

# Link between Periodontal Disease and Coronary Artery Disease: Bangladesh Perspective

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### Abstract:

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Coronary artery disease (CAD) is an increasingly important medical and public health problem, and is the leading cause of mortality in Bangladesh. Besides conventional risk factors and ethnicity, a number of emerging risk factors may explain the undue prevalence of CAD in this population. Periodontal disease (PD) is one of them, with prevalence of approximately 50%. As with many other diseases, PD is associated with CAD, and the association is independent of conventional risk factors. Low socioeconomic condition, illiteracy and ignorance, metabolic syndrome, nutritional deficiencies including hypovitaminosis D presumably contribute to the prevalence of PD in Bangladesh. In fact, PD and CAD share some cardiometabolic risk factors including diabetes mellitus, obesity and metabolic syndrome. Future research will hopefully explore different aspects of both public health problems, namely, PD and CAD in the country. The information gathered thereby, will help formulate policy to promote good oral health and tackle the deadly epidemic of CAD more efficiently.

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### Introduction:

Coronary artery disease (CAD) is an important medical and public health issue because it is common and leading cause of death throughout the world. Bangladesh has been experiencing epidemiological transition from communicable disease to non-communicable disease (NCD). The overall mortality rate has decreased significantly over the couple of decades. But deaths due to chronic diseases, specially the 'fatal four' i.e. cardiovascular disease, cancer, chronic respiratory disease and diabetes, are increasing in an alarming rate.<sup>1</sup> CAD is an important contributor to one of the four i.e. cardiovascular disease. The unduly high prevalence of CAD in Bangladesh is not fully explained; besides epidemiological transition, environmental contaminants and genetic or metabolic make-up, a number of recently known lifestyle related factors may play important role in the aetiopathogenesis of CAD in this population.<sup>2</sup> Periodontal disease (PD) may be one of them. However, the nature of interaction between PD

and CAD has not been studied in the context of Bangladesh.

### Rationality of the Review

Data related to CAD and PD in Bangladesh is often insufficient, suffers from statistical flaws and is not readily available. Many articles were published in national, non-indexed journals which are not available online and difficult to procure. Recognizing these limitations, the present review has been planned to compile the available data on this important public health issue. This review will hopefully encourage future research and act as a source of information.

### Methods:

Data have been collected from the articles available from MEDLINE and BanglaJOL supported by the International Network for the Availability of Scientific Publications (INASP) up to the year 2014. Besides this, national journals which are not available online but recognized by the Bangladesh Medical and Dental Council have also been considered.

### What is Periodontal disease?

PDs comprise a continuum of conditions involving inflammation of gingival tissues in response to dental plaque accumulation, and may range from milder gingivitis to more advanced periodontitis. There may (“periodontitis”) or may not (“gingivitis”) be substantial inflammatory destruction of the supporting tissues, including gingival tissue, periodontal ligament, and alveolar bone.<sup>3</sup> Gingivitis is a reversible inflammatory reaction of the dento-gingival tissues to bacterial plaque accumulation which resolves soon after the dental bacterial biofilm is disrupted.<sup>4</sup> Periodontitis, in contrast, is a chronic inflammatory reaction of the same compartment involving not only superficial gingival tissues but also periodontal ligament and the alveolar bone. In its earlier stage, it is rather symptomless, presenting with gingival bleeding and swelling. But in more advanced stage of periodontitis, the inflammation extends deeper and deeper causing progressive destruction of the dental supporting tissues, gingival recession, drifting of teeth, mobility, suppuration, and eventually tooth exfoliation.<sup>5</sup>(Figure 1)

Periodontitis is a chronic ‘infectious/inflammatory’ disease of multifactorial aetiology; interplay between environmental and genetic factors play varying role in an individual patient.<sup>3</sup> Bacterial infection, host inflammatory response and some predisposing factors are important in the aetiopathogenesis of periodontitis. Anaerobic bacteria like *Porphyromonas gingivalis*, *Tannerella forsythia*, *Treponemadenticola*, and *Selenomonas noxia*, as well as, like *Campylobacter rectus*, *Aggregatibacter* (formerly *Actinobacillus*) *actinomycetemcomitans*, and *Prevotellaintermedia*, and spirochetes accumulate and organize in the dental biofilm to initiate the disease process, this is followed by activation of host’s cell-mediated immuneresponse.<sup>6-12</sup> Activated leucocytes in the gingival tissues generate disproportionate amounts of inflammatory mediators including cytokines-chemokines and matrix metalloproteinases (e.g. collagenase) promoting soft and hard tissue destruction.<sup>13</sup>

Figure 1. Periodontal anatomy in health and disease. A tooth with anatomy in health (left

side) and with periodontal disease (right side). The increased depth of gingival sulcus caused by loss of the gingival attachment to create a periodontal pocket; the loss of alveolar bone due to the inflammatory response from plaque and calculus.

