Tikrit Journal for Dental Sciences 12(1) (2024) 188-195
https://doi.org/10.25130/tjds.12.1.21

Tikrit Journal
for
Dental Sciences
https://tjds.tu.edu.iq
ISSN:2073-1213

Salivary Biophysical Properties in Relation to Dental Caries Severity Among Type 1 Diabetic Children

Shahad Fahim Obaid [(1)*]
Shahbaa Munther [(2)]
[(1, 2)] Department of Pedodontics and Preventive Dentistry, College of Dentistry, University of Baghdad, Iraq.

Keywords:
dental caries, type 1 diabetes, salivary biophysical properties.

Article Info.:

Article History:
Received: 23/8/2023
Received in revised form: 9/9/2023.
Accepted: 13/9/2023
Final Proofreading: 13/9/2023
Available Online: 1/6/2024

Citation: **Obaid SH, Munther SH. Salivary Biophysical Properties in Relation to Dental Caries Severity Among Type 1 Diabetic Children. Tikrit Journal for Dental Sciences 2024; 12(1): 188-195**
https://doi.org/10.25130/tjds.12.1.21

***Corresponding Author:**
Email:
dentistshahad.ds@gmail.com

(1) Department of Pedodontics and Preventive Dentistry, College of Dentistry, University of Baghdad, Iraq.

Abstract

Diabetes Mellitus is a multifactorial metabolic disorder characterized by elevated blood glucose levels or hyperglycemia. Diabetes Mellitus may cause many oral problems as a result of both micro- and macrovascular complications. We aimed to assess the probable relationship between the severity of dental caries and the biophysical properties of saliva (flow rate, PH, and viscosity).

Materials and Methods: A cross-sectional comparative study was conducted in Karbala City, in which a sample of 45 children with type 1 diabetes aged between 10-12 years was compared with a group of 45 non-diabetic children matched in age and gender. Dental caries severity and experience were recorded and diagnosed using Manji et al.'s criteria and the decayed, missing, and filling index (DMFS/dmfs). Unstimulated salivary specimens were collected to evaluate flow rate, pH, and viscosity. Pearson (r) correlation coefficient test and one-way ANOVA test were employed for data analysis using SPSS-22.

Results: Salivary levels of viscosity and flow rate were not statistically significant ($P > 0.05$) predicators regarding the dental caries experience and severity among type1 diabetic children (controlled and uncontrolled) while pH level of saliva was a statistically significant predictor regarding dental caries experience (DS/ DMFT) among uncontrolled diabetic children.

Conclusion: Compared to non-diabetic children, type 1 diabetic children exhibited pronounced changes in salivary biophysical properties but unpronounced changes in caries status.

Introduction:

Diabetes Mellitus (DM) is a prevalent chronic disorder that affects individuals globally. It is a metabolic disease with multiple contributing factors, characterized by elevated blood glucose levels or hyperglycemia due to insulin secretion deficiency and/or insulin dysfunction. This condition leads to abnormal fat, carbohydrate, and protein metabolism (1). Type 1 Diabetes Mellitus (T1DM) is an autoimmune disorder that results from the destruction of pancreatic β-cells, leading to absolute insulin insufficiency and subsequent hyperglycemia. T1DM typically presents during childhood or adolescence, with polyuria, polydipsia, and hyperglycemia being hallmark symptoms (2,3). Due to the autoimmune destruction of pancreatic β-cells resulting in chronic insulin insufficiency, continual exogenous insulin replacement therapy is necessary to control insulin levels to meet the patient's metabolic needs (4). Oral health is part of overall health and is affected by chronic hyperglycemia. Diabetes mellitus may lead to various oral complications due to both micro- and macro-vascular complications. These complications include gingival inflammation, periodontal disease, xerostomia, dental caries, increased plaque deposition, opportunistic infection, delayed wound healing, oral paresthesia, and taste loss (5). Researchers have focused on the connection between diabetes and dental caries because both diseases are linked to carbohydrates (6-8). Dental caries is the most frequent chronic infectious disease related to specific bacteria (Streptococcus mutans and Lactobacillus) that are part of normal oral flora (9-12). Many factors contribute to dental caries and are considered a primary risk factor for disease, including the decreased flow of saliva, poor oral hygiene, improper feeding habits, excessive sugar consumption, and low socioeconomic status (6). In a diabetic patient, insulin hormone deficiency changes saliva's quantity and composition, resulting in hyposalivation and an increased glucose level in saliva, thus a higher chance of developing dental caries (7). A proper metabolic diet, along with mechanical removal of adhered biofilm by tooth cleaning and other different oral hygiene measures, could control or prevent the negative impact of decreased salivary flow and high glucose content, and thus a reduction in dental caries among people with diabetes patients by slowing down the proliferation of acidogenic bacteria (13,14).

