8.1% of the participants without maternal periodontitis delivered PLBW neonates.

Average clinical attachment loss and periodontal pocket depth were found to be higher in mothers who had delivered premature neonates with low weight at birth than in mothers who had uncomplicated vaginal delivery at complete gestation. The case control research study conducted by Khader et al., (2009) to evaluate premature low neonatal weight at birth and periodontitis in pregnancy involved 438 controls (mothers with normal weight and full term neonates) and 148 cases (mothers with premature neonates who had low weight at birth) where interview were conducted and review of medical records done. While recession of the gum was not statistically different between cases and controls, number of sites with loss of clinical attachment and periodontal pocketing depth > or = 3 millimeters were lower in controls than cases. They reached a conclusion that the greater the severity of periodontal disease, is the greater the chance of giving birth to premature neonates with low neonatal weight at birth.

Rajapakse et al., (2005) concluded that a mild to moderate relationship between delivery of neonates who are premature with low weight at birth and periodontitis in

pregnancy exists among rural women in Sri Lanka. The research was carried out with the objective of examining association between prematurity and periodontitis in pregnancy among nonsmoking women in Sri Lanka. 227 women in their final pregnancy trimester had a complete periodontal examination conducted and periodontitis was diagnosed as having gingival bleeding from probing scores, periodontal index and probing depth higher (either individually or in combination) than the intermediary value in the entire cohort.

Through a research study in Madagascar on 204 gravid women, Rakoto-Alson et al., (2010) found a strong relationship between premature birth, low neonatal weight at birth and periodontal disease in gravid women. Full periodontal examinations, interviews and ultrasounds were conducted during prenatal visits and periodontitis classified as ≥3 areas from non-similar teeth showing loss of clinical attachment of ≥4 mm. 47 of the study subjects had maternal periodontitis and of these, 17 delivered neonates with low weight at birth.

Gravid Caucasian ladies receiving antenatal care who were of the age group 14-39 years were enrolled in a cross sectional study by Marin et al., (2005) to evaluate the association between infant birth weight and periodontal disease. Bacterial plaque, depth of the periodontal pocket, bleeding upon probing and level of clinical loss of attachment were used to classify three groups, a gingivitis category, a periodontitis category and a healthy category. Weight at birth was measured after delivery. Of the mothers who delivered term babies, 3.5% had low birth weight neonates. Of those who delivered preterm, 25% had neonates with low weight at birth. Among participants greater than 25 years old, neonatal mean weight in the healthy group was (3588.33+/-531.83) being lower in the gingivitis group (3466.75+/-334.45) and even lower in the periodontitis group (3092.60+/-592.94). Statistically, bleeding upon probing was higher in ladies who had neonates weighing below 2500grams than those weighing between 2500 and 3499 grams. The findings led to the conclusion that in gravid Caucasian women aged above 25 years, periodontal disease was related to reduced neonatal weight at birth.

In a research study of 500 gravid Malay ladies, Saddki et al., (2008) demonstrated that 232 participants had periodontitis and of these, 33 delivered a neonate with low

weight at birth. 240 participants did not have periodontitis and 8 of them had a low birth weight neonate. Periodontitis was defined as presence of bleeding on probing and ≥4 areas with periodontal pocketing greater than or equal to 4 mm, and loss of attachment clinically ≥3 millimeters on the same area. They concluded that gravid ladies diagnosed with periodontitis pose a statistically significant greater risk of delivering neonates with low neonatal weight at birth.

Nuamah and Annan (1998) conducted a study to assess oral hygiene status and status of the periodontium in gravid and non-gravid women at Korle-Bu teaching hospital. The WHO standardized oral health assessment form was used to classify the one hundred gravid women attending prenatal clinic and aged between sixteen and forty-five age of years as well as an additional one hundred non-gravid women recruited in the study. Periodontitis in this study was classified through the community periodontal index for treatment needs. Gravid ladies were all in trimester two and three of pregnancy and among all the age groups assessed, gingival bleeding was found to be worse among the gravid participants (89%) than the non-gravid participants (61%). The average number of sextants with bleeding from the gum in second trimester participants was found to be high-greater than three sextants, regardless of the method used to practice oral hygiene. In gravid participants, average number of sextants with healthy periodontium was found to be 1.55 for the second trimester participants and 2.73 for the third trimester while for the non-gravid women the average was 3.78. Sextants with bleeding on probing among the participants in second trimester were 3.20, for third trimester 1.96 and 0.698 for the non-gravid women. The study showed that markers of periodontitis are higher in gravid than non-gravid women and gingival bleeding during pregnancy is worse in the second trimester than the third irrespective of method used to practice oral hygiene.

A prospective study on 1313 gravid women was conducted by Jeffcoat et al., (2001) to evaluate whether chronic periodontal infection is a risk factor for preterm births. The participants had behavioral and medical assessments as well as complete periodontal examinations conducted between gestation week 21 and 24, Neonatal gestational age at birth was recorded after delivery. Association between periodontitis and premature birth was calculated after adjusting for confounding factors such as parity status and smoking. Mothers diagnosed with generalized or severe periodontal

disease had 4.45 times risk of preterm low neonatal weight at birth and the risk was greater with increasing prematurity-less than 32 weeks of gestation. Periodontitis between week 21 and 24 of gestation was found to be positively related with preterm low birth weight.

Cruz et al., (2009) conducted a case control research study among 548 mothers who had delivered within six weeks to evaluate the contribution of maternal periodontitis to low neonatal weight at birth. Of the five hundred and forty-eight participants, 384 had delivered neonates with normal weight and these participants were grouped as controls. 164 participants had delivered neonates with low weight at birth and they were grouped as the cases. Information on other exposures for example alcohol consumption and tobacco smoking was obtained from interviews and antenatal cards. Periodontitis in this study was classified as presence in one or more sites of loss of clinical attachment ≥3mm, depth of probing ≥4mm and bleeding on probing on at least four teeth. 30% of the participants in the control group were found to have periodontitis while 42.7% of the cases were diagnosed with periodontitis. A statistically significant relationship existed between maternal periodontitis and low neonatal weight at birth in participants with low level of education.

Khader and Ta'ani (2005) carried out meta-analysis through three prospective studies and two case control studies to assess role of periodontitis in being a risk factor for low neonatal weight at birth and premature birth. All five studies were assessed on the outcome and exposure being measured, the design, sample chosen and its characteristics, confounding factors and how they were controlled. The results showed that as regards preterm birth periodontal disease in gravid mothers contributed to an adjusted risk of 4.28 times the risk for mothers with healthy periodontium and 5.28 times the risk for low birth weight. Maternal periodontitis was found to cause a significant increase in risk of neonates with low birth weight or preterm birth.

Periodontitis was established as an independent risk factor for adverse outcomes of pregnancy particularly premature birth and restricted fetal growth among middle class women. The prospective study carried out by Pitiphat et al., (2008) on 1635 medically insured women who had oral radiographs done at trimester two to validate periodontal disease that was diagnosed by means of self-reporting and outcomes of pregnancy

obtained from medical records found that 3.8% of the participants had periodontitis while 5.4% had restricted fetal growth, 6.4% delivered prematurely and 11% were both premature and growth restricted.

Buduneli et al., (2005) conducted a case control among post-partum mothers from low socio-economic background to evaluate periodontitis in pregnancy and premature low neonatal weight at birth. Post-partum mothers were assessed three days' post-delivery and an aggregate of 181 participants recruited in the research study with 128 being controls and fifty-three being cases. Periodontitis was diagnosed clinically through recording the depth of the periodontal pocket, recession of the gingival and dental plaque on six sites per tooth. In addition, DNA hybridization was conducted using plaque samples from below the gingival collected using paper points from the disto buccal and mesio buccal surfaces of randomly chosen incisor and first molar. Bacterial species scores from every individual sample were averaged. Though the values of clinical parameters used to assess periodontitis were almost similar in the cases and controls, the cases had significantly less increase in weight than the controls. Campylobacter rectus, Fusobacterium nucleatum, Peptostreptococcus micros, S. intermedius, Selenomonas noxia, Eikenella corrodens and P. intermedia were all greater in the cases than the controls. Campylobacter rectus and Peptostreptococcus micros statistically increased the chances of premature low neonatal weight at birth ($p<0.05$ and $p<0.01$ respectively). Actinobacillus actinomycetemcomitans, Porphyromonas gingivalis, Streptococcus intermedius, Prevotella intermedia and Prevotella nigrescens were all found to be greater in the controls as opposed to the cases. Actinobacillus actinomycetemcomitans and Prevotella nigrescens were found to be protective and decreased risk of premature low neonatal weight at birth.

Marakoglu et al., (2008) concluded that bacterial vaginosis and periodontitis were independent factors for premature low neonatal weight at birth through research to assess whether periodontal disease was a risk factor for delivering neonates with low weight at birth. The study involved a total of 48 participants with 20 of the participants having delivered preterm low birth weight neonates and was conducted at the faculty of dentistry, university of Cumhuriyet and had the mothers undergo mouth panoramic radiographs and full periodontal examinations. Periodontal pocket depth

and loe and sillness gingival index were used to classify periodontitis in the study. Poor periodontal health of the expectant woman was found to be a probable risk factor for adverse outcome of pregnancy in particular preterm low birth weight.

Alves and Ribeiro (2006) conducted research with the aim of determining the oral health status of gravid women and evaluating if there was any correlation between low neonatal weight at birth and periodontitis. 59 pregnant women were recruited and out of these 40 had normal weight neonates and 19 had premature low birth weight neonates. Mothers who gave birth to preterm low neonatal weight at birth neonates had an increased rate of maternal periodontitis which was diagnosed within 48 hours of delivery. They concluded that for this particular sample a positive relationship existed between low neonatal weight at birth and periodontitis in pregnancy.

A cross sectional research study carried out by Sánchez et al., (2007) to examine if there was a correlation between characteristics of the infant at birth and periodontal conditions in gravid women saw one hundred and thirteen pregnant women complete a questionnaire and have thorough periodontal and dental examinations conducted. Calculus index (CI), bleeding on probing (BOP), Probing depth (PD) and loss of clinical attachment (CAL) were utilized in categorizing 3 sub-sets. A healthy periodontium category, a gingivitis category (> or = 25% of sites with BOP) and a periodontitis group (having 2 or greater than two teeth with 1 or greater than one site having loss of clinical attachment > or = 3 millimeters and periodontal pocketing depth > or = 4 mm on a similar area). Those with complications related to pregnancy were excluded. Premature low neonatal weight at birth was defined as single live or miscarried birth with a neonate weight of < 5.5 pounds and having been delivered at < 37 weeks of gestation. The prevalence of gingivitis in this population was 54% while the prevalence of periodontitis was 23.9%. Prevalence of premature low neonatal weight at birth weight neonates for the healthy periodontium group was 13%, 19% in the category for periodontitis and 7% in the category for gingivitis. The study concluded that moderate relationships existed between infant birth weight and maternal periodontal conditions.

A prospective cohort study conducted in a community based in Mbale Eastern Uganda by Wandera et al., (2012) to determine if indicators of periodontal health in

gravid women at seven months gestation was associated with the anthropometric status of the infant post-delivery had seven hundred and thirteen gravid women recruited and undergo a complete periodontal examination using the simplified oral hygiene index and the community periodontal index of treatment needs. Of the 713 gravid ladies, 593 were followed up to assess anthropometric status of their neonates three weeks post-delivery. 12.1% of the participants were found to have poor oral hygiene, 65% had symptoms of periodontitis while a total of 67% were diagnosed with periodontitis. 6.9% of the neonates were found to be underweight while 2% were wasted. Information regarding oral health and socio demographic factors was found to be associated with indicators of oral health in gravid women in the studied population. Neonates at three weeks post-delivery whose mothers were diagnosed with periodontitis had worse height for age status than those whose mothers were found to have healthy periodontium.

A research study by Haerian-Ardakani et al., (2013) found that areas in the oral cavity diagnosed with periodontitis were 1.6 times more in mothers who had delivered low neonatal weight at birth neonates than controls. Participants who delivered low neonatal weight at birth neonates also had deeper periodontal pockets and less healthy areas of the gum. Preterm deliveries were excluded. 88 post-partum women had periodontal examinations conducted within 72 hours of delivery. Results showed that half of the women had neonates with normal weight at birth and the remaining half had neonates with low weight at birth. They established that periodontitis in gravid women is a probable risk factor for low neonatal weight at birth.

