



Dental Caries and its Relation to Salivary Calcium and Phosphate Among Soft Drinks Factory Workers

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ABSTRACT

Background: Soft drinks have many prospect health issues. It have both acidogenic and cariogenic effect due to its high content of acids and sugar. Soft beverages consuming was raised through the past some decades. This study was assumed to appreciate the physiochemical property of saliva with different frequencies of soft drinks consuming and its association with dental caries. This study aimed to study the influence of frequent consumption of soft bevarages on dental caries and its relation to calcium and phosphate.

Subjects and Methods: Sample is composed of 80 workers, there age was (27-40) years old, who was working in Al-Waha Soft Drink Company located in Karbala governorate in Iraq. The sample divided into five categories according to frequency of soft drinks consuming into: those with several times daily, once daily, several times weekly, once weekly and several times monthly. Diagnosis and recording of dental caries was assessed according to Decay, Missed, Filled WHO index. Collection of unstimulated saliva from workers was done, then measuring salivary flow rate; and chemically analyzed to determine salivary PH, calcium and phosphate. The data was analyzed by SPSS version 21.

Results: The result recorded highly significant at $p < 0.01$ in "DMFS" and "DMFT" with the frequency of soft drinking. There was highly significant at $p < 0.01$ in salivary flow rate and pH with frequency of soft drink consumption. Correlation between dental caries with salivary flow rate and pH by frequency of soft drinking, in which indirect relation between salivary flow rate and pH and both "DMFS" and DMFT" was found. There was marginal significant at $p < 0.05$ in salivary calcium. There was direct relationship in those highly consumption of soft drinks (several times daily and once daily) between salivary calcium and both "DMFS" and "DMFT", but this relation was not significant, while it was highly significant in those several times monthly. It was found an indirect relationship in those several times daily and once weekly between salivary phosphate and both "DMFS" and "DMFT" that was highly significant.

Conclusion: It is present from the result of this study the high frequency of soft drinks consuming connected with increase of the dental caries. The results were appeared significant variations in levels of salivary calcium and phosphate of the workers. Inorganic phosphate level in the saliva has a negative influence on the caries experience and negative relation with DMF index, so the caries activity was associated with depressed level of salivary inorganic phosphate.

Key words: Soft drinks, Dental caries, Salivary calcium, Phosphate

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INTRODUCTION

Soft drinks have inveterate sugars and acids that include both cariogenic and acidogenic possibility. Numerous studies manifested a direct relation between tooth decay and the consuming of soft beverages [1,2].

Soft drinks were proposed as giving rise to injury to the dental tissues for two purposes. Primarily, depressed PH and high titratable acidity of some beverages may cause erosion of tooth surface. Secondly, sugar contents in beverages were metabolized by microorganisms in the plaque to produce acids that causing demineralization and resulting of dental caries [3].

Dental caries is one of the oral health troubles, which bring about the dental hard tissue damage by action of both bacteria and fermentable carbohydrates [4]. Dental caries is one of the oral health troubles, which bring about the dental hard tissue damage by action of both bacteria and fermentable carbohydrates.4 Tooth decay is a multifactorial microbial disorder that is caused by the effect of acidogenic bacteria, fermentable carbohydrates and different host factors involve saliva [5].

Dental caries is a general health issues worldwide, about 60-90% of babies and around 100% of adults have tooth decay [6]. Soft beverages may consist of many various kinds of acid that causing depresses in salivary PH. They may ingrain and derived from the inherent ingredients that utilized in manufacture [7].

These acids involve phosphoric and citric acids found in cola-type beverages and another acid that supply taste and carbonic acid under pressure in sparkling beverages. Lastly, preservatives, like insertion of vitamin C (ascorbic acid), as well as participate to acidity of soft bevareges [7].

SUBJECTS AND METHODS

An ethical approval was received from Research Ethics Committee of College of Dentistry, University of Baghdad, Iraq. The subjects of current study were (80) soft drink factory workers aged (27 - 40) years old classified into five groups according to frequency of soft drinks consumption into: several times daily, once daily, several times weekly, once weekly and several times monthly(WHO 2013). Clinical examination was performed under natural light Teeth were dried using cotton wools. Oral examination and DMF index were conducted according to WHO 2013 basic survey method. Collection of unstimulated saliva was done between 10 - 12 a.m., at least two hours after worker's breakfast time. The workers asked to incline forward and spit saliva that produced in 5 minutes into a graduated test tube, through a glass funnel.

The salivary samples were centrifuged at 5000 r.p.m for 30 minutes; the clear supernatant was separated by micropipette and it was divided into 3 portions in test tubes, stored at -20°C in a deep freeze till the time of analysis.

