Salivary analysis and oral symptoms in controlled asthmatic patients

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Abstract :

Asthma is a common inflammatory condition of lung airways. Its cause is incompletely understood.

Patients with bronchial asthma are affected both by the disease and its treatment. The purpose of our study was to examine the salivary composition in asthmatic patients, and study the association between asthma and occurrence of selected oral symptoms.

The study was divided into two phases. In the first phase (salivary analysis) the salivary composition and unstimulated salivary flow rates of 50 asthmatic patients were compared with that of 25 non –asthmatic subjects. In the second phase (questionnair survey) the occurrence of symptoms of oral diseases in asthmatics (n=113) was compared with that of non-asthmatic subjects (n=111).

In addition to the symptoms of oral diseases, data on background information were taken. The results of salivary analysis showed no statistically significant differences between the asthmatic and non- asthmatics concerning the salivary flow rate and composition. However, the asthmatic saliva samples showed lower potassium and higher inorganic phosphorus levels.

In the questionnair survey , the subjects reported more symptoms (dry mouth ,sore mouth , halitosis , pain in Temporomandibular jiont (TMJ) , stuffiness in (TMJ) and clicking in (TMJ) compaired to the controlled group. The presence of asthma precipitating factors and medication used had a considerable effect on the probability of having symptoms of oral diseases when compaired to non- users.

Keywords:

Asthma, salivary composition, salivary flow, dry mouth, TMJ, halitosis, sore mouth.

Introduction:

Asthma has become one of the most common chronic diseases in industrialized countries and its prevalence is increasing throughout the world [1].

Asthma affects all age groups and is often persistent, accounting for a large proportion of health care spending and loss of work [2, 3, 4, 5].

Relatively few studies exist on the oral health of asthmatic patients. Findings indicating an increased risk of oral diseases in asthmatic patients are mainly obtained from studies on children and adolescents. According to most published reports, young asthmatic patients suffer more from caries and/or

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periodontal diseases than non-asthmatic subjects [6, 7, 8,].

These findings were mainly obtained from small-scale studies and there are two recently published studies that found no association between dental caries and childhood asthma or association over time between asthma and caries increment [9, 10].

The increased incidence of dental caries to the regular use of inhaled β_2-agonsits used in the treatment of asthma [11]. However, during the 1990's the treatment of asthma has changed dramatically. The regular use of inhaled β_2-agoinsts is not efficient and the early introduction of inhaled steroids is an internationally approved approach to the treatment of asthma [12].

The differences in salivary flow rate and saliva composition between asthmatic and non-asthmatic children have been reported. Saliva plays a major role in the health of the oral cavity and any changes in the amount or quality of saliva may alter the oral health status [13]. Saliva contains several defense systems aiming to protect dental enamel and oral mucous membranes. Their effects on the action mechanisms of various antimicrobial systems and bacterial, fungal and other species present in human saliva have been extensively studied *in vivo* [14]. However, little is known of their possible significance in vivo, and in particular with respect to systemic medication or systemic disease [15, 16].

The two most common oral diseases, dental caries and periodontal disease, are preventable to some extent, and early recognition of populations at high risk may help to focus dental health care resources more effectively on the prevention of these diseases. Based on clinical experience, asthmatic patients are also sometimes worried about the possible side effects of inhaled anti-asthma medications on their mouths.

In summary, many previous studies indicated that asthmatic children, adolescents and young adults may have an increased risk for oral diseases. Unfortunately, there is only very information little available concerning oral health, salivary secretion, and composition, and the occurrence of symptoms of oral diseases in adult asthmatics.

The purpose of the present study was to examine the salivary flow rate and salivary composition in a group of asthmatic and non asthmatic subjects, and to investigate the association between asthma and the following selected symptoms of oral diseases: dryness of mouth (Xerostomia), sore mouth, feeling of bad odor (halitosis), TMJ disorders (pain, stiffness, clicking), toothache, sensitivity to hot, cold or sweet and bleeding from gums by using a questionnaire survey and compare it with non-asthmatic subjects.

In addition, evaluate the effect of potential confounding variables (age, gender, smoking and concomitant use of medication other than for asthma) on the occurrence of symptoms of oral diseases.

