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Pregnancy periodontitis and low birth weight: A cohort study in rural Belgaum, India

Murthy S*, Mubashir A**, Kodkany BS***, Mallapur MD****

* Postgraduate Student, Dept of Public Health, KLE University** Asst. Prof & Coordinator, MPH Program, KLE University *** Director, Research Foundation, KLE University **** Lecturer, Department of Community Medicine, J.N.Medical College, K.L.E University, Belgaum- 590010

ABSTRACT

Background: Low birth weight can cause devastating long term medical and economical impacts to the family as whole and much interest prevails in preventing LBW by controlling its potential risk factors. Pregnancy periodontitis, being reported as one of such risk factors, is amenable to prevention, control and cure. Confirmative evidence can bring drastic improvements in birth weight and also health of the mother. This cohort study was an attempt to find if such a relation exists since limited conclusive evidence is available. Objectives: To determine the relation between pregnancy periodontitis and low birth weight of newborn in primigravida women in rural Belgaum. To assess the oral health status of the same primigravida women in rural Belgaum. Materials & Methods:Study Design & Period: A cohort study for 18 months Study location: 3 rural field areas of JNMC (Handiganur, Kinaye and Vantamuri) in Belgaum. Study Population: Primigravida women in the 3 villages in their first trimester in January/February 2011 during enrolment and expected to deliver in August/September 2011. Sample Size: 240 (120 in each cohort). Data Collection: After ethical review, a pilot study was conducted on 10% of study population in each village to essentially pre-test the interview schedule. Then screening visit to enrol women based on eligibility criteria was done. Subsequent screening periodontal examination was done by CPI to allocate the women into study (pregnant women with periodontitis) and control (pregnant women without periodontitis) cohort. Oral health status was also recorded using OHI-S and DMFT indices. Follow up visits consisted of trimester-wise visit to check on periodontal status and a post delivery visit to record term of delivery and LBW. Data was entered in Microsoft Excel 2007 and SPSS (β version 20) and analyzed in in proportions, percentages, Odds Ratio, Relative Risk, Chi-Square test and Logistic Regression Analysis.Results: The total incidence of LBW was 15% (22.5% in study cohort, 7.5% in control cohort). Incidence of PTB was 17.5%. 33.3% of PTB had LBW, while only 11.1% of term deliveries had LBW. Preterm birth (aOR=3.266; 1.384–7.704,p<.05), pregnancy periodontitis (aOR=2.403;1.1011-5.712,p<.05), anaemia (aOR=2.746;1.212-6.222,p<0.5) were significantly associated with LBW. Two thirds of study population had fair oral hygiene. Half of study population had dental caries while majority did not have filled or missing teeth. Conclusion: Preterm birth, pregnancy periodontitis and anaemia were found to be independent risk factors for LBW. This is importance because periodontal disease is a factor amenable to prevention and cure. Simple regular oral hygiene practices during pregnancy can effectively control and prevent periodontal disease, and possibility of low birth weight.

Key words: Periodontitis; pregnancy; low birth weight; oral health status; India.

Corresponding Author: Department of Public Health, II Floor, J.N.Medical College (J.N.M.C) Campus, K.L.E University, Belgaum- 590010.

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Introduction

All pregnancies, though a special time in a woman's life, are not fortunate enough to end in healthy lives of the mother &/or the baby. Among a battery of risk factors,[1] periodontal pathology possibly occupies a significant spot. Since the old wives' tale of "*the loss of a tooth for every pregnancy*", oral health during pregnancy has long been a focus of interest.[2]

Periodontal disease is basically a combination of gingivitis and periodontitis. Birth weight is governed by duration of gestation and intrauterine growth rate. On the basis of the current evidence from both animal and human studies, a hypothetical model of the

association between periodontal inflammation during pregnancy and fetal development may be proposed. This is based essentially on the vertical transmission of the periodontal pathogens, that is, transmission from parent to offspring (the other being horizontal, that is, passage of an organism between individuals out-side the parent-offspring relationship) and can range anywhere between 30-60%.

