Scholar Publishing Group
Water Pollution Prevention and Control Project
https://doi.org/10.38007/WPPCP.2022.030104
ISSN 2790-2730 Vol. 3, Issue 1: 32-41

Construction of Road Drainage System Based on Remote Sensing Technology and Support Vector Machine Algorithm

Bhre Wangsa Lenggana*

Taif University, Saudi Arabia

**corresponding author*

Keywords: Road Sewage Discharge System, Remote Sensing Technology, Support Vector Machine, Sewage Treatment Plant

Abstract: The problem of water pollution is not just a regional problem. Many local departments are dealing with this problem. With the acceleration of urbanization, there are more and more people in cities, and more and more urban domestic sewage has gradually destroyed its original balance. The problem of urban water pollution has also received more and more attention. The quality of the sewage system has a great impact on the environment, life, economy, health and other aspects. Many researchers have provided new ideas for the construction and research of road sewage system, which is the research direction and basis of this paper. This paper analyzed the significance of building road sewage system, and then carried out academic research and summary on the construction of road sewage system and the application of road sewage system based on remote sensing technology and support vector machine algorithm. Then an algorithm model was established, and relevant algorithms were proposed to provide a theoretical basis for the construction of road sewage system based on remote sensing technology and support vector machine algorithm. At the end of the article, the simulation experiment was carried out, and the experiment was summarized and discussed. According to the satisfaction of citizens in the four cities of Y region with the main road and auxiliary road sewage system, the satisfaction of the main road sewage system in cities A and D has reached more than 90, while the satisfaction of city B was only 87. Different from the main road sewage system, the satisfaction of citizens of the auxiliary road sewage system in the four cities was below 90. At the same time, with the in-depth research of fusion remote sensing technology and support vector machine algorithm, the application research of road sewage system is also facing new opportunities and challenges.

1. Introduction

With the acceleration of urbanization, the diversion of rainwater and sewage in roads has become inevitable, and the diversion of rainwater and sewage is an arduous task. In future urban construction, it is necessary to take into account the local geographical environment and pollution problems, and reasonably design the sewage system and sewage discharge mode, and a reasonable diversion system can better control water pollution, so as to better protect and improve the urban water environment. The transformation of urban sewage system can not only bring economic benefits, but also reduce the occurrence rate of floods, which can not only ensure the safety of people's lives and property, but also provide convenience for people's daily life. In addition, it also reflects the environmental benefits. The perfect urban sewage system can separate rainwater and wastewater, reduce the pollution of rainwater, and slowly flow into the natural river through the greening of sponge cities, with little ecological impact on the water body. At the same time, the wastewater should also be treated by corresponding processes to meet the discharge standards of the sewage treatment plant. It is of great significance to improve water quality and control water pollution by discharging rainwater into rivers as ecological make-up water.

The construction of road sewage system is studied. Liu Maodian's research provided the first picture of mercury released from urban sewage into various sinks. Policymakers should pay more attention to the diversity and complexity of mercury sources and transport, which may lead to the accumulation of mercury in the food web and may threaten human health [1]. Feng Yuheng's research provided basic data for phosphorus recovery from sewage sludge by thermochemical conversion [2]. The results of Fongaro Gislaine's research highlighted the effectiveness of monitoring in wastewater and human sewage as a non-invasive early warning tool to support health monitoring in vulnerable and remote areas, especially in developing countries [3]. The particle size analysis of Xiong Qiao's research showed that the sludge flocs become smaller. The addition of sludge to form a layered porous structure improved the compressibility of sludge and provided an outflow channel for free water, thus enhancing the dewatering capacity of sludge. These results showed that combining persulfate oxidation with it is a promising strategy to improve sludge dewatering capacity [4]. Wang Qian believed that anaerobic digestion and hydrothermal pretreatment are a new sewage sludge resource recovery technology [5]. Chaoua Sana studied an area with fragile water resources due to arid and semi-arid climate. Therefore, it has been suggested to use recycled wastewater for agricultural activities, but the pollution of these wastewater is a major problem [6]. The above studies have achieved good results, but with the continuous updating of technology, there are still some problems.