Material & methods:

Populations

In the salivary analysis fifty asthmatic subjects were enrolled from among patients visiting the clinic of pulmonary diseases in general Ramadi Hospital in Ramadi City, from those subjects 28 were females and 22 were males.

The control group include 25 non asthmatic subjects 13 of them were male

and 12 were female (medical staff from the same hospital).

In the questionnaire survey a random sample of 113 asthmatic subjects were enrolled and in the same way a random sample of 111 non asthmatic subjects were included both of the asthmatic and non asthmatic subjects living in Ramadi City.

Collection of saliva samples

The saliva samples were collected in the morning between (8.00-10.30) a.m, at least 1 hour after breakfast.

Unstimulated whole saliva was collected for five minutes from all the populations. The subject was kept as quite as possible, usually in a seated position.

They instructed to allow the saliva to flow into the mouth as normally as possible and to expectorate into large graduated plastic test tubes provided for sample collection which then held in crushed ice to the laboratory. Then the volume of each saliva sample was measured and the flow rate ml/5min. was calculated.

Analysis of saliva samples

After the collection of saliva, all samples were frozen at (-20°C) until assayed. At the time of biochemical analysis the saliva samples were thawed, homogenized by passing through the tip of the pipette several times then used for estimation of total protein, sodium, potassium, calcium and in organic phosphorus.

In the chemical assay the following items were analyzed from the saliva samples:

- Total protein. (by using Lab kit)
- Calcium. (by using bio merieux kit)
- In organic phosphorus. (by using bio merieux kit)
- Sodium. (by using flam photometry)
- Potassium. (by using flam photometry)

Statistical analysis of data was used at 0.05 significant level by using SPSS.10 program.

Results:

Results from the salivary analysis

Subjects characteristics

The mean age was 29 years in asthmatics and 25 in healthy subjects. The mean duration of asthma was 5 years, ranging from less than one year to 24 years.

Three asthmatics had diagnosed asthma for one year or less. In seven asthmatics the disease was graded mild; in 22 asthmatics as moderate and 21 asthmatics were classified as sever asthmatics. Twenty-seven subjects (54%) in the asthma group were a topic.

Salivary flow rate

No statistically significant difference was found in the unstimulated salivary flow rate between the asthmatic and healthy group. The mean flow rate was 2.710 in asthmatics and 3.215 in healthy subjects (tables 1, 2).

Table (1): Mean (SD) of unstimulated salivary flow rate (USFR) foe asthmatics and healthy subjects and 95% Confidence interval (95% CI) for difference between the means.

	Asthmatics	Healthy	Difference	95% CI
USFR(ml/min)	2.710(1.362)	3.215(1.228)	-0.504	-1.538+0.240

Table (2): Mean (SD) and the significant difference between the mean values of the groups (asthmatics and healthy) were estimated by student's t-test.

	Asthmatics	Healthy	t-test	p-value
USFR (ml/min)	2.710(1.362)	3.215(1.228)	1.528	0.143 (non significant)

Saliva analysis

In the same study the concentration of total protein, calcium (Ca^{2+}), inorganic phosphorus, sodium (Na^{+1}) and potassium (K^{+1}) in whole saliva of 50 asthmatic patients were compared with those of 25 non-asthmatic controls. The only statistically difference between the groups was found in the mean concentrations of inorganic phosphorus and potassium (Table 3, 4).

Table (3): Mean (SD) and their 95% confidence intervals of the difference (95% CI)

	Patients	Healthy	Difference	95%CI of the difference
Total protein	0.589(0.402)	0.647(0.166)	-0.057	-0.282+0.213
Calcium	4.888(2.113)	6.0125(1.183)	-1.124	-0.858+0.134
In organic phosorus	11.592(4.401)	7.549(2.873)	4.043	3.479+6.262
Sodium	3.102(1.198)	3.690(1.551)	-0.588	-1.075+0.733
Potassium	12.198(5.092)	14.300(5.098)	-2.102	-8.312-2.097

Table (4): Mean (SD) and the significant difference between the mean values of the groups (patients & Healthy) were estimated by student's t-test

	Patients	Healthy	t-test	p-value	Sig.
Total protein	0.589(0.402)	0.647(0.166)	0.289	0.776	NS
Calcium	4.888(2.113)	6.0125(1.183)	0.461	0.650	NS
In organic phosorus	11.592(4.401)	7.549(2.873)	7.328	0.000	HS***
Sodium	3.102(1.198)	3.690(1.551)	0.394	0.698	NS
Potassium	12.198(5.092)	14.300(5.089)	3.506	0.002	S**

* P>0.05 Non significant
** P<0.05 Significant
*** P<0.0001 Highly significant

Results from the questionnaire survey

Patient's demographics and background information

The mean age of the respondents was 35 years among asthmatics and 28 years among controls.