The PerioBIRTH project in USA said that 18.2% of all cases of premature low birth weight could be associated with gum disease. Interestingly, Indian studies also show congruence with that of USA, ranging from around 14- 18%.[3,4] Expectant mothers with periodontal disease may have a 3 to 7[5-7] times greater risk of giving birth to premature and low-weight babies. Periodontal diseases range from 10 - 60% in adults.[8] Maternal periodontitis ranges anywhere between 40 – 87 % in India. Pregnant women, especially in rural areas, are more susceptible to periodontal disease than their rural non-pregnant and urban pregnant counterparts.[9-11]

Birth weight is still probably one of the most important determinants not only of neonatal mortality but also of post-neonatal survival and of infant and childhood morbidity in both the developed and developing world. But low birth weight is amenable to prevention. So is periodontitis, and other oral health morbidities, which can effectively be prevented and cured by simple steps taken at the very beginning of pregnancy if it can be confirmed as an independent risk factor for low birth weight. This does not come without challenges, though, especially in India where disregard to oral health and lack of oral health data for all practical purposes is widely prevalent.

Thus, this was the beginning of such an effort to determine the possible association between periodontitis in pregnancy and low birth weight of the newborn in rural settings while trying to also assess their oral health status.

Methodology:

Study Design & Period: A cohort study; August 2010 to December 2011. Study Location: The 3 field practice areas of J.N.M.C - Vantamuri, Kinaye and Handiganur.

Study Participants: Primigravidae women in their first trimester during January-February 2011 during enrolment and expected to deliver a baby during August to September 2011.

Eligibility Criteria:

Non-smoking, non-drinking, $\geq$ 18 years of age residing in study area Were registered with their respective PHC/SC/AWC, and With not less than 20 permanent teeth, and With no systemic illness or conditions were considered to be risk factors for adverse pregnancy outcomes which could potentially confound the study variables, and Had not undergone oral prophylaxis or any type of periodontal therapy, and Gave informed consent

Study Cohort: The eligible primigravidae women with periodontitis

Control Cohort: The eligible primigravidae women without periodontitis

Sampling Strategy*: Sampling frame*: All the primigravida women from study area.

Sampling size calculation: $n = \frac{2(Z_\alpha + Z_\beta)^2.p.q}{(p_o - p_1)^2}$

α : 5%, β : 20%, Z_α=1.65, Z_β=0.84, p_o=incidence of LBW in pregnant women without periodontitis, p_1= incidence of LBW in pregnant women with periodontitis, $p = (p_o+p_1)/2$, ratio cohort : 1:1, the hypothesis was to test a relative risk of (estimated from previous studies): 3.6. [p=10.58, p_o-p_1= 11.96]

Sample size: The sample size from this calculation came to 83 in each cohort. The sample size we could enrol was much higher than the calculated size and came to 240; 120 in each cohort.

Study Tools: Pre-designed, pre-tested structured schedule consisting of socio-demographic profile, dietary history and dental indices recording sheet. The indices used were OHI-S, CPI and DMFT. Standardized and calibrated dental instruments were used. The CPITN-E probe was for determining the periodontal status.

Ethics: The research protocol was approved by local ethical committee and informed consent obtained from each subject prior to inclusion in the study.

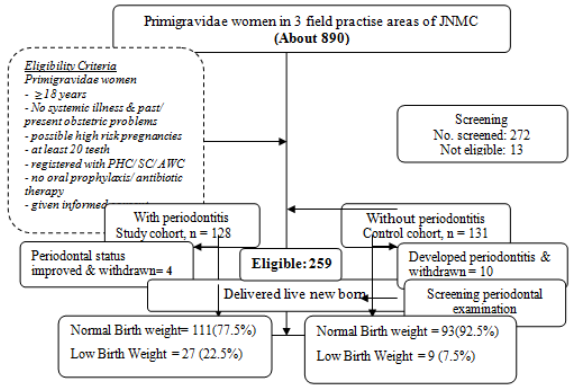
Data collection: After a pilot study from October to December 2010, data collection was done for 12 months from January to December 2011 in 2 stages-screening and follow up visits. The investigator was a qualified dentist and trained to conduct the dental assessment. Participants were screened for eligibility, periodontal status and enrolled into study and control cohort. This was done on ANC days, the feasibility of which was determined during pilot study. The operational definition for determining periodontitis was that given by *Lopez et al.* Six sites in all the teeth that were present in the dental arch were examined and the participants with a minimum of 4 sites with periodontal probing depth of 4mm and attachment loss of 3mm were determined to have periodontitis and subsequently assigned to study cohort. The schedule was completed subsequently and the oral health status was recorded by

OHI-S and DMFT indices. The participants were then followed-up till after they delivered.