Besides specific bacterial pathogens, poor oral hygiene, cigarette smoking, diabetes mellitus, osteoporosis, rheumatoid arthritis, obesity, metabolic syndrome, high sugary diet, ethnicity and psychological factors like stress are the known risk factors for PD.<sup>14-17</sup> In addition, ignorance and illiteracy, low socioeconomic condition, smokeless tobacco consumption, and hypovitaminosis D may contribute to PD. PD and CAD share some prevalent risk factors which could confound a relationship between them. Such risk factors include: increasing age, smoking, alcohol abuse, race/ethnicity, education and socioeconomic status, male sex, diabetes mellitus, obesity, metabolic syndrome and some genetic polymorphisms.<sup>18-21</sup>

Diagnosis of PD is based on clinical, as well as, radiographic parameters; clinical findings include: gingival bleeding; halitosis (fedor oris); inflamed, tender gingiva; bleeding on probing; deep or deepening periodontal pockets while using a calibrated probe; mobility, shifting and spacing of the teeth.<sup>22</sup> Periodontitis cannot be diagnosed by inspection alone, however, and requires specific diagnostic tests (periodontal probing and, sometimes, radiographs).<sup>23</sup> For the purpose of epidemiological studies, 3 clinical parameters are typically recorded to assess the prevalence of PD: (1) Bleeding on probing, (2) pocket depth, and (3) clinical attachment level, which reflects the amount of periodontal tissue loss.<sup>3</sup> Other markers of periodontitis include detection of subgingival microbial colonization by selected periodontal organisms<sup>24-27</sup> and evaluation of serum IgG or IgA antibodies to selected periodontal bacteria<sup>28-35</sup>.

### Epidemiology of CAD

South Asians are unduly prone to develop CAD.<sup>36</sup> Most notable features of CAD in this population are the extreme prematurity and severity; 2 to 4-fold higher prevalence, incidence, hospitalization and mortality; 5 to 10 years earlier onset of first myocardial infarction and 5

to 10-fold higher rates of myocardial infarction and death before the age of 40 years.<sup>36</sup> The exact prevalence of CAD in Bangladesh is not known. Only a limited number of small-scale epidemiological studies are available. The reported values indicate the prevalence of CAD include 0.33% in general population in 1976,<sup>37</sup> between 1.85% and 3.4% in rural<sup>38,39</sup> and 19.6% in urban working professionals.<sup>40,41</sup> Despite marked disparity in values, there seems to be a rising prevalence of CAD in Bangladesh.<sup>2,42</sup>

### **Epidemiology of Periodontal disease**

Periodontitis is the most common chronic inflammatory disease seen in humans, affecting 20-50% of the population worldwide.<sup>43,44</sup> However, severe periodontitis is relatively less common, may be less than 10% in general population.<sup>45-48</sup> The exact prevalence of PD in Bangladesh is not known. Despite lack of adequate data, however, poor dental hygiene is common<sup>49</sup> and periodontitis seems to be prevalent in the country, especially in the adults and the economically weak population.<sup>50</sup> The prevalence in Bangladesh has been found to be 18.5 to 42%.<sup>49-52</sup> A recent hospital-based study among the elderly diabetic population attending the Outpatient Department of BIRDEM Hospital revealed very high prevalence of dental caries e.g. 97%, while missing or filled teeth were found in 96% of the study subjects.<sup>53</sup> Among the rural school children between 5 to 15 years, the prevalence of dental caries, plaque, gingival bleeding and bleeding on probing was 69.6%, 91.6%, 66.8 % and 64% respectively.<sup>54</sup>

### **The Link between PD and CAD**

Periodontitis has been found to be associated with a number of systemic diseases and conditions, including stroke,<sup>55</sup> peripheral arterial disease,<sup>56</sup> type 2 diabetes,<sup>57</sup> rheumatoid arthritis,<sup>58</sup> chronic kidney disease,<sup>59</sup> and chronic obstructive pulmonary disease,<sup>60</sup> Alzheimer's disease,<sup>61</sup> cancers,<sup>62</sup> anaemia,<sup>63</sup> and low-birth weight baby.<sup>64-65</sup> Currently, however, there is a lack of consensus among experts on the nature of these associations and confusion among health care providers and the public on how to interpret this rapidly growing body of science.<sup>66</sup>

The relationship between PD and CAD is predominantly epidemiological based on cross-

sectional and longitudinal studies, and their meta-analysis. The association between the two public health problems is independent of traditional cardiovascular risk factors.<sup>43</sup> However; epidemiological studies can only suggest association, no causal relationship. Proving a causal link between PD and CAD will require large randomized controlled trials in which individuals are randomized to treatment vs. usual care of PD and followed carefully for CAD events. Such studies are lacking to date; and carrying out randomized control trials in this subject may be of ethical issue, because PD has already been found to have deleterious effect on human health, and depriving a study group of standard treatment of PD may be irrational.

