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Abstract

Caries disease is a public health problem with a high incidence in Romania and also in economically developed countries. Daily use of computer is a habit among children, so we decided optimization cario-prevention in school children aged 6-12 using a software. We designed an interactive application as a „diary" in which the child answers questions like: have you brushed your teeth in the morning/evening/after eating sweets? have you had a tooth ache today? etc. Data is saved daily and the user profile is generating. The doctor is automatically notified by the application if the child tooth hurts. DMF-T index value for the study group was 2, the reason for dentist visit was pain (80.6% of case). The Pearson coefficient between the D component of DMF-T with the frequency of tooth brushing (-0,506), sweets eating (-0,595) and the doctor visits (-0,443) is statistically significantly (p=0.00). The software application „Dentist" by the child-parent-doctor feed-back mechanism is modeling the child behavior for oral health. The data obtained can be used as statistical data.

Keywords: children dental caries prevention; „Dentist" application; DMF-T; interactive software; Pearson correlation.

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Introduction

The prevalence of tooth decay in Romania is 80-98% (Biclesanu, 2008); in developed countries such as the USA, tooth decay is considered to be the most common chronic disease in childhood (Fisher-Owens et al, 2007). Dental caries is a public health issue. Studies have shown that there is a strong relationship between behavioral, social, economic and clinical factors and dental caries (Casanova-Rosado, 2005; Milgrom et al, 2000; Li & Wang, 2002; Tagliaferro, Pereira, Meneghim & Ambrosano, 2006). Primary prevention aims to identify the causes of the disease and to prevent its onset. Thus, one of the objectives of primary prevention of tooth decay is changing diet habits by controlling the consumption of sugar (Cuculescu, 2010). People whose diet is rich in starch and low in sugar develop less caries (Van den Broek, Feenstra & De Baat, 2007). Sucrose is considered to be the carbohydrate with the highest cariogenic potential (Paes Leme, Koo, Bellato, Bedi & Cury, 2006). A direct link between the frequency of carbohydrate intake (sweet foods and drinks) and tooth decay has been proven (Sohn, Burt & Sowers, 2006). Vannobergen concluded that the intake of sweet drinks in between meals increased the risk and the severity of dental caries in 7 year old children (Vanobbergen, Martens, Lesaffre, Bogaerts & Declerck, 2001). It is recommended that there be a gap of at least two hours between the intake of sweet foods and drinks. After tooth eruption it is very important to maintain the health of dental tissues through correct and rigorous dental hygiene. The most important means of caries prevention is learning and thoroughly carrying out oral hygiene techniques. Initially, oral hygiene in children is performed by parents, then supervised by them and afterwards, oral hygiene must become an everyday habit of the child and throughout adulthood. The dentist and oral hygienist guide the child and the educators (parents, teachers) on the way of carrying out appropriate oral health measures and they have to explain their role in preventing oral diseases. The removal of dental plaque and preventing it from accumulating on the tooth surface are essential for maintaining oral health. A correct tooth brushing technique that also lasts for an appropriate amount of time and is carried out with the right frequency is the most important means of removing dental plaque (Cuculescu, 2010).

Interactive computer programs that evaluate individual caries risk and risk factors interaction have offered insights on individualized prophylaxis measures (Bratthall, Petersson & Stjernswärd, 2004). As the daily use of the computer has become a habit among children, we developed an interactive „Dentist" application for schoolchildren (6 to 12 year old). Based on this application we designed a pilot study to optimize caries prevention by influencing the child's behavior towards oral health. The „Dentist" application aims to educate 6-12 year old schoolchildren for oral and food hygiene skills and to point out the importance of regular check-ups at the dentist.

Materials and Methods

We carried out an interdisciplinary pilot proof of concept study that started in 2009 as collaboration between staff of the Faculty of Medicine and the Faculties of Engineering and Sciences of the „Lucian Blaga" University of Sibiu (Fratila, Pitic, Boitor, Sabau & Marinica, 2010). The involvement of the children and their contribution to the design of the application started at a later date. The study and program strategy aims to: (1) standardize the use of the „Dentist" application; (2) obtain the consent of the parents and motivate the children, their family and the institutions that are involved in the „Dentist" program; (3) the ethical consent of the medical staff of the Faculty of Medicine of Sibiu and also the written consent of the education authorities; (4) organize an interactive course regarding oral hygiene measures within the schools that are evaluated.