A paucity of research studies has been conducted in Iraq to investigate the salivary biophysical properties and their correlation with dental caries severity among children with type 1 diabetes. Thus, this study was undertaken to evaluate the potential link between salivary biophysical properties and dental caries in children diagnosed with type 1 diabetes and then to compare these findings with those of healthy children.

Methods and Material:

A cross-sectional comparative study was conducted among children diagnosed with type 1 diabetes in Karbala City, Iraq, from March to June 2022 to assess the possible relation between dental caries severity and the biophysical properties of saliva (flow rate, PH, and viscosity). The research was approved by the Scientific Committee in the College of Dentistry at the University of Baghdad (ref. no.578322 on June 2, 2022). Official permits were obtained from the competent authority before data gathering. An educational document outlining the current study and its importance in ensuring voluntary participation was provided to the parents and patients. A particular consent form was also created and distributed to the parents to obtain permission for their children to participate in the study and their full cooperation. The study sample includes 45 children (21 boys and 24 girls) with type 1 diabetes mellitus aged (10-12) years old (The quality of disease control determined by the level of HbA1c as more than 7.5 considered non-control diabetes) with normal body index (BMI = 5 percentile to less than 85 percentile) and without any other systemic problem from different geographical areas in the city, who were attending Al-Imam Al-Hassan Center for Endocrinology and Diabetes, compared with a control group that included 45 healthy children (22 boys and 23 girls) without any systemic disease, with the same age range of the study group, attending Al Hur Riahi Specialized Dental Center. The sample was determined statistically using G Power 3.1.9.7 (program written by Franz-Faul, Universitatit Kiel, Germany). With a

power of 80%, alpha error of probability of 0.05 is two-sided, assuming the moderate effect size of Cohen d of 0.6.
Data collection:
Unstimulated saliva was collected from children between 9:00 a.m. and 12:00 p.m. by spitting method (15). The child was asked to wash his mouth thoroughly to ensure the removal of any debris and sit in the chair and advised to keep calm and relax. Then instruct them not to speak, swallow and minimize their movement during the procedure. The child was also ordered to accumulate saliva on the floor of the mouth and then spit it out into the sterile disposable cap every minute until an adequate volume was collected. The samples were immediately placed in a cooler box containing ice until subsequent processing. A portable pH meter (HANNA Instruments, Romania) was used to measure saliva pH according to the manufacturer's instructions. The salivary flow rate was measured by dividing the volume of the collected saliva in milliliters (ml) by the time needed for the salivary collection in minutes (min). The determination of saliva viscosity involves the utilization of an Ostwald viscometer (Aldrich Company), a commonly employed and straightforward apparatus for measuring the viscosity of liquids. This method entails allowing saliva to pass through a tube with a circular cross-section, while concurrently monitoring the rate of flow (16). The determination of liquid viscosity often involves a comparative analysis with a reference liquid, often water:

$\eta_1 / \eta_2 = \rho_1 t_1 / \rho_2 t_2$
η_1 = Distilled water's viscosity (η_1= 0.008904 dyne/cm3)
η_2 = Saliva's viscosity.
ρ_1 = Distilled water's density gm. /cm3.
t_1 = time required for the distilled water to pass in seconds.
ρ_2 = A salivary sample's density.
t_2 =the time required to pass the saliva in seconds [16].