Surrogate variables like C-reactive protein, antibodies against oral bacteria, endothelial function assessed by flow-mediated dilatation of brachial artery, have been used as outcome variables in the studies relating PD and CAD; positive link has been found between the surrogate variables, PD and CAD, and beneficial effects of treating PD on these surrogate variables have also been documented.<sup>67-69</sup>

Periodontal treatment resulted in consistent and progressive reductions in systemic inflammation and biomarkers of atherosclerosis. However, no studies have used hard outcomes such as primary or secondary cardiovascular events. Also, there are no studies on the effects of periodontal treatment on primary prevention of atherosclerosis, and only one feasibility trial is available to date on secondary prevention.<sup>43</sup> The existing secondary prevention trial is the PAVE (Periodontitis and Vascular Events) study, a multicenter study involving subjects with established CAD and PD. These patients were randomized to receive either non-surgical periodontal therapy (experimental group) or basic oral primary care (control group). There were increased, but non-significant adverse cardiovascular events in the primary care (control) (6.6 vs. 3.3%) group.<sup>70-71</sup> Also, maintaining and promoting oral health has been found to be cost-effective.<sup>72-73</sup>

Traditionally, oral health and periodontal disease was neglected and left to the domain of dentists. However, in the recent years, it has become a

matter of a growing tide of interest, swelled by a burgeoning literature, specially because of the possible link between PD and a number of chronic diseases.<sup>74</sup>

### **Risk Factors for PD in Bangladesh**

Besides the well-known risk factors, ignorance and illiteracy, low socioeconomic condition, smokeless tobacco consumption, malnutrition and hypovitaminosis D may contribute to the prevalence PD in Bangladesh.

### **Poor dental hygiene**

Dental hygiene appears to be a neglected subject, and poor dental hygiene is common in Bangladesh,<sup>49</sup> specially in the adults and the economically weak population.<sup>50,52</sup> Most of the people do not follow the basic rules of dental health. Regular brushing and flossing are not practiced methodically, scaling is done infrequently. Unsafe materials like wood coal, wood ash, and traditional tooth powder, even sand are used by people, specially those of low-socioeconomic condition in urban slums and rural areas. These factors may compromise oral hygiene and predispose to PD. A study among 1200 school students aged 10-15 years in Dhaka city revealed that 69.2% respondents brushed their teeth regularly, 69.2% brushed once a day, 27.5% twice and only 3.3% more than twice a day; 92.5% used toothbrush and 83.3% used tooth paste.<sup>75</sup> Contrary to the urban setting, tooth brush users were only 33.2% among the rural school children in another study involving 250 school children.<sup>54</sup> Among the elderly patients attending the Outpatient Department of BIRDEM Hospital, Dhaka, daily tooth cleaning was practiced by 90%; tooth brush users were 79%, tooth paste users 85%, dental floss users 44%, brushing time of 1-3 minutes was followed by 49%, and 82% of those taking snacks between meals did not clean the mouth after snacks.<sup>53</sup> However, this is an urban hospital mainly catering to the relatively well-to-do people, hence may not represent the majority.

### **Ignorance and illiteracy**

PD has a reciprocal relationship with educational level;<sup>14</sup> the higher the educational level, the lower the periodontal diseases. Despite recent advances, the adult literacy rate in Bangladesh

remains low e.g. 57.7%.<sup>76</sup> The illiterate people are unaware of the concept of healthy lifestyle, including importance of dental health. Even the literate people are relatively less motivated about oral hygiene. The physicians often leave this issue to the dentists. In a study involving the urban school children in Dhaka city,<sup>75</sup> 92.5% understood the importance of taking care of oral cavity, 76.7% agreed that regular brushing would prevent tooth decay, 67.5% knew that sweet food caused harm to teeth and 50.0% thought that soft drinks would have the same effects on teeth. Again, this was an urban school-based study mainly involving the well-to-do children, and hence may not be representative of the general people of Bangladesh.