Salivary PH was measured directly by digital PHmeter. Then flow rate was estimated as ml/ min.

Calcium in saliva was measured by CPC (O-Cresol Phtalein Complexone) procedure. Calcium OCPC procedure (AGAPPE Kit) is based on the reaction of calcium ions (Ca++) and O-cresolphthalein complex in an alkaline solution to make a bright violet colored complex, that appears maximum absorbance at 578nm. 8-hydroxy quinoline prevents Mg++ interference upto 4 mmol/L. Salivary

phosphate was measured by AGAPPE Kit. Determination of inorganic phosphate according to the following reaction:

Ammonium molybdate + Sulfuric acid gives Phosphomolybdic complex in presence of ATP.

Data description, analysis and presentation were carried out by use Statistical Package for social Science (SPSS version 21); mean and standard deviation (SD) for quantitative variables while frequency and percentage for qualitative ones. One Way Analysis of Variance (ANOVA): use to detect the differences between K independent means of the quantitative variable with Dunnett's T3 (unequal variance and equal sample size, Tukey honestly significant difference (HSD) (equal variance and equal sample size. Levene test: test variance of the data for independent groups about homogeneity or heterogeneity of variance. Pearson correlation: test the correlation between quantitative variables either strong >0.5 or weak <0.5 and either negative or positive. Level of significance as: Not significant P>0.05, Significant P<0.05, highly significant P<0.01. Intra and intercalibration had been conducted with well-trained dentist in order to ensure the consistency of diagnostic criteria followed.

RESULTS

Results concerning caries experience are displayed in Table 1 in which there was highly significant in "DMFS" and "DMFT" and the difference times of soft beverages consuming.

Results concerning flow rate and PH are displayed in Table 2 in which there was highly significant p<0.0. Highest mean of salivary flow rate for workers that drink the soft drinks once weekly, followed by those several times monthly drinking, the lowest was found in those once daily. Highest mean of salivary PH in those once weekly followed by several times weekly and the lowest was found in those several times daily.

Table 3 illustrate the correlation between dental caries and flow rate and PH by different frequencies of soft beverage intake, in which there was indirect relation between flow rate and PH and both "DMFS" and "DMFT".

Results concerning calcium and phosphate are displayed in Table 4 in which there was marginal significant at p<0.05 in salivary calcium. Highest mean for workers that drink the soft drinks once weekly was (7.925), followed by those several times daily drinking(7.538) followed by those several times weekly (6.950), followed by several times monthly (6.713) and the lowest mean for once daily (6.550). The total of calcium was (7.135). There was highly significant p<0.01in salivary phosphate. Highest mean for workers that drink the soft drinks several times weekly was (6.925), followed by those once weekly drinking(6.763) followed by those several times monthly (6.300), followed by once daily (6.038) and the lowest mean for several times daily (6.012). The total of phosphate was (6.408).

Table 5 demonstrates the correlation between caries experience and salivary biochemical analysis (calcium and phosphate) by times of consumption of soft drinks. There was direct relationship in those highly consumption of soft drinks (several times daily and once daily) between salivary calcium and both "DMFS" and "DMFT", but this relation was not significant, while it was highly significant in those several times monthly. There was indirect relationship in those several times daily and once weekly between salivary phosphate and both "DMFS" and "DMFT" that was highly significant.

Table 1: Caries experience (means ± SD) and different frequencies of soft drinks consumption.

Caries Experience	Soft drinks consuming	Mean	± SD	Minimum	Maximum	F	P value
DS	Several times daily	6.88	2.217	3	10	9.902	0.000**
	once daily	7.25	3.89	3	16		

	Several times weekly	5.25	2.295	2	10		
	Once weekly	4.5	1.033	3	6		
	Several times monthly	2.75	0.856	1	4		
	Total	5.33	2.805	1	16		
	Several times daily	1.88	3.594	0	10		
	once daily	3.75	5.627	0	15		
	Several times weekly	1.88	2.5	0	5		
	Once weekly	0.63	1.708	0	5		
	Several times monthly	1.88	2.5	0	5		
MS	Total	2	3.522	0	15	1.667	0.167 [^]
	Several times daily	3.25	2.91	0	8		
	once daily	2.38	2.63	0	7		
	Several times weekly	2.25	2.113	0	6		
	Once weekly	2	1.549	0	4		
	Several times monthly	1.25	1.983	0	6		
FS	Total	2.23	2.322	0	8	1.585	0.187 [^]
	Several times daily	12	2.53	10	18		
	once daily	13.38	4.38	9	22		
	Several times weekly	9.38	2.63	4	12		
	Once weekly	7.13	2.391	3	10		
	Several times monthly	5.88	2.217	3	9		
DMFS	Total	9.55	4.037	3	22	18.57	0.000 ^{**}
	Several times daily	5.5	1.366	3	7		
	once daily	6	0.894	5	8		
	Several times weekly	4.75	1.528	2	6		
	Once weekly	4.38	0.719	3	5		
	Several times monthly	3.38	1.258	2	5		
DMFT	Total	4.8	1.479	2	8	11.673	0.000 ^{**}