The percentage of females was 61% and 63% respectively. In asthmatics 91 of subjects used asthma medications. Medications other than for asthma were used by 29% of asthmatic while in controls 11% used other medications.

Symptoms of oral diseases and asthma, allergy and asthma medication

More asthmatic than healthy subjects reported symptoms of oral diseases. The probability of having dry mouth, sore mouth, halitosis and also symptoms of TMJ disorders were significantly high between asthmatics and healthy subjects (Table 5).

Table (5): Number (n) and percentage (%) of subjects symptoms of oral diseases among asthmatic (Asthma, n=113) and non asthmatic subjects (Healthy, n=111).

Symptoms	Subjects with symptoms			
	Asthma		Healthy	
	N	%	N	%
Dry mouth	90	79	13	11
Sore mouth	36	31	11	9
Halitosis	54	47	29	26
TMJ pain	20	17	15	13
TMJ stiffines	10	8	3	2
TMJ clicking	63	55	22	19
Toothache	32	28	19	17
Sensitivity	12	10	23	20
Bleeding	49	43	20	18

When the data from the study population were analyzed according to the presence of self-reported allergy, allergic subjects reported more symptoms of oral diseases than non-allergic subjects(table 6).

The data from the study population were also analyzed according to the use of asthma medication (Table 7). In this analysis those who used asthma medications had higher probabilities of having symptoms of dry mouth, sore mouth, and halitosis and TMJ disorders. The probabilities of having toothache, sensitivity or bleeding from gums were on the same level in both groups.

Table (6): Number (n) and percentage % of subjects reporting symptoms of oral diseases among allergic (Allergy, n=168) and non allergic subjects (No allergy, n=56).

Symptoms	Subjects with symptoms			
	Allergy		No allergy	
	N	%	N	%
Dry mouth	129	76	33	58
Sore mouth	123	73	9	16
Halitosis	115	68	12	21
TMJ pain	109	64	7	12
TMJ stiffness	30	11	11	19
TMJ clicking	152	90	24	42
Toothache	67	39	13	23
Sensitivity	87	51	10	17
Bleeding	88	32	18	32

Table (7): Number and percentage (%) of subjects reporting symptoms of oral diseases among subjects with anti-asthma medication (medication, n=88) and without anti-asthma medication (No medication, n=133).

Symptoms	Subjects with symptoms			
	Medication		No medication	
	N	%	N	%
Dry mouth	79	89	12	9
Sore mouth	64	72	4	3
Halitosis	73	82	6	4
TMJ pain	34	38	2	1
TMJ stiffness	28	31	3	2
TMJ clicking	45	51	15	11
Toothache	20	22	28	21
Sensitivity	33	37	46	34
Bleeding	43	48	58	43

The detailed effects of potential confounding variables (Table 2) on the occurrence of symptoms of oral diseases are presented in tables (8, 17).

The strongest single factor affecting the most symptoms of oral diseases was the concomitant use of medications other than for asthma. The effect of other possible confounders was modest or nit.

The occurrence of the symptoms of dry mouth was higher among subjects older than 35 years than in younger subjects and also higher among smokers than non smokers (Table 9). Smoking and age over 35 years were associated with the symptoms of sore mouth (Table 10). Few of the potential confounding factors had significant effect on halitosis (Table 11).