The decayed, missing, filled index (DMFS/dmfs) was used to record dental caries using a dental mirror and explorer. Diagnosing dental caries was done according to Manjie et al. criteria (17). These criteria allow for recording the severity of the decayed lesion.

Statistical Analysis:
A one-way ANOVA test was used to find the differences between groups using Hochberg GT2 and Games-Howell post hoc analysis. A Pearson (r) correlation coefficient test was used to investigate whether there is an association between physical salivary variables and caries experience and severity. Analysis was performed using the Statistical Package for Social Science (SPSS) version 22 (Chicago, Illinois, USA). A $P<0.05$ was considered a statistically significant difference.

Results:

Ninety participants were included in this study (mean age = 11.2 ± 0.81, range 10–12 years, 47.78% male). The sample consisted of 35 diabetic non-control (DNC) children, 10 diabetic control (DC) children, and 45 non-diabetic children. Except for the D4 grade, which was significantly higher in the control group, dental caries experience and severity grades in permanent and primary teeth were not statistically different among the study groups ($p>0.05$), as shown in Tables 1 and 2.
Table 3 shows the distribution of salivary flow rate (SFR), pH (SPH), and viscosity among groups. SFR was significantly higher in the healthy control group. At the same time, the mean value of salivary viscosity was the highest in the DNC group, with a significant difference. By applying multiple comparisons of SFR and viscosity among groups, it was found that only the result between healthy and DNC was significant for both SRF and viscosity ($P=0.009$, $P=0.015$ respectively), while other findings were non-significant.
In the permanent teeth, there was a significant negative correlation between SFR and D2 in the healthy group and a significant negative correlation between SPH and D1, DS, and DMFT in the DNC group. While in primary teeth, there was a positive weak significant correlation between d2 and salivary viscosity in the

healthy control group, while other results were non-significant, as shown in Tables 4 and 5.

Discussion:

The results of the present study showed that caries experience was slightly higher in the non-diabetic group but statistically not significant, which is in agreement with previous studies conducted by Al-Badr et al. (6), Ismail et al. (18) and Lai et al. (19). However, this finding contrasts with many studies that report significantly higher caries experiences in children with type 1 diabetes (8,20,21). These results might be due to the diabetic children may have a diet with a restricted intake of carbohydrates according to the nutritional recommendation and a good metabolic regulator that prevents the most harmful changes in saliva, such as increased glucose level and low pH; additionally, diabetic children's oral hygiene practices and education appear to be slightly better than healthy children's (22). Hence, the progression of caries occurs less frequently. Also, they might be because the control sample was recruited from children attending Specialized Dental Center seeking dental treatment. Moreover, the mean value of salivary flow rate was significantly lower in diabetic children, as reported in previous studies by Al-Khayoun and Diab (20) and Anandakrishna et al. (23). At the same time, it disagreed with Assiri et al. (7) and Panchbhai et al. (24) who did not observe any statistically significant differences in the salivary flow rates between individuals with diabetes and those without diabetes. Diabetes patients may experience decreased salivary flow rate or mouth dryness for various reasons. It could be related to insulin insufficiency, which causes intracellular fat accumulation in the salivary glands, or it could be due to physical changes in mucosal cells. Other factors that lead to a decreased salivary flow rate may be metabolic abnormalities and neuropathy that reduce the function of salivary glands and diabetic medications or concomitant medications. In addition, dehydration associated with hyperglycemia and glycosuria also decreases the volume of saliva excreted (8,23,25,26). In addition, the correlations of salivary flow rate with approximately all grades of Ds/ds and DMFT/dmft in three groups were non-significant that came in accordance with Assiri et al. (7) and Premnath et al. (26) but contrary to the finding from studies by Al-Khayoun and Diab (20) and Anandakrishna et al. (23). These differences in results between the studies may be due to the methodological variety, such as the time during the day the saliva was collected and the measurement of the saliva flow rate in addition to the sample size. Regarding pH, the difference between groups was statistically non-significant, which is consistent with Assiri et al. (7) and Moskovitz et al. (27). However, many studies found low significant salivary pH in diabetic children (20,25,26). Among the uncontrolled diabetic group, the correlations were only significant for the lower grade of caries severity and caries experience with salivary pH in a negative direction. These results agreed with a study by Al-Khayoun and Diab (20) and Basir et al. (25).

