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Research Article

Association of Poor Oral Health (OH) with Obesity-Further Emphasis on Childhood OH, Including Salivary Parameters, Reduction in Sweetened Beverages, Tax on Same, CGAS Regarding SNP Associated with Obesity, OH, Metal Changes in Tooth and Blood and Association with T2DM and Metabolic Syndrome in Elderly

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Abstract

Incidence of obesity with its co-morbidities is increasing worldwide in adults along with children and adolescents. Poor oral health (POH) has been seen to be associated with obesity. Earlier we have reviewed how POH is correlated with obesity. Here we further emphasize on how OH has to be improved right from infancy, cut down on soft drinks and improve dental habits of those having high socioeconomic status (SES) besides aiding those who are deprived. So much so that in some countries sweetened beverages are getting taxed, further the salivary changes in children having POH and DFMT (decayed, filled, missing teeth) decayed/extracted/missing teeth (demt) changes are discussed and correlation of type 2 diabetes (T2DM) and its interlinking with OH which forms a vicious cycle in control of sugars and interlinking of metabolic syndrome (MetS) in elderly with oral hygiene, number of teeth and speed of eating is discussed. Role of obesity in peri-implant health, various genes correlating with obesity and POH along with changes in minerals in teeth are further explored.

Keywords: *POH; SES; Obesity; Sweetened Beverages; Tax; T2DM; MetS; DFMT; Peri-implant Health*

Introduction

Obesity continues to be a big public health problem, with its prevalence increasing continuously. As per the WHO it has been estimated that in last 40 years, obesity prevalence almost tripled and in 2016, over 650 million people around the world, which included various million infants and children became obese [1]. Increased body weight is associated with development of several severe chronic conditions like type 2 diabetes mellitus, (T2DM), cardiovascular disease (CVD), musculoskeletal disorders and different cancers [2]. Every year because of overweight/obesity, there are 28 million deaths worldwide [2]. Further obesity leads to a big medical, social and economic burden [3]. Earlier we had reviewed the correlation of obesity and oral health (OH), in different obesity related morbidities and changes at the extremes of ages [4-6]. Here we further update the association of obesity and OH further in extremes of age including infancy, childhood and elderly.

Methods

We searched by the pubmed search engine using the MeSH terms obesity, OH, periodontitis, salivary markers, genes associated, different metals associated with dentine changes in children and elderly in update of articles from 2018 - 2019.

Results

On literature search we found a total of 54 and further 15 articles on checking for counter references used for this review. No meta-analysis was done.

Obesity results in onset of various systemic diseases like type 2 diabetes mellitus (T2DM), metabolic syndrome (MS), hypertension, and certain cancers [7]. Besides that there is change in production and release of important defense cells, like neutrophils that are recognized as the 1st line of defense for periodontal tissues and T and B lymphocytes. In obesity, that is responsible for cellular and humoral responses [8]. This inflammatory state gets reflected by an increased circulating levels of proinflammatory proteins and occurs both in adults along with children and adolescents. Inflammatory mediators get secreted by adipose tissue and the immune system that can create hyperinflammatory states [9,10].

Most oral inflammatory diseases apparently originate locally but have certain predisposing factors [11]. Hence obesity is considered a risk for periodontal health [12]. Most systematic reviews have found prevalence of periodontal health in obese adults [13], but fewer studies have examined periodontal health in overweight/obese children and adolescents [9, 14]. Gingivitis is there in subjects of all ages that includes children and adolescents and mostly precedes periodontitis [15]. This needs general practitioners to be aware of link between obesity and periodontal disease [16]. A recent systematic review and meta-analysis linked periodontal changes in children might be associated with obesity [7].

