Incidence of Periodontitis among Mothers Delivering Low Birth Weight Neonates in Kiambu County, Kenya

Rachel Gichuki [1*]***, Viola Siongei***[1]***, Job Mapesa*** [1]

[1] *Kenya Methodist University, P.O. Box 45240-00100, Nairobi, Kenya.*

***Correspondence email*:** gichukirachel@gmail.com

Abstract

Periodontitis is estimated to affect about 95% of adults in Kenya. In addition, low birth weight in Kiambu County, Kenya, has increased in the last ten years. Information on the effect of periodontitis on maternal and child health is scanty. We therefore sought to examine the relationship between low birth weight and periodontitis and to determine the incidence of periodontitis in mothers delivering low birth weight neonates in Kiambu County. In addition, we sought 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 County 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. All teeth, excluding third molars, were assessed using Clinical Case Definitions proposed by the Centers for Disease Control and Prevention working group for use in population-based periodontitis surveillance. About 92% of the participants were observed to have periodontitis, of which 53% had 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 $r = 0.875$, $P < 0.001$. 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. Oral health preventive and curative services should be incorporated in antenatal programmes in Kenya.

Key Words: *Periodontitis, Low birth weight, Oral hygiene practices, Neonates, Kiambu County*

IJPP 9(1),36-47

1.0 Introduction

Periodontal diseases are inflammatory diseases of the oral cavity brought about by bacteria in dental plaque. There are two broad classifications of periodontal disease: periodontitis and gingivitis. Periodontitis involves destruction of the alveolar bone and

the ligament of the periodontium. Gingivitis involves inflammation of the soft tissues around the teeth (Muwazi et al., 2014). Periodontal diseases affect more than 95% of the adult population in Kenya and the prevalence of gingival inflammation in adult females aged 35-44 years is reported as 97.7% (Ministry of Health Kenya National Oral Health Survey Report, 2015).The World Health Organization (WHO) defines low birth weight (LBW) as neonatal weight at birth below 2.5kgs. LBW is primarily caused by intrauterine growth restriction and premature birth.

LBW has been constantly documented as a likelihood factor for neonatal death and morbidity. LBW results in multiple short and long-term complications such as respiratory distress syndrome and congenital anomalies. In Kenya, about 74,000 children die every year before reaching the age of five years and 46% of these deaths are neonatal deaths (UNICEF). LBW neonates have a 20 times greater chance of death than heavier neonates and LBW is estimated to contribute to over 60% of all neonatal deaths. According to the Kenya Demographic Health Survey, LBW is estimated to be 7.6% countrywide and 9.2% in the central region showing a 3.7% increase in the region (Kenya National Bureau of Statistics [KNBS], 2015). In addition, the neonatal mortality rate in Kenya was found to exhibit the slowest rate of decline among all early childhood mortality rates.

Animal models have explored the association linking outcomes of pregnancy and periodontitis. A study on pregnant mice inoculated with *Porphyromonas gingivalis (P. gingivalis*); found that *P. gingivalis* did not contribute to growth restriction in every mouse foetus but in every litter. The DNA of P. *gingivalis* was demonstrated exclusively in placentae of involved foetuses, and these placentae had elevated pro-inflammatory cytokines (Lin et al., 2003). Offenbacher et al. (1996) conducted a landmark human survey that demonstrated periodontal disease as a determinant for pre-term low birth weight (PLBW).

Their results showed that mothers of PLBW neonates had remarkably more severe maternal periodontitis than mothers who delivered neonates with normal weight. Maternal periodontitis was found to cause a seven-fold increase in chance of PLBW. Approximately 18% of PLBW births in the study were attributable to maternal periodontitis.Periodontal treatment was found to reduce PLBW rates by 68% in mothers with periodontitis (López et al., 2005). Bansal et al.(2013) recommend that ladies should be targeted before conception as periodontal therapy can be carried out more aggressively and a lengthier post-treatment maintenance phase done thus ensuring systemic inflammation induced by periodontitis is able to resolve.

