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THE EFFECTS OF CHRONIC PERIODONTITIS AND OBESITY ON TOTAL ANTIOXIDANT/ OXIDANT STATUS AND OXIDATIVE STRESS INDEX

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Abstract

Objective. Both obesity and periodontal diseases are significant diseases that affect the quality of life. Recent studies have focused on the relationship between obesity and periodontal disease. The aim of this study is to determine the pathophysiological relationship between obesity and periodontal disease by evaluating the clinical periodontal parameters and oxidative status.

Subjects and Methods. The study included 80 individuals divided into four groups including 20 individuals in each group as following; periodontally healthy patients with normal weight, (NH), patients with chronic periodontitis and normal weight (NCP), periodontally healthy patients with obesity (OH) and patients with chronic periodontitis and obesity (OCP). Clinical periodontal parameters were recorded, and serum, saliva and gingival crevicular fluid (GCF) samples were obtained. Local and systemic levels of total antioxidant status (TAS), total oxidant status (TOS), oxidative stress index (OSI) were assessed biochemically.

Results. No statistically significant difference was found among the groups regarding TAS, TOS and OSI values in serum and saliva samples ($p>0.05$). GCF-TAS values in NH group were statistically significantly higher compared with other groups ($p<0.05$). GCF TOS values increased in obese groups (OH, OCP) compared with non-obese groups (NH, NCP) ($p<0.05$). Our results suggest that obesity and chronic periodontitis do not effect oxidant/antioxidant levels in serum and saliva.

Conclusions. Many factors such as daily living conditions of the individual, stress and nutritional habits TAS and TOS levels of the individual may affect oxidative stress parameters. However, these factors could not be standardized in the study.

Keywords: obesity, oxidative stress, periodontal disease.

INTRODUCTION

Periodontal diseases are one of the most commonly seen bacterial infections in people. Periodontitis is the most frequently detected cause of irreversible tissue losses in the periodontal tissues. The primary etiological factor of periodontitis is facultative or Gram-negative anaerobic bacteria in the subgingival biofilm. A substantial part of periodontal tissue damage emerges as a result of excessive host response in contradiction of these bacteria and their products (1). The recent researches have shown that periodontal inflammation is correlated with obesity and systemic disorders such as diabetes mellitus (DM) and cardiovascular diseases (CVD) (2-4).

Obesity is a chronic disease described by the increased ratio of body fat mass to fat-free mass resulting from energy taken by foods higher than energy expenditure. Obesity also may lead to many health problems unless it is controlled and it is related with a spectrum of pathological disorders including hypertension, diabetes mellitus (type II), CVD and cancer (5).

Free radical (FR) is the term used for the molecules carrying single or multiple unpaired electrons. These molecules that easily exchange electrons with other molecules are also named as oxidant molecules. Reactive oxygen species (ROS) are the most important free radicals formed in the human body. The substances that can prevent or delay oxidation of oxidizable substances such as lipids, proteins, carbohydrates and deoxyribonucleic acid (DNA) are called as antioxidants (AO) and this entity

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is termed as antioxidant defense. A certain level of increased oxidant molecules is eliminated by natural AOs always found at certain levels in the body (6).

There is always a balance between creation and elimination rates of FRs and this phenomenon is called oxidative balance. The organism is not affected by FRs as long as oxidative balance is maintained. A reduction in the formation or elimination rate these radical causes oxidative imbalance. This entity so-called "oxidative stress (OS)" simply indicates the serious imbalance between formation of FR and AO defense mechanism and consequently causes tissue damage. In other words, if the balance between antioxidants and oxidants shifts in favor of oxidants, this entity is named as OS. Oxidative stress may lead to tissue damage in many aspects (7). It was suggested that free radicals play a role in pathogenesis of many medical disorders including periodontal diseases. It has been demonstrated in many studies that ROS and OS biomarkers increased as AO capacity decreased in periodontitis and obesity (6,8).