Salivary immunoglobulins play an important role in Inflammatory diseases of the oral mucosa [11]. Salivary immunoglobulin A (s IgA) secretion confers a protective role against oral bacteria, inhibits the adhesion of microorganisms to the surface of mucosal cells, and hence protect against their penetration into organic tissues [11,17]. It has been suggested that an increased s-IgA level is associated with a lesser risk of developing gingivitis [18], although few studies in children exist on this topic. Additionally, studies have shown that chronic stress promotes a decrease in s IgA in children. Hence s IgA is an important biomarker of immune balance in children and may oral disease development. Thus, Perez., *et al.* aimed to determine correlations and associations between gingival inflammation (Simplified Oral Hygiene Index, and Gingivitis Index), Salivary immunoglobulin A (s IgA), and salivary parameters (salivary flow and osmolality) in normal weight and overweight/obese children. 91 children aged 6 - 12 years (8.6 ± 1.9 years) were divided into 2 groups according to their body mass index (BMI), circumferences, skinfold measurement and body fat percentage: normal weight group (NWG; n = 50) and overweight/obese group (OG; n = 41). A calibrated examiner performed the clinical examination using the Simplified Oral Hygiene Index, and Gingivitis Index and salivary collection. Data analysis included descriptive statistics and association tests ($p < 0.05$). They found OG presented statistically > s IgA values as compared to NWG, mainly in obese children ($p < 0.05$). Significant positive correlation between s IgA and salivary osmolality in OG ($p < 0.05$), and between s IgA and BMI values ($p < 0.05$) and body fat percentage ($p < 0.05$) were seen in all children. Effect size varied from moderate for s IgA values (d = 0. 5) to large for BMI (d = 2.60). Thus, they concluded that gingival inflammation and salivary parameters were similar for NWG and OG, though s IgA presented higher values in OG with correlations between BMI and body fat percentage [19].

Further Lehmann Kalatta., *et al.* studied whole mix saliva for 16 soluble parameters that covered 4 categories (inflammation, oxidative stress, endothelial dysfunction, adipokines). In the discovery group, 19 obese and 25 non-obese women matched for age, having similar hygiene habits with no comorbidities and not taking any medication known to affect saliva secretion were analyzed. In the validation group, a cohort of no preselected 81 individuals (34 obese) were analyzed. They found individuals having obesity had significantly salivary concentrations of several cytokines and adipokines, of which TNF-R1, serpin A12 and PAI -1 were identified as parameters discriminating between obese and non-obese subjects with the highest sensitivity and specificity. Thus, they concluded that obesity distinct changes in the concentrations of several parameters in the saliva. These findings may have diagnostic role in distinguishing the effects of obesity and obesity linked comorbidities on oral health [20].

Obesity and oral health (OH) share common risk factors as both are associated with unhealthy dietary habits -sugary soft drinks, snacks and sugar rich diets. Hence the world health organization (WHO) emphasizes on the need to adopt a unified approach for the promotion of general and oral health instead of the previous single level strategies [21]. This common risk approach has been proposed a more rational, cost effective, sustainable, and affordable. The period from childhood to adolescence is the early stage of life in a time when children acquire important behavioral habits that is pertaining to their general and oral health. Unfortunately, poor dietary habits that are established In childhood tend to be carried throughout adulthood. Increased urbanization and economic development in most countries have led to adverse dietary changes, towards consumption of sugar and fat, with decreased intake of dietary fibers, which impairs OH as well as increases BMI [22]. Obesity is abnormal or excessive fat accumulation which impairs health. Sugar (sucrose) or some other carbohydrates are the ones documented to be the main dietary culprit in dental caries. Per capita sugar consumption directly varies with dental caries prevalence in any nation that has been seen during world war II [22]. A correlation may exist between dental caries and obesity especially in children, since they can tolerate sweets than adults, the “BLISS EFFECT” [23]. For measuring the involvement of dental caries in terms of the number of teeth WHO recommends DMFT/deft index. Thus, Halder., *et al.* tried to study the correlation if any between obesity and OH. A cross-sectional study was done in 5 districts of West Bengal in India. A total of 1227 school going children of 6 - 12 years were examined from the district of Hooghly, West Midnapore, South 24-parganas and North 24-parganas. Following indices were analyzed. Decaying missing filled teeth (DMFT), decayed, extracted, filled teeth (deft), Simplified Oral Hygiene Index (OHI-S). Depending on their nutritional status subjects were categorized as being normal weight, and overweight/obese. Logistical regression analysis were applied to the study to find an association between the above dental indices and independent variables like gender and nutritional status. They found a positive association between obesity and OH. Thus, they concluded that obesity is related to oral hygiene status of children. Thus, dietary modifications was needed to improve the oral hygiene status [24].