Periodontitis during pregnancy may be positively related with elevated risk of adverse end result of pregnancy. This was concluded in a systematic review conducted by Xiong et al., (2006) to ascertain whether the postulations that presence of persistent and subclinical infection from periodontitis may lead to stimulation of an inflammatory response that elevates chances of adverse end results of pregnancy. The review included published prospective, case control, cross sectional research studies as well as randomized and non-randomized trials. Eighteen of the twenty-five studies in the review found that there existed a relationship between poor end results of pregnancy and periodontitis while three of the studies demonstrated a 50% reduction in premature births and a 57% reduction in premature low neonatal weight at birth due

to periodontal therapy. Seven out of twenty-five studies found no association between periodontal disease and poor pregnancy outcomes.

Moreu et al., (2005) carried out a research study on ninety-six gravid women to examine contribution of a mother's periodontal status during pregnancy on adverse delivery outcome in particular premature low birth weight. The participants had probing depth, gingival inflammation and plaque scores assessed in their first, second and third pregnancy trimesters. Of the ninety-six participants, seven of the women had miscarriages all of which occurred in trimester two of pregnancy. Eighty-nine live neonates were delivered and of these sixteen were premature and seven were premature neonates with low weight at birth. A statistically significant association was found between probing depth especially in sites greater than 3mm in depth and low neonatal weight at birth. No statistical relationship was found between periodontitis measurement indicators and age of gestation at birth. It was thus concluded that periodontitis is a risk factor for low neonatal weight at birth but not for premature delivery.

In a study of 3576 Turkish women with the goal of assessing their status of oral health in relation to poor pregnancy outcomes, Toygar et al., (2007) divided the participants into 3 groups and found that there were increased low birth weight deliveries in the groups that had increased periodontal treatment needs.

Ide and Papapanou (2013) conducted a study to assess the epidemiology of relationship between adverse outcomes of pregnancy and periodontitis in pregnancy. The systematic review involved multiple databases in different languages based on case control, prospective and cross-sectional research studies that had explored the association between premature birth, preeclampsia and low neonatal weight at birth with periodontal disease in pregnancy. The variables that measured outcome included miscarriage and the neonate being small for gestational age. The sample consisted of mothers assessed pre-nataly and post-nataly and those with healthy periodontium as well as those with periodontitis. All studies in this review had taken into consideration confounding factors and modes of additional exposures. The review showed that despite the publications included having heterogeneity; periodontitis in pregnancy is

modestly but significantly associated with premature birth and low neonate weight at birth.

2.3.2 Studies that found a relationship between low birth weight and moderate or severe periodontitis

According to the clinical characteristics by the centers for disease control working group for use in assessment of periodontitis in the population, severe periodontitis occurs where there are two or greater than two interdental areas with loss of clinical attachment ≥6 mm, not on the same tooth, and one or greater than one interdental areas with probing depth ≥5 mm while moderate periodontitis occurs where there are two or more interdental areas with loss of clinical attachment ≥4 mm, not on the same tooth, or two or greater than two interdental areas with periodontal probing depth ≥5 mm, not on the same tooth. The use of interdental areas in diagnosis is because the disease commences and tends to be worst off at interdental areas and interdental areas reduce the interference of recession of the gum line on correctly measuring the depth of the pocket.

A research study was done by Kawar et al., (2016) to evaluate if there existed correlation between premature birth and neonatal low weight at birth with periodontitis. 59 mothers in the delivery ward had full mouth clinical examinations conducted and their data collected about confounding factors e.g. pregnancy complications, infections and number of previous pregnancies etc. It was found that 79% of the subjects with moderate and severe periodontitis had low birth weight neonates who were preterm. Moderate and severe periodontitis in this research was diagnosed when ≥ 10% of the areas measured ≥ 5 mm periodontal probing depth. A positive relationship was established between neonatal low weight at birth and periodontitis.

A prospective study conducted within a 5 year period by Offenbacher et al., (2001) to assess association between obstetric outcomes in particular growth restriction and premature birth with periodontitis in pregnancy had women who had not yet reached gestation week 26 enrolled and receive full periodontal examinations at that gestation period as well as within 48 hours of postpartum. Participants were thus assessed for periodontal changes during pregnancy as the exposure and classified into three

categories- moderate/severe periodontitis, mild periodontitis and healthy periodontium. Among the confounding factors that were controlled for was chorioamnionitis and previous premature birth. Findings demonstrated that periodontitis was positively related with high prevalence of low neonatal weight at birth and premature birth. Among participants with moderate to severe periodontitis the unadjusted prevalence of premature birth was 11.1%, while in those with healthy periodontium it was 1.1%. For low neonatal weight at birth, none of the mothers with healthy periodontium delivered neonates weighing less than 1000g while 11.4% participants diagnosed as having moderate to severe periodontitis and 6.1% diagnosed with mild periodontitis delivered neonates below 1000g. This same pattern was experienced in mothers diagnosed with ante partum periodontitis.

A multi-centered prospective research was done by Sharma et al., (2007) to establish whether mothers who had maternal periodontitis in the Fiji islands delivered neonates who were premature or had low weight at birth. They carried out oral examination on 670 women. Confounding factors for example medical illnesses, participant's age, smoking tobacco and consumption of alcohol were identified through interviewing the participants. Data collected showed that greater than half of this group suffered from moderate to severe periodontitis and there existed greatly significant correlation between premature delivery, low weight at birth and periodontitis

Chokkaiyan et al., (2017) found that there exists an association between premature birth, neonatal low weight at birth and periodontitis. They conducted a Case Control Study in Mahatma Gandhi Medical College and Research Institute where 200 mothers were recruited in the study with 100 mothers in each category (controls and cases). Periodontal measurements used were plaque and bleeding indices, periodontal pocket depth and loss of clinical attachment. All periodontal parameters were significantly more in cases than controls and evidence of periodontitis was seen in 86% of the cases

Offenbacher et al., (2001) sought to establish the correlation between poor outcomes of pregnancy and maternal periodontitis in particular premature birth and growth restriction. 812 pregnant women at gestation stage of <26 weeks were recruited and

had clinical mouth examinations and medical interview conducted at enrollment and post giving birth. Periodontitis was diagnosed as:

-Mild periodontitis- more disease than the oral health category but lesser than moderate and severe categories.

-Moderate to severe periodontitis categorized by> 4 sites with minimum 5 mm PD and 2 mm loss of clinical attachment at ≥4sites

-Oral health was defined as lack of probing depth >3 mm and lack of areas with loss of clinical attachment >2 mm.

5.5% of the participants were diagnosed as having moderate to severe periodontal disease while 18 neonates were premature and thirteen had low neonatal weight at birth. They concluded that periodontitis has a statistically significant role in risk for neonatal low weight at birth and PB.

2.3.3 Studies that did not find association between maternal periodontitis and low birth weight

In contrast to the above listed studies some studies failed to find association between maternal periodontitis and low birth weight. Mafi et al., (2016) carried out a research study to investigate the relationship between periodontitis in pregnancy and poor outcomes of Results showed that clinical characteristics of periodontitis (bleeding upon probing and loss of clinical attachment) were elevated in the controls than cases. Following these results, they resolved that in that particular sample periodontitis was not a risk factor for premature neonates or neonates with low neonatal weight at birth.

In a research study of non-smoking gravid ladies at gestation week twelve, Moore et al., (2006) demonstrated that there was no relationship connecting poor health of the periodontium and low neonatal weight at birth or premature birth. The participants had their medical, demographic and behavioral data collected and periodontal examinations conducted. Upon delivery, data on their delivery outcome was recorded. Though there was no relationship between premature birth and low neonatal weight at birth and periodontitis, a relationship existed between periodontitis and miscarriage in the late gestational weeks.

Bassani et al., (2007) carried out research with the objective of measuring the relationship of periodontal disease in pregnancy with low neonatal weight at birth. They reported a crude relationship linking intra-uterine restriction of growth and moderate periodontitis but no significant association linking outcomes of pregnancy and periodontal disease.

Maternal periodontal micro biota and clinical characteristics of periodontitis were not established as being related with having low neonatal weight at birth babies in research by Vettore et al., (2006). Clinical attachment levels in this sample were similar in both cases and controls and probing depth was lower in participants who delivered low birth weight neonates than in controls.

Calabrese et al., (2010) conducted an observational study to determine if there existed an association between preterm low birth weight and periodontitis. Using a sample size of 120 gravid mothers, one periodontologist examined all the mothers and used two thresholds to define periodontitis. 27% of the participants were found to have periodontitis with 17% delivering preterm and 11% delivering low birth weight neonates. 9% delivered pre-term low birth weight neonates. Following statistical analysis, no association was found between poor end results of pregnancy and the two thresholds defining periodontitis.

A prospective cohort study conducted by Ali and Abidin (2012) on 73 gravid women between week 28 and 36 of gestation to evaluate the role of status of the periodontium of women attending prenatal care on end results of pregnancy found that periodontitis was not among the risk factors for low neonatal weight at birth and pre-term births. The participants had complete periodontal examinations conducted to assess clinical loss of attachment, depth of periodontal pocket, gingival index, plaque index and papillary bleeding index. Neonatal birth weight, age of gestation at delivery and complications encountered during delivery were recorded after birth. The cases comprised mothers who delivered both premature and low neonatal weight at birth neonates. From the total 73 participants, 36 did not have periodontal disease while 37 were found to have periodontal disease. Four participants delivered preterm while 3 of the same category delivered neonates with low birth weight. Following statistical analysis, only plaque index was found to be a significant predictor of adverse birth

outcomes. No periodontitis variables were found to be significantly related with low birth weight or preterm birth.

Progression of periodontitis was not associated with elevation in chance of having a premature neonate or one with low neonatal weight at birth Michalowicz et al., (2009). It was found that providing rescue periodontal therapy did not bring a significant change in gestational age among participants with periodontitis that was progressing and those who didn't have significant dissimilarity in mean weight at birth and gestation age at delivery.

2.3.4 Role of periodontal treatment and oral hygiene practices in reducing adverse outcomes of pregnancy.

Research results have demonstrated that treatment of periodontitis can lower the chance of neonatal low weight at birth in mothers diagnosed with maternal periodontitis. A study by Sadatmansouri et al., (2006) found that inclusion of the first phase of periodontal treatment(full mouth scaling) on pregnant women diagnosed with periodontitis decreased the occurrence of PTLBW deliveries.

López et al., (2002) demonstrated maternal periodontitis as independent risk factor for low neonatal weight at birth and periodontal treatment decreases the occurrence of low birth weight deliveries that are preterm. The study involved 400 women where half of them had periodontal therapy prior to gestation week 28 and the other half had periodontal treatment post-delivery. The data demonstrated that maternal periodontitis was the greatest factor related to delivery of neonates with low neonatal weight at birth as well as premature birth.

Meta-analysis carried out by George et al., (2011) to evaluate effect of treatment of the periodontium during pregnancy on birth outcomes in particular neonatal low birth weight and premature birth involved randomized control trials that compared outcomes of pregnancy between gravid ladies who received treatment of the periodontium in the period of pregnancy and those who had not. A total of 10 studies with an overall sample size of 5645 participants that had be published or were currently in progress were assessed and the data extracted then analyzed. Periodontal treatment was found to significantly lower low birth weight and premature births

though no significant difference was found regarding still births or spontaneous abortions. Mothers who had experienced previous low birth weight or premature deliveries and undergone periodontal treatment were found to have less severe periodontal disease and lower rate of adverse outcomes of pregnancy in subsequent births.

