



SCIENTIFIC OASIS

Journal of Soft Computing and  
Decision Analytics

Journal homepage: [www.jscda-journal.org](http://www.jscda-journal.org)  
ISSN: 3009-3481

JOURNAL OF SOFT  
COMPUTING AND  
DECISION ANALYTICS

Volume 1, Issue 1, 2023

www.jscda-journal.org

## Investigation the Effect of Covid-19 Pandemic in The Sales for Online Education Using Machine Learning Methods

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### ARTICLE INFO

#### Article history:

Received 19 August 2023

Received in revised form 28 September 2023

Accepted 30 September 2023

Available online 1 October 2023

**Keywords:** Sale forecasting; Machine Learning; Decision analytics; COVID 19.

### ABSTRACT

Due to the pandemic which is the cause of the COVID-19 virus that emerged in 2019, many educational institutions had to follow online (remote) education. The situation in which the content of the pandemic occurred was also the reason for the education preferences of the users. The aim of this study is to analyze the effect of the pandemic, which includes the number of registered users of one of the online education platforms operating in Turkey thanks to machine learning, on distance education sales, and to create strategies by making sales forecasts for the future. Seven independent and one dependent variable were used to make sales forecasts using the data of the education structure. For accurate modelling, machine learning methods were first applied for decision analytics in a univariate manner and then multivariate applied and the applied methods were tested for error. By testing the success of the prediction models created with machine learning used in the study; 91.43% for support vector machine (SVM), 92.02% for multi-layer perceptron (MLP), and 96% for Long / Short Term Memory (LSTM). K-Folds cross validation method was also used for the success return of the established model.

## 1. Introduction

It is extremely important for every institution to forecast their sales. Institutions make decisions for planning their future, recruiting personnel, and making investments based on these estimates. There are many factors affecting product demand makes it difficult to forecast sales. Decision makers' encounters with multivariate dynamics often force decision makers to make decisions with their experiences and subjectively. Research shows that companies perform better when they apply data-driven decision-making methods. In fact, companies in the top three of their sectors are on average 5% more efficient and 6% more profitable than their competitors by using data-based decision making [1,2].

As of 11 March 2020, when COVID-19 was declared as a pandemic disease, 118,000 cases of COVID-19 were seen in 114 countries [3,4]. Due to the COVID-19 epidemic, which emerged in Wuhan

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<https://doi.org/10.31181/jscda11202322>

city in China and affected the whole world, employees in many sectors were the first to be affected by this situation. Employers and employees in many sectors such as health, tourism, transportation, education, service, and food have been affected in many ways. To prevent the spread of the epidemic, education continued online (remotely) as of March 2020 in Turkey [5]. Online education can also be defined as a system where the student and the person teaching are not in the same environment, and the training is done in a computer-aided environment. Students in Turkey have completed their education by communicating with their teachers online during the pandemic period. Online education is also provided by different institutions through sales. In the world and in Turkey, these institutions have developed many sales strategies and started to serve their customers for a long time. With the impact of the COVID-19 pandemic on the whole world, it has become the focus of attention, and today, many institutions provide online education services to their users [6,7].

In this study, using the data of the online education institution to determine the necessary online education strategies using different machine learning algorithms, the effect of the COVID-19 pandemic on online education sales was examined for decision analytics and a sales forecast for online education for the future was made. Accurate forecasting will further assist companies in meeting customer requirements for planning and management.

Accordingly, future sales forecasts were made by analyzing the impact of the COVID-19 pandemic on sales. With this study, the effect of the COVID-19 pandemic, which has recently affected the whole world and our country, on the sales of the online education institution in the literature has been examined for the first time. The research models of the study are trial and comparison methods. Within the scope of the study, support vector machine (SVM) algorithm, artificial neural network model multi-layer perceptron (MLP) and artificial neural network (ANN) model long/short-term memory (LSTM) algorithms were compared.

The data used for the application part of the study were provided by an online education institution. In addition, some of the independent variables added to the data set were obtained from the website of the Turkish Statistical Institute (TUIK). Before applying machine learning algorithms on the data set, data preprocessing was done. After the data set was prepared for use, machine learning algorithms were applied to the data and the achievements were compared.

