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SOIL EROSION FACTOR IN DETERMINING EROSION SUSCEPTIBILITY IN AGRICULTURAL AND PASTURE LANDS

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Abstract: Erosion is a process that deviates from its natural course due to human intervention. Erosion has many causes and continues to intensify due to mistakes made in agricultural areas and improper use of pastures. In order to understand the level of soil erosion, it is essential to understand the physical and chemical properties of the soil. This study aimed to determine the value of the K factor, also known as the soil erosion index in Alaçam district. The study includes collecting and analyzing soil samples, descriptive statistics and interpretation of the results, calculation of the K factor, and mapping of the K index by appropriate geostatistical method. SPSS 17.0 program was used for the statistics. In determining the geostatistical methods, the method with the lowest mean square error was preferred, and the ArcGIS 10.2.2 program was used during these processes. As a result of the research, it was observed that the K value was lower in agricultural areas. This situation is related to the amount of organic matter and permeability values. The fact that the erodibility is higher in agricultural areas with low slopes than in pasture lands with higher slopes indicates that agricultural activities are carried out to increase erosion. Although erosion is controllable throughout the district, agricultural practices and activities related to pasture animal husbandry should be meticulously monitored.

Keywords: Erosion, K factor, Agriculture land, Pasture

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1. Introduction

Erosion, which we can define as the wearing and moving of soil by external forces, is also a fundamental process in geomorphology. While the natural erosion process does not usually pose a problem, this process emerges as a natural environment problem due to the increase of human intervention. Many factors cause erosion. The main factors are soil becoming infertile over time due to incorrect agricultural practices, and pastures gradually deteriorating due to incorrect animal husbandry techniques. Various erosional forms, such as gullies that occasionally observed to time in the field, remind the importance of protecting limited natural resources. Soils with differing physical and chemical properties may exhibit varying properties to erosion under the same climatic conditions (Yakupoglu and Demirci 2013). The best way to understand the erosion properties of soils is to reveal their physical and chemical properties. Therefore, the accurate analysis of soil properties is essential for correct and effective erosion control. Ekberli and Dengiz (2017) emphasized that comprehensive soil physical and chemical data are necessary for developing techniques to protect, predict, and enhance soil fertility. The soil K factor is fundamentally important in soil erosion measurement models such as the Universal Soil Loss Equation (USLE) and the revised RUSLE. In recent years, studies using these models have gained importance (Değerliyurt 2013; Ege 2019; Fiçici and Soykan 2022; Durak and Cürebal 2025; Fahd et al. 2025; Ocak and Bahadır 2025) and have become widely applied by scientists. Since this factor is directly related to the properties of the soil regarding erosion and sediment transport, it is also used as the soil erosion index (Demir et al. 2022). Soil analyses must be performed to determine the K factor, which is complex and slow. For this reason, (İrvem and Tülücü 2004; Cebel et al. 2013) conducted studies to determine the K values of large soil groups throughout the country. Researchers have accepted and used the values obtained in these studies (Mutlu and Soykan 2018; Özdemir and Tatar Dönmez 2016; Aktaş et al. 2024). This research was carried out to determine the K values for agricultural and pasture lands. According to the results obtained, the district's land use in terms of agriculture and animal husbandry was evaluated.

2. Materials and Methods

2.1. Research Area Location

Alaçam, located on the western coast of Samsun province, is a coastal district covering approximately 630 km² (Figure 1). The Black sea climate, which gradually loses its influence toward the inland areas, prevails in the region. The district is rich in terms of vegetation cover. The district lands, which contain broad-leaved, mixed, and coniferous forests, which gradually diminish toward the south. The highest area in the south is the Kızlan Plateau, which consists mostly of meadows. The most common soils in the study area are alluvial soils. These soils are classified as fluviosols according to the soil classification system. It is also found in acidic, clay-rich, infertile allisols soils.

