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Evaluation of the effect of caries experience and etiological risk factors on oral dental health operation costs

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Abstract
This study aims to examine the effect of caries experience and etiological risk factors on the potential cost burden of the individual on the health system.
A cross sectional study 1497 adult individuals in 25-30 age group were evaluated. The study was conducted using questionnaires and clinical examinations. Current DMFT/DMFS values of individuals were calculated. The dental needs of individuals were determined, a planning was created for each individual with the most basic procedures met by the SSI. The number of filling, shooting, canal treatment, prosthesis, periodontal treatment needs were evaluated separately for each individual. A total of the cost was calculated for each individual by multiplying the scores in the SSI Health Application Communiqué table with the notified coefficients. The obtained DMFT values, etiological risk factors and total costs were statistically analyzed.
While the average DMFT/DMFS values of individuals in the group below the cost average are 4.82/9.44, the ones above it are 13.72/34.53. It was determined that the frequency of brushing, brushing habit before sleep and the use of fluorinated oral care agents and dental floss between groups had a significant effect on the cost reduction between groups. It was observed that dental examination frequency and orthodontic treatment had a significant effect on cost reduction. It was determined that smoking had a significant effect on increasing the cost.
It was concluded that the individuals with adequate oral care habits and who went to regular dentist examination decreased their caries experience and therefore their possible total costs would be low.

Keywords: Caries experience, etiological risk factors, ooral dental health operation costs, DMFT, DMFS

Introduction
Dental caries is one of the most common bacterial diseases. This disease affected people even in prehistoric times and has become more common with the nutritional changes of modern times. Although the importance of dental treatments has decreased for general human health since they do not pose a vital problem, their economic cost is very high [1].
The bruise experience shows how much the individual was affected by the risk factors that caused caries up to that day. It has been supported by many studies that individuals with caries lesions in the early period and individuals with large number of newly formed caries lesions will have more rotten lesions in the coming years [2–4].
Determining the effect of different etiological factors on caries risk does not only help prevent caries experiences from increasing but also reduces treatment costs. In order to maintain the current situation, the risk factors of the patients should be determined. The aim of this study is to investigate the effect of caries experience and etiological risk factors on the potential cost burden of the individual on the health system.

Materials and Methods
This research was conducted as a cross-sectional study. ethical approval was obtained from Necmettin Erbakan University, Dentistry Faculty(Decision no:2017.11; November 9, 2017). The informed consent forms were obtained from the individuals who participated in the study. 1497 young adults between the ages of 25-30 who applied to the Faculty of Dentistry, University of Necmettin Erbakan for treatment and examination were evaluated within the scope of this research. To calculate the probability sample, we adopted a 95% confidence interval level, 20% accuracy and design effect of 2. We used the simple formula to determine the sample size as follows: $n= (t^2_{a/2}\ pq)/d^2$. Although the formula gave us approximately 1345 participants, we decided to increase the sample size to increase the power of the study and to get more accurate results.
The exclusion criteria for patients were with systemic problem, undergoing fixed orthodontic treatment. Clinical examinations of the individuals were performed by same researcher according to the World Health Organization (WHO) criteria, with the help of mirrors and sickle probe under the reflector light. In the clinical evaluation, teeth with definite caries symptoms were considered caries, teeth with restoration were considered as fillings, and teeth extracted due to caries were considered to be missing. Initial enamel lesions and white-brown spots were considered intact. Bitewing and panoramic radiographs were used for radiographic examinations. Wisdom teeth were excluded from the study. Radiolucent areas, which were clearly observed from the enamel-dentin border to the dentine on the radiograph, were recorded as caries. DMFT (Decay Missing Filling Total) and DMFS (Decay Missing Filling Surface) values of each individual were recorded. Patients who underwent clinical and radiographic examinations were asked to fill out a questionnaire investigating etiological risk

factors. Factors related to oral care habits: 1- Tooth Brushing Frequency (at least twice a day/ once a day/occasional or never), 2- Tooth brushing before bedtime (yes/no), 3- Using flourinated toothpaste (yes/no), 4- Using flourid mouthwash (yes/no), 5- Dental floss use (yes/no), 6- Frequency of going to dentist (every six months/ once a year/ only when they have dental problems), 7- Orthodontic treatment (yes/no), 8- Smoking (yes/no); To compare habits related to sleep patterns: 1-Sleep pattern (regular/ irregular), 2- Average sleep duration at night (less than 6 hours/ 6-8 hours/ more than 8 hours), 3- Eating before sleep (yes/no).