Tarannum and Faizuddin (2007) conducted a study to evaluate the role of non-surgical treatment of the periodontium on outcomes of birth in gravid women diagnosed with periodontal disease in particular premature birth-less than 37 weeks gestation and low neonatal weight at birth. Two hundred gravid women who had been diagnosed as having periodontal disease were enrolled in the research study and had complete full mouth examinations of the periodontium conducted including clinical attachment loss, oral hygiene simplified index and bleeding index. The ladies were randomly categorized in two categories, a treatment group which received non-surgical treatment in form of full mouth scaling, polishing and root planning all done under local anesthesia during the pregnancy period and a control group which had the same periodontal therapy procedures done but after giving birth. The participants in category for treatment also had instructions on control of plaque. For the premature births, sixty-eight of the participants in the control group delivered neonates before 37 weeks of gestation while fifty-three in the treatment group had premature births. Mean gestation age in controls was (32.7+/-2.8) weeks while in those who received treatment (33.8+/-2.8 weeks). For neonatal low weight at birth, forty-eight low birth weight neonates were delivered in the control group while the treatment group registered twenty-six. Mean birth weight controls were (2,459.6+/-380.7 g) while in the treatment group it was (2,565.3+/-331.2 g). Following multiple regression analysis, non-surgical periodontal treatment caused a decreased risk for low neonatal weight at birth and premature birth in gravid women diagnosed with periodontitis.

A randomized controlled trial involving 870 gravid ladies diagnosed with early periodontal disease in the form of gingivitis was conducted by López et al., (2005) to examine if periodontal treatment -full mouth scaling, polishing and control of plaque reduced occurrence of premature and low neonatal weight at birth in mothers diagnosed with pregnancy gingivitis. The participants were recruited while receiving antenatal care and randomly distributed into two groups; one group had periodontal

therapy done before week 28 of gestation while the other group had periodontal therapy done post-delivery. Daily rising with a chlorhexidine-based mouthwash, scaling, polishing and control of plaque constituted periodontal therapy while maintenance therapy involved reinforcing instructions on oral hygiene after each two to three weeks and removal of supragingival plaque on a need basis. Following regression analysis, gravid women who received periodontal therapy demonstrated a lower risk of premature birth and low neonatal weight at birth than those who were diagnosed with gingivitis. In addition, the incidence of premature birth and low neonatal weight at birth was lower in the category that received treatment of the periodontium being 2.14% as compared to 6.71% in the control group. The authors thus concluded that premature birth and low neonatal weight at birth were significantly reduced by periodontal therapy and gingivitis in gravid women was found to be among the risk factors for poor pregnancy outcomes.

Bobetsis et al., (2006) concluded that a more preventive approach in treatment of periodontitis is needed to avoid adverse birth outcomes in mothers diagnosed with periodontitis. Mothers should have periodontal therapy in the form of scaling and polishing initiated prior to conception for maximal benefit to the unborn baby and gravid mother. Periodontal treatment done in the final and second trimesters may not decrease occurrence of adverse birth outcome in mothers diagnosed as having periodontitis.

In a clinical trial by Tarannum and Faizuddin (2007) to evaluate if periodontal treatment had an effect on the pregnancy outcome in women diagnosed with maternal periodontitis, the study subjects in the treatment category had periodontal treatment before delivery while the participants in the non-treatment category had periodontal therapy post-delivery. Study subjects in the treatment group demonstrated a decrease in poor outcomes of pregnancy.

2.4 Conceptual framework

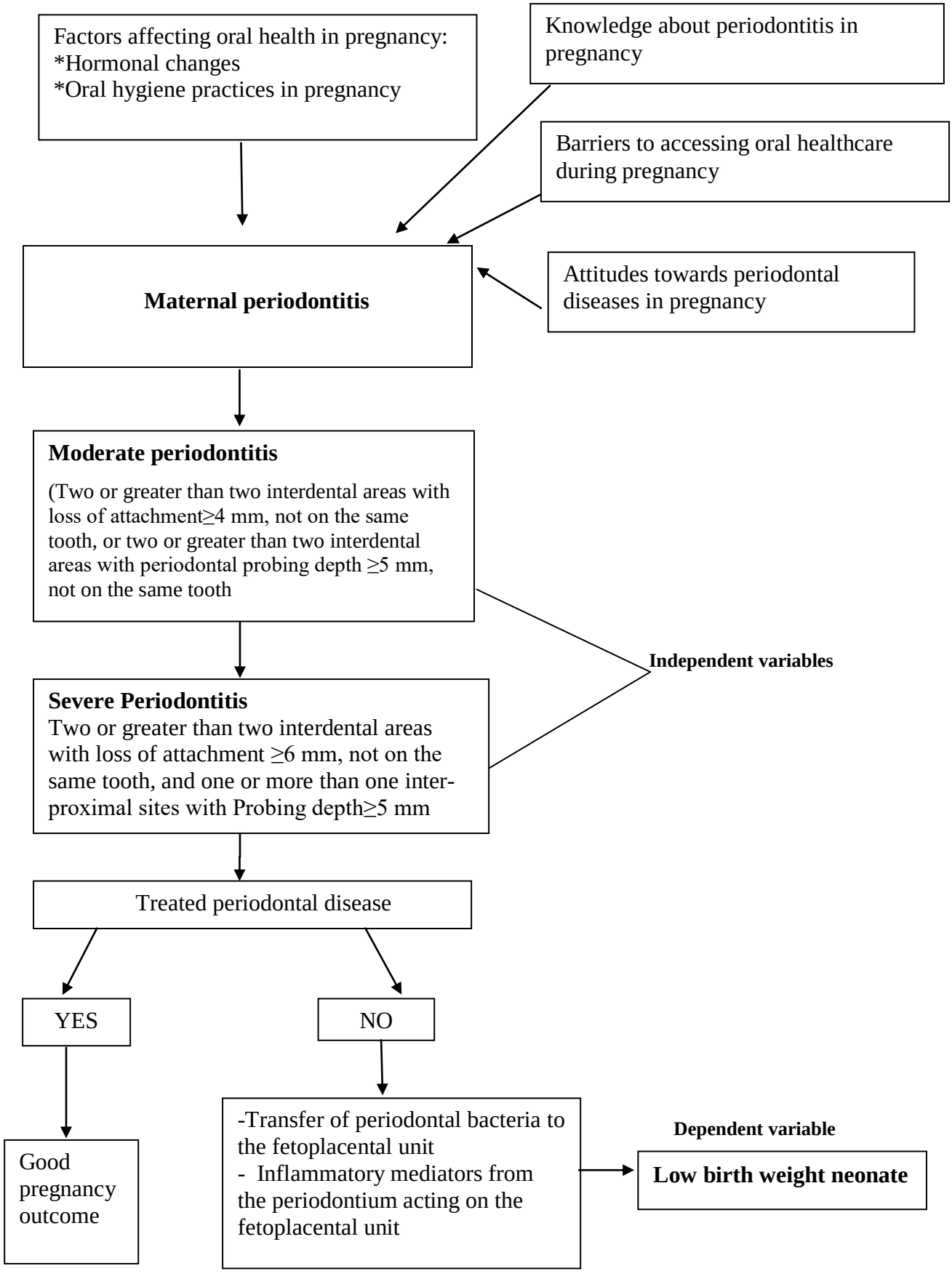
Pregnancy is characterized by changes in the body that are both physiological and physical and these have an impact on most of the body's organ systems, including the mouth. The elevation of hormones in pregnancy in particular progesterone and estrogen causes reduced immune-competency of the host and the blood vessels of the

oral cavity become more permeable. This results in an increase in the chance and degree of oral inflammation as a reaction to chemical, bacterial and physical irritations (Tilakaratne et al., 2000).

Periodontitis during pregnancy affects the mother and may also bring adverse effects to the fetus if no treatment is instituted. Research studies have demonstrated that periodontitis in pregnancy may increase the chance of poor outcomes of pregnancy like low birth weight and preterm birth. Periodontal treatment (full mouth scaling and root planning) may decrease the chance of these poor pregnancy outcomes.

Figure 2.2

Conceptual Framework



CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Introduction

This chapter consists of the target population, the design of the research, sampling procedure, instruments of collection of data and the method of analysis of data.

3.2 Research design

The research adopted a cross sectional study using medical records and clinical dental examinations of post-partum mothers in Kiambu County. To qualify for the study, a post-partum mother must have given birth in the last 48 hours, and must have delivered a neonate with low weight at birth. The study subjects were clinically examined for maternal periodontitis using the clinical case definitions proposed by the centers for disease control and prevention (CDC) working group for use in assessment of periodontitis in the population. Data on birth weight was obtained from the medical records

3.3 Target population

The target population was post-partum mothers aged 18-50 years who delivered in the county of Kiambu. Kiambu is a county in the former Central Province of Kenya. Kiambu county has 12 sub counties; these are; Thika Town, Ruiru, Juja, Kiambu Town, Kiambaa, Githunguri, Limuru, Lari, Kikuyu, Kabete, Gatundu South, Gatundu North. Kiambu County is estimated to have a population of 1,623,282. Males account for 49% of the population and females 51% (Population and housing census, 2009). The sample was drawn from the three level five hospitals (Thika, Kiambu and Gatundu), and two level four hospitals (Ruiru and Tigoni) in the county. The choice of these particular hospitals was due to the number of deliveries that are recorded in each hospital per day. The choice of Kiambu County was based on Statistics et al., (2015) where it was estimated that 90% of the neonates delivered in Kiambu County are delivered in a health facility. In addition, LBW was estimated at 5.5% in Central region in 2009 and 9.2% in 2014 showing a 3.7% increase in the region in 5 years.

Figure 3.1

Map of Kiambu County

©County government of Kiambu, 2018

Inclusion criteria

Post-partum mothers who delivered a neonate with low weight at birth regardless of method of delivery.

Post-partum mothers who had delivered within the last 48 hours

Post-partum mothers aged 18-50 years

Mothers who had a singleton pregnancy

Post-partum mothers who consented to the study.

Exclusion criteria

Preterm deliveries.

Mothers on antibiotic prophylaxis

Mothers with medical conditions

Mothers who had multiple pregnancies (twins, etc.)

Maternal short stature- height of the mother 145cm and below

Mothers diagnosed with poor pre-pregnancy nutritional status

Mothers diagnosed with uterine pathologies-e.g. uterine fibroids and müllerian duct abnormalities

Mothers who smoked cigarettes or practiced tobacco use in the pregnancy period

Mothers who consumed alcohol during pregnancy.

3.4 Sampling procedure and sample size determination

Kiambu County has three level-five hospitals namely, Thika level five hospital, Kiambu level five hospital and Gatundu level five hospital. There are ten level IV hospitals. The sample was drawn from the three level V hospitals and two level IV hospitals namely Ruiru level IV hospital and Tigoni level IV hospital. Convenience sampling was done. All participants who delivered neonates with low weight at birth at the maternity wards of the five hospitals, who fit the inclusion criteria and consented to the study, were recruited. 100 participants were recruited in Thika level five hospital, 96 in Kiambu level five hospital, 45 in Gatundu level V hospital, 50 in Tigoni level IV hospital and 93 in Ruiru level IV hospital. This was as per the number of deliveries recorded per day in each hospital.

Using Cochran (1977) formula for prevalence in cross sectional studies when the study population is 10000 or above, the desired sample size was thus determined as follows:

$$n = \frac{z^2 \times p\,(1-p)}{c^2}$$

n = desired size of sample

z = confidence level at 95% (standard value of 1.96)

p = the proportion in the population estimated to have the characteristics being measured when the prevalence is not known (50%)

c = margin of error at 5% (standard value of 0.05)

$$n = \frac{1.96^2 (0.5) (0.5)}{0.05^2}$$

=384.16

=384

3.5 Instrumentation

Post-partum mothers were screened using a screening form. Those who met criteria for exclusion were not included. A thorough brief of the study was given to participants who fulfilled the criteria for inclusion. Mothers who consented to being enrolled in the research study were required to fill and append their signatures on a form for consent.

Data on socio-demographic characteristics and oral hygiene practices was gathered using a structured questionnaire that was filled by the main investigator and trained research assistants. The participants' periodontal status was measured and recorded on a clinical examination form. A Community Periodontal probe (WHO recommended) and a mouth mirror were used.

3.6 Methods of data collection

All clinical examinations in this research were conducted using standardized clinical dental instruments. Informed consent was sought from the study participants prior to conducting the examinations. Mothers were examined within 48 hours of post-partum. Subjects were examined while lying supine on a bed with head to the foot of the bed using artificial white light. This was to ensure that the examination position was reproducible in all participants.

The WHO recommended community periodontal probe was used to record the following variables:

i. Recession-The measurement from the height of the free margin of the gingiva up to the cement- enamel junction, measured in millimeters.

ii. Pocket depth-the measurement from the height of the free margin of the gum to the most apical position of the tooth pocket

iii. Clinical attachment loss (CAL)-This is the value that results from adding recession to pocket depth.