### **Low socioeconomic condition**

The possible relationship between periodontal disease and socioeconomic status was found in several studies.<sup>77-81</sup> In Bangladesh, a large number of the people still live in low socioeconomic condition; the country's gross national income per capita was only USD 2,030, 3.6% of GDP was for total health expenditure, and the per capita health expenditure was only USD 68 in 2012.<sup>82</sup> This low-income population in general is more prone to malnutrition and infection, and becomes victim to poor oral hygiene, including PD. In a recent study in Dhaka city,<sup>75</sup> 69.2% of the school children went to dentist on requirement basis and only 8.3% underwent regular dental checkup. Again, this is an urban school-based study mainly involving the well-to-do children, and hence may not reflect the real scenario of Bangladesh.

### **Smoking and smokeless tobacco use**

Besides its major role in CAD, smoking is a strong risk factor for PDs; down-regulation of anti-inflammatory factors and up-regulation of pro-inflammatory cytokines may be the explanation.<sup>83,84</sup> Also, smoking cessation has beneficial effect on occurrence and healing of PD.<sup>85-86</sup> Besides cigarette smoking, consumption of smokeless tobacco e.g. betel quid chewing with or without tobacco leaf is a recognized risk factor for PD and its severity.<sup>87,88</sup> Tobacco consumption is quite common in Bangladesh: prevalence is 51.0% for any form, 26.2% for smoking and 31.7% for smokeless tobacco.<sup>89</sup> In a recently

published study, betel quid chewing was found in 33.2% of rural population.<sup>90</sup> Bangladesh is one of top 10 countries that make up two-thirds of the world population of smokers.<sup>91</sup> Such a high prevalence of smoking and smokeless tobacco consumption presumably play important role in the prevalence of PD in Bangladesh.

### Diabetes Mellitus

Diabetes mellitus has been found to be associated with occurrence and severity of PD.<sup>92-93</sup> Exact prevalence of DM in Bangladesh is not known. According to the (NCD) Risk Factor Survey 2010,<sup>89</sup> prevalence of self-reported or documented DM is 3.9% (men 4.3% and women 3.6%). The prevalence of DM in rural population was 7.2% in a recent study.<sup>94</sup> Like in all other developed and developing countries, prevalence and incidence of type 2 DM is increasing in Bangladesh. In 2010, the International Diabetes Federation (IDF) estimated that 5.7 million (6.1%) and 6.7 million (7.1%) of people living in Bangladesh is suffering from DM and impaired glucose tolerance (IGT) respectively; by 2030, that number of diabetic population is expected to rise to 11.1 million.<sup>95</sup> High prevalence of diabetes may contribute to the burden of PD in Bangladesh.

### Obesity

A significant association exists between obesity and periodontitis.<sup>96-7</sup> Bangladesh is going through an adult nutritional transition with increases in pre-obesity and obesity particularly in urban areas.<sup>98</sup> In general, 21.5% adults (male 21%, female 22%) have body-mass index (BMI)  $\geq 25$  kg/m<sup>2</sup>; increased waist circumference is alarming especially in women (33.7%).<sup>89</sup> However, the significance of obesity and its contribution to PD has not been studied in Bangladesh.

### Metabolic syndrome

Recently, a positive link has been found between the metabolic syndrome and PD.<sup>99</sup> As a result of socioeconomic transition, lifestyle, as well as, the dietary pattern is changing in Bangladesh. Logically, metabolic syndrome is becoming an important health issue in this country, as well. The prevalence of metabolic syndrome has been found to be 20.7%, 11.2% and 8.6% following modified Adult Treatment Panel III,

International Diabetes Federation and World Health Organization definitions, respectively.<sup>100</sup> In a recently published study, 19.5% of older persons in rural Bangladesh - 20.8% women, and 18.0% men - had metabolic syndrome.<sup>101</sup> Prevalence of metabolic syndrome presumably contributes to both PD and CAD in Bangladesh.

### Osteoporosis

There may be a relationship between osteopenia, oral bone loss, and PD,<sup>102-104</sup> and osteopenia does play a role in the expression of PD.<sup>14</sup> The exact prevalence of osteoporosis in Bangladesh is not known. Limited data indicate that Bangladeshi women may have lower bone mineral density in comparison to that in the western population.<sup>105</sup> Osteopenia and osteoporosis seems to be a common problem in Bangladeshi population; in a recent study involving women, 43.6 and 5.5% of 16-45 year old women, and 40.7 and 41.8% of 46-65 year old women had osteopenia and osteoporosis, respectively.<sup>106</sup> High prevalence of osteoporosis may contribute to PD.