The subsequent follow-up-visits consisted of 2 trimester-wise pregnancy visits conducted and 1 post-delivery visit. The trimester-wise ANC visits were done to re-assess their periodontal status and general health of the participants. Control cohort participants who developed periodontitis and study cohort participants whose periodontal status improved, those who had an abortion or developed systemic illnesses were withdrawn from the study. The final follow-up visit was done to record the birth weight of the new born, and any pregnancy outcome other than a live birth was not recorded in the analysis. Confidentiality was ensured by allotting a unique code to each participant.

Data Entry & Analyses: Done in Microsoft Excel spreadsheet 2007 and SPSS (β version 20). Analysis was in proportions, percentages, Odds Ratio, Relative Risk, Chi-Square test and Logistic Regression.

RESULTS:
The flowchart describes the enrollment and the numbers available at the end of the study.



Socio-demographic profile: (Table 1)
A total of 92% (220) participants were between 20 – 29 years of age of which 97.5% (117) were in the study cohort and 85.8% (103) in the control cohort. The tradition of joint families was predominantly (92.5%, 222) observed in the study; about 94.2% (113) in the study cohort and 90.8% (109) in the control cohort. Almost the entire spouse population (99.2%) were educated. The highest level of education was graduate/ diploma (31.6%), followed by an equal proportion (23.3%) of the spouses had higher secondary and secondary level of education, and lastly primary education (20.8%). Interestingly, a higher proportion of higher secondary (31, 25.8%) and graduate/ diploma (40, 33.3%) was seen among the spouses of the study cohort. The educated class constituted the majority (79.2%) of the study population. The higher secondary education level constituted the major group (37.9%), followed by secondary education (27.9%), primary (11.3%) and graduates (2.1%). Proportions for all levels, except no schooling (26.7%) and primary level (15%) of education, were higher in the control cohort. 85% belonged to Class II [Modified B.G.Prasad scale], of which 87.5% were among the study cohort and 82.5% in the control cohort. None of the study cohort participants belonged to class III, whereas, 10% of the control cohort belonged to Class III. 92.1% (221), were involved in light/ non- strenuous activities like household activities. A higher proportion of light activity (94.2%) was seen in the study cohort. Majority, 87.9%, (211) were Hindus, while the rest, 12.1% (29) were Muslims. A similar proportion was seen in both the study and control cohort.
The average gestational age was 37.9 $\pm$ 1.9 years.
Birth weight: The total incidence of normal and low birth weight was 85% and 15% respectively. The incidence of low birth weight was 22.5% was in the study cohort compared to only 7.5% in the control cohort.

Term of gestation: From a total incidence of 17.5% pre term births, a higher (38.9%) incidence of preterm births was seen among low birth weight category.

Anaemia: The prevalence of anaemia was 47.1% (113) among the participants. A higher prevalence of anaemia was seen among low birth weight category (69.4%)

Oral Health Status: (Table 2) *OHI-S:* Majority (62.9%) had a fair OHI-S score while 26.7% had poor score and a minor segment (10%) had good score.
DMFT: More than one third (39.6%) of the population had a DMFT index of 0 having no decayed, missing and filled components. A similar portion (13.3%, 12.9%, 11.3%) had an score ranging from 2-4. Less than 2% had scores of 5, 8 and 9. About 9% had a score of 6 and 7.
Decayed: About 50% of the participants had no decayed teeth, while about 20% had 2 decayed teeth. Less than 2% had 5 or more decayed teeth.