All measurements were done on the interproximal sites of the teeth and were in millimeters. All the teeth excluding the third molars were examined. Two categories were provided for periodontitis: moderate and severe periodontitis. Severe periodontitis was classified as two or greater than two interproximal areas with loss of clinical attachment ≥6 mm, not on the same tooth, and one or greater than one inter-proximal sites with probing depth≥5 mm. Moderate periodontitis was classified as two or greater than two inter-proximal areas with loss of clinical attachment ≥4 mm not on the same tooth, or two or greater than two inter-proximal areas with probing depth ≥5 mm not on the same tooth.

Table 3.1

Clinical Case Definitions Proposed by the CDC Working Group for Use in Population-Based Surveillance of Periodontitis

CLINICAL DEFINITION			
DISEASE CATEGORY	Clinical attachment loss		Periodontal probing depth
Severe Periodontitis	≥2 inter proximal areas with CAL ≥ 6 mm (not on same tooth)	And	≥1 inter proximal area with probing depth ≥5 mm
Moderate Periodontitis	≥2 inter proximal areas with CAL ≥ 4 mm (not on same tooth)	Or	≥2 inter proximal areas with probing depth ≥5 mm (not on same tooth)
No periodontitis	Neither moderate nor severe periodontitis.		

Note. Third molars are excluded

The outcome of pregnancy focused on in this research study was neonatal weight at birth which was measured in grams. LBW in this research study was as per the definition of the World Health Organization- weight at birth which is less than 2500g despite the pregnancy duration. The neonatal birth weight was obtained from the medical records and had been measured using a digital infant weighing machine within one hour upon delivery.

Maternal socio-demographic characteristics recorded included age, employment status, marital status and education level, the parity status of the mother was also recorded. Mothers were classified into multiparous or primiparous categories.
The principal investigator and trained research assistants completed the structured questionnaire with the participants' socio-demographic information and oral hygiene practices. The clinical examination form was a stand-alone form.

3.7 Pre-testing

The questionnaires were pre-tested, inspected, scrutinized and cross-checked to ensure completeness, uniformity, accuracy, consistency and relevance of collected data. All data collection tools were pretested at Wangige and Juja health centers.

3.8 Operational definition of variables

Independent (exposure) variables:
Severe periodontitis- two or greater than two interdental areas with loss of clinical attachment ≥ 6 mm that are not on the same tooth, and one or greater than one interdental areas with probing depth ≥ 5 mm.
Moderate periodontitis- two or greater than two interdental areas with loss of clinical attachment ≥4 mm that are not on the same tooth, or two or greater than two interdental areas with probing depth ≥ 5 mm that are not on the same tooth
No periodontitis - neither severe nor moderate periodontitis.
Dependent (outcome) variables:
Neonatal weight of less than 2500g
Socio-demographic variables:
Age – number of years

Education level- highest level of education

Marital status- Married or not married

Parity status- Primiparous (having given birth for the first time)

-Multiparous (having experienced one or more previous childbirths).

3.9 Method of data analysis

Prior to filtering responses, questionnaires that had been completed underwent editing to ensure consistency and completeness. Data from the questionnaire, the participant screening forms and clinical examination form was then coded to facilitate grouping of responses into categories. Descriptive statistics for example percentages were used to analyze data. Quantitative method was utilized for analyzing the closed-ended questions where a computer application (SPSS software Version 23) was utilized. To ease analysis and understanding of data, figures and tables were used for presentation of data. Responses were summarized to enable comparison and more critical analysis Quantitative data was analyzed using Pearson correlation and simple linear regression. The simple linear regression model utilized was as follows;

$Y= \beta 0+ \beta 1X+ e$

Where,

Y: the dependent variable (low birth weight) expressed as a linear combination of independent variable X

$\beta 0$: The regression constant i.e. $Y = \beta 0$ when $X= 0$

$\beta 1$: Coefficient of maternal periodontitis (independent variable X)

e: Error term

Analysis of linear regression was utilized to estimate coefficients of a linear equation and the independent variable that best predicts value of Y. Out of the model, significance test at 5% level of significance was conducted on the variables using coefficient of determination (R^2), correlation coefficient (R), F-test and ANOVA table to assess significance of analyzed data.

3.10 Ethical consideration

The study was approved by the Kenya Methodist University Scientific and Ethics Review Committee (KEMU/SERC/PHT/17/2019), National Commission for Science, Technology and Innovation (NACOSTI/P/19/84005/29033) and Kiambu County government (KIAMBU/HRDU/AUTHO/2019/05/10/GichukiRN). Informed consent was sought from all the mothers before commencing the research study.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter contains the results of data analysis and provides explanation, description and interpretation of the data collected. The chapter presents background information of the participants and data analysis findings based on objectives of the study. Descriptive statistics have been utilized in discussing findings of the study.

4.2 Incidence of maternal periodontitis in post-partum women who delivered a low birth weight neonate within 48 hours in Kiambu County

384 participants were recruited in this study. 100 post-partum mothers were recruited from Thika level five hospital, 96 from Kiambu level five hospital, 45 from Gatundu level five hospital, 50 from Tigoni level IV hospital and 93 from Ruiru level IV hospital. 353(92%) of the study participants were found to have maternal periodontitis with 202(52.7%) having severe periodontitis, 151(39.2%) moderate periodontitis and 31(8.1%) did not have periodontitis. Kiambu County is in line with the Kenya National Oral Health Survey 2015 where it was found that periodontal diseases affect more than 95% of the adult population in Kenya with gingival inflammation affecting 97.7% of the females in Kenya.

Figure 4.1

Incidence of Maternal Periodontitis in Kiambu County

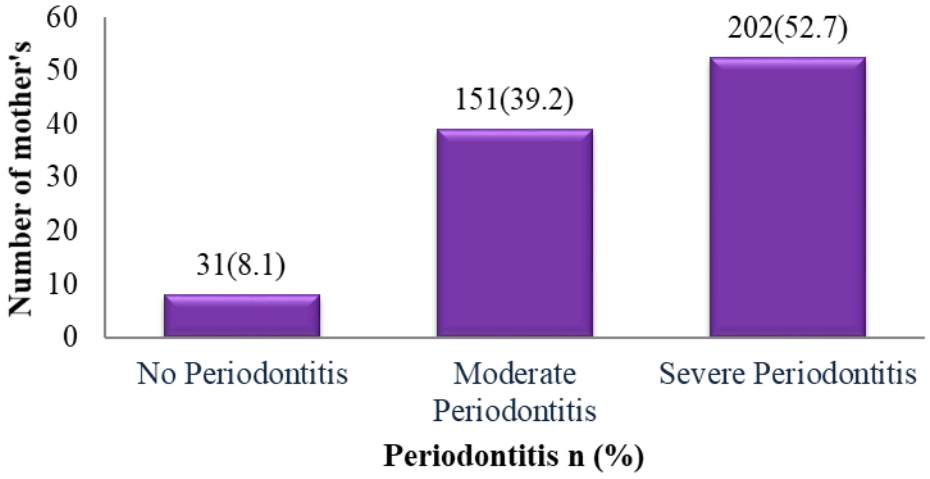


Table 4.1

Study Areas and Periodontitis Severity

		No Periodontitis	Moderate Periodontitis	Severe Periodontitis	Total
Area	Gatundu	4 (8)	9(20)	32(70)	45
	Kiambu	6 (6)	43(45)	47(49)	96
	Ruiru	6 (6)	35(38)	52(56)	93
	Thika	11(11)	42(42)	47(47)	100
	Tigoni	4 (8)	22(44)	24(48)	50
Total		**31**	**151**	**202**	**384**

From the findings, Ruiru registered the highest number of participants with severe periodontitis (52) followed closely by Thika and Kiambu where both hospitals had 47. Tigoni registered the least cases of severe periodontitis (24). Of the 151 mothers found to have moderate periodontitis, Kiambu (43) and Thika (42) registered the highest cases while Gatundu had the least (9).

Table 4.2

Study Area Chi-Square test

	No Periodontitis	Moderate Periodontitis	Severe Periodontitis	Test	Df	p Value
Gatundu	4 (8)	9(20)	32(70)	χ^2=11.49	8	**0.175**
Kiambu	6 (6)	43(45)	47(49)			
Ruiru	6 (6)	35(38)	52(56)			
Thika	11(11)	42(42)	47(47)			
Tigoni	4 (8)	22(44)	24(48)			

The stages of periodontitis were not related to the area of residence of the participants as shown in the table 4.2. The results indicated an insignificant relationship.

4.3 Socio-demographic characteristics and parity status

Majority of the mothers 218 (56.9%) were aged between 26 to 30 years. More than half 246 (64.2 %) of the participants were married whereas 138(35.8%) of the mothers were not married. 219 (57.1%) of the post-partum women had received secondary education, 150 (39%) had reached up to primary level, 12 (3.1%) had advanced beyond secondary school while 3 (0.8 %) had no formal education. Most of the respondents 315 (82.1%) were unemployed while only 69 (17.9%) were employed. As regards the status of parity, 190 (49.6%) of the participants had previously given birth to 1 or 2 neonates, 178 (46.2%) were first time mothers while 16 (4.2%) had delivered 3 times or more.

Table 4.3

Social Demographic Characteristics and Parity Status

Characteristics	Frequency N=384	Percentage (%)
Age in years		
25 and below	141	36.6
26 to 30	218	56.9
31 to 35	22	5.7
36 to 40	3	.8
Marital Status		
Married	246	64.2
Not married	138	35.8
Education Level		
No education	3	.8
Primary	150	39.0
Secondary	219	57.1
Above secondary	12	3.1
Employments Status		
Employed	69	17.9
Not employed	315	82.1
Number of Previous births		
None	178	46.2
Between 1-2	190	49.6
3 or More	16	4.2
Total	**384**	**100.0**

Table 4.4

Distribution of Periodontitis Severity according to Study Participant's Socio-demographic Characteristics and Parity Status.

	Periodontitis n (%)			**Test**	**df**	**p**
Variable	**No Periodontitis**	**Moderate Periodontitis**	**Severe Periodontitis**			
Age (Years.)				χ^2=12.86	6	**0.045**
25&below	9 (2.3)	49(12.7)	83(22)			
26 to 30	19 (5)	98(26)	101(26)			
31 to 35	3 (0.8)	4(1.04)	15(4)			
Marital Status				χ^2=3.88	2	**0.143**
Married	21(5.4)	104(27)	120(31.25)			
Not Married	10(2.6)	46(12)	82(21.3)			
Highest Education Level				χ^2=17.66	6	**0.007**
Primary Education	7(1.8)	49(12.7)	94(24.4)			
Secondary Education	24(6.25)	92(24)	103(27)			
Employment Status				χ^2=5.91	2	**0.052**
Employed	5(1.3)	36(9.37)	28(7.29)			
Not Employed	26(6.7)	115(30)	174(44)			
Number of Previous births				χ^2=0.853	4	**0.931**
None	14 (3.6)	69(18)	95(25)			
1-2	15 (4)	77(20)	98(26)			
3 & above	2 (0.5)	5(1.3)	9(2.3)			

Mothers aged 26-30 years had more severe periodontitis 101 (26%) than the other age groups. A significant association was found between age and maternal periodontitis (p = 0.045). With a mean child bearing age of 28.84 years in Kenya, the theory by Michaela & Milan, (2011) that increased production of pregnancy hormone stimulates formation of prostaglandin E2, which is pro-inflammatory on periodontal tissue and if the pregnant woman had early stages of periodontitis, progression of the disease to more severe stages is then possible could explain this finding.

Mothers who had reached secondary level of education had higher levels of severe periodontitis 103(27%) than those who had studied beyond secondary level 3(0.8%). There was a statistically significant association linking highest level of education attained and maternal periodontitis (p = 0.007). This was also observed by Boillot et al., (2011) when they concluded that an elevated risk of chronic periodontitis occurs in adults who have attained low levels of education than those with higher levels of education. This effect may be explained by lower education level being correlated to lower IQ, reduced periodontal health awareness and use of dental services, insufficient oral hygiene practices leading to greater accumulation of calculus and plaque, poorer coping strategies and increased smoking.