Methods of study

The clinical study was carried out on a group of 134 children 1st to 4th graders, aged 6 to 12, from Sibiu, Romania. The children were examined in the dental office of the selected school. The examination was carried out under artificial light from the dental unit, using examination instruments (mirror, dental probe) and sterile gloves for every patient, according to WHO criteria (WHO basic method 1997). The findings were written in patient's charts that included information regarding the dental status (decay, missing and fillings using the DMF-T caries history index). The computer assisted study is based on the „Dentist" application. In order to standardize the working protocol of the „Dentist" application, its interface underwent a series of changes, children playing an important role in the evaluation. The children have to keep a *e-diary* of their personal activities that are of interest for the dentist. The application asks them daily, questions like „Have you brushed your teeth in the morning/evening/after eating sweets?", „Did any of your teeth hurt today? If yes, which one?", „Have you had gum problems?" etc. This information is saved daily, which allows us in time, to create a user profile. The statistical study has been carried out using the software SPSS v. 19 for Windows (SPSS Inc., Chicago, USA). We used the Pearson correlation coefficient.

Developing the application „Dentist"

When the application is used for the first time, some identification data is required. To minimize the amount of information required from the user, the parent should start the application for the first time and fill in the information of the child; afterwards, the latter can use it without other requirements. When the application is started for the first time, the name of the dentist is also required.

The point is that the doctor should be notified by the application if a child reports having an aching tooth for more than 3 days in a row (*Figure 1*).
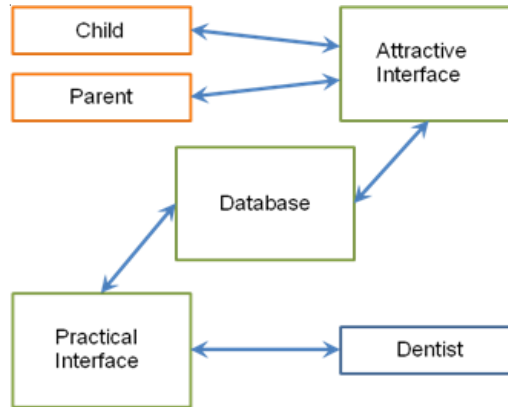

Figure 1. *The application workflow*

The interface with the child-user is simple, intuitive and attractive. The application was written using C= and WPF in order to obtain a friendly interface with animated menu items, the possibility to choose themes, to change text with suggestive pictures, the selection menu consists of rotating circles *(Figure 2)*; the menu is configured in such a way as to easily change the number of options and the pictures it consists of; one can also set a start-up sound and other audio effects; when minimized, an avatar appears in the lower left corner of the screen, reminding the child of the application. The application architecture for the dentist user is presented in *Figure 3*. Due to practical reasons we used a MySql database server.

Results

The mean value of the caries experience index DMF-T for the studied group is 2, its mean value in the 1st grade is 1.31, in the 2nd grade 1.91, in the 3rd grade 2.21 and in the 4th grade it is 2.66 (*Figure 4*).

The value of the DMF-T index increases with age (children from higher grades have higher index values). As the permanent teeth erupt, they start to develop tooth decay. The analysis of the index shows that the value of the F component (number of filled teeth) is lower than that of the D component (number of teeth with active carious lesions). We explained this by the lack of interest towards the treatment and the prevention of the disease. The majority of the subjects are not used to see a dentist for a routine check-up or curative treatment (*Figure 5*). We also found that the reason for dentist visits is an emergency in 80.6 % of the cases (management of pain) *(Figure 6)*.
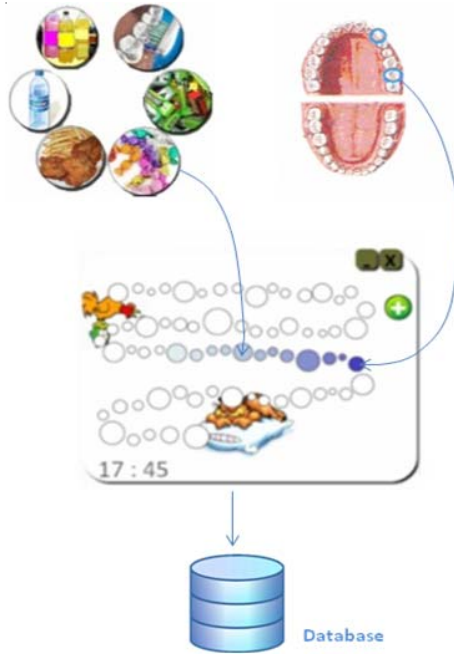
Figure 2. *The interface of the „Dentist" application for the child user*