While there are many known risk factors for LBW and interventions are present to prevent these factors prior to pregnancy and in the pregnancy period, the prevalence of LBW in Central Kenya has increased by 3.7%. The contribution of periodontitis to low birth weight in Kenya is unknown. In addition, antenatal oral health programmes exist in other countries but the programme is not part of antenatal care in Kenya. We hypothesized that there exists a relationship linking LBW and maternal periodontitis in Kiambu County. We further sought to determine the incidence of periodontitis in mothers delivering low birth weight neonates in Kiambu County and to assess the relationship between low birth weight and oral hygiene practices in the same county.

2.0 Materials and Methods

The study was a cross-sectional survey conducted between June and December 2019. The target population was post-partum mothers aged between 18-50 years who delivered in Kiambu County. Kiambu County has 12 sub-counties and an estimated population of 2,417,735 people. Males account for 49% of the population while females are at 51% (Kenya Population and Housing Census Volume I, 2019).

The sample was drawn from three level five hospitals (Thika, Kiambu and Gatundu), and two level four hospitals (Ruiru and Tigoni) in the county. The choice of Kiambu County was based on the Kenya Demographic Health Survey of 2014 which estimated that 90% of neonates delivered in Kiambu County were delivered in a health facility (KNBS, 2015).The calculated sample size of 384 was based on Cochran formula for prevalence in cross-sectional studies when the study population is 10,000 or above (Cochran, 1977).

$$n_0 = \frac{Z^2pq}{e^2}$$

Homogenous convenience sampling was done. All participants who delivered neonates with LBW at the maternity wards of the five hospitals, who fit the inclusion criteria and consented to the study, were recruited. Participants were recruited as follows: 100 from Thika Level Five Hospital, 96 from Kiambu Level Five Hospital, 45 from Gatundu Level Five Hospital, 50 from Tigoni Level Four Hospital and 93 from Ruiru Level Four Hospital.To qualify, a post-partum mother must have given birth in the last 48 hours to a LBW neonate. Once a participant qualified, they were screened using a screening form. Those who did not meet the inclusion criteria were excluded. Exclusion criteria included multiple confounding factors such as pre-term deliveries, medical conditions, antibiotic prophylaxis, maternal short stature (height below 145cm), poor pre-pregnancy nutritional status, uterine pathologies, and tobacco and alcohol consumption during pregnancy.

A thorough brief on the purpose of the study, procedures involved, all anticipated risks, benefits and confidentiality was given to participants who fulfilled the inclusion criteria. Mothers who consented to being enrolled in the study were required to append their signatures or thumbprint on a consent form. A questionnaire with structured questions was administered by research assistants who had been trained to gather data on socio-demographic characteristics, oral hygiene practices and symptoms experienced during pregnancy, perceptions on dental treatment and usage of dental services. The questionnaires had been pretested at two local health centres.

The clinical examination form was a stand-alone form. All clinical examinations were done by three dentists using standardised clinical instruments and within 48 hours of post-partum to ensure significant changes had not occurred in the oral cavity. Participants were examined while lying face upwards, with head to foot on the bed and using artificial white light to ensure that the examination position was reproducible in all participants. A University of Michigan ‘o’ periodontal probe with Williams marks at 1,2,3,5,7,8,9 and 10mm was used to record three variables:

i. Recession-Measurement from height of free gingival margin to cemento-enamel junction.
ii. Pocket/probing depth- measurement from height of free gingival margin to the most apical position of tooth pocket

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

All measurements were done in millimetres on interproximal sites of the teeth. All teeth, excluding third molars, were examined. This modification was done in order to avoid scoring the deepened eruption sulcus as a periodontal pocket. Maternal periodontitis was diagnosed using clinical case definitions proposed by Centres for Disease Control and Prevention Working Group for use in assessment of periodontal disease in the population. 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 a similar tooth, and one or greater than one inter-proximal areas with depth of periodontal pocket ≥ 5 mm.

Moderate periodontitis was classified as two or greater than two inter-proximal areas with loss of clinical attachment ≥ 4 mm not on a similar tooth, or two or greater than two inter-proximal areas with depth of periodontal pocket ≥ 5 mm not on a similar tooth. Neonatal birth weight was obtained from medical records and had been measured using a digital infant weighing machine within one hour upon delivery.

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.