Similarly, Khadri., *et al.* tried to study the effects of obesity on dental caries among school children in Sharjah, UAE. 803 school children, between 11 - 17 years were studied in the form of a randomized cross-sectional manner using 2 questionnaires. The 1st assessed the socioeconomic and general health while the 2nd detailed their demographic, oral hygiene, and dietary habits. Dental examination included dental caries assessment using the WHO 1997 criteria and gingival health evaluation. Clinical examination consisted of height, weight, and BMI. Data analysis was done by descriptive, univariate and multiple regressions. They found that in this sample 75% had dental caries and the mean decayed, missing, and filled teeth (DMFT) was 3.19 (standard deviation: 2.9). In 15% adolescents obesity was seen and the mean BMI was 21. The link between DMFT and BMI when evaluated using univariate analysis, showed a significant correlation ($r = 0.097$, $p = 0.006$), indicating that the rise in BMI by 10 points increase in DMFT by 0.57. However in the multivariate analysis, a significant relationship was only seen between father’s education ($p < 0.001$), adolescents age ($p < 0.001$), gender ($p = 0.008$), ethnicity ($p < 0.001$), soft drink consumption with DMFT while BMI showed a significant association with age ($p < 0.001$), school fees ($p = 0.005$), obesity in family ($p < 0.001$) and soft drink consumption ($p < 0.001$). Thus, they concluded that obesity and dental caries were not significantly associated. The most important predictor for obesity and dental caries was soft drink consumption [25].

Al Khaday F., *et al.* studied 20 patients with BMI 27.5 kg/m^2 and 18 non-obese controls. All patients had indications for single or mandibular molar replacement with the adjacent teeth intact. Peri-implant clinical (plaque index [PI], bleeding on probing [BOP], probing depth [PD]) and radiographic (marginal bone loss [MBL] were measured at 12, 24 and 60 months of follow up. They found all parameters showed statistically significant difference between obese and nonobese individuals. Obese group recorded significantly BOP, PD and MBL at different observation times. PD and MBL increased significantly with advance of time in both groups. After 60 months of follow up period, greater PI and BOP was observed in obese patients ($p < 0.01$). At 60 months follow up period, obese patients showed significantly increased PD (3.69 mm) as compared to nonobese individuals (2.46 mm). MBL varied in nonobese individuals from 0.30 mm after 12 months, reaching 0.55 mm after 560 months of follow-up period while in obese patients MBL values went from 0.36 mm after 12 months to 0.91 mm at 60 months ($p < 0.01$). Thus, they concluded that patients having obesity are at risk of increased Peri-implant soft and hard tissue inflammation. Thus, they recommended that clinicians need to educate obese patients about risk of increased peri-implant tissue inflammation and susceptibility to bone loss and need stringent oral hygiene for ideal peri-implant health [26].

Elgar W., *et al.* studied 1628 children between ages of 6 months - 9 yrs where besides dental examination regarding decayed, missing, filled teeth (dmft) index in primary dentition and evaluated oral hygiene, the BMI standard deviation score (BMI SDS) along with recording socioeconomic status (SES). They found that the presence of overweight/obesity was associated with higher caries prevalence ($p < 0.001$), a lower SES and non-optimal OH were associated with increased dmft. The Poisson regression also showed a significantly higher risk in the combination of a high SES and overweight/obesity βlow-high = 0.21, p = 0.01). The increase was evident in both good and poor OH. In contrast, there was no significant difference between the lower and middle social strata (low-medium = 0.03, p = 0.6). With increasing age, the BMI influence decreased (age: BMISDS = -0.06; $p < 0.001$). Thus, they concluded that BMI, OH and SES are important factors in caries prevalence. In the highest social class, however, increased body weight has an adverse effect regardless of OH [27].

Breaher and Lewis further emphasized in the role of OH in infancy although infants are not born with teeth and only a few teeth erupt during the 1st year of life. However, infancy is a critical time for formation of habits. Positive habits like twice daily brushing with fluoride tooth paste starting at 1st teeth eruption provides topical fluoride. Negative habits, such as bottle propping and frequent juice consumption reinforces behaviors that promote caries and obesity. Congenital anomalies affecting the mouth as well as acquired conditions, primarily dental caries were reviewed by them. Further OH preventive modalities, including professionally applied products and home based strategies were discussed [28].