[^]=Not significant at p>0.05, ^{**}=Highly significant at p<0.01

Table 2: Salivary flow rate and PH (means ± SD) and different times of soft beverages intake.

Soft beverages intake	Flow Rate				pH			
	Mean	± SD	F	P value	Mean	± SD	F	P value
Several times daily	0.238	0.072			6.631	0.555		
Once daily	0.188	0.081			7.15	0.453		
Several times weekly	0.263	0.102			7.375	0.59		
Once weekly	0.325	0.045			7.563	0.438		
Several times monthly	0.313	0.081			7.15	0.603		
Total	0.265	0.092	8.234	0.000 ^{**}	7.174	0.606	6.872	0.000 ^{**}

^{**}=Highly significant at p<0.01

Table 3: Correlation between dental caries and flow rate and PH with differences times of soft drinks consuming.

Consuming of soft drinks	DMF	PH	Flow Rate
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		R	p	R	P
Several times daily	DS	-0.078	0.774	-0.554	0.026
	MS	0.303	0.254	-0.806	0.000**
	FS	0.082	0.764	0.781	0.000**
	DMFS	0.456-	0.076	-0.733	0.001**
	DMFT	-0.559	0.024*	-0.068	0.803
Once daily	DS	-0.219	0.414	-0.542	0.030*
	MS	0.183	0.498	-0.184	0.496
	FS	0.14	0.605	0.338	0.2
	DMFS	0.124-	0.647	-0.514	0.041*
	DMFT	-0.099	0.716	-0.37	0.159
Several times weekly	DS	-0.822	0.000**	-0.354	0.178
	MS	0.26	0.331	0.033	0.905
	FS	0.604	0.013*	0.539	0.031*
	DMFS	0.015	0.956	-0.155	0.567
	DMFT	-0.244	0.363	-0.064	0.814
Once weekly	DS	-0.162	0.549	0.289	0.278
	MS	0.212	0.431	-0.218	0.417
	FS	-0.55	0.027*	-0.192	0.475
	DMFS	-0.275	0.302	-0.156	0.564
	DMFT	-0.418	0.107	-0.311	0.241
Several times monthly	DS	-0.181	0.503	0.241	0.368
	MS	0.155	0.567	0.207	0.442
	FS	-0.134	0.622	0.229	0.393
	DMFS	-0.015	0.956	-0.531	0.034*
	DMFT	-0.272	0.308	-0.739	0.001**

*=Significant at p<0.05, **=Highly significant at p<0.01

Table 4: Salivary calcium and phosphate (means ± SD) and times of consumption of soft drinks.

Soft beverages consuming	Ca				Po4			
	Mean	SD	F	p	Mean	SD	F	p
Several times daily	7.538	1.558	2.907	0.050*	6.012	0.356	5.114	0.001**
once daily	6.55	0.537			6.038	1.211		
Several times weekly	6.95	1.313			6.925	0.389		
Once weekly	7.925	1.912			6.763	0.49		
Several times monthly	6.713	1.065			6.3	0.864		
Total	7.135	1.423	6.408	0.812				

*=Marginal significant at p<0.05, **=Highly significant at p<0.01

Table 5: Correlation between caries experience and salivary biochemical analysis by different frequencies of soft drinks consumption.

Soft drinks consuming	Caries experience	Ca		PO4	
		R	P	R	p
Several times daily	DS	0.056	0.835	-0.167	0.537