Many studies have shown the presence of the relationship between periodontal disease and obesity (4,9,10). Although, the mechanism of this relationship is not yet clear, it is considered that hormones and cytokines originating from adipose tissue play a role in that mechanism. Excessive adipokines and adipocytokine release from the adipocytes may impact pathogenesis of periodontal disease by inducing inflammatory response. It has been exhibited that adipocytes also produce ROS and consequently increase OS in the body. It has been stated that increases OS and ROS have a significant role in periodontal disease. It is considered that increased production of ROS may induce a negative impact with respect to periodontal health in obesities (11,12). In our literature review, we have detected no research that investigated the association between periodontal diseases and obesity concurrently in blood, saliva and gingival crevicular fluid (GCF) samples based on oxidative indicators. In the light of all these informations, the purpose of this study is to compare total antioxidant status (TAS), total oxidant status (TOS), and oxidative stress index (OSI) levels in blood serum, saliva and GCF samples obtained from periodontally healthy and chronic periodontitis obese individuals with those obtained from periodontally healthy and chronic periodontitis non-obese individuals and to analyze the relationship of TAS, TOS and OSI levels with clinical periodontal assessment.

PATIENTS AND METHODS

Our study included totally 80 individuals who applied to Periodontology Department of *Gaziantep University* Dentistry Faculty to be examined and who were diagnosed with obesity by Endocrinology and Metabolism Diseases Division of *Gaziantep University* Medical Faculty between January 2013 and January 2014. The individuals were separated into 4 groups including 20 individuals in each group. Signed voluntary informed consents were taken from all the study individuals after they were informed on the aim and method of research. This study was approved by the human subjects ethics board of *Gaziantep University* Dentistry Faculty with Decision Number of 03042012/157 and was conducted in accordance with the Helsinki Declaration of 1975, as revised in 2013.

Research groups were classified according to periodontal status and obesity as following:

- Group NH: normal weight with periodontally healthy;
- Group OH: obese with periodontally healthy;
- Group NCP: normal weight with chronic periodontitis;
- Group OCP: obese with chronic periodontitis.

General inclusion criteria were as following: (1) 18-65 years of age and having 15> teeth; (2) having not received previous periodontal treatment in the recent 6 months before data collection; (3) no smoking history; (4) not being in pregnancy, menopause or lactation period for female patients; (5) having no systemic problem for individuals in the NH and NCP groups, no systemic problems except obesity for individuals in the OH and OCP groups; (6) having not previous antimicrobial treatment in the recent 6 months before data collection.

Evaluation of obesity

Obesity was diagnosed in accordance with assessments of body mass index (BMI) and waist circumference (WC) defined by WHO. BMI and WC were used to assess general obesity and abdominal obesity, respectively. BMI is defined as the weight of an individual in kilograms (kg) divided by the square of height in meters (m²). According to BMI scale; 18.5-24.99 kg/m²; 25-29.99 kg/m²; and ≥30 kg/m² are defined as normal weight, overweight and obese, respectively. Thus, the participants with a BMI≥30 kg/m² and WC>110cm (for males) or WC>88 cm (for females) were diagnosed to be obese (13).

Evaluation of Periodontal Status

The criteria such as probing depth ≤ 3 mm as well as absence of attachment loss and bleeding on probing were required to accept as periodontally healthy individuals (NH and OH groups). The patients with periodontal problems were clinically and radiographically evaluated for chronic periodontitis according to the criteria of the American Academy of Periodontology in 1999 (14). With respect to chronic periodontitis, the patients that have ≥ 15 teeth, and that indicate clinical attachment level ≥ 5 mm and probing pocket depth ≥ 5 mm in ≥ 2 of those existing teeth were included in the study. All the individuals included in the study underwent clinical periodontal examination (14).

Periodontal evaluation of the participants was carried out based on following clinical parameters; Plaque Index (Silness & Loe) (15); probing depth; Gingival Index (Loe & Silness) (16); clinical attachment level (CAL) and bleeding on probing (BOP). Clinical parameters were measured on six sites per tooth (mesiobuccal, midbuccal, distobuccal, mesiolingual, midlingual, distolingual) using a William's periodontal probe (Hu-Friedy; Chicago, IL, USA) calibrated in mm.

Collection of samples

Serum, saliva and GCF samples were taken after a week from the clinical periodontal examination. All samples were collected early in the morning (17). Before collecting samples the participants were commanded not to brush teeth and not to drink or eat anything except water within at least 12 hours.