The present study showed that the viscosity of saliva was the highest in the DNC group, with a significant difference that agreed with López et al. (28) and Veleganova et al. (29). Salivary viscosity and foam are associated with flow rate, which was decreased in diabetics. The higher level of proteins reflects viscosity and foam in patients with diabetes, and turbidity of saliva is related to mucus, epithelial cells, and especially to the presence of oral bacteria (28). Furthermore, there was a non-significant positive correlation between salivary viscosity and caries experience in three groups which agreed with Rahiotis et al. (30) and Yas and Radhi (16), who observed no significant correlation between salivary viscosity and caries experience and activity. This result may be due to the fact that dental caries are multifactorial, and the risk of caries may be influenced by various factors that may increase or decrease the individual's risk (31). At the same time, these results contrasted with a study by Lubis and Prakas (32). These differences in the results may be due to the study sample size and procedure used to measure salivary viscosity. It is recommended that a larger sample size be used in future studies considering the parents' socioeconomic and educational levels, which have a profound indirect effect on their children's oral health.

Conclusion:

Type 1 diabetic children revealed pronounced changes in salivary biophysical properties but unpronounced changes in caries status compared to non-diabetic children. Further studies with a larger sample size are recommended.

Table 1: Caries experience in permanent and primary teeth represented by DMFT/dmft and DMFS/dmfs with its component (DS/ds) among groups.

Vars.	Control			DC			DNC				
	Mean	±SD	±SE	Mean	±SD	±SE	Mean	±SD	±SE	F	P value
DS	6.82	3.08	0.46	4.70	3.37	1.07	6.34	4.89	0.83	1.21	0.30
ds	2.64	3.75	0.56	1.50	2.01	0.46	3.49	6.18	1.04	0.76	0.47
DMFS	7.76	3.75	0.56	5.20	4.05	1.28	6.89	4.96	0.84	1.55	0.22
DMFT	5.20	2.43	0.36	3.90	2.92	0.92	4.63	2.77	0.47	1.18	0.31
dmfs	4.98	7.42	1.11	3.10	3.32	1.05	4.89	8.42	1.42	0.27	0.77
dmft	2.04	2.48	0.37	1.60	1.65	0.52	1.83	2.77	0.47	0.16	0.86

Table 2: The severity of dental caries represented by grades of DS/ds (D1-4/d1-4) among groups

Vars.	Control			DC			DNC				
	Mean	±SD	±SE	Mean	±SD	±SE	Mean	±SD	±SE	F	P value
D_1	1.69	1.64	0.24	1.70	1.49	0.47	1.91	1.77	0.29	0.19	0.83
D_2	2.09	1.96	0.29	2.20	2.15	0.68	2.71	2.24	0.38	0.90	0.41
D_3	1.33	1.49	0.22	0.60	0.84	0.27	1.60	3.59	0.61	0.63	0.54
D_4	1.71	0.79	0.11	0.20	0.42	0.13	0.11	0.53	0.09	63.54	**0.00**
d_1	0.22	0.64	0.09	0.30	0.48	0.15	0.08	0.37	0.06	0.95	0.39
d_2	0.51	0.89	0.13	0.10	0.32	0.10	0.34	0.91	0.15	1.07	0.35
d_3	1.73	2.93	0.09	1.10	1.91	0.61	2.77	4.92	0.83	1.12	0.33
d_4	0.18	0.81	0.12	0.00	0.00	0.00	0.29	1.69	0.29	0.24	0.79

Table 3: Descriptive and statistical test of SFR, SPH, and viscosity among groups.