As a result of the clinical and radiological examination data of the individuals, minimum number of procedures necessary for rehabilitating and improving the current condition were planned for each individual. The transactions in the plans created separately for each individual were multiplied by the amounts per procedure as a result of the multiplication of the scores specified in the current 2013 Health Application Communiqué ANNEX-2/C Dental Treatment Score List of the SSI's 05.07.2018 Amendment Communiqué. A total cost was created for each individual by summing up the transaction amounts obtained. The average of the total transaction costs obtained from each planning was calculated for the entire working group and two groups were formed, below and above the average.

The data obtained as a result of the measurements made during the study were evaluated using SPSS statistical software (SPSS Statistics 17.0, Chicago, USA) in Windows environment. Independent sample t test was applied to determine the relationship between caries experience and total treatment costs. The etiological caries risk factors obtained from the questionnaire and the total cost averages required for the oral and dental health of individuals were evaluated with the ANOVA and t test.

Results

In order to determine their effects on cost, the average cost of the group we worked with was calculated and two groups were created. While the average DMFT value of the individuals in the group that was below the cost average was 4.82, the average DMFT value of the individuals above the cost average was 13.72. DMFT value had a significant effect on increasing cost ($p < 0.001$).

While the average of DMFS values of the individuals in the group below the cost average was 9.44, the average DMFS value of the individuals above it were 34.53. DMFS value had a significant effect on increasing cost ($p < 0.001$).

While the average DT value of the individuals in the group below the cost average was 2.23, the individuals above the average were 5.84. While the average MT values of the individuals in the group below the cost average was 0.25, the individuals above the average were 2.19. While the average of FT values of the individuals in the group below the cost average was 2.38, the individuals above it were 5.68. DT, MT, FT values had a significant effect on increasing the cost ($p < 0,001$) (Table 1).

Table 1: Evaluation of the Effect of Caries Experience Cost Average

	Total Cost	Number of Individuals	Average	Standard Deviation	t	p
DMFT	Below the average	921	4,82	3,77	-22,695	0,001
	Above the average	576	13,72	4,95		
DMFS	Below the average	921	9,44	9,67	-21,282	0,001
	Above the average	576	34,53	16,68		
DT	Below the average	921	2,23	2,45	-13,088	0,001
	Above the average	576	5,84	3,72		
MT	Below the average	921	,25	,73	-12,240	0,001
	Above the average	576	2,19	2,62		
FT	Below the average	921	2,38	2,88	-9,224	0,001
	Above the average	576	5,68	5,11		

Table 2: Findings regarding oral care habits and cost comparison

		Number of individuals	Average ($)	Standard deviation	Min ($)	Max ($)	Test	Test value	p
Tooth Brushing Frequency	At least twice a day	687	73,42	84,21	0	494,5	One-way ANOVA	21,363	0,001
	Once a day	627	120,33	117,31	0	584,83			
	Occasional or never	183	157,47	107,31	14	443,16			
Tooth Brushing Before Bedtime	Yes	873	79,99	93,58	0	550,83	Independent Sample T test	-5,818	0,001
	No	624	135,91	114,09	0	584,83			
Using Fluorinated Toothpaste	Yes	990	89,76	104,97	0	584,83	Independent Sample T test	-4,054	0,001
	No	507	129,79	103,86	0	443,16			
Using Fluorid Mouthwash	Yes	198	73,40	89,37	0	322	Independent Sample T test	-2,473	0,014
	No	1299	107,93	107,89	0	584,83			
Dental Floss Use	Yes	435	74,73	81,80	0	350,5	Independent Sample T test	-4,455	0,001
	No	1062	115,06	112,70	0	584,83			
Frequency of Going to the Dentist	Every six months	195	72,23	99,94	0	494,5	One-way ANOVA	5,667	0,004
	Once a year	180	80,84	92,35	0	421,83			
	Only when they have dental problems	1122	112,48	107,99	0	584,83			
Orthodontic Treatment	Yes	192	77,94	97,32	0	421,83	Independent Sample T test	-2,076	0,038
	No	1305	107,17	107,05	0	584,83			
Smoking	Yes	405	124,77	111,94	0	494,5	Independent Sample T test	2,773	0,006
	No	1092	95,37	102,99	0	584,83			