Participants who were married had more severe periodontitis 120 (31.25 %) than those who were not married 82(21.3%). The unemployed had more severe periodontitis 174 (44%) than the employed 28(7.29%). Participants who were first time mothers and those who had between one and 2 previous deliveries had almost similar levels of both moderate and severe periodontitis. Non-significant relationships were elicited between marital status, employment status, number of previous births and periodontitis.

4.4 Oral hygiene practices

330 (86%) of post-partum mothers cleaned their teeth twice day, 53 (13.8%) once a day, whereas 1 (0.3%) of the respondents indicated teeth cleaning at least weekly. 336 (87.5%) of the respondents used a commercial toothbrush to clean their teeth while 48 (12.5%) of the respondents cleaned their teeth using a chewing stick. None of the respondents used a piece of cloth to practice teeth cleaning. 374 (97.4 %) of the participants took approximately 2 minutes for oral hygiene. Most of the participants

336 (87.5%) were not aware of what dental floss is and did not use it while only 48 (12.5%) indicated use of dental floss.

Table 4.5

Oral hygiene Practices (Frequency, Duration and Materials Used)

Practices	Frequency n=384	Percentage (%)
Oral Hygiene Frequency		
Once a day	53	13.8
Twice a day	330	86.0
Materials Used		
Commercial toothbrush	336	87.5
Chewing stick	48	12.5
Oral Hygiene Period		
Approximately 1 minute	6	1.6
Approximately 2 minutes	374	97.4
Greater than 2 minutes	3	0.8
Use of Dental Floss		
Yes	48	12.5
No	336	87.5
Total	**384**	**100.0**

Of the 336 post-partum mothers who did not use dental floss, 184 (47%) were found to have severe periodontitis while 126 (32.8%) had moderate periodontitis, only 26 were not found to have periodontitis. From table 4.6, non-significant associations were elicited between oral hygiene practices and maternal periodontitis. All the oral hygiene practices p values were greater than the level of significance (0.05) and all the calculated χ^2 were less than the critical χ^2.

From a clinical perspective, while most participants indicated brushing twice a day and taking on average 2 minutes to brush their teeth, the high levels of moderate and severe periodontitis found in such participants might be attributable to poor brushing techniques resulting in inadequate removal of dental plaque and calculus.

This was demonstrated by Crouch et al., (2016) when they conducted a study where brushing habits and subsequent periodontal health were explored to ascertain the oral health status of adults in Meru, Kenya. Most of the study participants reported having a commercial toothbrush and brushing on the minimum once a day but they were also found to have multiple carious lesions and pain. This was attributed to lack of proper knowledge on oral health care and hygiene. They concluded that poor brushing

techniques leading to inadequate removal of plaque was the underlying cause for the caries and gingival inflammation in that population. They further note that an overwhelming percentage of adults in rural Kenya regions do not possess basic oral health knowledge.

Table 4.6

Distribution of Periodontitis Severity according to Study Participants' Oral Hygiene Practices.

	Periodontitis n (%)			**Test**	**df**	**p**
Variable	**No Periodontitis**	**Moderate Periodontitis**	**Severe Periodontitis**			
Oral Hygiene Frequency				χ^2=6.504	4	**0.165**
Once a Day	4(1.07)	28(7.29)	21(5.4)			
Twice a Day	27(7)	122(32)	181(47)			
Material Used				χ^2=3.732	2	**0.155**
Commercial Toothbrush	26(6.7)	127(33)	183(47.6)			
Chewing Stick	5(1.3)	24(6.25)	19(5)			
Oral Hygiene Duration				χ^2=3.362	6	**0.762**
Approximately 2 Minutes	31(8)	146(38)	197(51)			
Use of Dental Floss				χ^2=5.024	2	**0.081**
Yes	5(1.3)	25(6.5)	18(4.6)			
No	26(6.77)	126(32.8)	184(47)			

4.5 Visits to the dentist before and during pregnancy and dental awareness at the antenatal clinic

284 (74.0%) of the participants had ever visited a dental practitioner while 100 (26%) had never visited a dental practitioner. 367 (95.6%) of the post-partum mothers who had delivered low birth weight neonates did not visit a dentist during their current pregnancy while only 17(4.4%) had utilized dental services in their current pregnancy. 374 (97.4%) of the mothers were of the belief that dental treatment is not safe practice during pregnancy whereas only 10(2.6%) were of the contrary opinion. Furthermore 332 (86.2%) of the mothers indicated that they were not informed on the importance of good oral hygiene during pregnancy at the antenatal clinic while only 52(13.8%) had received sensitization on the importance of good oral hygiene at the antenatal clinic.

Table 4.7

Visits to the Dentist Before and During Pregnancy and Dental Awareness at the Antenatal Clinic

Visits and Dental Awareness	Frequency N=384	Percentage (%)
Visits to the dentist		
Yes	284	74.0
No	100	26.0
Dentist visit during pregnancy period		
Yes	17	4.4
No	367	95.6
Perception on dental treatment		
Yes	10	2.6
No	374	97.4
Sensitization on good oral hygiene		
Yes	52	13.8
No	332	86.2
Total	**384**	**100.0**

From a clinical perspective:

191(50%) of the post-partum mothers who didn't utilize dental services during pregnancy were found to have severe periodontitis while 145 (38%) had moderate periodontitis. In a research conducted in California USA during California's maternal and infant health assessment **(**California Dental Association Foundation & American College of Obstetricians and Gynecologists, District IX, 2010) it was reported that only 35% of gravid ladies who delivered in 2002-2007 sought dental review in the pregnancy period. This is despite 52% of them reporting to have had a dental problem. Further analysis revealed that gravid ladies who did not utilize dental services were highly likely having incomes that were lower and had lower levels of education. They further note that the pregnancy period is crucial in addressing oral health and dental treatment can also be undertaken throughout pregnancy since it is safe.

Table 4.8

Distribution of Periodontitis Severity according to Visits to the Dentist Before and During Pregnancy and Dental Awareness at the Antenatal Clinic

	Periodontitis n (%)			**Test**	**Df**	**p**
Variable	**No Periodontitis**	**Moderate Periodontitis**	**Severe Periodontitis**			
Visits to the dentist				χ^2=8.916	2	**0.012**
Yes	22(5.7)	100(26)	162(42)			
No	9(2.3)	51(13.2)	40(10.4)			
Dentist visit during pregnancy period				χ^2=2.005	2	**0.367**
Yes	0(0)	6(1.5)	11(2.9)			
No	31(8)	145(38)	191(50)			
Perception				χ^2=0.655	2	**0.721**
Yes	1(0.3)	5(1.3)	4(1.04)			
No	30(7.8)	146(38)	198(52)			
Sensitization				χ^2=1.021	2	**0.600**
Yes	5(1.3)	23(6)	24(6.25)			
No	26(6.77)	128(33.3)	178(46.3)			

198 (52%) of post-partum participants with the belief that dental treatment in the pregnancy period is not safe were found to have severe periodontitis and 146 (38%) of this same category had moderate periodontitis. A survey done by Wilder et al., (2007) on obstetricians focusing on practice, attitudes and knowledge regarding oral health in the pregnancy period demonstrated misconceptions in this subject matter, for example, the belief that decay of the teeth could become more severe and that gravid ladies are guaranteed to have tooth loss in the pregnancy period. 50% of obstetricians advocated examination of the oral cavity in the pregnancy period and physicians suggested postponement of dental treatment till post-partum period.

Dinas et al., (2007) conducted a study whereby four hundred and twenty-five post-partum women had an anonymous questionnaire administered to them 3 days post-delivery. The study was conducted with the aim of assessing oral health problems and perception of dental services in the pregnancy period by pregnant women in Greece. While 27.3% participants had utilized dental services in their current pregnancy period, 72.2% were of the opinion that having dental procedures in the period of pregnancy could result in negative effect on outcomes of pregnancy. 46.8% of the participants had experienced symptoms of gingival inflammation and bleeding during their current pregnancy and there was significant association linking gingivitis in pregnancy and lack of routine primary dental treatment. The authors recommended that there is great need to create preventive oral health programs for all women within the age of reproduction and to educate all gravid women on the need of good oral health and misconceptions surrounding dental procedures in the pregnancy period.

Of the 332 (80.2%) of the post-partum mothers who indicated having not received any sensitization on the need of good practices of oral hygiene in the pregnancy period, 178(46.3%) were found to have severe periodontitis, 128(33.3%) had moderate periodontitis while only 26(6.77%) did not have periodontitis. California Dental Association Foundation & American College of Obstetricians and Gynecologists, District IX (2010) reports that pregnant woman preparing for a healthy pregnancy interact with prenatal healthcare providers as the first health professionals to consult but majority of the professionals are not aware of the need of good oral health in the pregnancy period. Delivery of dental care in the pregnancy period is not included in medical school curricula as well.

Similarly, Honkala and Al-Ansari (2005) conducted a cross sectional study among six hundred and fifty gravid women at maternity wing of the biggest government owned hospital in Kuwait. Majority of the participants were primigravida and a third of the participants reported currently having symptoms of periodontitis. 40% of participants experienced pain or discomfort in the mouth within the previous six months. Majority of the participants did not receive any sensitization regarding oral health and dental treatment during their pregnancy.

A significant relationship was demonstrated linking visits to the dentist before pregnancy and maternal periodontitis ($p = 0.012$). This concurs with research done by Karimi et al., (2016) where the occurrence of neonates with low weight at birth was established to be 2.3 times more in primigravida women with maternal periodontitis than those in periodontal health. In addition, premature labor was 12 times greater in ladies diagnosed as having maternal periodontitis. They resolved that the more severe maternal periodontitis is, the greater the chance of premature labor and low neonatal weight at birth and an inverse relationship was found to exist between median weight at birth and the severity of periodontitis in gravid ladies. They recommend that whenever possible ladies should conceive without periodontitis and periodontitis detected during the pregnancy period should be clinically attended to promptly to minimize the chance of neonatal low weight at birth or premature birth. Women should be informed and encouraged to maintain good practices of oral hygiene and oral health prior to and throughout pregnancy. Bansal et al., (2013) also recommend that women should be targeted before they conceive as periodontal therapy can be carried out more aggressively and a lengthier maintenance period after treatment carried out ensuring that any inflammation induced in the body system is able to clear completely.

4.6 Symptoms of periodontitis experienced during pregnancy

246 (64.2%) of the respondents experienced discomfort or pain in the mouth, teeth or gums during pregnancy while 138 (35.8%) indicated otherwise. 232 (60.5%) of respondents had experienced bleeding gums during brushing while 152 (39.5%) had not. 129 (33.8%) of respondents experienced mobile/shaking teeth while 255(66.2%) did not.

Table 4.9

Symptoms of periodontitis experienced during pregnancy

Symptoms of Periodontitis Experienced	Frequency N=384	Percentage (%)
Pain in mouth, teeth or gums		
Yes	246	64.2
No	138	35.8
Bleeding Gum		
Yes	232	60.5
No	152	39.5
Shaking teeth		
Yes	129	33.8
No	255	66.2
Total	**384**	**100.0**

Table 4.10

Distribution of Periodontitis Severity according to Symptoms of Periodontitis Experienced During Pregnancy

Variable	Periodontitis n (%)			Test	df	p
	No Periodontitis	Moderate Periodontitis	Severe Periodontitis			
Pain During Pregnancy				χ^2=95.92	2	**<0.001**
Yes	9(2.3)	62(16.1)	175(45.5)			
No	22(5.7)	89(23.1)	27(7.03)			
Bleeding Gum				χ^2=101.5	2	**<0.001**
Yes	8(2.08)	54(14)	170(44.2)			
No	23(6)	97(25.2)	32(8.33)			
Shaking Teeth				χ^2=46.18	2	**<0.001**
Yes	3(0.8)	27(7)	99(25.7)			
No	28(7.2)	124(32)	103(27)			

175 (45.5%) of the participants who experienced pain or discomfort in the mouth teeth or gums during pregnancy were found to have severe periodontitis and only 9 (2.3%) of this category were found not to have maternal periodontitis. 170 (44.2%) of participants who experienced bleeding gums were found to have severe periodontitis and only 8 (2.08%) of the mothers who had experienced bleeding gums did not have periodontitis. There were statistically significant associations between all symptoms of periodontitis experienced by the mothers during pregnancy and maternal periodontitis. All the p values (<0.001) were less than the level of significance (0.05) and all the calculated χ^2 were greater than the critical χ^2. While 255 participants indicated having not experienced mobile or shaking teeth 103 of these participants had severe periodontitis and 124 had moderate periodontitis.