Schmidt., *et al.* in the Leipzig research centre for civilized diseases (LIFE) child study included 498 adolecents (10 to 18 yrs). Early signs of periodontal inflammation were measured by PD at six teeth (16, 11, 26, 36, 31, 46). Blood levels of stress related hormones (cortisol, dehydroepiandrosterone-sulfate [DHEAS-S]) and along with that interleukin-6 (IL-6) were measured. SES, OH, orthodontic appliance and nutritional status, recorded by BMI-SDS, were considered as confounding factors. Further in 98 participants, an oral chair side active matrix metalloproteinase-8 (aMMP-8) test was done. Statistical tests were the Mann Whitney U tests, chi-squared tests and multivariate logical regression model. They found, IL-6, BMI SDS, as well as aMPP test results were significantly associated with maximum PD > 3 mm ($p < 0.05$). However no statistically significant associations between stress related hormones (cortisol and DHEA-S) and presence of maximum PD. >3 mm were found ($p < 0.05$). Higher DHEA-S and BMI were associated with a positive aMMP-8 result, even after adjusting for age and gender (p = 0.027, PADJ = 0.026). Thus, Concluding that the results reveal no associations between PD and stress related hormones (cortisol and DHEA-S). aMMP-8 test result might be associated with DHEA-S levels. Nutritional status seems to influence periodontal diseases in adolescents. Thus, clinically in view of DHEA-S and BMI SDS showing associations with early stages of periodontitis in adolescence aged 10 - 18 years, this association should be confirmed by the investigation of high risk groups [29].

Haake R., *et al.* tried to confirm common genetic factors between periodontitis and metabolic traits using Candidate Gene Association Study (CGAS) in the Korean Population. Based on the analyses of CGAS, this study did linear regression analysis to examine the single nucleotide polymorphisms (SNPs) between periodontitis and metabolic syndrome traits. Among the analyzed SNPs, 2649 SNPs in 5 genes (TENM2, LDLRAD4, SLC9C2, MFSD1 and A2BP1) showed a statistical significance at ($p < 0.05$). Interestingly A2BP1 and TENM2 were related to obesity. Also increased LDLRAD4, SLC9C2 and MFSD1 were seen in patients with high blood pressure. Taken together this study suggests that some of the SNPs are related to periodontitis. Therefore, if any of TENM2, LDLRAD4, SLC9C2, MFSD1 and A2BP1 is detected in patients with periodontitis, obesity and BP have to be treated simultaneously [30].

Onagan., *et al.* suggested that in view of increased sweetened beverage consumption in Philippines along with increasing incidence of obesity a proposal to tax sugar sweetened beverage was introduced in the House of Common representatives and merged into a proposed comprehensive Tax reform for Acceleration and inclusion (TRAIN) Bill to increase the likelihood of acceptance. The health department and finance department recommended policy that would maximize the benefits both to the public health and department revenue. To advance discussions, the health department expanded the health argument to include the country's poor performance In OH. The approved TRAIN Law adopted the terms sweetened beverage to emphasize that the tax covers both sugar and non-sugar sweetened beverage. The tax rate was set to 6.00 Philippines pesos (0.111US $) per liter of sweetened beverages. The sugar industry successfully lobbied for higher tax rates on sweetened beverage containing high fructose, corn syrup, resulting in differential rate of 12.00 Philippines pesos per liter. Despite a 12% value added tax on sugar sweetened beverages, sales had been sustained by enhanced marketing and product variants being offered In smaller portions. One month after the implementation of tax on 1st January 2018, prices of arable sweetened beverage had increased by 16.6% to 20. 6% and sales in sari-sari (convenience) scores had declined to 8.7%. Thus, the lessons learnt were that the tax benefited from high level government commitment and support, keeping policy simple, reduced opportunities for tax avoidance and evasion, and taking both health and non-health considerations into account were helpful in arguing for the tax [31].