## 2. Literature Review

In recent years, machine learning algorithms have been widely used in the creation of forecasting models. In this section, machine learning and ANN methods used in sales forecasting in the literature, as well as machine learning studies related to online education are discussed.

Karaatli *et al.* [8] aimed to make future planning for the automotive industry more accurate by forecasting the amount of new automobile sales by using ANNs. While creating the data set of the study, the independent variables were determined as real sector confidence index, gross domestic product, investment expenditures, dollar exchange rate, consumer confidence index, consumption expenditures and time, and the total amount of vehicles sold was determined as the dependent variable. In a study conducted by Cakmak *et al.* [9] in 2019, the click-through rates of hotels that advertise via the internet were estimated. In the study, decision tree-based methods, augmentation algorithms and state-of-the-art estimation algorithms supporting vector regression were used. In the study, using the Extreme Gradient Increasing (XGBoosting) algorithm, the expected number of site visitors (Click-Through-Rate, CTR) of the institutions that advertise via the internet the next day was estimated.

Shi *et al.* [10] aimed to predict precipitation forecasts with machine learning. In the study, the LSTM algorithm, which is an ANN method, has been extended to have convolutional structures in

both input-to-state and state-to-state transitions. The applications show that the ConvLSTM network understands spatio-temporal correlations better and outperforms LSTM and the ROVER algorithm, which is frequently used for precipitation.

Kotsiantis *et al.* [11] developed a model in their study to evaluate student performances for distance education universities. The developed learning algorithm was then used to estimate the performance of new students. Thus, the application was used as a useful tool to identify people who are predicted to show poor performance. Among the algorithms applied, the most successful algorithm was the Naive Bayes algorithm. Chen *et al.* [12] aimed to investigate the satisfaction of users in online (distance) education platforms in China. In the study, a survey was conducted to collect the data of the users' experiences. Using the results of this survey, it is aimed to predict user satisfaction with the ANN method. Lalmuanawma *et al.* [13] aimed to widely examine the role of artificial intelligence and machine learning as an important method in screening, estimate, contact tracing and drug development for SARS-CoV-2 and related epidemic. Villegas-Ch *et al.* [14] suggested the integration of technologies such as artificial intelligence and data analysis with learning management systems to enhance learning. Accordingly, it includes robust educational models in which certain activities are applied in online mode, contained technologies that admit students to have effective guidance in their learning. Parthiban *et al.* [15] investigated different online learning programs and teaching source delivery technology and modern technologies used to enable students to study. Accordingly, channels have been created to generate a trusted environment to prevent copying in online tests. Thus, besides students' perceptions that e-learning is worse and has a negative effect on general well-being and social relationships, they also revealed many difficulties in managing online teaching methods. A technique has been proposed that allows an online classroom to be as good as a single online classroom by providing students with a superior online classroom teaching experience. This study focused on everyday teaching methods using online learning supported by machine learning approach to provide a stress-free solution to the individual. Alhothali *et al.* [16] presented investigated the learning levels of online students using machine and deep learning techniques. With this study, it is aimed to define and categorize the features of what students have obtained from online courses, to reveal the strategies used to determine the estimation outputs, and to provide a classification by defining the metrics used for evaluation. Munir *et al.* [17], the literature on the use of artificial intelligence-based algorithms in digital education was examined. The research revealed that machine learning and deep learning algorithms are applied in various topics of digital learning. These topics are the use of smart teachers, faulty forecasts, performance estimates, adoptive and predictive learning styles, analytics and group learning, and automation. Among these themes, artificial neural network (ANN) and SVM, random forest (RF), decision tree (DT), naive Bayes and logistic regression algorithms are used.

As a result of the literature research, it is seen that machine learning methods are frequently used to make forecasting. Forecasting is very important in many different industries. In this context, programming it and moving it out of the human perspective makes the estimation more scientific. When we look at the machine learning methods used, ANNs, SVM, RF algorithm and DT are frequently applied. When the areas used are examined, it is seen that it is used in many different areas such as production, education, sales, health, meteorology.

In this study, using the data of an online education institution using different machine learning algorithms, the effect of the COVID-19 pandemic on online education sales was examined and a sales forecast for online education for the future was made. The experimental method, after the creation of the data set, the machine learning methods SVM, as ANN methods MLP model and LSTM were applied to the data set. The comparison method, on the other hand, compared the success of the models applied after the application of machine learning methods to the data set.

