

MODELING DENTAL CARIES PREVENTION CARE IN POLISH PRIMARY SCHOOLS: A HYBRID SIMULATION APPROACH

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ABSTRACT

The aim of the study is to develop a universal hybrid approach based on discrete event simulation (DES) and agent-based simulation (ABS) to support decision makers in the planning of dental caries prevention programs in Polish primary schools. DES makes it possible to observe students during their education in primary school and changes that occur in their oral health. ABS is responsible for tracking changes in students' attitudes toward oral health care under the influence of close surroundings. The proposed hybrid model can support decisions regarding the planning of the amount and intensity of dental caries prevention services, as well as the identification of the human resources needed to provide these services. The research findings are promising, and the presented approach allows to check different preventive care scenarios, which can ultimately lead to the indication of the number of specialists necessary to provide services to a specific group of students.

1 INTRODUCTION

Dental caries affects more than half of the world's population. The best way to minimize it is to prevent the disease from occurring. However, the scale of the problem shows that current measures are insufficient and that the incidence of caries disease in children does not decrease with time. Prevention can be carried out individually in dental offices or in larger groups, e.g. in schools. As part of preventive services, sealing of teeth, fluoridation, regular dental check-up, and education are considered. The actions taken should be planned in such a way as to achieve the best possible results in reducing the occurrence and/or progression of caries disease while minimizing the costs of these activities. Therefore, it is necessary to determine at least the number and frequency of preventive services provided and environmental factors that can also affect the development of caries disease in students. In addition, the course of this disease is characterized by high dynamics and randomness. It is impossible to clearly predict the progression of the disease, because it is influenced by the individual predispositions of a given student, the type of preventive actions made at different times, or human decisions related to, for example, dietary habits or brushing teeth. Therefore, to support the planning of such programs, it is necessary to use advanced methods and tools, including the simulation approach.

2 SIMULATION IN HEALTHCARE

Simulation methods such as DES, ABS, system dynamics, and Monte Carlo simulation have been used successfully in healthcare. The numerous benefits of using hybrid simulation, which combines two or more simulation methods, have also been recognized (Zulkepli and Eldabi 2015). The literature review did not however reveal research on management support in the area of planning preventive care programs using

DES and ABS methods as part of a comprehensive hybrid approach. Both DES and ABS are used separately in studies related to the prevention of caries disease. For example, DES has been used to determine the optimal combinations of staffing levels and sealant stations for school-based sealant programs (Scherrer et al. 2007), and the ABS model was developed to assess the demand for dental visits in a selected society (Roudsari et al. 2015). The combination of these two methods as part of the proposed approach can make an important contribution to supporting the planning of caries prevention programmes.

3 METHODS

The DES-ABS hybrid simulation model is under development (Hajłasz and Mielczarek 2022). The DES part is responsible for simulating the primary education process, which in Poland lasts nine years. Each student is assigned four indicators related to oral health: the number of milk teeth, the number of permanent teeth, the number of milk teeth with caries and the number of permanent teeth with caries. During the stay at the school, milk teeth fall out and permanent ones begin to grow. Indicators associated with caries are also changing. Some children are not affected by this problem at all, in others, the disease progresses very quickly, and in others, the disease progression is slowed down or stopped. The process of caries development is influenced by preventive services, which can be characterized by different levels of effectiveness, and also by other nonmedical factors such as, for example, hygiene habits or diet. The individual behavior is shaped by the closest environment: parents, guardians or colleagues, and acquaintances. For the student it will also be a school. Therefore, the ABS part is responsible for tracking students' attitudes toward hygienic, dietary or other habits that may negatively, positively or neutrally affect the effectiveness of preventive services. Each student is assigned one of three attitudes: negative, positive, and neutral. By exchanging views with students from the immediate environment, understood as a student's class, the attitude of a given student may change. That is, from negative or neutral to positive, or from neutral or positive to negative. In the proposed simulation experiments, different configurations of preventive services and different frequencies of change of colleagues from the immediate environment are examined. The effect of these configurations on oral health in children at different stages of age is observed, i.e. how a given configuration affects indicators related to the number of milk and permanent teeth with caries in children.

4 CONCLUSIONS

The DES-ABS approach allows testing different scenarios of prevention programs, for example, to verify whether, given the availability of specialists able to provide preventive services, satisfactory results in inhibiting the occurrence and development of caries in Polish primary school students. Simulation experiments can also be conducted toward resource planning at the regional level. For example, by including more schools with different numbers of pupils, it would be possible to verify whether one specialist with a given hourly availability could support caries prevention programs in more schools.

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