Paiss M., *et al.* conducted a cross sectional study among children in Plymouth city aged 4 - 6 yrs, anthropometric measurements included weight and height (converted to BMI percentiles and z scores), waist circumference (WC). Caries was assessed by using the sum of the number of teeth that were decayed, missing or filled. A questionnaire was used to get information on children's demographic characteristics, OH, and dietary habits. The impact of deprivation on anthropometric values and caries was determined using Linear and Poisson regression models respectively. Multiple logistic regression was used to Study the impact of various demographic characteristics and health behaviors on the presence of obesity and caries. They found that total sample included 347 children aged 5.10 ± 0.31 (mean ± SD). Deprivation had a significant impact on caries and BMI-z scores ($p < 0.05$). Neither BMI nor WC z scores were shown to be significantly associated with dental caries. Among the neighbourhood characteristics examined the percentage of people dependent on benefits was found to have a significant impact on caries rates ($p < 0.05$). Households total annual income was inversely related to the caries risk and parental educational level affected children's tooth brushing frequency. Thus, they concluded that no associations between any measure of obesity and caries were found. However, deprivation affected both obesity and caries, which highlights the need to prioritize disadvantaged children in future prevention programmes [32].

Yalcin SS., *et al.* aimed to assess element status in whole blood and tooth dentin and identify their correlation in overweight, obese children without metabolic risk factors. This was a case control study, where 40 overweight and 80 normal weight children aged 6 - 10 yrs were enrolled. Samples of blood and tooth were collected. While all studied elements were similar in groups in univariate analysis, after adjustment for confounding factors, tooth Mn levels were lower and blood Zn levels were higher in overweight/obese group ($p = 0.049$ and $p = 0.032$, respectively). A significant correlation in blood and tooth dentin levels of Sr and Zn were detected in both groups. In both biological substances the concentrations of elements did not significantly differ on overweight children without metabolic risk comorbidities as compared to healthy children of normal weight. Presence of low Mn levels in tooth dentin and high Zn in blood samples should be explored in future studies was their conclusion [33].

Since children with lower inhibitory control have weight gain over time and consume more snack foods, Rheo., *et al.* aimed to test whether a pilot program based on enhancing self-regulation in prescribed children could decrease consumption of energy dense foods, 92 preschool children were randomized into the intervention or control group the intervention was a three week, play based programs that focused on enhancing executive function skills and reducing the consumption of energy dense snack foods. Controls met for a similar length of time but focused on dental hygiene, good sleep habits/routines and physical activity. Primary outcome included calories consumption during the post-intervention. "Eating in the absence of hunger'' paradigm controlling for baseline calories consumed. Inhibitory control was assessed using the "Day/Night" and "less is more" tasks. There were no differences in post-intervention calories consumed between groups (p = 0.42). However post-hoc analysis revealed a significant interaction between group and weight status (p = 0.04). In calories (118.0 kcal vs 124.1 kcal respectively, p = 0.64). However, in the control group overweight/obese and healthy weight children consumed more than normal weight children (155.9 kcals vs 103.6 kcals respectively, p = 0.01). With regards to Inhibitory control, post-hoc analysis revealed a significant interaction between group and age (p = 0.03), with younger children in the intervention group scoring higher than younger children in the Control group (0.93 vs 7.8 respectively, p = 0.007). No differences were seen between groups among older children (0.93 vs 0.96, p = 0.42). These types of programs for preschool children may help to temper consumption of excess calories among overweight/obese children. Further development and investigation of pediatric programs that prevent consumption of excess calories are warranted [34].

Karaszand Bonuck carried out a 2 part project that includes a randomized controlled trial and a Knowledge translation campaign. A randomized controlled trial will enroll n = 360 families from pediatric practices serving South Asians in the New York metro area. The intervention group will receive home visits by SA community health workers at 6, 8, 10, 12, 14 and 16 months of age. Controls will receive culturally tailored educational material. Primary outcome, Cariogenic and obesogenic feeding practices at 6, 12 and 18 months will be assessed with the My Smile Buddy I Pad Based tool. Secondary outcomes include oral hygiene practices, anthropometric and caries incidence at 18 months. A public education campaign will focus on both families as well as healthcare. There are few Common Health/ Risk factor approach published studies on obesity and OH risk In the children despite health morbidity and costs associated with both conditions. CHALO comprises a multiple level intervention designed to promote culturally competent sustainable change [35].