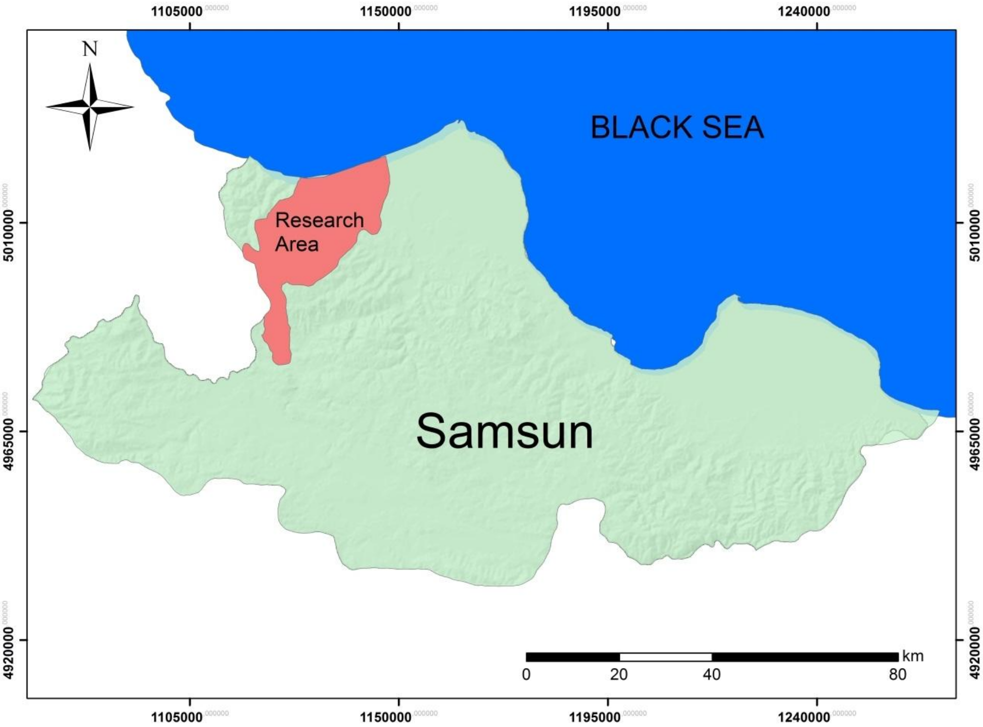

Figure 1. Research area district boundaries.

2.2. Method

Soil samples were collected from 32 different locations, comprising 16 pasturelands, and 16 agricultural fields with different topographic features in the research area (Figure 2). Following the sampling process, the soils were prepared for analysis in the laboratory, and various analyses were carried out on the soils. Texture was determined using the Bouyoucos hydrometer method (Bouyoucos, 1951); hydraulic conductivity was determined using saturated soil samples (Blake and Hartge, 1986); organic matter content was determined using the Walkley-Black method modified by Tüzüner (1990); and structural stability index was determined using the hydrometer method (Tüzüner, 1990). The results obtained were subjected to geostatistical analyses using the ArcGIS 10.2.2 program. The SPSS 17.0 program was used to perform descriptive statistics.

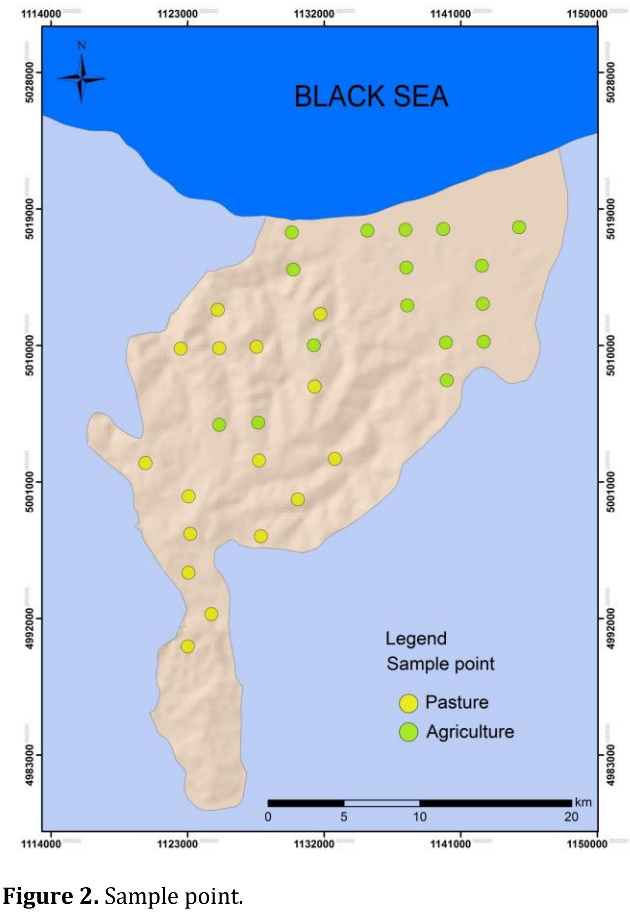

Figure 2. Sample point.