The application of remote sensing technology and support vector machine algorithm in the construction of road drainage system has been studied. Ni Qihang used particle swarm optimization support vector machine based on principal component analysis to comprehensively evaluate the groundwater quality of Xinzhou City, and compared it with many traditional water quality evaluation methods [7]. Sakaa Bachir studied and built a hybrid artificial intelligence model, namely, sequential minimum optimization support vector machine and random forest, as the benchmark model for predicting the water quality value of the Algerian river basin [8]. Bekkari Naceureddine studied that sewage treatment plant modeling is an important tool to control process operation and predict its performance. The purpose is to predict the performance of sewage treatment plant for ten months according to the chemical oxygen demand of wastewater using feedforward and back-propagation artificial neural network method [9]. Yasmin Nur Sakinah Ahmad believed that a simple and reliable prediction model is needed to meet the growing demand for high effluent quality of domestic sewage treatment plants [10]. Navidi Mir Naser believed that soil water content characteristics, including field water capacity and permanent wilting point, are key soil indicators for studying permeability, soil water capacity, sewage discharge, irrigation, plant water stress and solute transport [11]. Gholizadeh Asa believed that close range and remote sensing technology are important tools, which are very suitable for large-scale measurement and monitoring soil pollution in high time and space intervals [12]. The above research showed that the application of fusion remote sensing technology and support vector machine algorithm has a positive effect, but there are still some problems.

This paper studied the construction of road pollution control system based on the fusion of remote sensing technology and support vector machine algorithm. First, it analyzed the urban road pollution control system, then gave its relevant content, and designed the pollution control system. The relevant algorithms provided theoretical basis for the experiment. Finally, the water pollution prevention and control systems of the two places were compared and analyzed under the fusion of remote sensing technology and support vector machine algorithm, providing reference significance for such research.

2. Design of Urban Road Sewage System

2.1. Role of Road Sewage System

Urban sewage system is mainly used to treat urban wastewater and rainwater scouring. In the early stage of economic development, rapid economic development increases the population of the city, and people often neglect the maintenance of sewers. The former sewage system was composed of diffusion and natural evaporation, but with the growth of the population, the amount of sewage discharge is also increasing, and the original sewage system can no longer contain the sewage in the city. Now, the relevant departments must reconsider the impact of water pollution on the city, so people began to accurately analyze the sewage system and carry out corresponding transformation.

On this basis, the staff has improved the existing sewage system. The original sewage system is simple, and its cost is low. The discharged wastewater is directly discharged into the nature, and the industrial sewage, domestic sewage and natural sewage are discharged into the atmosphere. There is no need to separate the sewage and build a sewage discharge device. In principle, these sewage systems can ensure that the water quality would not be polluted. However, due to the gradual increase in the discharge of industrial sewage, rainwater and other pollutants, the land utilization rate has gradually decreased. The untimely diversion of rainwater and sewage without systematic treatment would also cause pollution to the water body, but the economic level at that time has not met the requirements. Therefore, the construction and operation costs of a good sewage system are relatively high. In order to prevent pollution, the most direct way is to collect sewage.

At present, people pay more and more attention to environmental protection, and the most important water pollution prevention and control measures have become the focus of public concern. During this period, a large-scale transformation of the traditional combined sewage system has been carried out, from the direct drainage combined system to the interception combined system, which to some extent alleviates the water pollution in rainwater runoff, river leakage and rainwater, but does not fundamentally solve the pollution problem. In order to prevent the secondary harm of water pollution to human body, the sewage discharge system has been comprehensively reformed. At present, the sewage treatment technology is gradually improved, and its position in water pollution treatment is increasingly prominent.

2.2. Design of Urban Road Sewage System

The design of urban road sewage system includes the following aspects, as shown in Figure 1:

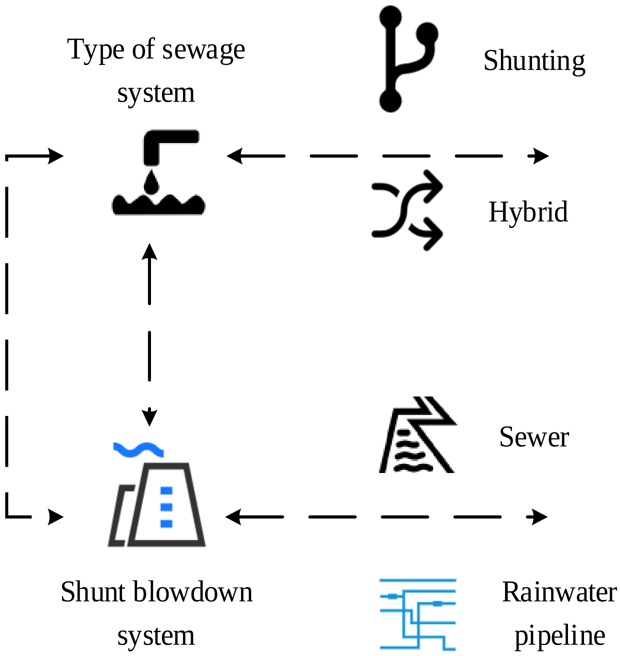

Figure 1. Design of urban road sewage discharge system

2.2.1. Type of Sewage System

The sewage system of urban roads can be divided into two types: shunt type and mixed type. The selection of sewage system should comprehensively consider the utilization of various local factors, and comprehensively consider how to build sewage system. Most of the newly built urban sewage systems are diversion, and the sewage systems in different areas of the city are also different. In the specific implementation process, the appropriate sewage discharge method can be selected according to the local conditions. For example, if the rainfall is small, the density is large, and the surface slope is large, the sewer can be built first to discharge the wastewater that is not conducive to the environment from the community, and the rainwater can also be temporarily discharged by using the open channel, but the economy and feasibility of constructing the rainwater system in the future must be considered in advance. When more rainfall brings inconvenience to people’s lives, people must build sewers and rainwater pipelines at the same time [13].

2.2.2. Separating Sewage System

Domestic sewage is separated by two or more pipes, and the discharge of industrial sewage and rainwater is called shunt sewage discharge. The system for collecting and treating domestic or industrial wastewater is called sewage system. The sewage system of the diversion system can be divided into two categories: one is to set up sewers and rainwater pipelines separately, and the other is to set up only sewers. In the sewers, rainwater pipelines are set up to make rainwater enter natural waters through underground, roads, ditches and other channels. The use of separate system for sewage discharge can effectively protect the environment, effectively recover the useful substances in the wastewater and reduce the amount of sewage from the main tributaries.

2.3. Optimization of Urban Sewage System

The details of the optimization of urban sewage system are shown in Figure 2:

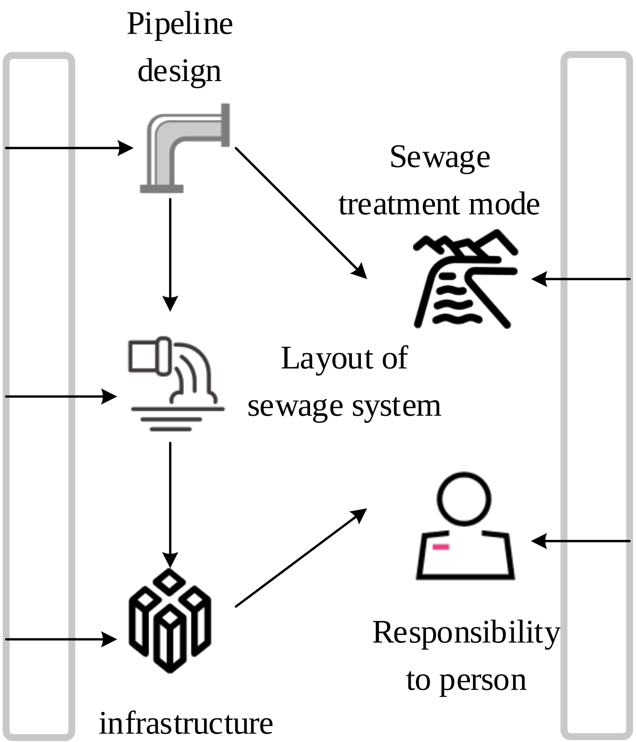

Figure 2. Optimization of urban sewage discharge system

2.3.1. Pipeline Design

The optimization of sewage system refers to the optimal design based on the design parameters such as pipe diameter and buried depth under a specific pipeline condition. After determining the designed pipe section, the corresponding pipe diameter and depth combination shall be carried out in strict accordance with the relevant design specifications [14]. In the design, the larger the pipe diameter, the shallower the buried depth, the lower the engineering cost, and the higher the corresponding pipe cost. Therefore, when determining the combination of pipe diameters, it is necessary to fully consider the actual situation of the project and reasonably adjust the relationship between the two, and optimize the design of the pipeline using the optimal method and the indirect optimal method. The direct optimization method is to select the best scheme through the selection, calculation and comparison of different design schemes or adjustable parameters. Indirect optimization is based on the optimal mathematical model and the optimal operation to obtain the optimal solution.