Figure 3. *The architecture of the „Dentist" application for the dentist*
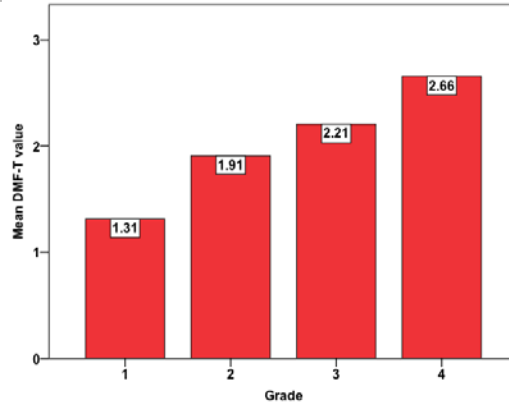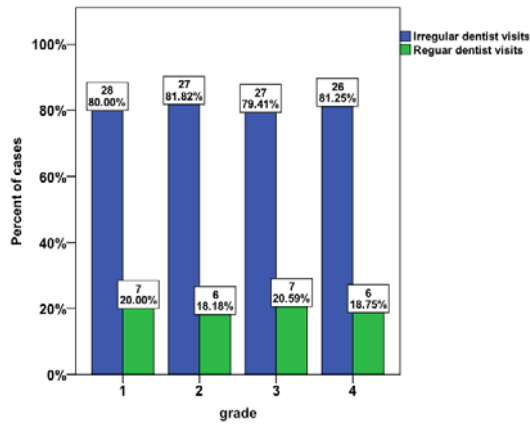
Figure 4. *Mean DMF-T value on grade*

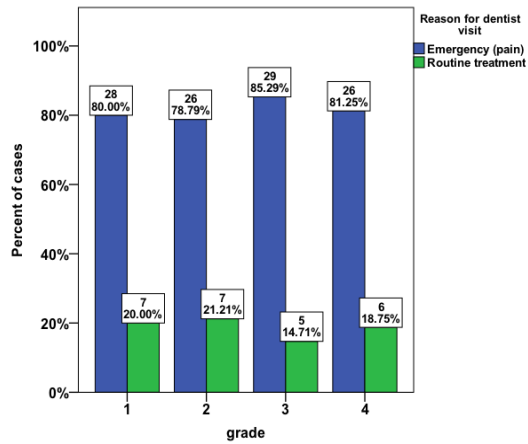Figure 5. *Addressability to the dentist*

Figure 6. *Reason for dentist visit*

Oral health is closely related to oral hygiene (frequency of tooth brushing). The lack of information on oral health of the parents reflects in a low level of their involvement in the children's oral health education; on average 48.98% of the subjects brush their teeth only once a day *(Figure 7)*. As the children grow older and advance in school, we observe that the percentage of those that brush their teeth twice a day increases from 28.57% in the first grade to 59.38% in the 4th grade *(Figure 7)*.
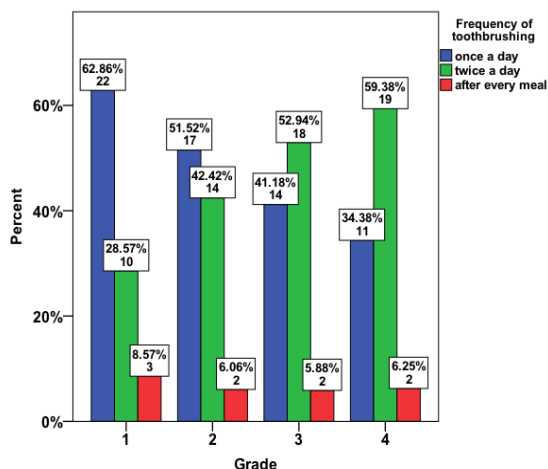
Figure 7. *Frequency of tooth brushing on grade of class*

The prevalence of tooth decay is related to the indulgency of the parents towards a cariogenic diet. More than a third of the children, 35.82% eat confectionery once a day and 29.85% eat sweets several times a day *(Figure 8)*. More than 80% of the children prefer, in-between the main meals, sweets (chocolate, ice cream) rather than fruits.
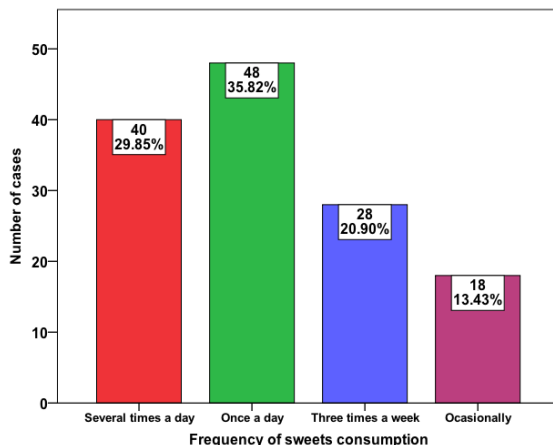