2.3. The soil erodibility factor (K Factor)

The K factor, which represents the erodibility of the soil, integrates various soil properties to indicate the soil's resistance to erosion by external forces. The rate of this resistance is determined according to the index value obtained on a 9% slope and 22.1 meters high land (Wischmeier and Smith, 1978). The equation 1 used to determine the K value is as follows:

$$K = \frac{1}{100}\left\{2.1\times10^{-4}\times(12-OM)\times\left[SI\times(SA+SI)\right]^{1.14}+2.5\times(PE-3)+3.25\times(ST-2)\right\} \quad (1)$$

In the formula, OM refers to the percentage of organic matter, SI represents the percentage of silt, SA indicates the percentage of sand, PE denotes the hydraulic conductivity, and ST corresponds to the structure stability index. The erodibility class valuesof the method are given in Table 1.

Table 1. Erodibility (K) classes and values (Wishmeier and Smith 1978)

Definition	Classes	Value
Very Little Erodobility	1	0.00-0.05
Low Erodobility	2	0.05-0.10
Moderate Erodobility	3	0.10-0.20
High Erodobility	4	0.20-0.40
Very High Erodobility	5	0.40-0.60

2.4. Descriptive and Geostatistical Analyses

Descriptive statistics were performed on 32 samples from agricultural and pasture lands in the research area. In addition to these statistics, the normal distribution of soil properties were checked with the Kolmogorov-Smirnov (K-S) test. Differences between land use types were assessed using multiple comparison tests to evaluate variations in soil properties and the corresponding differences in the K factor.

The interpolation method was used to determine the area distribution of the K factor. The root mean square error method (RMSE) was used to determine the appropriate method.

The method yielding the lowest RMSE value, as presented in Table 2, was selected as the most reliable interpolation technique. The most appropriate method was determined as Radial Basis Functions (RBF) Completely Regularized Spline (Table 2).

Table 2. RMSE values table for K value interpolation

Geostatistical Models			K factor
Inverse Distance Weighting (IDW)		1	0.01575
		2	0.01559
		3	0.01561
Radial Basis Functions (RBF)		Completely Regularized Spline	0.01554
		Thin Plate Spline	0.01747
Kriging	Ordinary Kriging	Spherical	0.01565
		Exponential	0.01576
		Gaussian	0.01557
	Simple Kriging	Spherical	0.01605
		Exponential	0.01616
		Gaussian	0.01623
	Universal Kriging	Spherical	0.01565
		Exponential	0.01576
		Gaussian	0.01557

3. Results

3.1. Topographic Features

Alaçam, a small coastal district of Samsun Province located along the Black Sea, has an average elevation of 15 meters and covers an area of approximately 630 km^2. It borders the Bafra district to the west, situated on the left bank of the Bafra Plain (Figure 3). The district has approximately 17 km of coastline and is an important recreation area with the Geyikkoşan forest area. It is also an important festival area; the fair and wrestling festivals are held annually. Although the lands in the south are limited, the Kızlan plateau at 1600 m and Dütmen Mountain are also tourism areas of the district. While the slope values show near-flat values on the coast, it is seen that the valleys consist of deeply cut, high-sloping slopes as you go up (Figure 4). On the other hand, as seen in the Canik Mountains, near-flat lands on erosion surfaces at high altitudes.