Table 3: Comparison of habits about sleep patterns with cost

		Number of individuals	Average ($)	Standard deviation	Min ($)	Max ($)	Test	Test value	p
Sleep pattern	Regular	789	99,67	98,17	0	550,83	Independent Sample T test	-2,252	0,026
	Irregular	708	114,59	113,60	0	584,83			
Average sleep duration at night	Less than 6 hours	402	99,76	100,83	0	487,66	One-way ANOVA	0,143	0,867
	6-8 hours	996	105,16	107,16	0	550,80			
	More than 8 hours	99	93,16	119	5,5	584,83			
Eating before sleep	Yes	570	119,67	112,15	0	584,83	Independent Sample T test	2,703	0,007
	No	927	93,38	101,27	0	494,5			

While the average total treatment costs of people who brushed their teeth at least twice a day was 73,42$, the average of the total treatment costs of people brushing their teeth once a day was 120,33$, and finally the average of the total treatment cost of the ones brushing their teeth once in a while was 157,47$.

While the average total cost of treatment of those with tooth brushing habits before bedtime was 79,99$, the average total cost of treatment of those who did not have this habit was 135,91$. It was determined that the frequency of brushing and the brushing habit before bedtime had a significant effect between the groups ($p < 0.05$).

While the average total cost of treatment of individuals using fluoridated toothpaste was 89,76$, the average total cost of treatment of those who did not use it was found to be 129,79$. While the average cost of treatment of individuals using fluoride, mouthwash was 73,40$, the average cost of treatment of those who did not use it was found to be 107,93$. While the average total cost of treatment of the individuals using dental floss was 74,73$, the average cost of treatment of those who did not use was 115,06$. It was determined that the use of fluorinated oral care agents and dental floss had a significant effect on cost reduction between the groups ($p < 0.05$).

According to the frequency +of dental examination; while the average total cost of treatment of those who saw their dentists every 6 months was 72,23$, it was found that the average total cost of treatment of those who saw their dentists once a year was 80,84$ and the average total cost of treatment of those who saw their dentists only when they had complaints was 112,48$. While the average total cost of treatment of the individuals who received orthodontic treatment was 77,94$, the average total cost of treatment of those who did not receive orthodontic treatment was found to be 107,17$. It was observed that the frequency of dental examinations and orthodontic treatment led to a significant difference between the groups in terms of cost reduction ($p < 0.05$).

While the average total cost of treatment of people who smoked was 124,77$, the average total cost of treatment of those who did not smoke was 95,37$ and it was observed that there was a difference between the groups ($p < 0.05$).

While the total operation cost average of individuals who reported their sleep pattern as regular was 99,67$, the total operation cost of individuals who described it as irregular was found to be 114,59$. In addition, it was found that the total operation cost of individuals with eating habits just before bedtime was 119,67$ while the total operation cost of individuals who did not have eating habit before bedtime was 93,38$. A significant difference was observed between the groups in terms of cost effectiveness ($p < 0.05$). It was observed that there was no significant difference in cost effectiveness between the groups according to the average night sleep duration and the latest food consumption time ($p > 0.05$).

Discussion

In addition to creating individual problems due to pain, oral and dental health diseases are of great importance in terms of social and health economics [5]. Direct treatment costs of dental diseases amounted to $ 298 billion in 2010, corresponding to an average of 4.6% of world health expenditures [6]. In this context, prevention of a disease is a lower cost option than the treatment of a disease. Economic evaluations regarding oral and dental health have not been studied much yet and the quality of publication needs to be improved further [7].