Statistical Analysis

Descriptive statistics were used for analysis. Quantitative method was utilised for analysing the questionnaire using software on Statistical Packages for Social Sciences Version 23 (IBM®SPSS® Statistics 23.0). Chi-square test was utilised in examining if there were associations linking socio-demographic characteristics, parity and visits to the dentist with maternal periodontitis. Pearson correlation and simple linear regression with the model $Y= \beta 0+ \beta 1X+ e$ were utilised in examining the relationship between the independent variable (maternal periodontitis) and the dependent variable (LBW). A 0.05 alpha significance level was utilised for the analysis.

3.0 Results

Socio-demographic characteristics and parity status

As shown in Table 1, majority of the mothers (56.9%) were aged between 26 to 30 years while only three participants were between 36 to 40 years. There were no participants aged above 40 years. Most of the participants (64.1%) were married. Regarding education level, 57% had received secondary education, 39% had reached primary level, 12 (3.1%) had studied beyond secondary while only 3 (0.8%) of the participants had no formal education. About 82% of the respondents were unemployed and 46.4% were first time mothers. Mothers aged 26-30 years had more severe periodontitis compared within age groups. To determine if there was association between socio-demographic characteristics and periodontitis, a chi-square test was done. Significant associations were established linking age and maternal periodontitis *(p= 0.045)* and education level and maternal periodontitis *(p= 0.007)*.

Table 1

Periodontitis Severity according To Study Participant's Socio-demographic Characteristics

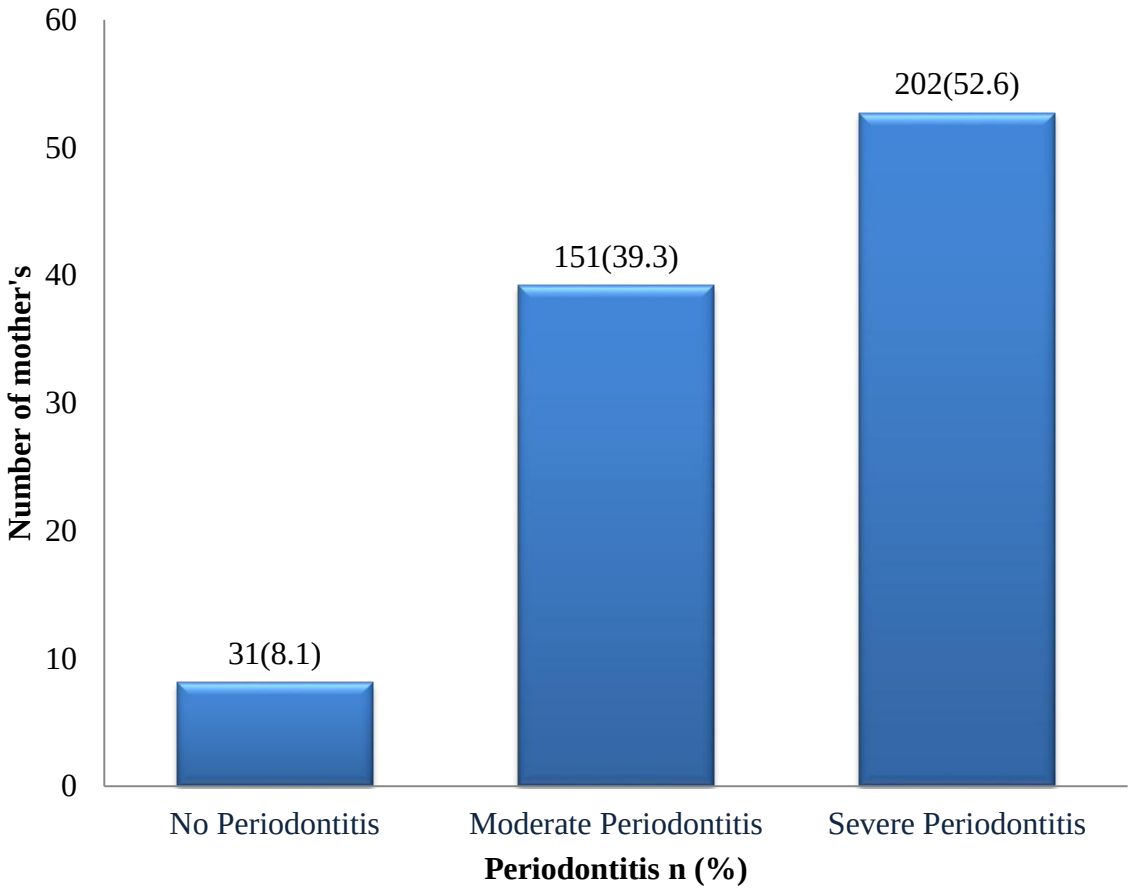
Variable	Total n (%)	Periodontitis n (%)			P Value
		Absent	Moderate	Severe	
Age (Years)					**0.045**
< 25	141 (36.6)	9 (2.3)	49(12.8)	83(21.6)	
26 to 30	218 (56.9)	19 (4.9)	98(25.5)	101(26.3)	
31 to 35	22 (5.7)	3 (0.8)	4(1)	15(3.9)	
Marital Status					**0.143**
Married	246 (64.1)	21(5.5)	104(27)	120(31.3)	
Not Married	138 (35.9)	10(2.6)	46(12)	82(21.4)	
Education Level					**0.007**
Primary	150 (39)	7(1.8)	49(12.8)	94(24.5)	
Secondary	219 (57)	24(6.3)	92(24)	103(26.8)	
Employment Status					**0.052**
Employed	69 (18)	5(1.3)	36(9.4)	28(7.3)	
Unemployed	315 (82)	26(6.8)	115(30)	174(45.3)	
Parity					**0.931**
None	178 (46.4)	14 (3.6)	69(17.9)	95(24.7)	
1-2	190 (49.4)	15 (3.9)	77(20)	98(25.5)	
3 & above	16 (4.2)	2 (0.5)	5(1.3)	9(2.3)	