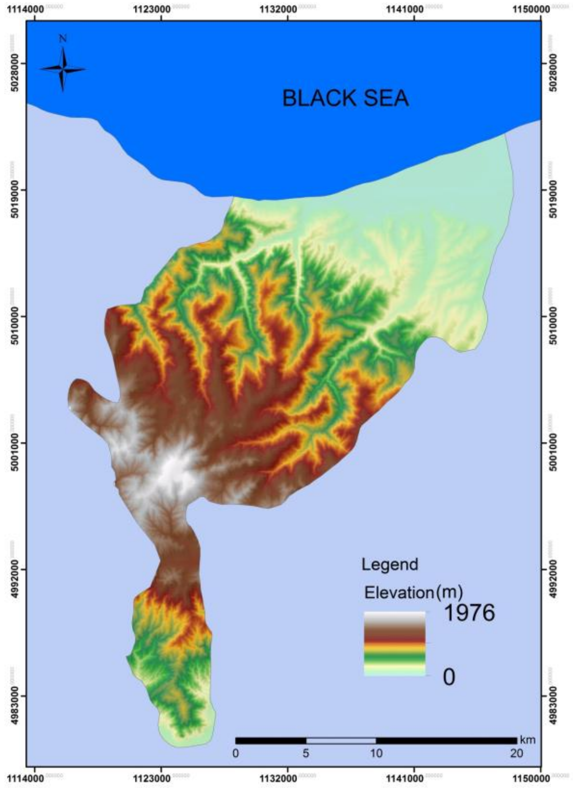

Figure 3. Elevation map.

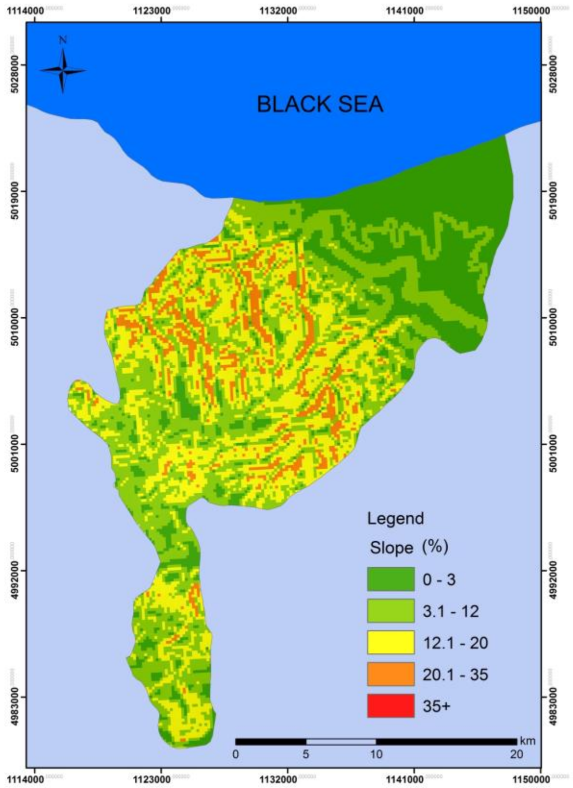

Figure 4. Slope map.

3.2. Land use and land cover

Alluviums are at the level of the plain in the research area; these are areas with existing land uses such as paddy fields, irrigated and non-irrigated agricultural, and mixed lands (Figure 5). In the district where settlements are located in the coastal area, pasture lands and forest lands begin to appear with the increase in elevation. A significant part of the pastures is located within forest lands. These lands are presumed to be old agricultural areas, and unproductive areas have been converted into pastures.

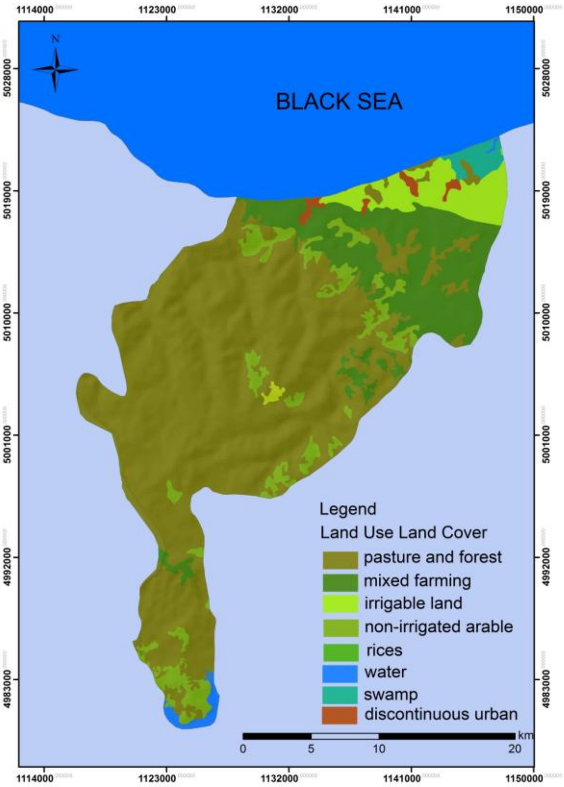

Figure 5. Land use map (Corine 2018).