Missing: The majority (92%) did not have any missing teeth. About 8% had a single missing tooth, while less than 2% had 3 or more missing components. Filled: Almost the entire study population (about 98%) did not have any fillings. Among those who did have, majority (1.3%) had single filled tooth.

Associations and risk: *Periodontitis and birth weight: (Table 3)*Low birth weight was significantly associated with the study cohort (χ =10.588, df=1, p=.001). The unadjusted odds ratio was 3.581 (1.604- 7.994; 95% CI) and relative risk was 3 (1.473-6.106; 95% CI). The attributable risk was 66.6%

Table 1: Distribution of socio-demographic variables according to the cohort

Variable		Study cohort		Control cohort		Total	
		n	%	n	%	n	%
Age of pregnant woman (in completed years)	18 - 19 years	3	*2.5*	17	*14.2*	20	*8.3*
	20 – 29 years	117	*97.5*	103	*85.8*	220	*91.7*
Type of family	Nuclear	7	*5.8*	11	*9.2*	18	*7.5*
	Joint	113	*94.2*	109	*90.8*	222	*92.5*
Education of the husband	No schooling	0	*0*	2	*1.7*	2	*0.8*
	Primary	26	*21.7*	24	*20.0*	50	*20.8*
	Secondary	23	*19.2*	33	*27.5*	56	*23.3*
	Higher secondary	31	*25.8*	25	*20.8*	56	*23.3*
	Graduate/ Diploma	40	*33.3*	36	*30.0*	76	*31.6*
Education of the pregnant woman	No schooling	32	*26.7*	18	*15.0*	50	*20.8*
	Primary	18	*15.0*	9	*7.5*	27	*11.3*
	Secondary	28	*23.3*	39	*32.5*	67	*27.9*
	Higher secondary	41	*34.2*	50	*41.7*	91	*37.9*
	Graduate/ Diploma	1	*0.8*	4	*3.3*	5	*2.1*
Socioeconomic Status(Modified B.G.Prasad scale)	Class I	15	*12.5*	10	*8.3*	25	*10.4*
	Class II	105	*87.5*	99	*82.5*	204	*85.0*
	Class III	0	*0*	11	*9.2*	11	*4.6*
Work/ activity of the pregnant woman	Light/non-strenuous activity	113	*94.2*	108	*90.0*	221	*92.1*
	Heavy / strenuous activity	7	*5.8*	12	*10.0*	19	*7.9*
Religion	Hindu	104	*86.7*	107	*89.2*	211	*87.9*
	Muslim	16	*13.3*	13	*10.8*	29	*12.1*

Table 2: Oral hygiene status of the participants

Community periodontal index		
CPI score	Frequency	Percent (%)
Healthy	0	0
Bleeding	240	100
Calculus	115	47.9
Pocket 3.5 to 4.5mm	120	50.0
Pockets >4.5 to 6 mm	0	0
Oral Hygiene Index - Simplified		
OHI-S Score	Frequency	Percent (%)
Good	25	10.4
Fair	151	62.9
Poor	64	26.7
Total	240	100.0
DMFT		
DMFT	Frequency	Percent (%)
0	95	39.6
1	6	2.5
2	32	13.3
3	31	12.9
4	27	11.3
5	3	1.3
6	21	8.8
7	19	7.9
8	4	1.7
9	2	.8
Total	240	100.0

Other factors:

Anaemia was significantly associated with low birth weight (χ =8.5, df=1, p=.004), but not periodontitis (χ =3.763, df=2, p=.052). Preterm birth was significantly associated with low birth weight (χ =13.42, df=1, p=.000) and periodontitis (χ =5.657, df=1, p=.017).

Variables other than outcome which were significantly associated with periodontitis, but not low birth weight were: age of the pregnant woman (χ =10.61, df=2, p=.004; p = .001), education of the pregnant woman (χ =11.41, df=4, p=.004; p = .022) and socio-economic status (p = .002). Education of the pregnant women was significantly associated with both low birth weight (χ =18.219, df=4, p=.001) and periodontitis (χ =11.416, df=4, p=.002).

On multivariate logistic regression analysis (Table 4), the following emerged to be the risk factors for low birth weight: preterm births (aOR=3.266; p=.007), anaemia (aOR=2.746; p=0.15) and periodontitis (aOR=2.403; p=.047).