	MS	-0.0514	0.042*	-0.645	0.007**
	FS	0.248	0.355	0.293	0.271
	DMFS	0.494	0.052	-0.726	0.001**
	DMFT	0.041	0.881	-0.562	0.023*
	DS	0.224	0.405	-0.432	0.094
	MS	0.066	0.807	0.213	0.429
	FS	-0.543	0.030*	0.33	0.212
	DMFS	0.043	0.876	-0.088	0.747
Once daily	DMFT	0.028	0.919	-0.222	0.41
	DS	0.54	0.031*	-0.635	0.008**
	MS	0.335	0.204	0.36	0.171
	FS	0.485	0.057	-0.673	0.004**
	DMFS	0.238	0.376	-0.329	0.213
Several times weekly	DMFT	0.219	0.414	-0.034	0.902
	DS	0.486	0.056	-0.119	0.662
	MS	0.117	0.665	0.269	0.314
	FS	0.036	0.895	-0.721	0.002**
	DMFS	0.317	0.231	-0.326	0.218
Once weekly	DMFT	0.036	0.894	-0.677	0.004**
	DS	0.325	0.219	-0.45	0.08
	MS	-0.059	0.827	0	1
	FS	-0.683	0.004**	-0.054	0.841
	DMFS	0.553	0.026*	-0.223	0.407
Several times monthly	DMFT	0.66	0.005**	-0.307	0.248

*=Significant at $p < 0.05$, **=Highly significant at $p < 0.01$

DISCUSSION

The study consists of 80 males who work at least for three years in the Al-Waha Soft Drink Company. The selected workers were nonsmokers, looking healthy and not take any medications in the last two weeks to exclude their effects on the oral health status. All teeth except the third molar were examined. Data analysis in this study demonstrated that dental caries in permanent dentition (DMF) among the workers with highest mean in those with high consumption of the soft drinks (several times daily and once daily). While the lowest mean of "DMF" in those workers that had low frequency of consuming of soft beverages (once weekly and several times monthly). This finding agrees with other studies who have shown a direct relation between dental caries with frequency of soft drinks intake [1,2,7,8-13].

Unstimulated whole saliva was used as this kind of saliva is dominates nearly at every time, it is important for maintenance of oral health and its act as a mirror that manifesting physiological condition of oral cavity and whole body [14].

Data showed that salivary flow rate and PH among workers was highly significant difference with frequency of soft drinks consuming. The correlation coefficient between salivary flow rate and PH and dental caries was negatively correlated among the workers, this is agree with others that considered the salivary flow rate as an indicator of caries susceptibility [15] and agree with others that considered the salivary PH as an indicator of caries susceptibility [15-17].

Finding of this study can be demonstrate by that there was marginal significant in calcium and frequency of soft drinks consuming. The highest mean for workers that drink the soft drinks once weekly was, followed by those several times daily drinking.

The correlation between caries experience and salivary biochemical analysis (calcium) by times of drinking was differ with direct relationship. However, this relation was not attaining significant level. These results were in agreement with [18-21], who found that an increase salivary Ca concentration related with the increase in dental caries severity. The direct correlation of salivary Ca levels with dental caries could be assigned to that the main inorganic constituents of saliva, which are Ca, PO₄ and hydrogen ions, together with fluoride, have an essential part relating to the solubility of the minerals of dental tissue. Any decline in the salivary PH, it will causing under saturation of saliva to hydroxyapatite that result in its dissolution to their ionic constituent to increase the grade of the gradient. For that reason, calcium ions diffused from dental tissues to saliva. However, these findings differ from [23-26], who reported that higher calcium levels in those with caries-free. In meanwhile [27], stated that the mean level of calcium was lower in higher caries when compared to lower caries and it was statistically significant. They explained that high calcium concentration in saliva lead to remineralization of incipient caries lesions that decreases caries experience rate. The saliva becomes a reservoir supersaturated with calcium and phosphate that create an environment that support remineralization over demineralization.

The finding of this study can be explicated by that there was highly significant in phosphate and frequency of soft drinks consumption. The highest mean for workers that drink the soft drinks several times weekly, followed by those once weekly drinking.

The correlation between caries experience and salivary biochemical analysis (phosphate) by times of drinking was different with indirect relationship.

This result may give an indication of the protective role of inorganic phosphate ions against tooth decay. The indirect correlation of salivary inorganic phosphate ions with caries may be due to its cariostatic action through its ability to preserve the saturation of saliva with phosphate ions [28] and give notion about potential impact of inorganic phosphate in remineralization of incipient caries lesion. Inverse relation with DMF associated to its action in buffer and remineralization and phosphate can conflict with adherence of pellicle and bacterial plaque to tooth surfaces [28] This finding is in agreement with the conclusion of [21,25,26].

CONCLUSION

It is present from the result of this study the high frequency of soft drinks consuming connected with increase of the dental caries.

The results were appeared significant variations in levels of salivary calcium and phosphate of the workers. Saliva has been used to found caries risk.

Inorganic phosphate level in the saliva has a negative influence on the caries experience and negative relation with DMF index, so the caries activity was associated with depressed level of salivary inorganic phosphate.

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