3.3. Basic Descriptive Statistics

The descriptive statistics of soil properties for pasture and agricultural areas are given in Tables 3 and 4. According to the descriptive statistics tables of soils, it was observed that the K value was homogeneous in agricultural areas and pasture lands, and the coefficient of variation of K value was distributed homogeneously in both land use types.

Table 3. Descriptive statistics of pasture areas

Feature	Minm.	Maks.	Mean	Standard deviation	Coefficient of variation (CV)	Skewness Coefficient	K-S
EC dS/cm	0.167	0.547	0.38	0.10	0.263	-0.219	0.976
pH	5.84	7.81	6.87	0.77	0.108	0.004	0.362
Kireç %	0.2	20.4	4.58	7.34	1.549	1.473	0.056
Phosphorus	0.2	67.41	12.56	16.92	1.304	2.379	0.060
Potassium	14	166	45.1	37.93	0.814	2.184	0.315
Sand	20.97	58.45	39.68	10.07	0.254	-0.448	0.331
Silt	22.10	40.87	30.50	4.78	0.157	0.368	0.933
Clay	19.45	41.84	29.81	6.15	0.206	0.571	0.519
Org. M	1.36	4.48	2.93	0.74	0.243	0.183	0.571
Hc cm/sa	0.6	1.98	0.85	0.42	0.480	1.308	0.511
K	0.093	0.131	0.0965	0.0157	0.157	0.053	0.593
HA gr/cm3	1.37	1.5	1.41	0.064	0.044	-0.442	0.455

According to descriptive statistics, it was observed that most variables in the samples were close to normal distribution, K value was homogeneous according to the coefficient of variation, and according to the K-S test result, it was found to be in conformed to normal distribution (P>0.05).

Table 4. Descriptive statistics of agricultural areas

Feature	Minm.	Maks.	Mean	Standard deviation	Coefficient of variation (CV)	Skewness Coefficient	K-S
EC dS/cm	0.249	0.611	0.4129	0.0912	0.2139	0.3632	0.786
pH	6.06	7.82	7.3338	0.5496	0.0726	-1.3021	0.090
Kireç %	0.2	33.9	7.2938	9.0052	1.1954	1.7092	0.391
Phosphorus	1	47.9	14.6562	14.3015	0.9448	1.2472	0.414
Potassium	22	102	54.00	23.8076	0.4269	0.4598	0.973
Sand	9.53	53.24	27.68	11.17	0.403	0.743	0.409
Silt	22.64	51.93	35.77	7.16	0.200	0.387	0.904
Clay	24.12	50.53	36.54	7.05	0.193	-0.161	0.423
Org. M	1.36	4.84	2.6612	0.9403	0.3421	0.7844	0.847
Hc cm/sa	0.175	3.239	0.6984	0.7334	1.0167	2.7891	0.143
K	0.0732	0.1468	0.1162	0.0193	0.1606	-0.7092	0.592
HA gr/cm3	1.27	1.53	1.3656	0.0678	0.0481	0.8965	0.481

In agricultural areas, pH, lime, and hydraulic conductivity values have a high coefficient of skewness, and the distribution is asymmetric, while other values show normal distribution.

Comparison of soil properties between agricultural and pasture lands, revealed that pH values did not differ significantly, and there are slightly higher averages in agricultural areas. It was observed that phosphorus and potassium amounts were higher in agricultural areas, and it was thought that this situation could be related to fertilizer application. The amount of organic matter was higher in pastures. Its that the hydraulic conductivity was higher in pastures, which shows that pasture lands may be more resistant to erosion and that surface runoff will be less. It is seen that the average K values are low in both land uses. K values are seen to be higher than the average in agricultural areas. This shows that the sensitivity to erosion is higher in agricultural areas. This situation is also related to the continuous processing of agricultural areas.

3.4. Distribution of the K factor

The accuracy of the K factor in the Alaçam district soils was evaluated with different geostatistical methods, and the most appropriate distribution was determined. During the geostatistical modeling of the K factor, the most accurate results were obtained using the Radial Basis Function (RBF) interpolation method, specifically the Completely Regularized Spline model, which was found to be the most suitable approach based on error metrics. According to the map obtained with this method, it was determined that the K value in the district soils were generally low to moderate (Figure 6). Although spatial variations in K values were observed between pasture and agricultural lands, the overall differences between these land use types were not pronounced (Figure 7).