Tooth mobility is undue horizontal and vertical tooth displacement and is scored based on the range of tooth movement from no detectable mobility to movements between 1 and 3 millimeters in any given direction. It is mostly detected incidentally and majority of individuals are usually not aware until attention is brought to the tooth by tenderness experienced on chewing. According to Azodo and Ogbebor, (2017) ,individuals who have mobile teeth normally result to unilateral chewing and restricting their diet as a coping mechanism and tooth mobility being one of the main features of periodontal disease if left untreated or treated improperly, leads to inevitable tooth loss. The grade of tooth mobility is also positively associated with the severity of chronic periodontitis.

4.7 Neonatal Birth Weight

The neonatal birth weight was obtained from the medical records and had been measured using a digital infant weighing machine within one hour upon delivery. This was done to ensure that significant post-natal weight loss had not occurred. 347 (90%) of the participants delivered neonates weighing between 2000 and 2500gms while 37(10%) delivered neonates weighing below 2000gms.

Table 4.11

Study Areas and Neonate Weight

		Below 2000gms	2000- 2500gms	Total
Area	Gatundu	5(1.3)	40(10.4)	45
	Kiambu	14(3.6)	82(21.4)	96
	Ruiru	8(2)	85(22.1)	93
	Thika	3(0.7)	97(25.3)	100
	Tigoni	7(1.8)	43(11.2)	50

Kiambu recorded the highest number 14(3.6 %) of neonates below 2000gms while Thika had the highest number 97(25.3%) of neonates above 2000gms.

4.8 Oral hygiene practices and low birth weight in Kiambu County.

From table 4.12, a statistically significant association was demonstrated linking all oral hygiene practices and neonatal weight at birth. All the oral hygiene practices variables had p values less than the level of significance (0.05%) and all the calculated χ^2 were greater than the critical χ^2

Table 4.12

Distribution of Neonate Birth Weight according to Study Participant's Oral Hygiene Practices.

	Neonate Weight n (%)		Test	df	p
Variable	**Below 2000gms**	**2000 to 2500 gms**			
Oral Health Frequency			χ^2=21.0	6	**0.002**
Once a Day	14(1.08)	39(831)			
Twice a Day	24(9)	306(36)			
At Least Weekly	0(0)	1(0.2)			
Material Used			χ^2=16.07	3	**0.001**
Commercial Toothbrush	25(6.7)	310(33)			
Chewing Stick	12(1.3)	36(6.25)			
Oral Hygiene Duration			χ^2=73.86	9	**<0.001**
Approximately 1 Minute	2(0)	4(0.5)			
Approximately 2 Minutes	35(8)	339(38)			
Greater than 2 Minutes	0(0)	3(0.5)			
Not sure	0(0)	1(0.26)			
Use of Dental Floss			χ^2=29.61	3	**<0.001**
Yes	15(1.3)	33(6.5)			
No	23(6.77)	313(32.8)			

All oral hygiene measures are aimed at reducing plaque coverage and plaque coverage can be used as a measure of oral health in particular health of the periodontium. Hope et al., (2014) carried out research with the assumption that the quantity of plaque on an individual's teeth due to their oral hygiene measures contributes to distribution of individual species of bacteria within it, in particular, bacteria that cause periodontitis and that if poor overall oral health is associated with PLBW, it is anticipated that more plaque coverage would occur in mothers who delivered PLBW neonates. Following linear regression, a relationship was found linking coverage of plaque resulting from oral hygiene practices and the mothers viewed to be at risk of PLBW.

A study conducted by Wiener and Waters (2018) found a significant contrast between gravid women who practiced oral hygiene measures more than an overall of 13 times in one week and those who did so less than the 13 times in one week with the latter having a greater risk of delivering a neonate with low weight at birth. They further indicate that good practices to control oral infection for example brushing teeth and usage of dental floss promote overall health of the oral cavity and have the possibility of decreasing chances of premature birth and low neonatal weight at birth.

Table 4.13

Distribution of Periodontitis Severity according to Neonatal Birth Weight

		Periodontitis			
		No Periodontitis	**Moderate Periodontitis**	**Severe Periodontitis**	**Total**
Neonate Birth Weight	Below 2000gms	3(9%)	12(8%)	22(11%)	37
	2000 to 2500gms	28 (91%)	139 (92%)	180(89%)	347
Total		**31**	**151**	**202**	**384**

Of the 151 mothers found to have moderate periodontitis, 139 ((92%) delivered neonates weighing between 2000 to 2500gms and 12 (8%) delivered neonates weighing below 2000gms. 202 mothers were found to have severe periodontitis and 180 (89%) delivered neonates weighing between 2000 to 2500gms while 22 (11%) delivered neonates weighing below 2000gms. Only 31 mothers fell under the no

periodontitis category and 28 (91%) delivered neonates weighing between 2000 to 2500gms while 3 (9%) delivered neonates weighing below 2000gms.

The results obtained are in line with a multi-centered prospective research done by Sharma et al., (2007) evaluating whether mothers who had maternal periodontitis in the Fiji islands delivered neonates who were premature or had low weight at birth. They carried out oral examination on 670 women. Confounding factors for example medical illnesses, maternal age, tobacco usage and consumption of alcohol were identified through interviewing the participants. Data collected showed that greater than half of this group suffered from moderate to severe periodontitis and a greatly significant correlation linked premature delivery, low weight at birth and periodontitis. A research study by Kawar et al., (2016) evaluating correlation linking premature birth and neonatal low weight at birth with periodontitis had 59 mothers receive full mouth clinical examinations and confounding factors such as pregnancy complications excluded. It was found that 79% of the subjects with moderate and severe periodontitis had low birth weight neonates who were preterm. Moderate and severe periodontitis in this study was diagnosed if greater than 10% of areas measured $\geq$ 5 millimeters periodontal probing depth. They concluded that a significant association existed between neonatal low weight at birth and periodontitis.

4.9 Hypothesis Test

To test the hypothesis, low birth weight as index of dependent variable was regressed upon low birth weight in Kiambu County as a composite of independent variable.

The regression equation obtained from this output was:

Low Birth Weight = 3.566 + 0.653 Maternal Periodontitis + error margin.

Test regression results in the above table show that adjusted r square value for regression of low birth weight and maternal periodontitis is 0.732 which means that maternal periodontitis explains 73.2% of variation in low birth weight in Kiambu county. In the ANOVA table results the F-ration (1, 384) = 59.175 which is significant for this relationship at P value <0.001, and demonstrates that this model significantly predicts outcome of relationship between maternal periodontitis and low neonatal weight at birth in Kiambu County.

Table 4.14

Maternal Periodontitis and Low Birth Weight in Kiambu County

(a) Model Summary

Model	r	r Square	Adjusted r Square	Std. Error of the Estimate
1	.875[a]	.766	.732	.25797

a. Predictors: (constant) Maternal Periodontitis
b. Dependent: Variable: Low Birth Weight

(b) ANOVA

Model		Sum of Squares	Df	Mean Square	F	Sig.
1	Regression	3.938	1	3.938	59.175	.000[b]
	Residual	25.594	382	.067		
	Total	**29.532**	**383**			

a. Dependent Variable: Low Birth Weight

(c) Coefficient

Model		Unstandardized Coefficients		Standardized Coefficients	T	Sig.
1		B	Std. Error	Beta		
	Constant	3.566	.134		26.709	.000
	Maternal Periodontitis	.653	.085	.366	7.693	.000

b. Dependent: variable: Low Birth Weight

The Beta un-standardized coefficient for maternal periodontitis is 0.653 and is significant at P value < 0.001, demonstrating that when maternal periodontitis changes by a single unit in the scale of assessment, low birth weight in Kiambu County will also change by 0.653 units.

The constant term value is 3.566, demonstrating that when maternal periodontitis is zero; low birth weight in Kiambu County will have a default value of 3.566. The null hypothesis one, stating that there is no relationship between maternal periodontitis and low birth weight in Kiambu County, has been rejected. The inference is that indeed,

there is a positive relationship between maternal periodontitis and low birth weight in Kiambu County.

4.10 Correlation Results

The table below shows results of correlation test analysis between the independent variable (Maternal Periodontitis) and the dependent variable (Low Birth Weight).

Table 4.15

Correlations

		Maternal Periodontitis	Low Birth Weight
Maternal Periodontitis	Pearson Correlation	1	0.875
	Sig.		<0.001
	N	384	384
Low Birth Weight	Pearson Correlation	0.875	1
	Sig.	<0.001	
	N	384	384

Note. Correlation is significant at the 0.05 level

The study revealed a positive correlation coefficient linking maternal periodontitis and low birth weight as demonstrated by correlation factor equal to 0.875 the relationship was further found to be significant as the P value was < 0.001. The results concur with landmark literature by Offenbacher et al., (1996) where it was found that periodontitis in gravid women causes a seven-fold increase in chance of giving birth to a premature neonate with low weight at birth and approximately 18% of PLBW births are due to periodontitis. In addition, both primiparous and non-primiparous women who had delivered premature neonates with low weight at birth were found to have significantly worse maternal periodontitis than the controls (women who delivered neonates with normal weight at birth).

Jacob and Nath (2014) also established periodontitis as an independent risk factor for neonatal low weight at birth. Mothers who delivered neonates with low weight at birth had significantly more severe periodontitis than participants who had normal weight at birth neonates and Karimi et al., (2016) resolved that the more severe maternal

periodontitis is, the greater the chance of low neonatal weight at birth and premature labor and an inverse association was found to exist between median birth weight and the potency of periodontitis in gravid ladies. Haerian-Ardakani et al., (2013) found that areas in the oral cavity diagnosed with periodontitis were 1.6 times more in mothers who had delivered low birth weight neonates and that these same mothers had deeper periodontal pockets and less healthy areas of the gum than those who had delivered normal birth weight neonates and further concluded that periodontitis in gravid women is a probable risk factor for low neonatal weight at birth.

4.11 Summary

The incidence of maternal periodontitis in Kiambu County was found to be 92% with majority of the mothers 52.7% having severe periodontitis, 39.2% with moderate periodontitis and 8.1% did not have periodontitis. Ruiru sub-county had the highest number (52) of mothers with severe periodontitis. Under socio-demographic characteristics, statistically significant associations were found between age and maternal periodontitis ($p = 0.045$) and the highest level of education and maternal periodontitis ($p = 0.007$). Majority of participants (86%) did teeth cleaning twice a day, 87.5% used a commercial tooth brush, while 87.5% did not use dental floss. Of those who did not use dental floss, 47% had severe periodontitis while 32.8% had moderate periodontitis.

Non-significant associations were demonstrated linking oral hygiene practices and maternal periodontitis. 26% of the participants had never visited a dental practitioner, only 4.4% of the mothers visited a dental practitioner during their current pregnancy, 97.4% held the belief that having dental procedures during pregnancy is not safe practice and 86.2% of the mothers did not receive any sensitization at the antenatal clinic on the need of proper oral hygiene in the pregnancy period. A significant association was demonstrated linking visits to the dentist prior to the pregnancy period and maternal periodontitis ($p = 0.012$). 64.2 % of the mothers had experienced discomfort or pain in the mouth, teeth or gums during their current pregnancy. 60.5% experienced bleeding gums during brushing while 33.8% had experienced mobile or shaking teeth.

There were statistically significant associations between all the symptoms of periodontitis experienced and maternal periodontitis. 90% of the participants

delivered neonates weighing between 2000 to 2500gms and the remaining 10% delivered neonates weighing below 2000gms.Kiambu had the highest number of neonates below 2000gms (3.6%) while Thika had the highest number of neonates above 2000gms (25.3%). A significant relationship was found between all oral hygiene practices and neonatal weight at birth. 92% of the mothers diagnosed with moderate periodontitis delivered neonates weighing between 2000 and 2500gms while the remaining 8% delivered neonates below 2000gms. 89% of the mothers diagnosed with severe periodontitis delivered neonates weighing between 2000 to 2500gms while 11% delivered neonates below 2000gms.