Gingival Crevicular Fluid Sampling

GCF samples were taken from the single-rooted teeth with a pocket depth of 5-7 mm in the chronic periodontitis. Maxillary teeth were preferred to minimize saliva contamination risk. On the other hand, the samples were collected from the maxillary premolar teeth in healthy individuals. After teeth were isolated using cotton rolls in the GCF sampling site, the plaques in the sampling sites were removed using probes. The sampling site was meticulously dried using air spray perpendicularly to the longitudinal axis of the tooth from both vestibular and palatal sites. Paper strips (Periopaper Oraflow Inc., Plainview, USA) was placed in the gingival sulcus until a resistance was felt by implementing deep intracrevicular method (18). After waiting for 30 seconds, paper strips were placed in the precalibrated Periotron 8000 (Oraflow Inc., Plainview, USA) device to measure GCF volumes (19). The

Periotron scores are then converted to microlitres by using the MLCONVERT program and the results were recorded. The samples contaminated with blood and saliva were not analyzed. Paper strips were moved into the Eppendorf tubes and saved at -80°C until analysis time.

Calibration of the Periotron Device

The Periotron device was positioned in a sampling room in order to minimize the possible amount of evaporation, and the device was calibrated in accordance with the manufacturer's instructions. Calibration was carried out with a 1 μl Hamilton syringe using distilled water. We calibrated our device every 3 months in our study. We also zero the Periotron by placing a dry Periopaper between the jaws until zero appeared on the screen in each sample (20).

Saliva Sampling

The patients were instructed to come to our clinic in the morning with at least a 8-hour fasting after performing oral hygiene in the previous night. The patients were requested to spit the saliva collected in the mouth without swallowing to the provided sampling container in the sitting position for 5 minutes in a quite place of the clinic avoiding exposure to any stimulus. These samples were centrifuged at 5000 g for 5 minutes. The clear supernatant saliva samples were transferred to the Eppendorf tubes and until analysis time, then stored at -80 degrees.

Serum Sampling

From the antecubial fossa, venous blood was collected and kept at room temperature for 10 minutes, then centrifuged at 3000 g for 10 minutes. Until analysis time serum aliquots were saved at -80°C .

Laboratory Assessments

TAS and TOS levels were measured by an automatic colorimetric technique determined by Erel (21,22). Measurable value for the detection of clinical samples, TAS and TOS assay kit (Assay REL Diagnostics; Gaziantep, Turkey) were used. TAS scores were defined as millimolar Trolox equivalent per liter (mmol Trolox Eq/L), and TOS value as micromolar hydrogen equivalent per liter (mmol H_2O_2 Eq/L). The samples were tested in duplicate and for statistical analysis the mean values were used (21). OSI is a parameter which indicate the amount of OS more directly. When calculating the OSI, first the TAS value was converted from millimole trolox equivalent

per liter to micromole equivalent per liter. OSI was calculated as follows: $OSI = [(TOS, \text{mmol/L}) / (TAS, \text{mmol Trolox Eq/L}) \times 100]$.

Gingival crevicular fluid analyses

All the paper strips that were taken from the patients and then stored at -80°C were concurrently thawed. All the paper strips collected from the patients and stored at -80°C were concurrently thawed. Each eppendorf tube was added 400 μl fosfat buffered saline with pH adjusted to 7.4 for recovery of GCF sample from the content of the paper strips (23). Eppendorf tubes were mixed for 30 seconds using Heidolph Reax Top Vortex device featured with 5 mm orbital shaking that operates with vortex-induced circular vibration motion. It is centrifuged at 15,000 rpm for 30 seconds using StatSpin Mp Multipurpose centrifuge device after vortexing.

Statistical Analyses

For testing the distribution normality of the continuous variables Kolmogorov Smirnov test was used. The normally distributed variables were compared between more than 2 groups using ANOVA and LSD while Kruskal Wallis and Dunn tests were applied to compare more than 2 groups in terms of non-normally distributed variables. Statistical analyses were executed using SPSS for Windows Version 22.0 software package and any $p < 0.05$ value was accepted as statistically significant.

RESULTS

Demographic and periodontal findings

Our study included 80 individuals (52 females and 28 males) aged between 19 and 62 years (the mean age 34.79 ± 10.39 years). The demographic data of the study participants were presented in Table 1. An evaluation regarding mean ages revealed that mean ages of NH and OH groups were statistically significantly lower than NCP and OCP groups ($p < 0.05$).