Figure 8. *Frequency of sweets intake*

Table 1. *Correlation between the D and F components of the DMF-T index with frequency of tooth brushing, sweets intake and frequency of dentist visits*

Correlations			
		D	F
frequency of tooth brushing	Pearson Correlation	-0.506**	-0.324**
	Sig. (2-tailed)	0.000	0.000
	N	134	134
sweets intake	Pearson Correlation	-0.595**	-0.449**
	Sig. (2-tailed)	0.000	0.000
	N	134	134
frequency of dentist visits	Pearson Correlation	-0.443**	-0.296**
	Sig. (2-tailed)	0.000	0.001
	N	134	134
*. Correlation is significant at the 0.05 level (2-tailed).			
**. Correlation is significant at the 0.01 level (2-tailed).			

Statistically, there is an inverse relation between the D component of the DMF-T index and the frequency of tooth brushing (r = -0.506), the frequency of sweets consumption (r = -0.595) and the frequency of dentist visits (r = -0.443); the correlation is statistically significant (p=0.000). The same is observed regarding the F component.

Discussion

The most common used indexes for measuring and individual's caries experience are DMF-T and DMF-S (Decayed, Missing, Filled –Tooth/-Surface). Studies that gather data from oral health surveys show that caries experience index values of individuals from Central and Eastern Europe are higher than those of Western Europe (Julihn, 2010; Petersen, 2003). The study at hand reveals a mean DMF-T value of 2. The DMF-T values are below those recommended by the WHO (DMF-T is 3 at 12 years of age) but they are still higher than those found in developed countries like Denmark, Germany, Sweden, Switzerland.

The high DMF-T values of this study are due especially to the D component, which is much higher than the F component; this suggests a lack of interest for the treatment of active lesions. For the majority of the subjects in this study, the main reason for seeing a dentist is an emergency, the treatment of pain; the children are not accustomed to having regular check-ups every six months or getting treatment for incipient lesions. Lower caries experience indexes are found in countries where oral health programs are part of the public health network.

Oral health status and caries prevalence are directly linked to the frequency of tooth brushing (Boitor, Fratila, Stanciu, Pitic & Acu, 2011), but there can also be found a connection to the parent's education level, respectively the social and economic environment of the child (Maes, Vereecken, Vanobbergen & Honkala, 2006). Tooth brushing once a day at most is a significant risk factor for early caries of deciduous teeth, whilst brushing at least twice a day constitutes a protective factor (Ivan, Luca, Stenciu & Vinereanu, 2005).

Within our study group we have observed that as children progress in age, the frequency of tooth brushing increases, from once a day in first grade to twice a day in fourth grade, children becoming aware of the importance of tooth brushing. The frequency and duration of tooth brushing are essential for oral health; as they grow older, children are not as strictly supervised by their parents anymore, so they tend to brush their teeth superficially. Even if the frequency is satisfactory (twice a day), they do it hastily and with low efficiency, a fact that is shown by the values of the DMF-T index, which are higher in 4th graders than 1st graders.

Studies have confirmed that individuals that eat sweets, especially in-between main meals, have an increased caries risk (Arcella, Ottolenghi, Polimeni & Leclercq, 2002; Touger-Decker & Cor van Loveren, 2003; the Vipenholm study 1954). For the children in our study, sweets are high on the list of dietary preferences. Approximately one third eat confectionery once a day and 30% several times a day. During the examination we asked the children what they would rather have for snacks - fruits or a chocolate bar or ice cream - and the answers indicated their preference for sweets. This is consistent with the data obtained from their virtual diaries. In developed countries, despite the consumption of confectionery, given the preventive measures based on adequate fluoride input and insuring correct oral hygiene, the prevalence of tooth decay has greatly decreased (Moynihan & Petersen, 2004; Petersen & Lennon, 2004).

Conclusions

The „Dentist" application is a useful tool that allows for computer assisted education of the child concerning oral health, via the child-parent-dentist feedback mechanism. The „Dentist" application makes the child aware about the importance of oral hygiene, along with dietary habits and reminds the child and the parent to see a dentist for regular check-ups, in order to ensure prevention of tooth decay. Modern visual and multimedia technologies allow for the development of attractive applications, thus increasing the possibility that the target age group actually uses them. The information provided by the user could be used by the dentist to create profiles or perform statistics. The implementation of this prevention tool requires minimal investment and targets large population groups. Last but not

least, involving children in the design and evaluation of software applications developed for children-users is a rewarding idea.

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