Following regression, it was demonstrated that when maternal periodontitis changes by a single unit in the scale of assessment, low neonatal weight at birth in Kiambu County will subsequently change by 0.653 units, if maternal periodontitis was zero; low neonatal weight at birth in Kiambu County would have a default value of 3.566. The null hypothesis stating that there is no relationship between maternal periodontitis and low birth weight in Kiambu County has been rejected. The inference is that indeed, there is positive relationship linking maternal periodontitis and low birth weight in Kiambu County.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents summary of the entire study beginning with chapter one and highlighting the purpose and objectives of the study. The conclusions reached are based on the set objectives and the recommendations are made from the conclusions drawn from the results obtained.

5.2 Summary of the study

Periodontal diseases comprise inflammatory diseases of the oral cavity caused by bacteria in dental plaque. There are 2 broad classifications of disease of the periodontium; gingivitis and periodontitis with periodontitis involving destruction of ligament of the periodontium and alveolar bone which support the teeth. The World Health Organization defines low neonatal weight at birth as neonatal weight below 2,500 g. Low neonatal weight at birth has been constantly documented as a potential risk factor for infant morbidity and death. Survival of neonates having low weight at birth is dependent majorly on their weight at birth with the least weighing neonates (<500 grams) showing the lowest survival rate.

Neonates who weigh lower than 2,500 g have a 20 times greater chance of death than heavier neonates and low neonatal weight at birth is estimated to responsible for 60 to 80% of all deaths in the neonatal period. Animal models and multiple human research studies have explored the association linking pregnancy outcomes and maternal periodontitis with varying results on the correlation between the two. With a reported prevalence of 97.7% of gingival inflammation (the first stage of periodontitis) in adult females aged 35-44 years in Kenya and a 3.7% increase in neonates delivered with low weight at birth in central region there was need to investigate whether a relationship exists linking low weight at birth and maternal periodontitis.

The purpose of this research study was to establish if there was a relationship between low neonatal weight at birth and maternal periodontitis with a general objective of determining the relationship between low birth weight and maternal periodontitis in Kiambu County. The specific objectives were;

1. To determine incidence of maternal periodontitis in post-partum women who had delivered neonates with low weight at birth within 48 hours of delivery in Kiambu County.
2. To determine the relationship between low birth weight and moderate maternal periodontitis in Kiambu county.
3. To determine the relationship between low birth weight and severe maternal periodontitis in Kiambu County.
4. To determine the relationship between low birth weight and oral hygiene practices in Kiambu County.

The null hypothesis stated was that there is no relationship linking low neonatal weight at birth and maternal periodontitis in Kiambu County. This study was justified by the basis that low neonatal weight at birth is attributed to cause 60 to 80 % of all deaths in the neonatal period and among all the early childhood mortality rates in Kenya, neonatal mortality has showed the slowest rate of decline. With the high prevalence of periodontitis in Kenya, the contribution of maternal periodontitis to low birth weight in Kenya remained unknown.

Chapter two focused on review of available literature. Literature showing association between poor pregnancy outcomes in particular low birth weight and maternal periodontitis was explored. Under theoretical literature review multiple theories on the mechanism by which maternal periodontitis leads to low birth weight were explored. These include:

1. Metastatic spread of infection from the mouth due to transient bacteremia.
2. Metastatic injury due to circulating oral bacteria e.g. lipopolysaccharide.
3. Metastatic inflammation as a result of injury to the immune system caused by oral bacteria.
4. The penetration of Bacteria and their toxins into the fetoplacental unit
5. Genetic polymorphisms of immunologically active substance
6. Increased oxidative substances and decreased antioxidants in the final pregnancy trimester
7. Influence of hormones

Review of the above theories culminated in the adoption of a theoretical framework. Under empirical literature review, studies that found relationship linking low neonatal

weight at birth and periodontitis in pregnancy were explored with emphasis being placed on studies that focused on moderate and severe maternal periodontitis. Studies that found no relationship linking low neonatal weight at birth and periodontitis in pregnancy were also reviewed and the benefit of treatment of the periodontium in reducing poor pregnancy outcomes elaborated. Creation of a conceptual framework for the study concluded this chapter.

Chapter three focused on the research methodology, with the study being a cross sectional study utilizing medical records and clinical dental review of post-partum ladies who delivered a neonate with low weight at birth within 48 hours in Kiambu County. Data on birth weight was obtained from the medical records. The target population was post-partum mothers aged 18-50 years who delivered within 5 hospitals in Kiambu County, namely Thika, Kiambu, Gatundu, Ruiru and Tigoni. Convenience sampling was done. All participants with neonates with low weight at birth at the maternity wards of the selected five hospitals, who fit the inclusion criteria and consented to participating in this study, were recruited.

Using a total sample size of 384 participants,100 participants were recruited from Thika level five hospital, 96 from Kiambu level five hospital, 45 from Gatundu level V hospital, 50 from Tigoni level IV hospital and 93 from Ruiru level IV hospital. Pre-term and multiple births were excluded from the study as well as all other factors pre-disposing to low birth weight. After being screened using a screening form, data on socio-demographic characteristics and oral hygiene practices was gathered using a structured questionnaire and an oral examination conducted to measure and record the participant's periodontal status. Two categories were used for periodontitis: moderate and severe periodontitis. No periodontitis meant neither moderate nor severe periodontitis.

Chapter four focused on the results and discussion of these results. The incidence of maternal periodontitis in Kiambu County was found to be 92%. 52.7% of the participants had severe periodontitis, 39.2% had moderate periodontitis while 8.1% did not have periodontitis. 92% of the mothers diagnosed with moderate periodontitis delivered neonates weighing between 2000 and 2500gms while the remaining 8% delivered neonates below 2000gms. 89% of the mothers diagnosed with severe periodontitis delivered neonates weighing between 2000 to 2500gms while 11%

delivered neonates below 2000gms. A significant association was demonstrated linking all practices of oral hygiene and neonatal weight at birth. The null hypothesis stating that there is no relationship between maternal periodontitis and low birth weight in Kiambu County was rejected. The inference is that indeed, there is positive relationship between maternal periodontitis and low birth weight in Kiambu County.

5.3 Conclusions

The incidence of maternal periodontitis in post-partum women who delivered neonates with low birth weight within 48 hours of delivery in Kiambu County is 92%.

This study concludes that there is a positive relationship between low birth weight and maternal periodontitis in Kiambu County. Maternal periodontitis has been found to be a strong, independent and clinically significant risk factor for low birth weight in Kiambu County.

The study concludes that 52.7% of mothers delivering in various hospitals in Kiambu County suffered from severe maternal periodontitis and 89% of these mothers delivered babies weighing between 2000 to 2500gms.

The study concludes that 39.2% of the mothers delivering in various hospitals in Kiambu County suffered from moderate maternal periodontitis and 92% of these mothers delivered babies weighing between 2000 to 2500gms.

The study concludes that poor oral hygiene practices are a significant predictor of low birth weight in Kiambu County and there exists a statistically significant relationship between all oral hygiene practices and neonatal low birth weight in Kiambu County.

This study further concludes that the utilization of dental services during pregnancy in Kiambu County is very poor with only 4.4% of the mothers who delivered a low birth weight neonate within 48 hours of delivery having visited a dentist during their current pregnancy. In addition, 97.4% of the mothers delivering in various hospitals in Kiambu County do not perceive dental treatment as being safe practice during pregnancy. Furthermore 86.2% of the mothers delivering in various hospitals in

Kiambu County did not receive any sensitization on the need and importance of good oral hygiene during the period of pregnancy.

5.4 Recommendations

The County government of Kiambu needs to place greater emphasis and prioritize oral health care in particular periodontal care before, during and after pregnancy to improve outcomes of birth in the studied population.

The Ministry of health should incorporate oral health preventive and curative services in maternal antenatal programs in Kenya to promote utilization of dental services before, during and after pregnancy.

The Ministry of health should institute public health awareness and sensitization on the importance of good and proper oral hygiene practices as well as routine dental care prior to, during and after pregnancy.

Large prospective cohort studies are required to investigate the relationship between low birth weight and maternal periodontitis in different populations in the country.

There is need for further research on the misconceptions surrounding dental care during the pregnancy period and barriers limiting utilization of dental services during pregnancy.

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APPENDICES

APPENDIX 1: CONSENT FORM

PURPOSE

This research study on RELATIONSHIP BETWEEN LOW BIRTH WEIGHT AND MATERNAL PERIODONTITIS-A CASE STUDY OF KIAMBU COUNTY will be carried out by Rachel Njoki Gichuki (0729027075) a postgraduate student pursuing a Master of Science degree in public health at the Kenya Methodist University. The purpose of this study will be to establish whether there is an association between maternal periodontitis and low birth weight and consequently help in establishing whether maternal periodontitis is a risk factor for low birth weight.

PROCEDURES

The study will involve a mouth examination using a dental mirror, periodontal probe and artificial light and all the teeth excluding the third molars will be examined. No dental treatment will be rendered during the examination but you will be referred for treatment if need be.

DURATION

The oral examination will be conducted in a maximum of two sessions, each session lasting on average 20 minutes.

CONFIDENTIALITY

To protect your confidentiality, no names or identification numbers will be used in this study. Instead each study participant will be identified using independently generated study participant numbers. All personal information learned about you in this research will be kept strictly confidential and your identity will not be revealed in any publication resulting from this study.

RISKS

There are no anticipated risks associated with participating in this study. However, you may experience slight discomfort in the gums and bleeding from the gums during the examination.

BENEFITS

You will benefit from a free dental check up and be referred if further treatment is required. In addition, the results obtained from this study will help in identifying risk factors for low birth weight and will also contribute towards attainment of a Master of Science degree in public health at the Kenya Methodist University.

WITHDRAWAL

Participation is voluntary and refusal to participate will involve no penalty.

You may discontinue participation from this study at any time and you are free to refuse to answer any question at your discretion.

CONCERNS

Please contact Rachel NjokiGichuki (0729027075) for any queries about the research or related to the study.

You may also contact Department of public health, Human nutrition and dietetics, Kenya Methodist University (P.O. Box 45240-00100 Nairobi, Kenya) for any concerns that cannot be discussed with the researcher.

CONSENT

I certify that I have read all the contents of this consent form or it has been read to me and that I have understood it. I certify that I have been given a copy of this consent form. My signature below means I freely give my consent to participate in this study.

Participant's signature……..Date.....

APPENDIX 2: PARTICIPANT'S SCREENING FORM

Date……

Serial no…….

Age (Yrs)……

Date of delivery…….

	YES	NO
Preterm delivery.		
Mother on antibiotic prophylaxis		
Mother with medical condition		
Multiple delivery (twins, etc.)		
Uterine factors-e.g. Uterine fibroids and müllerian duct abnormalities		
Cigarette or tobacco use during pregnancy		
Alcohol consumption during pregnancy		
Maternal short stature- height of the mother 145cm and below		
Mothers diagnosed with poor pre-pregnancy nutritional status		

APPENDIX 3: CLINICAL EXAMINATION FORM

Study participant number…….

Federation Dentaire Internationale (FDI) is a dental notation widely used by dentists internationally to associate information to a specific tooth. The first digit indicates the quadrant: 1 to 4 for the permanent dentition. The second digit indicates the tooth within a quadrant: 1 to 8 for the permanent teeth. For example, the permanent upper right central incisor is 11 (pronounced “one one,” not “eleven”).

RECESSION

17	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
47	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**

POCKET DEPTH

17	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
47	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**

CLINICAL ATTACHMENT LOSS

17	**16**	**15**	**14**	**13**	**12**	**11**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
47	**46**	**45**	**44**	**43**	**42**	**41**	**31**	**32**	**33**	**34**	**35**	**36**	**37**

APPENDIX 4: QUESTIONNAIRE

TITLE: ASSOCIATION BETWEEN MATERNAL PERIODONTITIS AND LOWBIRTHWEIGHT: A CASE STUDY OF KIAMBU COUNTY.

Date…… Study participant number……

Neonate birth weight……

1) Age (in years) ☐

2) Marital status Married ◯
Not married ◯

3) Highest level of education

☐ No education
☐ Primary
☐ Secondary
☐ Above secondary

4) Employment status

☐ Employed
☐ Not employed

5) Number of previous births

☐ None
☐ Between 1-2
☐ 3 or More

6) Do you clean your teeth?