Vars.	Control			DC			DNC				
	Mean	±SD	±SE	Mean	±SD	±SE	Mean	±SD	±SE	F	P value
SFR	0.45	0.19	0.03	0.38	0.14	0.05	0.33	0.15	0.03	4.74	**0.01**
SPH	7.16	0.39	0.06	7.08	0.49	0.16	6.92	0.46	0.08	3.06	0.05
viscosity	0.02	0.01	0.00	0.02	0.01	0.00	0.04	0.03	0.01	6.17	**0.003**

Table 4: The correlations between physical salivary variables and both caries experience and severity of permanent teeth.

Vars.	Groups	SFR		SPH		viscosity	
		r	p	r	p	r	p
D_1	Control	-0.001	0.99	-0.03	0.82	0.16	0.29
	DC	0.24	0.51	0.11	0.76	0.20	0.58
	DNC	0.09	0.62	-0.57	**0.000**	0.12	0.49
D_2	Control	-0.34	**0.02**	-0.09	0.53	0.05	0.74
	DC	0.32	0.37	-0.53	0.11	0.41	0.24
	DNC	-0.21	0.24	-0.21	0.23	0.22	0.20
D_3	Control	0.14	0.36	-0.15	0.32	0.02	0.89
	DC	-0.07	0.85	0.17	0.65	0.26	0.46
	DNC	-0.17	0.32	-0.19	0.29	0.05	0.79
D_4	Control	0.01	0.94	0.16	0.31	0.21	0.16
	DC	-0.45	0.19	0.09	0.79	0.49	0.15
	DNC	-0.02	0.92	-0.24	0.17	0.07	0.69
DS	Control	-0.15	0.34	-0.11	0.46	0.09	0.52
	DC	0.23	0.52	-0.24	0.51	0.35	0.32
	DNC	-0.19	0.27	-0.46	**0.005**	0.08	0.63
DMFS	Control	-0.04	0.80	-0.06	0.69	0.19	0.19
	DC	0.31	0.38	-0.13	0.72	0.50	0.14
	DNC	-0.19	0.25	-0.43	0.01	0.04	0.84
DMFT	Control	-0.03	0.84	-0.04	0.77	0.21	0.18
	DC	0.16	0.67	-0.13	0.72	0.24	0.51
	DNC	-0.11	0.55	-0.48	**0.004**	0.15	0.39

Table 5: The correlations between physical salivary variables and both caries experience and severity of primary teeth.

Vars.	Groups	SFR		PH		viscosity	
		r	p	r	p	r	p
d_1	Control	0.06	0.70	0.26	0.08	0.09	0.57
	DC	-0.07	0.86	-0.23	0.53	0.52	0.12
	DNC	0.09	0.59	0.09	0.62	0.14	0.41
d_2	Control	0.14	0.38	0.14	0.37	0.32	**0.03**
	DC	-0.37	0.30	-0.24	0.51	0.54	0.11
	DNC	0.29	0.09	0.03	0.86	0.03	0.86
d_3	Control	-0.03	0.84	-0.03	0.86	0.24	0.11
	DC	-0.27	0.45	-0.13	0.72	0.03	0.93
	DNC	0.07	0.70	0.11	0.53	0.003	0.99
d_4	Control	0.21	0.16	0.15	0.33	0.11	0.47
	DC						
	DNC	-0.04	0.83	0.09	0.63	0.02	0.92
ds	Control	0.06	0.68	0.09	0.56	0.07	0.64
	DC	-0.33	0.35	-0.22	0.55	0.24	0.51
	DNC	0.09	0.59	0.12	0.49	0.003	0.99
dmfs	Control	-0.12	0.45	0.16	0.28	0.03	0.86
	DC	-0.47	0.18	-0.11	0.75	0.29	0.41
	DNC	-0.01	0.95	0.08	0.64	0.02	0.92
dmft	Control	-0.01	0.97	0.16	0.29	0.06	0.68
	DC	-0.46	0.18	-0.17	0.64	0.57	0.08
	DNC	0.05	0.79	0.09	0.59	0.01	0.94