### **3. Methodology**

#### **3.1 Support Vector Machines (SVM)**

SVM is a machine learning method created using statistical theories. This method was first proposed to solve prediction and classification type problems. In a SVM application, data is divided into two classes and an optimal and n-dimensional hyperplane is created. The most appropriate discriminator in SVM regression is to use “an approximation error” instead of the margin between the hyperplane and support vectors [18,19]. SVM is successful in applications of data sets containing small but high-dimensional data [20].

Both linearly separable and nonlinear data sets are estimated and classified with SVM. With a non-linear mapping, the n-dimensional data set is transformed into a new m-dimensional data set where  $m > n$ . Linear classification and prediction are also performed in high dimensions. By always making an appropriate transformation, the data can be divided into two different classes with a hyperplane. The learning data nearest to the hyperplane are known as support vectors [21].

#### **3.2 Multi-Layer Perceptron (MLP)**

MLP developed as an ANN model with a feed-forward structure involving of an input layer, an output layer and the hidden layer(s) between these two layers. Data inputs received from the input layer are multiplied by the connection weights between the hidden layer and the input layer and conducted to the hidden layer. The input data coming to the neurons in the hidden layer are combined and multiplied by the link of weights between the hidden layer and the output layer and transmitted to the output layer. The neurons in the output layer collect the transmitted input data and produce an appropriate output [22]. The main structure of the MLP model is to minimize the error between the output produced by the neural network and the expected output [23]. During training, these neural networks are shown both the input data and the (expected) output values that should be produced in response to that input data. The input of data is provided by the input layer, the data is handled in the hidden layers and the results are attained from the output layer [23].

#### **3.3 Long / Short Term Memory (LSTM)**

This machine learning method is used in many complex fields such as speech recognition, face recognition, handwriting recognition and many more. LSTM networks are extremely suitable for classification and prediction of time series data. An ordinary LSTM structure contains a cell, input, output and forget gates. The cell learns values at random time intervals, and these gates regulate the flow of information entering and leaving the cell. The forgetting gate decides when and which of the transmitted information will be forgotten or will continue to be kept. For forgetting information, the weight is taken as 0. Information multiplied by weight is forgotten. Sigmoid function is used in the forgetting gate. The value range of this function varies between 0 and 1 [24,25].

The Sigmoid function is used in the input gate, which is the gate where the input is provided, and it decides with the Tanh function whether the transmitted information is kept in its memory. The output gate allows the transmitted information to be predicted [26].

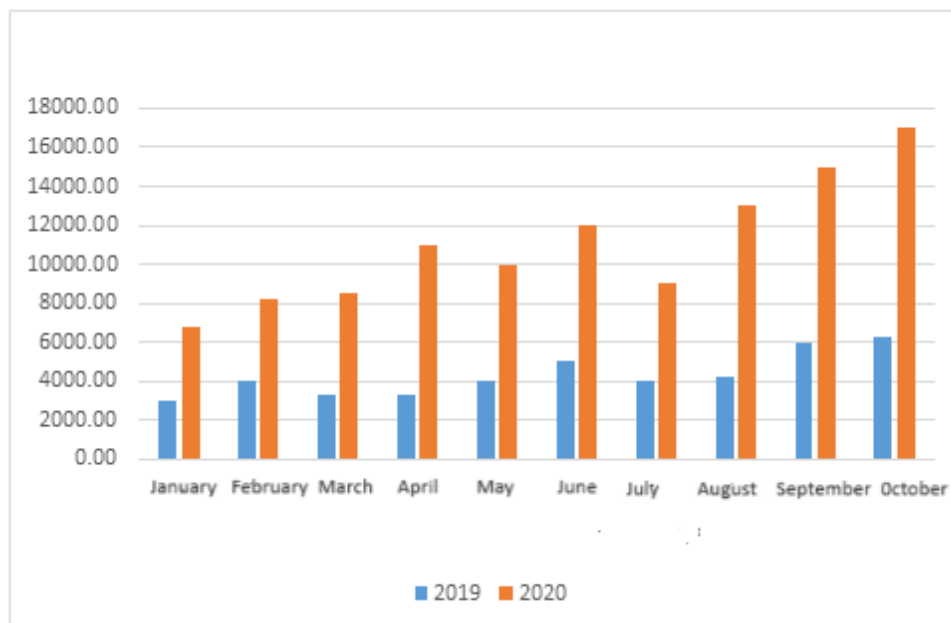
### **4. Problem Definition**

In this study, the existing data consisting of the number of users of the online (remote) education institution was analyzed with the help of machine learning algorithms and the effect of the COVID-