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

As shown in Figure 1, about 353 (92%) of the participants were found to have maternal periodontitis with 202 (52.6%) having severe periodontitis while 151 (39.3%) had moderate periodontitis. However, 31 (8.1%) did not have periodontitis.

Figure 1

Incidence of Maternal Periodontitis in Kiambu County



Dental visits before and during pregnancy and dental awareness at the antenatal clinic

As shown in Table 2, 284 (74%) of the participants had ever visited a dental practitioner while 100 (26%) had never visited a dental practitioner. About 95.6% of the mothers did not visit a dentist during their current pregnancy while only 4.4% had utilised dental services in their current pregnancy. Majority (97.4%) of the mothers were of the belief that it is not safe to have dental procedures done during pregnancy whereas only 2.6% were of the contrary opinion. Furthermore, 332 (86.5%) of the mothers indicated that they were not informed on the need of proper oral hygiene during pregnancy at the antenatal clinic while only 52 (13.5%) had received sensitisation on the same. To examine the relationship between visits to the dentist and maternal periodontitis, a chi-square test was done. A significant relationship was demonstrated linking visits to the dentist before pregnancy and maternal periodontitis *(p = 0.012).*

Table 2

Periodontitis Severity According To Dental Visits before and During Pregnancy and Dental Awareness at the Antenatal Clinic

Variable	Total n (%)	Periodontitis n (%)			P Value
		Absent	Moderate	Severe	
Visits to the dentist before pregnancy					**0.012**
Yes	284(74)	22(5.7)	100(26)	162(42.1)	
No	100(26)	9(2.3)	51(13.3)	40(10.4)	
Dentist visit during pregnancy period					**0.367**
Yes	17(4.4)	0(0)	6(1.6)	11(2.9)	
No	367(95.6)	31(8.1)	145(37.8)	191(49.7)	
Perception on safety					**0.721**
Yes	10(2.6)	1(0.3)	5(1.3)	4(1)	
No	374(97.4)	30(7.8)	146(38)	198(51.5)	
Sensitization at antenatal clinic					**0.600**
Yes	52(13.5)	5(1.3)	23(6)	24(6.3)	
No	332(86.5)	26(6.8)	128(33.3)	178(46.4)	

Neonatal Birth Weight

About 90% of the participants delivered neonates weighing between 2-2.5kg while (10%) delivered neonates weighing below 2kg (Table 3).