Discussion:

The present study attempted to observe if there was a relation between periodontal disease and low birth weight of newborn. The plausible explanation would boil down to the inflammatory response triggered by periodontal pathogens which enter systemic circulation from the periodontal infection. The inflammatory

products and bioactive molecules cross and damage areas on placenta which affects the transfer of maternal nutrients to the fetus, thus resulting in low birth weight. Pre term birth is thought to be caused by the early dilatation of the cervix.[3,4,20]

Table 3: 2x2 contingency table of periodontitis with birth weight

		Birth Weight of the new born		Total
		normal birth weight	low birth weight	
Periodontal status of pregnant woman	Without periodontitis	111	9	120
	With periodontitis	93	27	120
Total		204	36	240

Table 4: Risk Estimates

(unadjusted)	Value	95% Confidence Interval	
		Lower	Upper
Odds Ratio	3.581	1.604	7.994
Relative Risk	3.000	1.4739	6.1062
Attributable Risk	66.6%		

Table 5: Multiple logistic regression analysis

Birth Weight of the new born		B	Std. Error	df	p	Exp(B)	95% Confidence Interval for Exp(B)	
							Lower Bound	Upper Bound
Low birth weight	Intercept	-.114	.535	1	.830			
	Periodontitis	.877	.442	1	.047	2.403	1.011	5.712
	Pre term birth	1.183	.438	1	.007	3.266	1.384	7.704
	Anaemia	1.010	.417	1	.015	2.746	1.212	6.222
	Primary	-1.052	.586	1	.072	.349	.111	1.100
	Secondary	.481	.574	1	.402	1.618	.525	4.988
	Higher secondary	.625	.544	1	.250	1.869	.644	5.424

The incidence of low birth weight was 22.5% among pregnant women with periodontitis and 7.5% among pregnant women without periodontitis in the present study. This was lower compared to the low birth weight incidence in the general population on India which stands at 27.6%. Kothiwale et al. (2011) in Belgaum reported an incidence of 25.58% among mothers with periodontitis[5] which was higher than that of the present study.

Pregnant women with periodontitis were 3.58 times (odds ratio) at risk of giving birth to low birth weight babies compared to pregnant women without periodontitis. Moliterno et al. observed an OR of 3.48[12]. This association was suggested by Offenbacher et al. (1996)[13] and established in studies further carried out in Chile (Lopez et al. 2002)[14], Thailand (Dasanayake 1998)[15] and Hungary (Radnai et al. 2004)[16], with ORs between 3.5 to 7.9. However, Davenport et al. (2002)[17], Moore et al. (2004)[18], Holbrook et al. (2004)[19] did not observe such an association. An incidence of 23.3% pre term birth was observed among pregnant women with periodontitis compared to that of 11.7% in pregnant women without periodontitis. These figures were way higher than the that observed by Lopez et al. (2002) with a 2.8% incidence of preterm birth with 1.5% in periodontally healthy women and 5.2% (P = 0.014) in women with periodontal disease. The relative risk for a woman with periodontal disease having a preterm birth was 3.5 (95% confidence interval 1.3 to 9.2; P = 0.006).[14]

The present study found that about 39% of low birth weight infants were born pre term compared to only about 14% of normal birth weight infants who were born pre term. These findings were lower than Kothiwale et al (2011) where the values of 48.5% and 17.3% LBW occurrence in preterm and full term births respectively were observed. The average gestational age reported in that study was 38.09 $\pm$ 2.58 weeks which was similar to the current 37.9 $\pm$ 1.9 years.[5]

Lopez at al. in 2002 observed that 94.7% of the pre term infants were low birth weight, the incidence of preterm birth among low birth weight infants was quite less.[14]

The findings are in accordance with evidence from a retrospective study which showed that preterm infants weigh less than infants of the same gestational age who remain in utero, meaning that many preterm infants were also growth-retarded and hence, low birth weight. The risk of having LBW attributed to maternal periodontitis in the total population was approximated at 67%.83 Consistent results with the present study were observed in the case control study in 2004 that the risk of LBW was significantly reduced with longer gestational period (OR=0.24, 95% CI: 0.15-0.37).[22]