19 epidemic on the online education sector was examined. Figure 1 consist of the values of the “Number of users” variable used as the dependent variable in the data set. Seven independent and one dependent variable were used in the data set. Independent variables: Time, COVID-19 Number of Patients Per Day, Restrictions Applied, Dollar Rate, Number of System Website Visitors, Consumer Confidence Index, Turkey Household Internet Access Rate, and dependent variable is System User Number.



**Fig. 1.** Time dependent variation of the independent variable in the data set.



**Fig. 2.** Monthly user number comparison for 2019 – 2020.

In Figure 2, the number of users per month for 2019 – 2020 is given. When analyzed by months, it is observed that the increase in the number of users has increased rapidly especially after September, the month when schools started the new education period. With the effect of the restrictions imposed on people under the age of 20, the transition of primary, secondary, and high schools to online education has led to a great mobilization in this sector. While the group in the

specified age range continues their education remotely at the schools where they are currently registered, students who need support in their classes have started to prefer online education institutions.

Before applying machine learning methods, normality analysis and ANOVA analyzes which is applied to data sets containing multiple independent variables, were also applied using the SPSS program.

The created data set was loaded into the SPSS program and then the normality analysis of the data was performed. In the literature, a kurtosis value of  $\pm 1.0$  for the normal distribution is considered excellent for most purposes, but a value between  $\pm 2.0$  is also accepted in most cases, depending on some applications [27-30].

In the normality analysis, the Skewness and Kurtosis values were found to be between  $\pm 2.0$ . For the sales forecast, the previously determined SVM, MLP and LSTM algorithms from ANN methods and the data set were analyzed with Python programming language over Jupyter. The performances of machine learning algorithms applied to the data set were compared.

The SVM method, as one of the machine learning methods, was first applied to the created data set. For this process, necessary operations were made using the Jupyter interface of the Python programming language. First, the necessary libraries were loaded into the Jupiter program in order to make the estimation. To analyze the data set called "Dataset.csv", the data set is divided into two as testing and training. The part of the data set reserved for testing was 33%, and the remaining part was reserved as training data.

As shown in Figure 3, the application of the SVM method to the data set enabled the estimation to be realized.

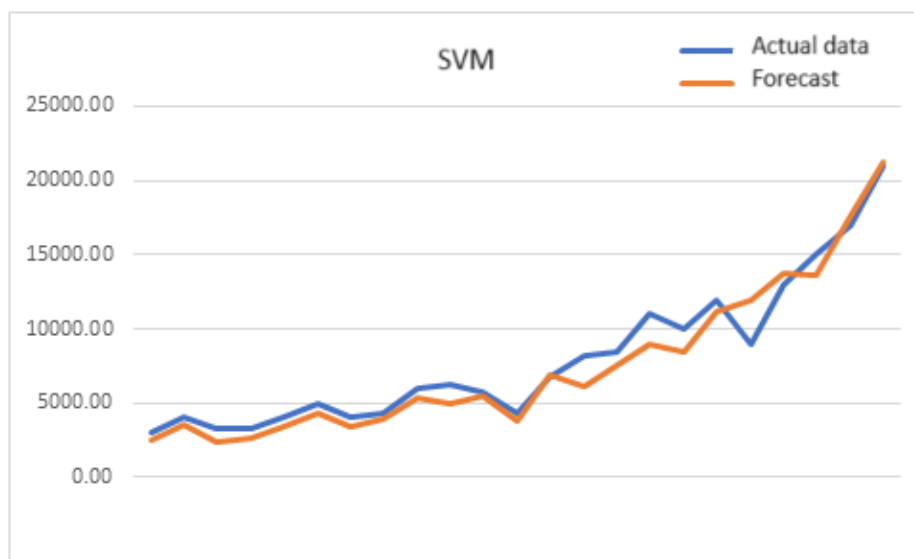


Fig. 3. Actual and forecasting values for SVM.