Oral hygiene practices

As shown in Table 3, 330 (86%) of post-partum mothers cleaned their teeth twice a day, 53 (13.8%) cleaned once a day while only one mother cleaned on a weekly basis. About 87.5% used a commercial toothbrush to clean their teeth while 12.5% used a chewing stick. Majority (97.4%) of the participants took approximately two minutes on oral hygiene while only 2.6% cleaned their teeth for shorter durations. Most of the participants (87.5%) were not aware of what dental floss is and did not use it while only (12.5%) reported use of dental floss. To evaluate the relationship between oral hygiene practices and LBW, a chi-square test was done and all the oral hygiene practices variables had p values less than the level of significance (0.05%) showing significant associations between all oral hygiene practices and LBW.

Table 3

Distribution of Neonate Birth Weight According To Study Participants' Oral Hygiene Practices

		Neonate Weight n (%)		P Value
Variable	**Total n (%)**	**Below 2kg**	**2kg to 2.5kg**	
Oral Hygiene Frequency				**0.002**
Once a Day	53(13.8)	14(3.7)	39(10.2)	
Twice a Day	330(86)	24(6.3)	306(79.7)	
Material Used				**0.001**
Commercial Toothbrush	336(87.5)	26(6.7)	310(80.7)	
Chewing Stick	48(12.5)	12(3.1)	36(9.4)	
Oral Hygiene Duration				**<0.001**
Approximately 2 Minutes	374(97.4)	35(9.1)	339(88.3)	
Use of Dental Floss				**<0.001**
Yes	48(12.5)	15(3.9)	33(8.6)	
No	336(87.5)	23(6)	313(81.5)	

Regression and Correlation results

Regression results in Table 4 show the adjusted R^2 value (coefficient of determination) for regression of low birth weight and maternal periodontitis is 0.732 which is significant (*P<0.001*) for this relationship. Un-standardised beta coefficient (0.653) and Pearson correlation (r = 0.875) were significant (*P<0.001*). The model for regression obtained from this output was Low Birth Weight = 3.566 + 0.653 Maternal Periodontitis, indicating 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 equal to 3.566 demonstrates that when maternal periodontitis is zero, low birth weight in Kiambu will have a default value of 3.566.

Table 4

Regression and Correlation Results

Adjusted R^2	**Mean square**	**F**	**Unstandardized Coefficients**	**Pearson correlation**	**Significance**	**n**
0.732	3.938	59.175	0.653	0.875	0.001	384

4.0 Discussion

This study was conducted with the aim of determining the incidence of periodontitis in mothers delivering LBW neonates in Kiambu County. A high incidence of maternal periodontitis (92%) was found in mothers in Kiambu with 52.6% having severe periodontitis. These findings coincide with the Ministry of Health Kenya National Oral Health Survey Report (2015) where periodontal diseases were shown to affect more than 95% of adults in Kenya. The theory by Michaela et al. (2011) could explain this finding.

According to this theory, increased production of pregnancy hormones stimulates formation of prostaglandin E2, which is pro-inflammatory on the periodontal tissue and if the pregnant woman had early stages of periodontitis, progression of the disease to more severe stages is made possible.. A significant association was demonstrated linking age and education level with maternal periodontitis. Boillot et al. (2011) concluded that an elevated risk of chronic periodontitis occurs in adults who have attained low education levels than those with higher levels.

This effect may be explained by lower education level being correlated to reduced periodontal health awareness, less use of dental services and insufficient oral hygiene practices. A significant relationship was found between visits to the dentist before pregnancy and maternal periodontitis. Studies have shown

that whenever possible, ladies who conceive without periodontitis and periodontitis detected during pregnancy should be clinically treated promptly to minimize LBW (Reza et al.,2015). In addition, women should be targeted before conception, as periodontal therapy can be carried out more aggressively and a lengthier maintenance period carried out ensuring any induced systemic inflammation is able to resolve (Bansal et al., 2013).

We sought to evaluate the relationship between LBW and oral hygiene practices in Kiambu. A statistically significant association was demonstrated between all oral hygiene practices and LBW ($p<0.05$). Poor oral hygiene practices could be a predictor of LBW in Kiambu County. Hope et al. (2014) conducted research with the assumption that the quantity of plaque on an individual's teeth contributes to distribution of individual species of bacteria within it, in particular, bacteria that cause periodontitis.Furthermore, if poor overall oral health is associated with PLBW, it was anticipated that more plaque coverage would occur in mothers who delivered preterm low birth weight neonates. A relationship was found linking coverage of plaque and the mothers viewed to be at risk of PLBW.