References

1. Rakhmatillaevna KF. Diagnostic value of salivator cytokines in dental diseases in children with diabetes mellitus type 1. European Journal of Molecular & Clinical Medicine. 2020; 7(4): 1518-1523.
2. Dabelea D, Rewers A, Stafford JM, Standiford DA, Lawrence JM, Saydah S, et al. Trends in the prevalence of ketoacidosis at diabetes diagnosis: the search for diabetes in youth study. Pediatrics. 2014; 133(4): e938-e945.
3. Abduljabbar HA, Abd-Alrazak OM, Ghalib BA. Growth Indices among Children and Adolescents with Type 1 Diabetes-Baghdad–Iraq, 2013. J Fac Med Baghdad. 2014; 56(3): 258-263.
4. Rathod S. Novel insights into the immunotherapy-based treatment strategy for autoimmune type 1 diabetes. Diabetology. 2022; 3(1):79–96.
5. AlMulhim AA, Zakaria OM, Daoud MY, Almulhim SA. Dental and oral problems among diabetic patients: A developing country local perceptual study. Asian Pac. J. Health Sci. 2021;8(2):67-70.
6. Al-Badr AH, AlJameel AH, Halawany HS, Al-Jazairy YH, Alhadlaq MK, Al-Maflehi NS, et al. Dental caries prevalence among type 1 diabetes mellitus (T1DM) 6- to 12-year-old children in Riyadh, Kingdom of Saudi Arabia compared to non-diabetic children. Saudi Dent J. 2021;33(5):276–82.
7. Assiri SA, El Meligy OA, Alzain IO, Bamashmous NO. Assessment of dental caries and salivary characteristics among type 1 diabetic Saudi children. J Dent Sci. 2022;17(4):1634–9.
8. Ferizi L, Dragidella F, Spahiu L, Begzati A, Kotori V. The influence of type 1 diabetes mellitus on dental caries and salivary composition. Int J Dent. 2018; 2018:1–7.
9. Moye ZD, Zeng L, Burne RA. Fueling the caries process: carbohydrate metabolism and gene regulation by Streptococcus mutans. J Oral Microbiol. 2014; 6(1): 24878.
10. Yas BA, Awn BH. Selected salivary antioxidants and lipid peroxidation biomarker in relation to oral health among a group of dental students. Ann Trop Med Public Health. 2020; 23: 23026.
11. Al-Tamimi HK, Al-Rawi NA. Age-Related Changes with Selected Salivary Physical Properties and Caries Experience among Healthy Adult Men. Int J Med Res Health Sci. 2018; 7(9): 52-58.
12. Yousif SH, Qasim AA. Salivary Cathelicidins(LL-37) as a Dental Caries Biomarker in Relation to Nutrition Status among a Group of Adolescents. World J Dent 2023;14(4):352–358.