Various studies have been conducted to evaluate endodontic, periodontal, aesthetic and prosthetic treatments related to cost effectiveness [8-10]. In a study where the treatment options for the first molar tooth with failed endodontic treatment were evaluated according to cost effectiveness, it was reported that the application of endodontic microsurgery was the most appropriate method. It has been reported that the restoration with the implant after tooth extraction is the treatment option with the lowest cost effectiveness despite the high survival rate [8]. In their study, Pennington *et al* [11]. investigated the cost-effectiveness of preventive periodontal therapy in different countries associated with preventing attachment loss. While the cost effectiveness of preventive periodontal treatment is low in America, Ireland, Japan and Germany because of low value of attachment loss treatments, cost effectiveness has been found sufficient in England, Australia, and Spain and it has been reported that it should be supported.

The high DMFT and DMFS values indicate that the individual has high caries experience, and this means that the treatment needs are high, but even if the patient has met the treatment needs and the current calculated cost has decreased, the patient's DMFT and DMFS values will remain high. For example, the patient may have had a prosthetic treatment of the extracted tooth (MT), and no additional cost is added to this dental cost estimate, or if the restoration of the filled tooth (FT) is not required, it will not affect the cost. For high DMFT and DMFS, it is not possible to make precise comments on cost. The only parameter that has a clear effect on the cost is the number of carious teeth (DT). It is certain that the need for treatment will be low in individuals with low DMFT and DMFS values, which can be interpreted as the cost will be low in the future.

Among the protective applications, the fluoridation of drinking water is the most economically appropriate measure for the prevention of dental caries, and it has also been recognized as a cost-effective practice to reduce dental caries in children since the 80s [12]. Mariño *et al*. (2012) [13] evaluated 3 community-based applications (fluoridation of

water, fluoridation of salt and fissure sealant applications) and 4 school-based applications (fluoridation of milk, fluorine mouthwashes, topical fluorine gel applications and tooth brushing with fluorinated toothpaste) over cost. The findings from this study confirmed that the cost-effectiveness of most community and school-based preventive interventions is high.

While no significant difference was found between the two groups in terms of caries prevention after 3 years in a study evaluating the cost-effectiveness of fluorine varnish and fissure sealant with 835 children at high risk of caries in England, it has been reported that the application of fluorine varnish saved of 68.13£ per person [14].

In addition, although it is known that fissure sealants are more successful in preventing caries in pits and fissures than fluorine varnish, the reason for the high cost per patient is probably due to the labor force it requires [15,16]. Another result of the cost-effectiveness studies is that the cost effectiveness of the applications that should be applied under professional physician control is lower than those that do not require expertise. This draws attention to raising awareness at early ages and regular oral dental health training.

The average cost of planned procedures of individuals who received orthodontic treatment was lower than those who did not receive orthodontic treatment. This situation can be explained for two reasons. The first is that dental crowding restricts oral care and the perplexity areas are suitable for plaque accumulation, creating an etiological factor for caries. The other reason is thought to be the increasing importance that individuals who have received orthodontic treatment attach for oral and dental health.

Another interesting result of our study is that non-smokers were found to have a significantly lower mean operation cost than smokers. The low oral hygiene habits of smokers make these individuals risky for caries. Karaoğlanoğlu *et al* [17]. reported that there is a significant relationship between smoking and DMFT. This is a fact explaining the increase in the planned operation costs of smokers.

In studies investigating the risk of caries and sleep patterns, it was reported that individuals who do not have regular sleep patterns have inadequate toothbrushing habits and the risk of caries is high [18]. The results of our study confirm this information. Possible total cost averages of individuals with regular sleep patterns were found to be less than those with irregular sleep patterns.

Treatments applied to 20% of the population, which are risky in terms of oral and dental health, constitute 80% of total treatment practices. This situation stems from the distribution of the disease in the society and refers to the segment that should be focused on in terms of preventive applications. The sooner early preventive practices are carried out in risky individuals, the more successful the measures are [19].

Conclusions

In countries with oral dental health policy based on therapeutic applications, it has been reported that DMFT is high and there are also a large number of young people without teeth. In countries planning oral dental health policy on protective practices, on the other hand, DMFT is reported to start to decrease over time.

It was concluded that caries experience decreased with individuals with adequate oral care habits and who went to dental examination regularly. Therefore, their possible total costs would be low. It is thought that the probable future treatment costs of individuals who have received orthodontic treatment will be low. The low caries experience indicates that the future costs of the individual will be little.

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