Mean and standard deviation values of PI, GI, PPD, BOP, PD and GCF levels in the patients were presented in Table 2. All the clinical parameters were found statistically significantly higher in the periodontitis groups (NCP, OCP) compared with periodontally healthy groups (NH, OH) ($p < 0.001$).

Laboratory Findings

GCF findings

Mean and standard deviation values of GCF-TAS, TOS and OSI levels of all the groups were presented in Table 3. Intergroup statistical analysis showed that TAS levels of NH group was statistically significantly higher all other groups ($p < 0.05$). According to statistical analysis, OH and OCP groups (obese groups) were statistically significantly higher GCF-TOS values than NH and NCP groups (non-obese groups) ($p < 0.05$). During laboratory analyses, GCF-TOS levels of 16 and 2 individuals from NH and NCP groups could not be analyzed, respectively. Statistical

Table 1. Intergroup comparison regarding demographic data

	NH (n=20) ^a	OH (n=20) ^b	CP (n=20) ^c	OCP (n=20) ^d	p
M/F ratio	4:16	6:14	13:7	5:15	$<0.05^{ac, bc, cd}$
Age	25.60 ± 3.20	30.05 ± 7.79	40.75 ± 8.51	42.75 ± 9.44	$<0.001^{ac, ad, bc, bd}$
BMI (kg/m^2)	22.40 ± 1.98	35.00 ± 3.97	23.30 ± 1.86	32.45 ± 2.62	$<0.001^{ab, ad, bc, cd}$
Waist circumference (cm)	76.25 ± 12.06	112.05 ± 10.79	90.15 ± 11.39	104.15 ± 9.25	$<0.05^{bd}$ $<0.001^{ab, ac, ad, bc, cd}$

Data were presented in terms of mean $\pm$ standard deviation except male: female ratio. $p < 0.05$ statistically significant. $p < 0.001$ extremely statistically significant. ab Between NH and OH groups, ac Between NH and NCP groups, ad Between NH and OCP groups, bc Between OH and NCP groups, bd Between OH and OCP groups, cd Between NH and OH groups.

Table 2. Intergroup comparison regarding periodontal parameters

	NH(n=20) ^a	OH (n=20) ^b	NCP(n=20) ^c	OCP (n=20) ^d	p
PI	0.18 ± 0.07	0.45 ± 0.24	2.07 ± 0.56	2.44 ± 0.55	$<0.001^{ac, ad, bc, bd}$
GI	0.44 ± 0.23	0.46 ± 0.16	1.93 ± 0.51	1.88 ± 0.28	$<0.001^{ac, ad, bc, bd}$
PD (mm)	1.62 ± 0.34	1.80 ± 0.35	3.65 ± 0.94	3.54 ± 0.79	$<0.001^{ac, ad, bc, bd}$
BOP (%)	0	0	78.49 ± 24.17	81.00 ± 17.10	$<0.001^{ac, ad, bc, bd}$
CAL (mm)	1.76 ± 0.28	1.88 ± 0.17	4.75 ± 1.17	4.44 ± 0.60	$<0.001^{ac, ad, bc, bd}$
GCF Volume (μl)	0.12 ± 0.04	0.15 ± 0.07	0.62 ± 0.13	0.72 ± 0.21	$<0.001^{ac, ad, bc, bd}$
GCF Volume*	23.60 ± 6.54	28.20 ± 11.73	103.85 ± 22.13	119.85 ± 34.09	$<0.001^{ac, ad, bc, bd}$

Data were presented in terms of mean $\pm$ standard deviation. * Score measured by Periotron device. $p < 0.05$ statistically significant. $p < 0.001$ extremely statistically significant. ac Between NH and NCP groups, ad Between NH and OCP groups, bc Between OH and NCP groups, bd Between OH and OCP groups.

analysis indicated that GCF-OSI values of obese groups (OH, OCP) were statistically significantly higher than NCP group.

Serum findings

Mean and standard deviation values of serum TAS, TOS and OSI levels of all the groups were presented in Table 4. According to statistical analysis, no statistically significant difference was founded between the groups regarding serum TAS, TOS and OSI levels ($p>0.05$).