We hypothesized that there exists an association linking LBW and maternal periodontitis in Kiambu. This study revealed a positive correlation coefficient linking LBW and periodontitis in pregnancy as demonstrated by r = 0.875. The null hypothesis which stated that there exists no relationship linking LBW and maternal periodontitis in Kiambu County has been rejected. The inference is that indeed, there exists a positive relationship linking LBW and maternal periodontitis in Kiambu County.

These findings are in line with numerous other studies (Chakki et al., 2012; Haerian-Ardakani et al., 2013; Jacob & Nath, 2014; Kumar et al., 2013; Mesa et al., 2013; Rakoto-Alson et al., 2010; Ren & Du, 2017; Reza-Karimi et al., 2015; Vogt et al.,2010; Wang et al., 2013) that have found a

relationship linking LBW and periodontitis and established maternal periodontitis as a likely risk factor for LBW.

5.0 Conclusion

There is a high incidence of periodontitis in mothers delivering LBW neonates in Kiambu County. Poor oral hygiene practices are a potential predictor of LBW in this population. A positive relationship has been found between LBW and maternal periodontitis in Kiambu County**.** There is need to prioritise periodontal care before and during pregnancy to improve outcomes of birth in the studied population. Oral health preventive and curative services should be incorporated in antenatal programmes 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 utilisation of dental services during pregnancy

References

Bansal, M., Khatri, M., Kumar, A., & Bhatia, G. (2013). Relationship between maternal periodontal status and preterm low birth weight. *Reviews in Obstetrics and Gynecology, 6*(3-4), 135-140.

Boillot, A., El Halabi, B., Batty, G. D., Rangé, H., Czernichow, S., & Bouchard, P. (2011). Education as a predictor of chronic periodontitis: A systematic review with meta-analysis population-based studies. *PLoS One, 6*(7), e21508. https://doi.org/10.1371/journal.pone.0021508

Chakki, B. A., Ealla, K. R., Hunsingi, P., Kumar, A., & Manidanappanavar, P. (2012). Influence of maternal periodontal disease as a risk factor for low birth weight infants in Indian population. *Journal of Contemporary Dental Practice, 13*(5), 676-680. https://doi.org/10.5005/jp-journals-10024-1208

Cochran, W. G. (1977). *Sampling Techniques,* (3rd ed.). Wiley.

Haerian-Ardakani, A., Eslami, Z., Rashidi-Meibodi, F., Haerian, A., Dallalnejad, P., Shekari, M., Moein Taghavi, A., & Akbari, S. (2013). Relationship between maternal periodontal disease and low birth weight babies. *Iranian Journal of Reproductive Medicine, 11*(8), 625-630.

Hope, C. K., Wang, Q., Burnside, G., Adeyemi, A. A., Quenby, S., Smith, P. W., Higham, S. M., & Whitworth, M. (2014). Assessing the association between oral hygiene and preterm birth by quantitative light-induced fluorescence. *Scientific World*

Journal, 2014; 374694 https://doi.org/10.1155/2014/374694

Jacob, P. S., & Nath, S. (2014). Periodontitis among poor rural Indian mothers increases the risk of low birth weight babies: a hospital-based case control study. *Journal of Periodontal & Implant Science, 44*(2), 85-93. https://doi.org/10.5051/jpis.2014.44.2.85

Kenya National Bureau of Statistics (2015). *Kenya Demographic and Health Survey 2014*. https://www.dhsprogram.com/publications/publication-fr308-dhs-final-reports.cfm

Kenya National Bureau of Statistics. (2019) *Kenya Population and Housing Census Volume I: Population by County and Sub-County.*KNBS.https://www.knbs.or.ke/?wpdmpro=2019-kenya-population-and-housing-census-volume-i-population-by-county-and-sub-county