☐ Yes
☐ No

7) How often do you clean your teeth?

- ☐ Once a day
- ☐ Twice a day
- ☐ At least weekly
- ☐ Rarely

8) What do you use to clean your teeth?

- ☐ Commercial toothbrush
- ☐ Chewing stick
- ☐ Cloth
- ☐ Other

9) How long do you take for oral hygiene?

- ☐ About 1 minute
- ☐ About 2 minutes
- ☐ More than 2 minutes
- ☐ I don't know

10) Do you use dental floss?

- ☐ Yes
- ☐ No

11) Have you ever visited a dentist?

- ☐ Yes
- ☐ No

12) Did you visit a dentist during this pregnancy?

- ☐ Yes
- ☐ No

13) Do you think dental treatment is safe during pregnancy?

☐ Yes

☐ No

14) Were you informed at the antenatal clinic on the importance of good oral hygiene during pregnancy?

☐ Yes

☐ No

15) Did you experience any discomfort or pain in the mouth, teeth or gums during this pregnancy?

☐ Yes

☐ No

16) Do your gums bleed when you are brushing?

☐ Yes

☐ No

17) Have you ever experienced mobile/shaking teeth?

Yes ☐ No ☐

APPENDIX 5: ETHICAL CLEARANCE LETTER

KENYA METHODIST UNIVERSITY

P. O. BOX 267 MERU - 60200, KENYA
TEL: 254-064-30301/31229/30367/31171
FAX: 254-64-30162
EMAIL: info@kemu.ac.ke

5TH MARCH 2019

KEMU/SERC/PHT/17/2019

Rachel Njoki Gichuki
PHT-3-0289-1/2017

Dear Rachel,

RE: ETHICAL CLEARANCE OF A MASTERS' RESEARCH THESIS

Your request for ethical clearance for your Masters' Research Thesis titled **"Relationship between low birth weight and maternal periodontitis: a case study of Kiambu County."** has been provisionally granted to you in accordance with the content of your project proposal subject to tabling it in the full Board of Scientific and Ethics Review Committee (SERC) for ratification.

As Principal Investigator, you are responsible for fulfilling the following requirements of approval:

1. All co-investigators must be kept informed of the status of the project.
2. Changes, amendments, and addenda to the protocol or the consent form must be submitted to the SERC for re-review and approval **prior** to the activation of the changes. The Proposal number assigned to the project should be cited in any correspondence.
3. Adverse events should be reported to the SERC. New information that becomes available which could change the risk: benefit ratio must be submitted promptly for SERC review. The SERC and outside agencies must review the information to determine if the protocol should be modified, discontinued, or continued as originally approved.
4. Only approved consent forms are to be used in the enrollment of participants. All consent forms signed by subjects and/or witnesses should be

retained on file. The SERC may conduct audits of all study records, and consent documentation may be part of such audits.

5. SERC regulations require review of an approved study not less than once per 12-month period. **Therefore, a continuing review application must be submitted to the SERC in order to continue the study beyond the approved period.** Failure to submit a continuing review application in a timely fashion will result in termination of the study, at which point new participants may not be enrolled and currently enrolled participants must be taken off the study.

Please note that any substantial changes on the scope of your research will require an approval.

Yours sincerely

DR. WAMACHI
Chair, SERC

cc: Director, RI & PGS

APPENDIX 6: COUNTY GOVERNMENT AUTHORIZATION LETTER

COUNTY GOVERNMENT OF KIAMBU
DEPARTMENT OF HEALTH SERVICES

All correspondence should be addressed to
HEAD HRDU – HEALTH DEPARTMENT
Email address: mndiritu@gmail.com
mkwasa@live.com
Mobile: 0721641516
0721974633

HEALTH RESEARCH AND DEVELOPMENT UNIT
P. O. BOX 2344 - 00900
KIAMBU

Ref. No: KIAMBU/HRDU/AUTHO/2019/05/10/Gichuki RN

Date: 10 May 2019

TO WHOM IT MAY CONCERN,

RE: CLEARANCE TO CONDUCT RESEARCH IN KIAMBU COUNTY

Kindly note that we have received a request by **Dr. Rachel Njoki Gichuki** of **Kenya Methodist University** to carry out research in Kiambu County, the research topic being on ***"Relationship Between Low Birth Weight And Maternal Periodontitis: A Case Of Kiambu County"***.

We have duly inspected her documents and found that she has been cleared by **National Commission For Science, Technology And Innovation** until **03 May 2020**. She thus does not need any further clearance with another regulatory body in order to conduct research within the county of Kiambu.

However, it is incumbent upon the facility in which the research is being carried out to ensure that they are conversant with the remit of the study and operate in line with their institutional norms on conducting research. This note also accords her the duty to provide feedback on her research to the county at the conclusion of her research.

DR. M. NDIRITU NDIRANGU
COUNTY HEALTH RESEARCH DEVELOPMENT UNIT
KIAMBU COUNTY

APPENDIX 7: NACOSTI AND HOSPITALS AUTHORIZATION LETTERS

NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY AND INNOVATION

Telephone:+254-20-2213471,
2241349,3310571,2219420
Fax:+254-20-318245,318249
Email: dg@nacosti.go.ke
Website : www.nacosti.go.ke
When replying please quote

NACOSTI, Upper Kabete
Off Waiyaki Way
P.O. Box 30623-00100
NAIROBI-KENYA

Ref: No. **NACOSTI/P/19/84005/29033**

Date: **6th May, 2019**

Dr. Rachel Njoki Gichuki
Kenya Methodist University
P.O. Box 267- 60200
MERU.

RE: RESEARCH AUTHORIZATION

Following your application for authority to carry out research on ***"Relationship between low birth weight and maternal periodontitis: A case study of Kiambu County"*** I am pleased to inform you that you have been authorized to undertake research in **Kiambu County** for the period ending **3rd May, 2020.**

You are advised to report to **the County Commissioner, the County Director of Education and the County Director of Health Services, Kiambu County** before embarking on the research project.

Kindly note that, as an applicant who has been licensed under the Science, Technology and Innovation Act, 2013 to conduct research in Kenya, you shall deposit **a copy** of the final research report to the Commission within **one year** of completion. The soft copy of the same should be submitted through the Online Research Information System.

GODFREY P. KALERWA MSc., MBA, MKIM
FOR: DIRECTOR-GENERAL/CEO

Copy to:

The County Commissioner
Kiambu County.

The County Director of Education
Kiambu County.

COUNTY GOVERNMENT OF KIAMBU
DEPARTMENT OF HEALTH

Tel.Thika 067 21621/2 fax 21778
All correspondence should be addressed to
MED.SUPT.
When replying please quote

Ref; NO. MOMS/TKA/ VOL. III (819)

THIKA LEVEL 5 HOSPITAL
P.O. BOX 227
THIKA

Date: 6th June, 2019

APPROVAL TO CARRY OF RESEARCH

Principle investigator: DR. RACHEAL NJOKI GICHUKI

RE: RELATIONSHIP BETWEEN BIRTH WEIGHT AND MATERNAL PERIODONTITIS: A CASE STUDY OF KIAMBU COUNTY AT THIKA LEVEL 5 HOSPITAL

Following deliberations by Thika Level 5 hospital research committee, your proposal to carry out the above research at this facility has been approved. However, you will need to provide us with licence from NACOSTI before you can commence the data collection.

Take note that you are required to submit a copy of your research findings upon completion of the study to the hospital. It is also expected that the Ethical consideration and the research subjects confidentiality will be maintained as you have outlined in your proposal.

Any patient confidential information that you may access during your research should not be used without consent.

This letter is valid up to 30th November, 2019.

For any queries feel free to contact the committee chair through the Medical Superintendent's office. Thank you and all the best.

DR. J. WANGECHI
CHAIR TREC
THIKA LEVEL 5 HOSPITAL

Noted.
No objection
to pay the require fee
of ksh. 4000

RUIRU SUB-COUNTY HOSPITAL
17 MAY 2019
P.O. BOX 844-00232

Dr. Rachel Njoki Gichuki Chege

P.O. Box 281201-00200

Cell no: 0729027075

Email: gichukirachel@gmail.com

17th May, 2019.

Approved to do the study.

RUIRU SUB-COUNTY HOSPITAL
20 MAY 2019
P.O. BOX 844-00232
20/05/19

TO:

THE MEDICAL SUPERINTENDENT,

RUIRU LEVEL IV HOSPITAL,

KIAMBU.

RE: REQUEST TO CARRY OUT RESEARCH AMONG POST-PARTUM MOTHERS IN RUIRU LEVEL IV HOSPITAL MATERNITY WARD.

I am Dr. Rachel Njoki Gichuki, a dentist at Loitokitok sub-county hospital currently pursuing a Masters in Public health at Kenya Methodist University. My research is on the relationship between low birth weight and maternal periodontitis and it is a case study of Kiambu County.

I hereby request to interview and examine post-partum mothers (up to 48 hours post-delivery) aged 18-50 years who have had low birth weight neonates at Ruiru level IV hospital .

Attached please find:

1) Clearance to conduct research in Kiambu county
2) Nacosti research authorization
3) Ethical clearance from the university scientific ethics and research committee
4) A copy of my research proposal

Looking forward to your feedback.

Yours sincerely,

Dr. Rachel Njoki Gichuki Chege

Gichuki

COUNTY GOVERNMENT OF KIAMBU
DEPARTMENT OF HEALTH SERVICES
GATUNDU LEVEL 5 HOSPITAL

Telegram: "MEDICAL"Gatundu
Telephone: 0786 916 894
When replying please quote
Email Address:

GATUNDU LEVEL 5 HOSPITAL
P.O BOX 84 - 01030
GATUNDU
gatundul4h@gmail.com

Ref:GTD/GEN/37/VOL.1/93

20TH MAY 2019

VICE-CHANCELLOR
KENYA METHIDIST UNIVERSITY
P O BOX 267 - 60200
MERU

RE: AUTHORITY TO COLLECT DATA – DR.RACHEL NJOKI GICHUKI CHEGE
ADM NO: PHT-3-0289-1/2017

Your application to conduct research on *"relationship between low weight and maternal periodontitis "* in this institution has been granted.

During the entire period of your research, you will be reporting to the MCH Incharge, who will be the key hospital coordinator during the data collection. She will support you access any information that may be relevant for the successful undertaking of the research.

Finally, you are expected to adhere to all the regulations relating to confidentiality of patient information, ethics in research as well as all norms regarding conduct in a Public Health Institution.

Wishing you a successful research.

THE MEDICAL SUPERINTENDENT
Sign
20 MAY 2019
P. O. Box 84 - 01030,
GATUNDU
GATUNDU LEVEL 5 HOSPITAL

KARIUKI J G
HEALTH ADMINISTRATIVE OFFICER
GATUNDU LEVEL 5 HOSPITAL

Dr. Rachel Njoki Gichuki Chege

P.O. Box 281201-00200

Cell no: 0729027075

Email: gichukirachel@gmail.com

17th May, 2019.

TO:

THE MEDICAL SUPERINTENDENT,

TIGONI LEVEL IV HOSPITAL,

KIAMBU.

MEDICAL SUPERINTENDENT
TIGONI HOSPITAL
20 MAY 2019
LIMURU SUB-COUNTY
P.O. Box 124 - 00217, LIMURU

RE: <u>REQUEST TO CARRY OUT RESEARCH AMONG POST-PARTUM MOTHERS IN TIGONI LEVEL IV HOSPITAL MATERNITY WARD.</u>

I am Dr. Rachel Njoki Gichuki, a dentist at Loitokitok sub-county hospital currently pursuing a Masters in Public health at Kenya Methodist University. My research is on the relationship between low birth weight and maternal periodontitis and it is a case study of Kiambu County.

I hereby request to interview and examine post-partum mothers (up to 48 hours post-delivery) aged 18-50 years who have had low birth weight neonates at Tigoni level IV hospital.

Attached please find:

1) Clearance to conduct research in Kiambu county
2) Nacosti research authorization
3) Ethical clearance from the university scientific ethics and research committee
4) A copy of my research proposal

Looking forward to your feedback.

Yours sincerely,

Dr. Rachel Njoki Gichuki Chege