Saliva findings

Mean and standard deviation amount of saliva TAS, TOS and OSI levels of all the groups were presented in Table 4. Statistical analysis revealed that no statistically significant difference was detected between the groups regarding saliva TAS, TOS and OSI levels ($p>0.05$).

DISCUSSION

In our literature review, we have detected no study that concurrently investigated the OS parameters of the relationship between chronic periodontitis and obesity in blood, saliva and GCF samples although many studies have been carried out on chronic periodontitis, obesity and OS. No statistically significant difference was found between the groups concerning TAS, TOS and OSI values according to our results in serum and saliva analyses. On the other hand, the analysis of GCF samples revealed that TAS values were found to be statistically significantly higher in the NH group and TOS values are significantly higher in the obese groups (OH, OCP) compared to the other groups. Beside that, OSI

value was found significantly higher in the obese groups compared with CP group.

Chen *et al.* reported that TAS and TOS are a more practical parameter than measuring different oxidants and antioxidants one by one; it also reflects the ultimate oxidant and antioxidant status, including the interactions of oxidant and antioxidant molecules and enzymes with each other. Therefore, they are useful and practical biomarkers for evaluating oxidative damage in periodontal tissues (7).

Essentially three methods for collection of GCF are prominent in the literature. These are capillary tube, gingival crevice washing and paper strips methods (24). In our study, filter paper placement method was used for its advantages of easy applicability and time-saving. The literature review on the studies that have investigated TAS and TOS levels in GCF revealed differences between the numbers of the sample collection sites. Esen *et al.* have collected GCF samples from totally 6 sites including incisor, premolar and molar teeth for each jaw without taking pocket depth into consideration in their study (25). Wei *et al.* have collected samples from 10 sites with pocket depth larger than 5 mm for TOS analysis in GCF in their study (26). As another example, Bostanci *et al.* have collected samples from a single site of maxillary incisors for analysis (27). In our study, GCF samples were obtained from only a single site of a single-rooted tooth with a pocket depth of 5-7 mm to assess regional response. Our rationale to prefer this method is easy practicability for both dentist and patient. The disadvantage of this method is that GCF volume collected in a single filter paper for analysis of TAS and TOS levels in a single sample may be below detection level.

Table 3. TAS, TOS and OSI levels in GCF

	NH (n=20) ^a	OH (n=20) ^b	NCP (n=20) ^c	OCP (n=20) ^d	p
TAS	0.41 ± 0.12	0.19 ± 0.02	0.19 ± 0.06	0.21 ± 0.03	<0.001 ^{ab,ac,ad}
TOS	NH (n=4) 0.05 ± 0.05	OH (n=20) 0.28 ± 0.13	NCP (n=18) 0.14 ± 0.07	OCP (n=20) 0.28 ± 0.07	<0.05 ^{ab,ad,bc,cd}
OSI	0.13 ± 0.24	0.14 ± 0.08	0.07 ± 0.05	0.13 ± 0.03	<0.05 ^{bc,cd}

p<0.05 statistically significant difference. p<0.001 statistically highly significant difference. ab Between NH and OH groups, ac Between NH and NCP groups, ad Between NH and OCP groups, bc Between OH and NCP groups, bd Between OH and OCP groups, cd Between NH and OH groups.

Table 4. TAS, TOS ve OSI levels in blood serum and saliva

	NH (n=20)	OH (n=20)	NCP (n=20)	OCP (n=20)	P
TAS ⁺	2.12 ± 0.12	2.15 ± 0.17	2.11 ± 0.18	2.13 ± 0.10	>0.05
TOS ⁺	5.62 ± 1.47	5.43 ± 1.46	6.71 ± 3.02	5.95 ± 1.48	>0.05
OSI ⁺	0.25 ± 0.03	0.25 ± 0.05	0.27 ± 0.05	0.26 ± 0.04	>0.05
TAS [*]	0.73 ± 0.20	0.88 ± 0.29	0.83 ± 0.32	0.92 ± 0.29	>0.05
TOS [*]	18.71 ± 10.18	16.23 ± 10.17	14.05 ± 6.76	15.71 ± 11.65	>0.05
OSI [*]	2.52 ± 1.44	1.98 ± 1.93	1.81 ± 1.28	16.7 ± 1.23	>0.05

p>0.05: no statistically significant difference, +: serum score, * saliva score.