13. Latti BR, Kalburge JV, Birajdar SB, Latti RG. Evaluation of relationship between dental caries, diabetes mellitus and oral microbiota in diabetics. J Oral Maxillofac Pathol. 2018;22(2):282.
14. Miko S, Ambrus SJ, Sahafian S, Dinya E, Tamas G, Albrecht MG. Dental caries and adolescents with type 1 diabetes. Br Dent J. 2010;208(6): E12.
15. Dhanarathna S, Jeddy N, Sabarinath B, Protyusha GB. Estimation and comparison of salivary flow rate and its composition in diabetic patients and non-diabetic patients: A pilot study. J Oral Maxillofac Pathol. 2021; 25(2):232.
16. Yas BA, Radhi NJ. Salivary viscosity in relation to oral health status among a group of 20-22 years old dental students. Iraqi J Comm Med. 2013;26(3):219-224.
17. Manji F, Fejerskov O, Baelum V. Pattern of dental caries in an adult rural population. Caries Res. 1989; 23(1):55-62.
18. Ismail AF, McGrath CP, Yiu CK. Oral health status of children with type 1 diabetes: a comparative study. J Pediatr Endocrinol Metab. 2017;30(11):1155-1159.
19. Lai S, Cagetti MG, Cocco F, Cossellu D, Meloni G, Campus G, et al. Evaluation of the difference in caries experience in diabetic and non-diabetic children—a case control study. PLOS ONE. 2017;12(11): e0188451.
20. Al-Khayoun JD, Diab BS. Dental caries, mutans streptococci, lactobacilli and salivary status of type 1 diabetic mellitus patients aged 18-22 years in relation to glycated haemoglobin. J. Baghdad Coll. Dent. 2013;25(1):153-158.
21. Ahmed RF, Al-Jubouri RH. Oral health status, salivary MMP-8 & secretory leukocyte peptidase inhibitor (SLPI) among uncontrolled Type-I diabetes mellitus in Iraqi patients. J Baghdad Coll Dent. 2017; 29:65-70.
22. Novotna, M., Podzimek, S., Broukal, Z., Lencova, E. and Duskova, J., 2015. Periodontal diseases and dental caries in children with type 1 diabetes mellitus. Mediators Inflamm. 2015; 2015:1–8.
23. Anandakrishna L, Manjushree R, Shetty AK, Prasad KS K. Evaluation of salivary components and dental plaque in relation to dental caries status in type 1 diabetes mellitus. Int J Clin Pediatr Dent. 2022;15(S2): S121-S125.
24. Panchbhai AS, Degwekar SS, Bhowte RR. Estimation of salivary glucose, salivary amylase, salivary total protein and salivary flow rate in diabetics in India. J Oral Sci. 2010; 52(3):.359-368.
25. Basir L, Aminzade M, Javid AZ, Khanehmasiedi M, Rezaeifar K. Oral health and characteristics of saliva in diabetic and healthy children. Austral Med J. 2017; 10(10): 883-889.
26. Premnath K, Prakash N, Raheel SA. The influence of salivary components on dental caries in patients with type I diabetes mellitus. Int J Oral Health Dent. 2019; 5(2):92-96.
27. Moskovitz M, Nassar M, Moriel N, Cher A, Faibis S, Ram D, et al. Characterization of the Oral Microbiome Among Children with Type 1 Diabetes Compared with Healthy Children. Front Microbiol. 2021; 12: 756808.
28. López M, Colloca M, Páez R, Schallmach J, Koss M, Chervonagura A. Salivary characteristics of diabetic children. Braz Dent J. 2003; 14(1):26-31.
29. Veleganova VK, Kondeva VK, Uzunova YI, Simitchiev KK. Salivary status of diabetic children. J Int Sci Publ. 2014; 12:263-76.
30. Rahiotis C, Mitropoulos P, Kakaboura A. Comparative Evaluation of Chair-Side Saliva Tests According to Current Dental Status in Adult Patient. Dent J. 2021; 9(1):10.
31. Ismail AF, McGrath CP, Yiu CK. Oral health of children with type 1 diabetes mellitus: a systematic review. Diabetes Res Clin Pract. 2015; 108(3):369-381.
32. Lubis WH, Prakas K. The effect of viscosity and saliva buffer in diabetes melitus patients on the dental caries: pengaruh viskositas dan buffer saliva terhadap terjadinya karies gigi pada pasien diabetes melitus. Dentika: Dental Journal. 2019; 22(1):1-5.