2.3.2. Layout of Sewage System

In the layout of the sewage system, first of all, the direction of the pipeline should conform to the development trend of the terrain and try to achieve downstream sewage, and then try to shorten the network density. Secondly, the selection of pipe diameter should conform to the planning of the community. Finally, sewage interceptors can be arranged near the shore and water area. The selection of sewage pipes should consider the use of natural or built sewage pipes. The discharge of sewage and rainwater shall be ensured from the water level and water flow height. When dividing the catchment area, it should be limited to a specific area, and the regular catchment area should be selected to make it closer to the terrain. Comprehensive planning shall be carried out for the areas where rainwater and sewage flow into, so as to achieve uniform and reasonable distribution. The selection of sewage pipes should be considered as a whole to avoid the complexity of pipeline crossing terrain.

2.3.3. Infrastructure

In recent years, with the acceleration of urbanization, the transformation of old urban areas has often been neglected. However, in the construction of new cities, they often only focus on the external image of the city and neglect the construction of urban sewage and other infrastructure. In the buildings of the old city, many cities can see the old pipe system.

2.3.4. Sewage Treatment Mode

In modern cities, there are many ways to treat sewage. Generally, a variety of combined processes are adopted for the water quality of relevant sewage, and different process schemes are scientifically selected to optimize the wastewater treatment process. Therefore, the prerequisite is to investigate the demand for reclaimed water and appropriately extend and improve the relevant treatment process to meet the corresponding water quality standards.

2.3.5. Responsibility to Person

The responsibilities of each department were clarified, the supervision of the system was strengthened, and corresponding laws and regulations were formulated, so that the work of the whole system was carried out in an orderly manner. At the same time, the maintenance and cleaning of sewage outlets should be strengthened to further improve the functions of the sewage system, so as to ensure the normal operation of production and life.

3. Evaluation on Support Vector Machine Algorithm in Sewage System

The data collected from a sewage treatment plant adopts the standard of statistical discrimination method to eliminate the abnormal data. The sample data is set as $l_1, l_2, \ldots, l_i$, and the deviation is:

$$v_i = l_i - l \tag{1}$$

$$\sigma = \left[\sum v_i^2 / (n-1)\right]^{1/2} \tag{2}$$

When the error of a certain data exceeds three standard deviations, it would be considered as abnormal data, and it would be used as the sample value of soft measurement mode through data screening.

Support Vector Machine (SVM) is a new machine learning method based on statistical learning. It uses kernel function technology to make nonlinear mapping from low-dimensional to high-dimensional space, thus effectively solving the low-dimensional wastewater pollution problem [15].

A training set is known:

$$L = \{(l_1, p_1), (l_2, p_2), \ldots, (l_i, p_i)\} \subset R^n \times R \tag{3}$$

The purpose of support vector machine regression is to find a regression function:

$$f(l) - (\omega \cdot l) + b \tag{4}$$

In the formula: $(\omega \cdot l)$ represents inner product;

According to the principle of the maximum interval method, the insensitive loss function ε is used to establish an optimal problem using the Lagrange function under certain constraints:

$$\min \frac{1}{2}\sum_{t,l-1}^{l}(\alpha_l - a_j^*)(\alpha_i - \alpha_j^*)k(x_i \cdot x_j) \tag{5}$$

4. Evaluation on the Construction of Road Sewage System

With the rapid development of economy, people's living standards are getting higher and higher, and road transportation is also getting more and more developed. As an important link in the urban road traffic system, the importance of sewage drainage system is increasingly prominent. A perfect urban sewage pipe network is an important infrastructure to ensure the smooth flow of urban roads and people's daily life. Table 1 shows the sewage treatment capacity and treatment rate of city B in five years, and the sewage treatment capacity is between 0-1:

Table 1. Sewage treatment capacity and treatment of city B in 5 years

	Sewage treatment capacity	Sewage treatment rate (%)
2018	0.5	56
2019	0.59	61
2020	0.67	69
2021	0.75	78
2022	0.82	85