Many different conclusions have been suggested in the studies that evaluated TAS levels of chronic periodontitis and healthy individuals. Esen *et al.* have found statistically significantly higher TAS values in the healthy group than chronic periodontitis group in TAS analyses performed on serum samples whereas they detected no statistically significant difference between the groups according to analyses conducted on GCF samples (25). Sezer *et al.* have emphasized in their study on serum samples that they determined no significant difference between two groups regarding TAS values (28). Even though, our results on TAS levels in saliva, serum and GCF samples from chronic periodontitis and healthy control group are consistent with some of previous studies, the results of the studies that have investigated this relationship in the literature are contradicting with others.

There is only a few studies in the literature that analyzed TAS values in the obese individuals and healthy control group. Demir *et al.* have suggested that obese children have lower serum TAS values than normal weight children (29). Catoi *et al.* have detected that serum TAS values of obese individuals were statistically significantly lower than healthy control group (30). We have determined in our study that serum TAS values of obese individuals were higher than non-obese individuals consistently with literature and that however this variation was statistically non-significant. It is concluded that more comprehensive studies on this issue carried out with a larger amount of patients are essential.

In the review of the studies that have assessed the relationship between obesity and chronic periodontitis with respect to oxidative parameters; Köse *et al.* found that TAS levels were lower in the saliva and serum samples of obese patients with periodontitis. Even so, TAS levels were found similar in patients with periodontitis or obesity (11). TAS levels in the study of Atabay *et al.* were lower individuals with periodontitis than healthy and obese patients (31). Dursun *et al.* have detected lower GCF and serum TAS levels in the obese women (32).

There are many studies that have evaluated TOS levels of the periodontitis individuals in the literature (25,26). Statistically significantly higher TOS levels were encountered in the chronic periodontitis groups compared with periodontally healthy individuals in the studies on TOS levels carried out by Wei *et al.* in saliva, serum and GCF samples, and by Köse *et al.* in serum and saliva samples (11,26).

With respect to the studies that have discussed

TOS levels in obese individuals; Catoi *et al.* have emphasized that TOS levels of obese individuals were significantly higher than healthy controls (30).

In the review of the studies on the association between chronic periodontitis and obesity in terms of OS; Köse *et al.* have found that TOS levels were higher in serum and saliva of obese patients with periodontitis (11). Nonetheless, TOS levels were found similar in individuals with periodontitis or obesity. Dursun *et al.* have measured higher GCF TOS levels in the obese women whereas serum TOS values demonstrated a non-significant trend to higher levels (32).

In the studies of Bostanci *et al.* and Esen *et al.*, GCF-OSI levels of chronic periodontitis group were statistically significantly higher than healthy group whereas they found no significant difference between these groups in terms of serum OSI levels (25,27). Also, Sezer *et al.* have encountered no significant difference between serum levels of the groups (33). In our study, no statistically significant difference between chronic periodontitis and healthy groups regarding OSI levels in saliva, serum and GCF samples. In contrast, our GCF-OSI results are inconsistent with the results of Bostanci *et al.* and Esen *et al.* (25,27,33).

The studies that investigated OSI values in obese individuals have shown that obese individuals have higher OSI values than the healthy controls (30,34). In our study, it has been determined consistently with previous literature results that OSI values of obese individuals increased.

The results of our study related with TOS levels in saliva, serum and GCF samples are supporting the result of many current studies. High TOS levels in GCF samples of obese individuals may be associated with nutritional habits. Because, it has been stated that free fatty acid-based diet may be one of the factors that increases OS in obesity. Since high values of GCF-TOS levels are found in the obese individuals, it is considered that obesity may affect TOS level in GCF and also periodontal disease by increasing oxidant amount in the periodontal pocket. The most important reason of inability to obtain significant results in serum and saliva samples may be resulting from multifactorial characteristic of OS. Although, it is known that several factors such as stress, nutritional habits and life standards of the study patients increase OS, the standardization of these entities could not be established in the study groups.

The limitations of our study may include TOS values of 16 individuals from healthy and 2 individuals from chronic periodontitis groups below detection

limits of the analysis, respectively. This result may be caused by inability to obtain adequate GCF volume for analysis since oxidant levels are low in the healthy individuals and also taking a single GCF sample from each individual.

Conflict of interest

The authors declare that they have no conflict of interest.

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