### Hypovitaminosis D

Vitamin D deficiency predisposes to PD and tooth loss, and vitamin D supplementation may have protective and beneficial effect on dental health.<sup>107-110</sup> Few studies have been carried out to determine the prevalence of hypovitaminosis D in Bangladesh. There may be high prevalence of vitamin D deficiency in the population; 78% of university students and 83% of veiled women had hypovitaminosis D.<sup>111-112</sup> Further research is needed to find out the association, if any, between vitamin D deficiency and PD in Bangladesh.

### Malnutrition

In the recent decade, Bangladesh has made spectacular health achievement despite economic poverty, which has been termed 'Bangladesh paradox'. The Bangladesh paradox shows the net outcome of successful direct health action in both positive and negative social determinants of health—i.e., positives such as women's empowerment, widespread education, and mitigation of the effect of natural disasters; and negatives such as low gross domestic product, pervasive poverty, and the persistence of income inequality.<sup>113</sup> However, despite epidemiological

and adult nutritional transition, a high percentage of the population of Bangladesh remains undernourished.<sup>98</sup> The prevalence of underweight (weight-for-age z-score <-2) among children aged <5 years is still high (41%), nearly one-third of women are undernourished with body mass index of <18.5 kg/m<sup>2</sup>, and the prevalence of anaemia among young infants, adolescent girls, and pregnant women is still at unacceptable levels.<sup>114</sup> In 1995/96, prevalence of anaemia was 74% in general, 64% in urban areas and 77% in rural areas. Iron deficiency may be an important cause of anaemia in the Bangladeshi population.<sup>115</sup> In a recent study in Noakhali region, 55.3% university students were found anaemic, of whom 36.7% were male, and 63.3% were female.<sup>116</sup> Such a high prevalence of under-nutrition and accompanying anaemia, osteoporosis and hypovitaminosis may presumably predispose to PD.

### Psychological factors

In the recent years, a positive relationship between psychological factors including stress and periodontal disease has been described.<sup>117-118</sup> Mental illnesses are important but under-recognized public health problems in Bangladesh; awareness about mental illness and acceptance of treatment are very low due to social stigma and superstition.<sup>119</sup> Nation-wide survey on mental health in Bangladesh in 2003-2005 found the prevalence of mental disorders 16.05% in adult population.<sup>120</sup> In other studies, the prevalence of mental disorders was 28% in urban areas<sup>121</sup> and 16.5% in rural areas.<sup>122</sup> No definite studies have been carried out in Bangladesh to find out the significance of psychosocial stress in the context of PD in this population.

### Future Directions

Data related to different aspects of periodontal disease as well as of IHD in Bangladesh are inadequate. Large, preferably nationwide epidemiological and clinical studies should be carried out to gain reliable information on these important public health issues. Mass awareness should be created regarding health impact of bad oral hygiene, and health benefit of promoting good oral hygiene. Physicians should be trained of basics of periodontal disease. Oral hygiene should not be left exclusively to the jurisdiction

of the dentists; rather the physicians and dentists should work hand in hand. Dentists should pay attention to the risk factor management in relation to PD and IHD for smoking cessation, reduction of sugar consumption, and weight control while dealing with individual patient.<sup>123</sup> Periodontal disease prevention should be integrated with primary health care. Oral health promotion should be part of the national media strategy and the health education curriculum. The public health approach should target population-wide life style intervention, screening for components of metabolic syndrome including DM and obesity. Healthy lifestyles including consumption of heart-healthy diets, avoidance to smoking and smokeless tobacco, moderation of sugary diets, should be promoted. All sorts of tobacco consumption should be discouraged, and should be dealt with rigorously. Necessary legislative and administrative steps should be taken in this regard. Special attention should be given to stop malnutrition and under-nutrition. Public awareness should be created to avoid childhood obesity. If indicated by further research, vitamin D deficiency should be avoided by fortification of food. Intensive research, may be in collaboration with international organizations, should be undertaken to explore the still-unidentified risk factors unique to this nation which are responsible for the prevalence of PD and IHD in Bangladesh.

### Conclusion

Periodontal disease is associated with IHD independent of traditional cardiovascular risk factors. Treatment and prevention of PD can help to prevent IHD, and probably a number of other diseases. Management of PD and promotion of oral health may be feasible and cost-effective. Both PD and IHD appear to be highly prevalent in Bangladesh, so, having great public health importance. Future research will hopefully determine the different aspects of PD and IHD in Bangladesh, including the link between the two. The information available thereby, would help to formulate national policy to combat these important public health issues more efficiently in future.

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**Conflict of Interest - None.**

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