Table (8): Number of asthmatics in different categories of potential confounding variables in questionnaire survey and 95% CI for independent variables

Confounder	Number of subject		95% CI
	Asthmatic	Healthy	
Age (years)			
<35	76	63	1.5-1.6
35 or more	37	48	
Gender			
Female	69	70	2.4-2,6
Male	44	41	
Smoking			
Smoker	52	50	1.1-1.3
Non smoker	61	61	
Use of medication			
No	80	97	2.2-2.3
Yes	33	14	

Table (9): Number of subjects with or without symptoms of dry mouth in different categories of potential confounding variables in questionnaire survey and 95% CI for independent variables

Confounder	Number of subject		95% CI
	Without symptom	With symptom	
Age (years)			
<35	126	13	0.5-0.6
35 or more	53	32	
Gender			
Female	128	11	0.3-0.5
Male	67	18	
Smoking			
Smoker	18	89	0.4-0.3
Non smoker	20	40	
Use of medication			
No	164	13	0.7-0.9
Yes	32	15	

Table (10): *Number of subjects with or without symptoms of sore mouth in different* categories of potential confounding variables in questionnaire survey and 95% CI for independent variables.

Confounder	Number of subject		95% CI
	Without symptom	With symptom	
Age (years)			
<35	123	16	0.4-0.6
35 or more	56	29	
Gender			
Female	162	21	0.5-0.6
Male	69	16	
Smoking			
Smoker	71	31	1.1-1.2
Non smoker	98	24	
Use of medication			
No	168	9	0.7-0.9
Yes	39	8	

Table (11): Number of subjects with or without symptoms of halitosis in different categories of potential confounding variables in questionnaire survey and 95% CI for independent variables.

Confounder	Number of subject		95% CI
	Without symptom	With symptom	
Age (years)			
<35	192	17	0.8-1.1
35 or more	54	21	
Gender			
Female	12	17	0.4-0.5
Male	57	28	
Smoking			
Smoker	86	16	1.6-1.3
Non smoker	116	6	
Use of medication			
No	95	82	1.1-1.6
Yes	41	6	

Women reported all TMJ symptoms slightly more than men did (Table 12, 13, 14), while other variables had negligible effects on the TMJ symptoms. From the three TMJ symptoms clicking was most often reported (Table 14).

Table (12): Number of subjects with or without symptoms of pain in TMJ in different categories of potential confounding variables in questionnaire survey and 95% for independent variables.

Confounder	Number of subject		95% CI
	Without symptom	With symptom	
Age (years)			
<35	130	9	0.3-0.5
35 or more	700	15	
Gender			
Female	115	24	1.6-1.3
Male	69	16	
Smoking			
Smoker	100	2	0.6-0.7
Non smoker	98	24	
Use of medication			
No	171	6	0.6-0.9
Yes	43	4	

Table (13): Number of subjects with or without symptoms of stiffness in TMJ in different categories of potential confounding variables in questionnaire survey and 95% CI for independent variables.

Confounder	Number of subject		95% CI
	Without symptom	With symptom	
Age (years)			
<35	124	15	0.1-0.3
35 or more	80	5	
Gender			
Female	116	23	0.1-0.3
Male	77	18	
Smoking			
Smoker	92	10	0.4-0.5
Non smoker	113	9	
Use of medication			
No	165	12	0.6-0.8
Yes	38	9	

Table (14): Number of subjects with or without symptoms of clicking in TMJ in different categories of potential confounding variables in questionnaire survey and 95% CI for independent variables.

Confounder	Number of subject		95% CI
	Without symptom	With symptom	
Age (years)			
<35	98	41	0.1-0.2
35 or more	66	1	
Gender			
Female	97	42	0.2-0.9
Male	73	12	
Smoking			
Smoker	84	25	0.4-0.5
Non smoker	99	23	
Use of medication			
No	153	24	0.5-0.7
Yes	35	12	

Smoking had a significant effect on toothache (Table 15) males reported less sensitivity to hot, clod and sweet than females (Table 16).Smokers had lower prevalence of bleeding from gums than the non smokers subjects (Table 17).

Table (15): Number of subjects with or without symptoms of toothache in different categories of potential confounding variables in questionnaire survey and 5% CI for independent variables.

Confounder	Number of subject		95% CI
	Without symptom	With symptom	
Age (years)			
<35	128	11	0.3-0.4
35 or more	70	15	
Gender			
Female	117	22	0.9-1.1
Male	76	9	
Smoking			
Smoker	82	20	0.1-0.2
Non smoker	101	11	
Use of medication			
No	172	5	0.7-0.9
Yes	38	9	

Table (16):Number of subjects with or without sensitivity of hot, cold or sweet in different categories of potential confounding variables in questionnaire survey and 95% CI for independent variables.