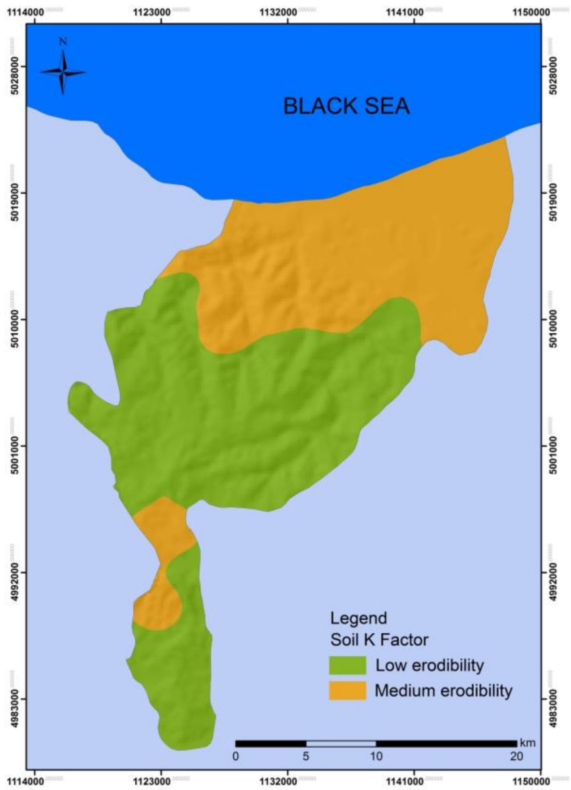

Figure 6. K factor map.

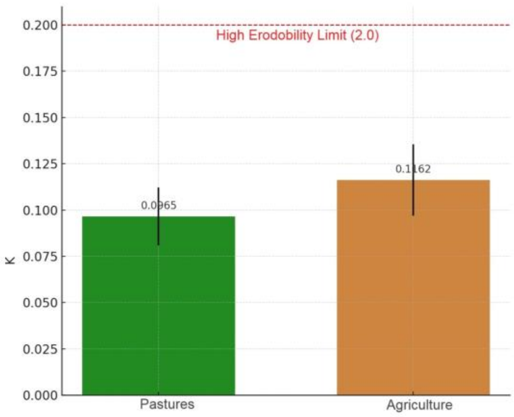

Figure 7. K value in agricultural and pasture areas.

4. Discussion and Conclusion

It is considered that K values are generally higher in agricultural areas compared to pastures, and the main reason may be the low organic matter and low permeability. İmamoğlu et al. (2016) found a similar result in their study in Çorum Alaca and determined a positive significant relationship between organic matter and K value. Özdemir et al. (2015) found that the effect of organic amendments on soil loss varies depending on texture and is more effective in soils under low rainfall intensity. Dengiz and İmamoğlu, (2016) in their study in Samsun province, they determined that the K factor was in similar ranges in agricultural pasture and forest lands throughout the province, however the erosion index values were higher in pasture areas. Low permeability facilitates surface runoff, and in such cases, slope becomes a critical factor. As a result, in agricultural areas with high slope values, surface flow is high, and the amount of erosion is higher. Although the K values obtained in both land uses showed there were no lands in high and very high erosion classes, and this showed that erosion was at a manageable level. Therefore, controlling animal husbandry in pasture areas and preventing the conversion of steep, high-altitude lands into agricultural fields are considered essential conservation measures to mitigate erosion risk.

Author Contributions

The percentages of the author' contributions are presented below. The author reviewed and approved the final version of the manuscript.

	A.İ.
C	100
D	100
S	100
DCP	100
DAI	100
L	100
W	100
CR	100
SR	100
PM	100
FA	100

C=Concept, D= design, S= supervision, DCP= data collection and/or processing, DAI= data analysis and/or interpretation, L= literature search, W= writing, CR= critical review, SR= submission and revision, PM= project management, FA= funding acquisition.

Conflict of Interest

The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Ethical Consideration

Since no studies involving humans or animals were conducted, ethical committee approval was not required for this study.

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