As per WHO overweight and obesity are the causative factors for 44% of type 2 diabetes mellitus (T2DM), result in 23% of ischemic heart disease patients and roughly 7 - 41% of some cancers [36,37]. Of these greatest association is of T2DM with obesity, with obesity related T2DM expected to double to 300 million by the year 2025 [38]. Because of which the word diabesity got coined, suggesting that most patients with T2DM are overweight or obese [39,40]. Hyperglycaemia is associated with various complications,instead of can complications that are related to different organ systems, eyes, kidneys, nerves, heart and blood vessels [41]. People with uncontrolled T2DM are also at increased risk of developing OH problems especially periodontal (gum) disease [42]. Periodontal (gum) disease, both gingivitis and periodontitis, is a common inflammatory order caused by pathogenic microflora in the biofilm which forms adjacent to the teeth on a daily basis [36]. Gingivitis is the mildest form of periodontal disease in which inflammation is confined to the gingiva, can be reversible, with effective OH while periodontitis is the advanced stage where inflammation extends deep into the tissues and causes loss of supporting connective tissue and alveolar bone [36]. Tissue destruction in periodontitis break down of collagen fibres of the periodontal ligament and to the formation of periodontal pockets between the gingiva and the tooth. Periodontitis is a slowly progressing disease but the tissue destruction is mainly irreversible [36,37]. Further the bacteria located within periodontal pockets are highly inflammatory with some having the ability to survive in the blood stream and infect other areas of the body [38,39]. Moderate periodontitis affects roughly 40-60%of adults worldwide [40].

It is well known that T2DM and periodontitis are directly related. Hyperglycaemia affects periodontal outcomes and periodontitis also is harmful regarding blood glucose levels, thus worsening T2DM complications. Although mechanism by which T2DM and periodontitis are linked is not well understood in the absence of experimental findings from clinical studies [43]. Yet whatever current information is available, it supports the potential complex interaction involving aspects of inflammation, immune functioning, neutrophil activity and cytokine biology [43]. Hyperglycaemia possibly increases levels of various cytokines and mediators in saliva and gingival crevicular fluid (GCF), oxidative stress in periodontal tissues and formation of Advanced Glycation End products (AGE). The AGE-RAGE (receptors for AGE) interaction exaggerated inflammatory response and periodontal tissue destruction in T2DM [40]. Similarly, periodontitis promotes measures of systemic oxidative stress and raises serum levels of C Reactive Protein and other acute phase reactants and biomarkers of oxidative stress. Non-resolving chronic inflammation derive from periodontal disease also impacts on diabetes control (increased HbA1c and complications [40]. These interventional studies give a suggestion that periodontal treatment can improve blood glucose control [40,44-46], though the evidence is often thought to be of low quality [12], in view of the heterogeneity of the studies and small sample size [47,48].

In view of the findings that periodontal diseases has a relation with T2DM, the benefits of good oral health practices are needed to minimize the risk of periodontal diseases, it is of utmost importance that people having DM are motivated to engage in good oral hygiene behaviors and are provided with risk assessment and dental referrals as a part of routine diabetes care [49-51]. Various studies done worldwide have assessed the knowledge, attitudes and practices of people with DM relating to OH care, however synthesis of these results had not been done. This type of review has importance as adequate OH knowledge or literacy is positively associated with good OH behaviors like increased frequency of brushing and dental visits [52] and good periodontal health [53]. Further OH behaviors are influenced by the social determinants of health [54]. Those who are disadvantaged are from lower socioeconomic groups having unhealthy habits, poor knowledge, and attitudes to OH and uptake of dental services and hence more likely to suffer from the burden of oral disease [54]. Thus, Poudel., *et al.* carried out a systematic review of literature on 5 databases using key search terms. The inclusion criterion were i) published in English language ii) from 2000 to Nov 2017 iii) conducted on persons with any type of DM and all ages iv) explored at least one study outcome knowledge or attitudes or practices towards oral health care and v) used quantitative methods for data collection. No restrictions were placed on the quality and setting of the study. They selected a total of 28 studies, which met the inclusion criteria. The total number of studies were 27,894 people having DM and were conducted in 14 countries. It was found that people with DM had inadequate OH knowledge, poor OH habits and few dental visits. They rarely received OH education and dental referrals from their care providers. And referral to dentists when required was associated with improved OH behaviors among them. Thus, concluding that overall people with DM had limited OH knowledge and poor OH behavior. Thus, it is essential to educate patients about their poor oral health behaviors, along with motivating them for good OH behaviors and facilitate them to dental care [55].