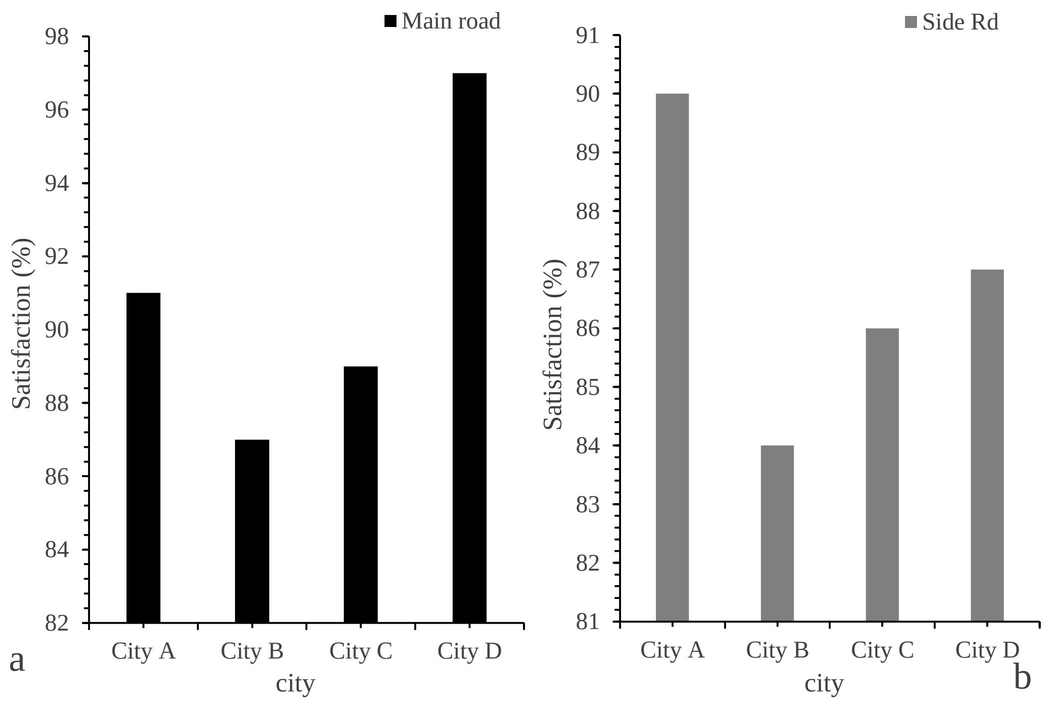

Figure 3a. Citizens' satisfaction with the main road

Figure 3b. Public satisfaction with the side road

Figure 3. Public satisfaction with the main road and side roads

Based on the above analysis of road drainage system, this paper discussed the urban road drainage system before and after the use of remote sensing technology and support vector machine algorithm. First of all, the data of several urban road sewage systems in the Y region was collected through the Internet, and then the opinions of urban residents on the road sewage system where they lived were reclassified and counted. After multiple screening, the residents' satisfaction of the sewage system of the main and auxiliary roads of cities A, B, C and D was statistically compared, as shown in Figure 3.

Figure 3a shows the satisfaction of citizens in the four cities in the region with the main road, and Figure 3b shows the satisfaction of citizens in the four cities in the region with the auxiliary road. It can be seen from Figure 3 that the satisfaction of the main road sewage system in the four cities above was more than 90 in cities A and D, while the lowest satisfaction of city B was only 87. Different from the main road sewage system, the satisfaction of citizens of the auxiliary road sewage system in four cities was below 90, which reflected that when planning the main road and auxiliary road sewage projects, the importance of the auxiliary road was often ignored and only the main road was concerned. In the face of this phenomenon, the relevant local departments should pay attention to it. The main road was the core of the road sewage system while the auxiliary road was the foundation. Only by combining the two better, can the urban road sewage system be better.