In the second stage MLP is applied. the success of sales forecasting with MLP, which is one of the frequently used models of ANN, is analyzed. For the MLP application, firstly, the necessary libraries are defined for the Jupiter program. After the library definition was performed, the data set was loaded. The date format of the relevant file is arranged according to the needs of the program.

The dataset is divided into two as test and training in order to realize learning. The ANN model was developed using standard scalers. Actual and forecasted values are shown in Figure 4 with the MLP method.

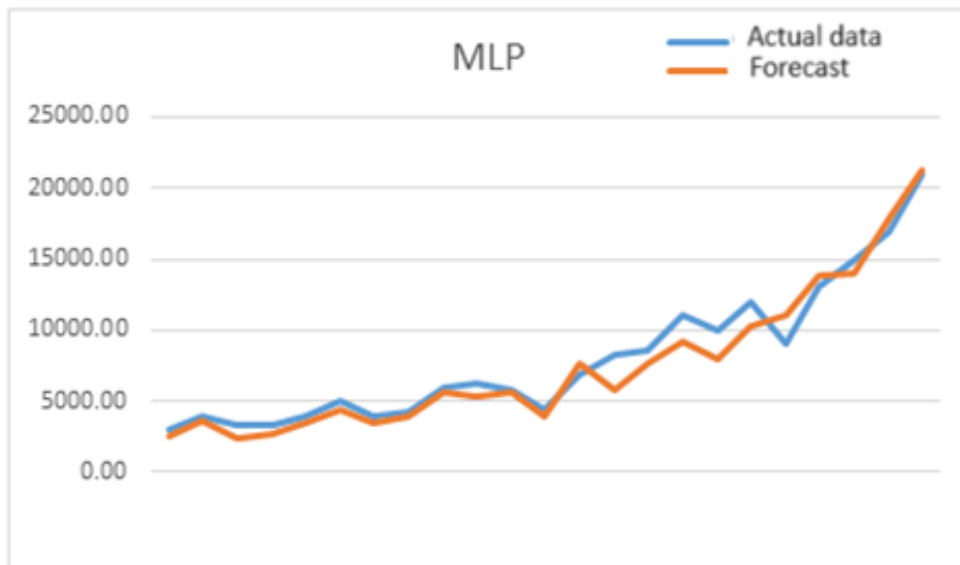


Fig. 4. Actual and forecasting values for MLP.

In the last stage, the success of sales forecasting with LSTM, which is one of the methods of ANNs, is analyzed. To apply the LSTM algorithm after the library definition was made, the step of loading the data set into the program was applied. The date format of the data set is arranged according to the needs of the program. The dataset is divided into two as test and training to realize learning process. Figure 5 shows the line graph of the actual values used in the data set and the estimated values.

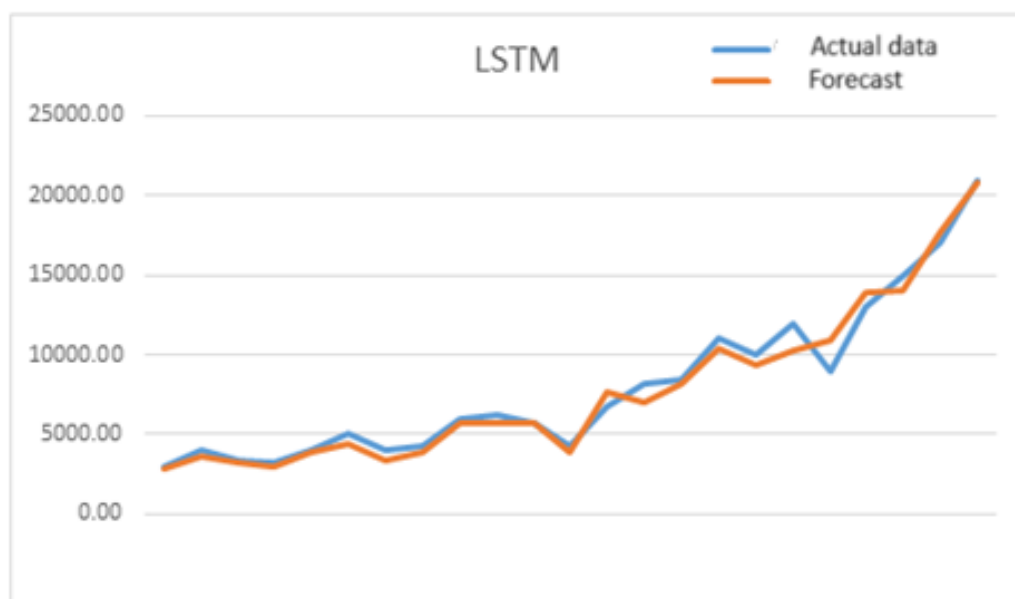


Fig. 5. Actual and forecasting values for MLP.