Confounder	Number of subject		95% CI
	Without symptom	With symptom	
Age (years)			
<35	184	15	0.6-0.8
35 or more	65	20	
Gender			
Female	119	20	0.2-0.3
Male	70	15	
Smoking			
Smoker	80	22	0.2-0.3
Non smoker	112	10	
Use of medication			
No	162	15	0.6-0.8
Yes	39	8	

Table (17):Number of subjects with or without bleeding from gums in different categories of potential confounding variables in questionnaire survey and 95% CI for independent variables.

Confounder	Number of subject		95% CI
	Without symptom	With symptom	
Age (years)			
<35	164	35	0.5-0.6
35 or more	62	23	
Gender			
Female	100	39	0.4-0.8
Male	75	10	
Smoking			
Smoker	82	20	0.7-1.1
Non smoker	88	34	
Use of medication			
No	97	80	1.1-1.4
Yes	30	17	

Taken together, generally the factors that were considered to be potential confounders had mainly slight effects on the probability of having symptoms of oral diseases. The only exception was the use of medication other than for asthma. which seemed to contribute to four of the nine symptoms evaluated.

Discussion:

Salivary analysis

Sample collection

To minimize the effect of individual variation, diurnal effect and general factors, the method of samples collection, the posture of subjects and the time after the breakfast meal have been standardized as possible for both groups.

Salivary secretion and composition has been the subject of several quantitative and qualitative investigations, but the results obtained have been discordant. This lack of agreement may be due to different experimental designs, different measuring procedures, also the effect of wide variety of physical, mental, dietary and age group factors on saliva secretion and composition, in addition to the proportional contributions effect of the different salivary glands in the whole saliva [17].

Flow-rate

The flow rate of whole resting saliva found to be significantly similar in both asthmatic and non-asthmatic groups. This study was the first published report on salivary flow rate and saliva composition in asthmatic patients in Iraq. However, this study shares the same problem as many of the earlier studies in children and adolescents; the measurement is based on a fairly small number of subjects.

This result is in agreement with other study which found no difference in salivary flow rate between asthmatics and non asthmatic group [18] and differ from other study which found that the secretion rate of estimated whole saliva was 26%(lower in, asthmatic than non asthmatic children and they indicate this decrease in secretion rate to the effect of drug used by asthmatic subjects rather than the disease itself, and other found that paraffin-estimated flow rate of saliva is decreased in adult asthmatic patients compared to non-asthmatic controls and the 24% reduction in flow rate of stimulated whole saliva in adult asthmatic patients is of about the same magnitude as that reported for asthmatic children and adolescents [19].

The decrease in salivary flow rate among asthmatics has previously been linked to the regular use of inhaled B_2-agonists [11]. The regulation of salivary synthesis and secretion is a rather complex system, involving at least adrenergic, cholinergic and non adreno-non-cholinergic nerves [20].

In the present study asthmatics used inhaled B_2-agonists on an as needed - basis and were less exposed to those medications than the asthmatics in the earlier studies, thus the use of B_2-agonists may not be enough to affect the salivary flow rate.

Salivary composition

The results of this study show that there are no statistical significant differences concerning the salivary composition of unmedicated asthmatic patients and that of matched healthy controls.

Patients with bronchial asthma are affected both by the disease and the drug. It is therefore difficult to dissociate the effect of the two, but there are indications that the drug treatment exerts the stronger effect.

In the present study no significant changes in total protein content were observed in saliva of asthmatics and this result agreed with other study which found no changes in total protein content of saliva in asthmatic patients [17], but disagreed with

study which found that the concentration of total protein and amylase in paroted saliva were significantly lower for the asthmatic children and they suggested that the decrease was caused by the drug. The explanation of this condition could be due to the irregular use of medication or with low dose as in inhaler [18].

Our data show no significant changes in Calcium concentration in asthmatic's saliva, this result is in agreement with other studies which found elevated concentration of calcium in correlation with increase in calculus in asthmatic patients this discrepancy might be due to clinical state of the patient [21, 22, 23].