This dissimilarity in these results could be attributed to the varying definitions of periodontitis employed in different studies. Offenbacher et al. (1996)[13] and Lopez et al (2002)[14] used different definitions in their landmark studies. Dasanayake et al. (1998)[15] and Davenport et al. (2002)[17] used the Community Periodontal Index of Treatment Needs (CPITN) to diagnose periodontitis. Though Papapanou (1996) states that CPITN underestimate the true values of periodontitis prevalence,[21] an adequate and large sample size can counter act this disadvantage according to Davenport et al. (2002).[17]

Anaemia was present in about 54% of pregnant women with periodontitis as compared to about 41% in pregnant women without periodontitis (similar to Norkhajizah S et al., 2004).[22] Thus the prevalence of anaemia was high enough to be ruled out as a confounding factor as was done for other plausible risk factors in this study. Anaemia was found to be significantly associated with birth weight of the new born ($p<0.05$) with an odds ratio of 2.2 (1.019-4.845; 95% CI). However, Kothiwale S et al. found no association with haemoglobin and low birth weight.[5,6]
This study included only primigravida women since multiple pregnancies were themselves considered a risk factor for low birth weight. Kothiwale et al. (2011) included primiparous patients, but did not show any significant association with PTB and LBW.[5,6] Studies support the supposition in the current study by stating that considering primi gravidae as a risk factor was just an 'artifact'. This was also confirmed by a hospital based study conducted in 1982.[23] previous cross sectional studies reported that a higher incidence of low birth weight was observed among women with higher parities.[24]

Primary schooling showed the highest incidence (30.6%) of low birth weight. Kothiwale et al. (2011) however observed more than double prevalence among literate (68.4%) of LBW infants compared to illiterate group (31.6%). This was attributed to fewer participants in the illiterate group. This could be due to them having a low awareness of antenatal care.[5] However, in the present study since it was made sure that loss to follow up was almost zero, the same explanation does not hold good for the primary education. It could however be related to their oral knowledge and attitudes prevailing among the participants which needs to be further explored.

No significant association was found between socio economic status and low birth weight in the present study. These results were consistent with that of Norkhajizah S et al.'s study in Malaysia (2004) which found that household income was not a risk factor for low birth weight.[22] However, the meta analysis by Kramer[1] and a study in Kaunas[25] found that poor socio-economic conditions as indicated by low level of education, occupation and household income, are important risk factors for LBW. They, however, did not find education of the pregnant woman to be a predictor for birth weight of the infant.

Majority (62.9%) had a fair OHI-S score while only 10% had good oral hygiene. More than one third (39.6%) of the population had a DMFT index of 0. About 13% had a score ranging from 2-4. Less than 2% had scores of 5, 8 and 9. Other studies showed a 87-99% of caries prevalence. However, oral hygiene was observed to be satisfactory.[26-27]

Limitations: This study was not without limitations. Deficiencies in birth weight recording is a ubiquitous observation in developing countries. Since it was practically impossible for the investigator to be present at every delivery, the birth weight records were the only source to be relied upon. When they were illegible, verbal estimates from attendants during birth had to be relied upon. The schedule of follow up visits could not be determined at the beginning due to the variability of ANC visit timings at the PHCs/SCs/AWC. The results should be interpreted with caution since the odds ratio from logistic regression analysis could slightly overestimate the actual risk.

Conclusion

This cohort study conducted on rural primigravida women showed evidence of an association between periodontal disease and increased risk of low birth weight. However, this does not establish periodontitis to be a sole risk factor for low birth weight. Other predictors significantly found to be risk factors for low birth were anaemia and pre term birth.
Potential limitations (in terms of inconsistent definitions of periodontal disease) and the inadequate number of randomised controlled trial studies limit us from giving a placid conclusion. It would need a few intervention trials to test this hypothesis of periodontal treatment potentially reducing rates of many adverse

pregnancy outcomes which can conclusively establish periodontitis as an established risk factor low birth weight.

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