#### 4. Results

In this study, three different machine learning models were created. Machine learning methods created using the Jupiter interface and the Python programming language were applied to the data set for which normality analysis was made. Model results were compared using performance measures. Table 1 shows the success of the three models used, as performance criteria Root-mean-

square error (RMSE), Mean absolute percentage error (MAPE) and mean square error (MSE) are calculated.

In this study, three different machine learning models were created. Machine learning methods created using the Jupiter interface and the Python programming language were applied to the data set for which normality analysis was made. Model results were compared using performance measures. Table 1.

**Table 1**  
Performance values for SVM, MLP, LSTM.

Method	RMSE	MAPE	MSE	Accuracy measure
SVM	878,23	15,35	1299255,33	91,43
MLP	853,13	15,22	1255561,69	92,02
LSTM	621,93	8,46	596612,88	96

As indicated in Table 1, it is seen that the MAPE values are below 20%. SVM, MAPE value is 15.35, MLP, MAPE value is 15.22 and LSTM, MAPE value is 8.46. Among the methods applied in the study, the model with the best performance was the LSTM model. The second-best model seems to be MLP and the third model is SVM. When the success rates of the models in Table 1 are examined, it is seen that the most successful model is LSTM and the MAPE value is in the very good class. It is seen that the best result from the machine learning methods applied in this context is LSTM. The data used in the study covers the dates when the COVID-19 pandemic was active. The results were compared by running the model with 5 different clusters by applying the K-Fold method of cross validation to three different machine learning models. According to the results obtained by cross-validation of SVM, MLP and LSTM methods, which are best known machine learning methods applied, the success average of the SVM method according to the cross-validation method is 91.18%, for the average of the MLP method is 91.82%, and for the LSTM method the average is found as 95.83%.

In addition, when the effect of the COVID-19 pandemic on the sales amount is examined, it is seen that the interest in the institution analyzed increases day by day in the COVID process where people continue their education through distance education. It is seen that the monthly sales amount of the institution in 2019 and the sales corresponding to the same month in 2020 have increased rapidly.

## 5. Conclusion

Education habits have started to change in the world during and after COVID 19 pandemic with rapid development in digitalization, and this situation has led to variety in education models. Thanks to coming technology into our lives, the online education model has started to be preferred frequently. With the increasing demand for online education, a new sector has emerged. In this study, the data were analyzed with the machine learning method using the existing data of an online education institution. Seven independent and one dependent variable were used in the data set. Independent variables: Time, COVID-19 Number of Patients Per Day, Restrictions Applied, Dollar Rate, Number of System Website Visitors, Consumer Confidence Index, Turkey Household Internet Access Rate, and dependent variable is System User Number. Normality analyzes for the selection of the variables of the created data set were performed using the SPSS program. Thus, before applying machine learning methods to the data set, it was checked that the variables were independent from each other. The success of the machine learning methods used in the study; SVM was 91.43%, MLP was 92.02% and LSTM was 96%. When the forecasting values obtained and the result of the analysis



were compared according to the performance criteria, it was seen that the most successful method was LSTM.

With this study, an estimation application was carried out for the sales of the online education institution for the first time. In addition, with this study, the effect of the COVID-19 pandemic on the sales of an online education institution was examined for decision analytics for the first time. SVM, MLP and LSTM methods were applied to the created data set and compared.

In future studies, a forecasting system based on the LSTM model can be created and presented as a forecasting model for investors who want to make a new breakthrough in online education. The use of a hybrid learning technique, in which machine learning methods are used in addition to the applied methods, will increase the success and make the sales forecast even more accurate.

## Acknowledgement

This research was not funded by any grant.

## Conflicts of Interest

The authors declare no conflicts of interest.

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