There was no significant difference concerning sodium concentration between healthy and asthmatic subjects. This result is in agreement with other studies [18, 21].

Potassium level found to be significantly lower in asthmatics than in healthy controls this result disagrees with other studies [18, 24].

The mean salivary in organic phosphorus level found to be significantly elevated among asthmatics than healthy subjects and this result agreed with other studies in which separate sub-maxillary and parotid saliva were analyzed and elevated phosphorus level were found. This discrepancy might be due to the treatment, or the clinical state of the patients [23].

The questionnaire survey

The major advantage of the questionnaire survey was the relatively large number of observation, which increases the credibility of the results.

Comparison of the demographic data of the questionnaire survey to those of KELA survey which reveals that at least the gender distribution is close to each other. However, the asthmatics in the questionnaire survey were somewhat younger and there were also difference in the distributions of basic education and professional education [25]. The validity of the questionnaire always crucial when estimating the scientific value of the result from questionnaire studies. One option to estimate the validity of the questionnaire used in the questionnaire survey is by comparing the results of the study against those published earlier by other researchers. The similarity of the results between the questionnaire survey and other studies concerning e.g. gender distribution, smoking habits, or prevalence of certain symptoms in the control group indicate that the results reported here as in line with results from other studies.

The questions used in the evaluation of symptoms of oral disease were obtained from the standard questionnaire used by dentists in their daily practice in order to collect oral health data for the planning of treatment. In the questionnaire survey altogether 22 of the 113 asthmatics did not use any type of asthma medication. KELA estimates that approximately 20% of the subjects in the register do not take medications regularly. Because the register is cumulative in nature, subjects who are once included to the register, will not be removed if they temporarily stop taking medication. Also in other survey in Finland, the percentage of asthmatics without ant asthma medication was 19% and this lower percentage can be explained by the age of the subjects [17]. In the questionnaire survey the age of the subjects ranged from 9 to 62 years and usually the disease is more severe in children and in old peoples and in our study most of the subjects were children

and old people and few are adult, this is why the percentage of subjects without medication was small (19%).

In the questionnaire survey slightly more gingival bleeding was reported by asthmatics than by non-asthmatics. However, the detailed analysis showed that the reason for higher probability for having gingival bleeding was due to co-existing allergy rather than asthma itself. Spontaneous gingival bleeding is regarded as a cardinal sign of gingivitis, although it may not always predict advanced periodontal diseases in atopics. The published report indicates that atopic subjects may have an increased risk for gingivitis [26].

Although the role of allergy is not clear, IgE mediated mechanisms are assumed to be involved in the pathogenesis of gingival and periodontal disease [27]. In patients having birch pollen allergy, an increased amount of gingivitis was observed during the pollen season when compared with the off-season [26]. Platelet activating factor, one of the mediators of allergic inflammatory reaction is also present in inflamed gingival Tissues [28]. Interestingly, some of the cytokines which mediate inflammatory processes in the mucous membrane of air ways are also found in inflamed periodontal tissues [29].

In the questionnaire survey the asthmatic subjects had significantly higher probability of having dry mouth than healthy subjects. When the combined effects of all three risk factors (asthma, allergy and asthma medication) were analyzed in the same model, it was found that subjects having asthma alone had the lowest probability for dry mouth, but the use of asthma medication was associated with significantly higher risk. This is in accordance with the finding of Bergdahl and Bergdal in their study low unstimulated salivary flow rate and subjective oral dryness were significantly associated with the use of anti-asthma drugs [30].

In the questionnaire survey the prevalence of dry mouth in asthmatic population was 79% which is higher than that reported in a large population based survey in Sweden [31]. In that study the prevalence of symptoms of dry mouth in non medicated population ranged from 10.1 to 9.6%, also this percentage is higher than that reported in Finland in which the prevalence of dry mouth in asthmatic population was 24% [17].

The concomitant use of medication other than for asthma was a strong confounding factor for dry mouth. This is in agreement with the findings which found that the polypharmacy is a true risk factor for oral dryness [31]. The use of medication other than for asthma was also a significant risk factor for the prevalence of other symptoms of oral diseases. On the other hand, the use of medication other than for asthma was more common among asthmatics than controls. The medications used are not known exactly, but the most likely explanation is the co-morbidity of allergic diseases. Asthmatic often tend to use medications for other allergic conditions, such as rhinitis, conjunctivitis, and dermatitis. However, the possible co morbidity of other than atopic diseases cannot be excluded, and is an interesting option for further research.