Metabolic Syndrome (MetS) is a combination of risk factors for coronary artery disease (CAD) and T2DM, including high cholesterol, high blood pressure (BP), hyperglycaemia, abdominal obesity, hypertriglyceridemia and low levels of high density lipoprotein (HDL) cholesterol. Once these risk factors are present at the same time it increases the risk of CAD and T2DM [56]. MetS is affected by diet and exercise habits [57]. Relationship between MetS and OH has been proved in different studies, like dental caries, periodontal disease and the number of the remaining teeth [58-61]. This is secondary to tooth loss caused by dental caries, periodontal disease affects masticatory function and diet [62,63] and chronic inflammation and oxidative stress are common risk factors in individuals having periodontal disease and MetS [64]. Earlier studies have studied the relationship between OH status and MetS mainly in middle aged population. As per the 2014 Nutritional Health and Nutrition Survey done in Japan, the prevalence of MetS in the Japanese adult population is increasing with advanced age and percentage of individuals having MetS with advanced age and percentage of those with MetS at > 75 yrs or roughly 25% which is less than that in middle aged and younger population. MetS imposes a significant risk of dementia and cognitive decline as well as CAD and T2DM in elderly people [65,66]. Further MetS also causes progressive disability and reduced mobility in the elderly [67,68]. Thus, Saito., *et al.* analyzed in a cross-sectional oral and medical health check update from 2379 participants aged 75 and 80 yrs. MetS index was diagnosed according to the Harmonization criterion, with the exception of that for central obesity and BMI was used instead of WC. Logistic regression analysis was performed to evaluate the condition between OH status and lifestyle factors in both sexes and by sex. In both sexes they found the odds ratio (OR) for MetS was 1.54 (95% confidence interval [CI]. 1.10 - 2.17) among those who had 0-9 teeth compared with those with 20 - 28 teeth. MetS was significantly more likely for those eating quickly than those eating slowly (OR 2.06; 95%CI 1.35 - 3.16). Participants using secondary OH products every day had A significantly lower OR (0. 71; 95%CI 0.55 - 0.92), for MetS than did those who did not. Participants those who had 0 - 9 teeth who ate quickly had a significantly higher OR (2.48; 95%CI 1.06 - 5.78) for MetS slowly compared with those with 20 - 28 teeth who ate slowly. Thus, concluding maintaining teeth, eating slowly and using secondary OH products every day are associated with a lower chances of MetS in the aged population [69].

Conclusions

Incidence of obesity and poor OH is increasing in children of all ages. Importance is given to starting good oral habits right from infancy when no teeth have erupted. Socioeconomic status (SES) has high relevance to poor OH with both high SES children along with deprived children at risk of developing periodontitis. Importance is also given on prevention of sweetened beverages so much so that a tax has been laid in Philippines to control various periodontal diseases in children. On studying CGAS if any of SNP like TENM2, LDLRAD4, SLC9C2, MFSD1and A2BP1 is detected in patients with periodontitis, obesity and BP have to be treated simultaneously. DMFT/deft are the common studied parameters as per WHO regarding obesity and OH. Obesity is a risk factor for peri-implant soft and hard tissue inflammation, hence dietary modifications are needed. Presence of low Mn levels in tooth dentin and high Zn in blood samples should be explored in future studies. As far as elderly are concerned maintaining teeth, eating slowly and using secondary OH products every day are associated with a lower chances of MetS in the aged population. People with DM had inadequate OH knowledge, poor OH habits and few dental visits. Thus, it is essential to educate patients about their poor oral health behaviors, along with motivating them for good OH behaviors and facilitate them to dental care.

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