It is not difficult to see that the satisfaction statistics reflected by the citizens in the above four cities show that the satisfaction of city B is the lowest in both the main road and the auxiliary road. Therefore, in order to improve and take this city as an example, the fusion of remote sensing technology and support vector machine algorithm studied in this paper is to build a new urban road sewage system, and allow the number of road sewage siltation in the city in a month before and after using this method, as shown in Figure 4:

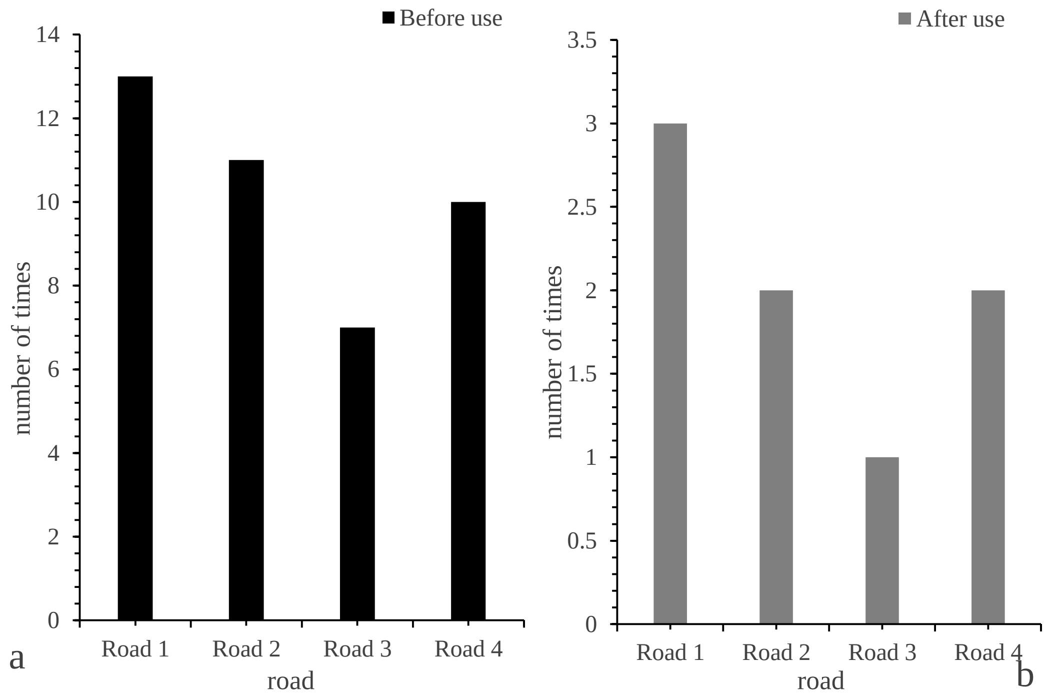

Figure 4a. Number of sewage deposition occurred before use

Figure 4b. Number of sewage deposition occurred after use

Figure 4. Comparison of the number of sewage deposition occurred before and after use

Figure 4a shows the number of sewage siltation on four roads in one month before the use of city B, and Figure 4b shows the number of sewage siltation on four roads in one month before the use of city A. It can be seen from Figure 4 that there were 13 times of sewage siltation on Road 1 before the city used this method; there were 11 times of sewage siltation on Road 2; there were 7 times of sewage siltation on road 3; there were 10 times of sewage siltation on Road 4. However, after using this method, there were 3 times of sewage siltation in Road 1; there were two times of sewage siltation on Road 2; the sewage siltation occurred once in Road 3; there were two times of sewage siltation on Road 4. It can be calculated that the difference between the siltation times of Road 1 before and after use was 10; the difference of siltation times of Road 2 was 9; the difference of siltation times of Road 3 was 6; the difference between the times of siltation on Road 4 was 8.

It can be seen that the number of times before and after the use of fusion remote sensing technology and support vector machine algorithm has changed significantly, and the road drainage system in this area has made qualitative progress compared with the previous.

5. Conclusion

With the growth of population, the discharge of industrial sewage is also increasing. The original rainwater drainage system would not be able to accommodate the sewage in the city and meet the flow direction of rainwater. This has led to people's attention to water pollution. Proper treatment of sewage and timely removal of rain and snow water are one of the necessary conditions to ensure the normal operation of the city. Therefore, the drainage system must be accurately analyzed and transformed accordingly. This paper analyzed the construction of the road sewage system integrating remote sensing technology and support vector machine algorithm, proposed a reasonable scheme for the design of the road sewage system, then compared the number of sewage sludge on the roads before and after the use of the city based on the support vector machine algorithm, and finally made a summary.

Funding

This article is not supported by any foundation.

Data Availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

Conflict of Interest

The author states that this article has no conflict of interest.

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