An interesting finding was the relationship between asthma, allergy and symptoms of TMJ disorders. It is worth noting that different TMJ symptoms were associated in a different way with

asthma and allergy, pain in the TMJ and clicking in the TMJ were mainly associated with allergy, while stuffiness in the TMJ was more common in asthmatic subjects. The possible mechanism behind this association is not clear.

The etiology of TMJ dysfunction still remains a matter of controversy but the theories proposed include the spatial relationship between mandible and maxilla as a major reason for the etiology for TMJ disorders [32]. Recently there has been growing interest in the research of tissue reactions in TMJ dysfunction. It seems that pain in the TMJ is caused by inflammatory changes in joint tissue leading to arthritis and tissue destruction. In this process cytokines are of utmost importance and at least IL-6 has been proposed as one major cytokine found in the synovial fluid of patients with chronic TMJ disorders [33].

In the questionnaire survey males had lower probability of having asthma compared to females. An epidemiological report from Finland shows that asthma is slightly more common among adult females than among adult males, but the difference was some what smaller than in our study [34]. Recently another questionnaire survey (the KELA Survey) evaluating the health status, use of health services and need for rehabilitation among people with asthma was published in Finland In the KELA survey the proportion of males was 36.5% compared to be over-represented in the asthma population, probably due to different behavior in responding to this type of questionnaire .

Although smoking is a known risk factor for several oral diseases, the effect of smoking on the symptoms of oral diseases has not been extensively reported. Among the asthmatics the proportion of smokers was 46% which is higher than that reported in KELA survey (30%) including regular and occasional smokers [25].

In the questionnaire survey the probability of oral dryness was increased in current smokers. This contradicts another report indicating that smoking dose not affect salivary flow rate.[35] However, the relationship between subjective feeling of dry mouth (xerostomia) and objective finding of decreased salivary flow rate (hypo salivation) dose not necessarily correlate. Subjects having normal salivary flow rate may feel symptoms of dry mouth because of mouth breathing that occurs e.g. when having a blocked nose. The feeling of xerostomia may also be more related to the condition of oral mucous membranes than to pathologically decrease salivary flow rate [36].

Smokers had increased probability of reporting toothache. Although smokers tend to have more caries, the direct effect of smoking on caries development has both been reported. The association found may reflect different health behavior rather than the effects of smoking on the development of

Caries.[37] In an epidemiological study in Finland, studied the association of lifestyle (physical activity, tobacco smoking, alcohol consumption and dietary habits) with dental caries, periodontal health, denture stomatitis and dental health behavior.[38] the study evaluating interactions between people's diet and their smoking habits showed that smokers had a tendency to use more sugar than non-smokers in their daily diet [39]

Smokers reported less gingival bleeding compared to non smokers. Smoking is a known risk factor for advanced periodontal diseases but gingival bleeding is less common among smokers than non smokers, probably due to the suppressive effect of smoking on peripheral circulation. Poor oral hygiene is a common risk factor for gingival bleeding and this finding may be explained by the general lifestyle. [38]

Previously it has been shown that allergy itself may cause burning and painful sensations on mucous membranes in the oral cavity in connection to exposure to allergens, especially in food allergies [40]. In the questionnaire survey allergy alone was not a significant risk factor for sore mouth, but the combination of asthma, asthma medication and allergy led to highest probability for reporting sore mouth. One of the reported side-effects of inhaled corticosteroids is sore throat. The direct effects of inhaled corticosteroids on oral mucous membrane are not known. However, the use of inhaled corticosteroids may sometimes increase the risk for Candida infections in mouth. [41] A condition that is also occasionally associated with painful feeling in oral mucous membranes. Often the reason for sore mouth remains unclear, but it is worth noting that in several reports and reviews, dry mouth has been proposed as one possible factor contributing to this syndrome.

Halitosis was a common problem, 26% of controls have halitosis. There are no reports available on the prevalence of halitosis in asthmatic population. In this study the prevalence of halitosis was highest among asthmatics that had all the three risk factors simultaneously.

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