Kumar, A., Basra, M., Begum, N., Rani, V., Prasad, S., Lamba, A. K., Verma, M., Agarwal, S., & Sharma, S. (2013). Association of maternal periodontal health with adverse pregnancy outcome. *Journal of Obstetrics and GynaecologyResearch,39*(1),40–45. https://doi.org/10.1111/j.1447-0756.2012.01957.x

Lin, D., Smith, M. A., Champagne, C., Elter, J., Beck, J., & Offenbacher, S. (2003). Porphyromonas gingivalis infection during pregnancy increases maternal tumor necrosis factor alpha, suppresses maternal interleukin-10, and enhances fetal growth restriction and resorption in mice. *Infection and Immunity, 71*(9), 5156-5162. https://doi.org/10.1128/iai.71.9.5156-5162.2003

López, N. J., Da Silva, I., Ipinza, J., & Gutiérrez, J. (2005). Periodontal therapy reduces the rate of preterm low birth weight in women with pregnancy-associated gingivitis. *Journal of Periodontology,* 76 (11), 2144-2153. https://doi.org/10.1902/jop.2005.76.11-S.2144

Mesa, F., Pozo, E., Blanc, V., Puertas, A., Bravo, M., & O'Valle, F. (2013). Are periodontal bacterial profiles and placental inflammatory infiltrate in pregnancy related to birth outcomes? *Journal of Periodontology, 84*(9), 1327-1336. https://doi.org/10.1902/jop.2012.120462

Michaela, T., Straka M., & Kotrán, M. (2011). Periodontitis and Preterm Low Birth Weight: Is there any Association? *Reproductive System & Sexual Disorders:* S2:007. doi:10.4172/2161-038X.S2-007

Ministry of Health, Kenya. (2015) National Oral Health Survey Report 2015. *Kenya E- Repository*. Retrieved 9 October 2020, from https://academia-ke.org/library/download/moh-kenya-national-oral-health-survey-report-2015/

Muwazi, L., Mugisha - Rwenyonyi, C., Nkamba, M., Kutesa, A., Kagawa, M., Mugyenyi, G., Kwizera, G., & Okullo, I. (2014). Periodontal conditions, low birth weight and preterm birth among postpartum mothers in two tertiary health facilities in Uganda. *Biomed Central oral health,* 14(42),1-8

https://doi.org/10.1186/1472-6831-14-42

Offenbacher, S., Katz, V., Fertik, G., Collins, J., Boyd, D., Maynor, G., McKaig, R., & Beck, J. (1996). Periodontal Infection as a Possible Risk Factor for Preterm Low Birth Weight. *Journal of Periodontology,* 67 (10), 1103-1113. https://doi.org/10.1902/jop.1996.67.10s.1103

Rakoto-Alson, S., Tenenbaum, H., & Davideau, J. L. (2010). Periodontal diseases, preterm births, and low birth weight: findings from a homogeneous cohort of women in Madagascar. *Journal of Periodontology*, *81*(2), 205-213. https://doi.org/10.1902/jop.2009.090351

Ren, H., & Du, M. (2017). Role of Maternal Periodontitis in Preterm Birth. *Frontiers in Immunology*, *8*(139),1-10 https://doi.org/10.3389/fimmu.2017.00139

Reza, K. M., Hamissi, J. H., Naeini, S. R., & Karimi, M. (2015). The Relationship Between Maternal Periodontal Status of and Preterm and Low Birth Weight Infants in Iran: A Case Control Study. *Global Journal of Health Science, 8*(5), 184-188. https://doi.org/10.5539/gjhs.v8n5p184

United Nations Children's Fund (2018). *Situation Analysis of Women and Children in Kenya, 2017.* https://www.unicef.org/kenya/reports/situation-analysis-children-and-women-kenya-2017

Vogt, M., Sallum, A. W., Cecatti, J. G., & Morais, S. S. (2010). Periodontal disease and some adverse perinatal outcomes in a cohort of low risk pregnant women. *Reproductive Health, 7,* 29. https://doi.org/10.1186/1742-4755-7-29

Wang, Y. L., Liou, J. D., & Pan, W. L. (2013). Association between maternal periodontal disease and preterm delivery and low birth weight. *Taiwanese Journal of Obstetrics & Gynecology, 52*(1), 71-76. https://doi.org/10.1016/j.tjog.2013.01.011