

# Invasive Plant Species of Recreational Zones of Kharkiv (Ukraine) <sup>†</sup>

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**Abstract:** The formation of synanthropic flora of any territory occurs in two ways—due to the penetration of anthropophytes (anthropophytization, adventization) and the transition of native plant species from natural phytocenoses to anthropogenic ecotopes (apophytization). The article highlights the results of the study of synanthropic flora and vegetation of recreational zones of Kharkiv (abandoned parks, recreational areas, green areas) for 2018–2020. The classification of synanthropic vegetation was performed on the basis of processing geobotanical descriptions in programs Turboveg 2.91 and Juice 7.0.127. Ecological amplitudes of syntaxons were determined by ecological scales of Ya.P. Didukh. The study of invasive plant species was carried out according to the classification of D. Richardson et al. As part of the synanthropic vegetation of recreational zones of Kharkiv, we have found 15 invasive plant species. Most of them, according to the degree of invasive potential, belong to the group with high invasive capacity (11). Among them there are dominate species of the family *Asteraceae* (8), therophytes (8), mesophytes (14), species of North American origin (13), kenophytes (15), xenophytes (6) and ergasiophytes (5), epiphytes (7). Woody phytocenoses of the class *Robinietaea* are sensitive to soil acidity and carbonate content in soil, thermal and cryo-climate. In their composition we have found 8 invasive species. In plant communities of herbaceous annual vegetation of classes *Bidentetea* and *Galio-Urticetea*, which are adapted to the variability of damping and nitrification of the edaphotope, 9 invasive plant species grow. Ruderal phytocenoses of classes *Artemisietea vulgaris* and *Stellarietea mediae* are formed with the participation of 10 invasive plant species. These communities are sensitive to the variability of damping, soil acidity, total salt regime, nitrogen content in soil, thermal climate, humidity, as well as to the continentality of climate.

**Keywords:** invasive plant species; synanthropic vegetation; recreational zones; Kharkiv; Ukraine

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## 1. Introduction

The formation of synanthropic flora of any territory occurs in two ways—due to the penetration of anthropophytes (anthropophytization, adventization) and the transition of native plant species from natural phytocenoses to anthropogenic ecotopes (apophytization) [1]. Urban flora is a type of anthropogenically transformed flora and forms in the conditions of urban agglomerations. It has a specific structure, as well as its own characteristic florogenetic processes. The need to study urban flora is determined by the fact that in this type of anthropogenically transformed flora “coexist” different types of flora (flora of man-made ecotopes, recreational areas, agrophytocenoses, cultivated flora, etc.) [2].

Gardens and parks form a special type of urban landscape. The individuality of the city largely depends on their location and landscaping. The landscape design of gardens and parks has its own patterns: the alternation of closed and open areas, flat places and

elevations, dry slopes and ponds, compliance with the natural basis of the created complexes [2].

The aim of the work is to study invasive plant species in the flora and vegetation of recreational zones of Kharkiv (abandoned parks, recreational areas, green areas) for 2018–2020.

## 2. Materials and Methods

We have studied the synanthropic flora and vegetation of abandoned parks, recreational areas and green areas for the period 2018–2020 (Figure 1). The study of invasive plant species was carried out according to the classification of D. Richardson et al.; taxonomic and biomorphic analyzes by Tolmachev [3] and Raunkiaer [4]. The classification of synanthropic vegetation was performed by the ecological-floristic method. Selection of syntaxons was based on the processing of geobotanical descriptions in programs Turboveg 2.91 [5] and Juice 7.0.127 [6]. The obtained phytocenones were identified by the Prodromus of vegetation of Ukraine [7]. Ecological amplitudes of syntaxons were determined by ecological scales of Ya.P. Didukh [8].

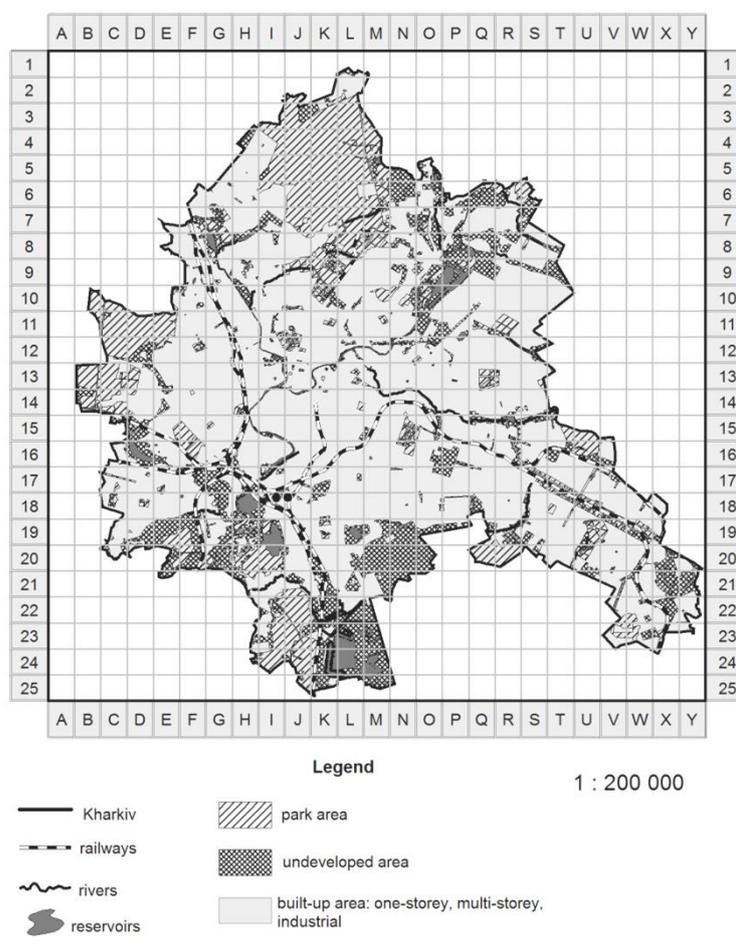
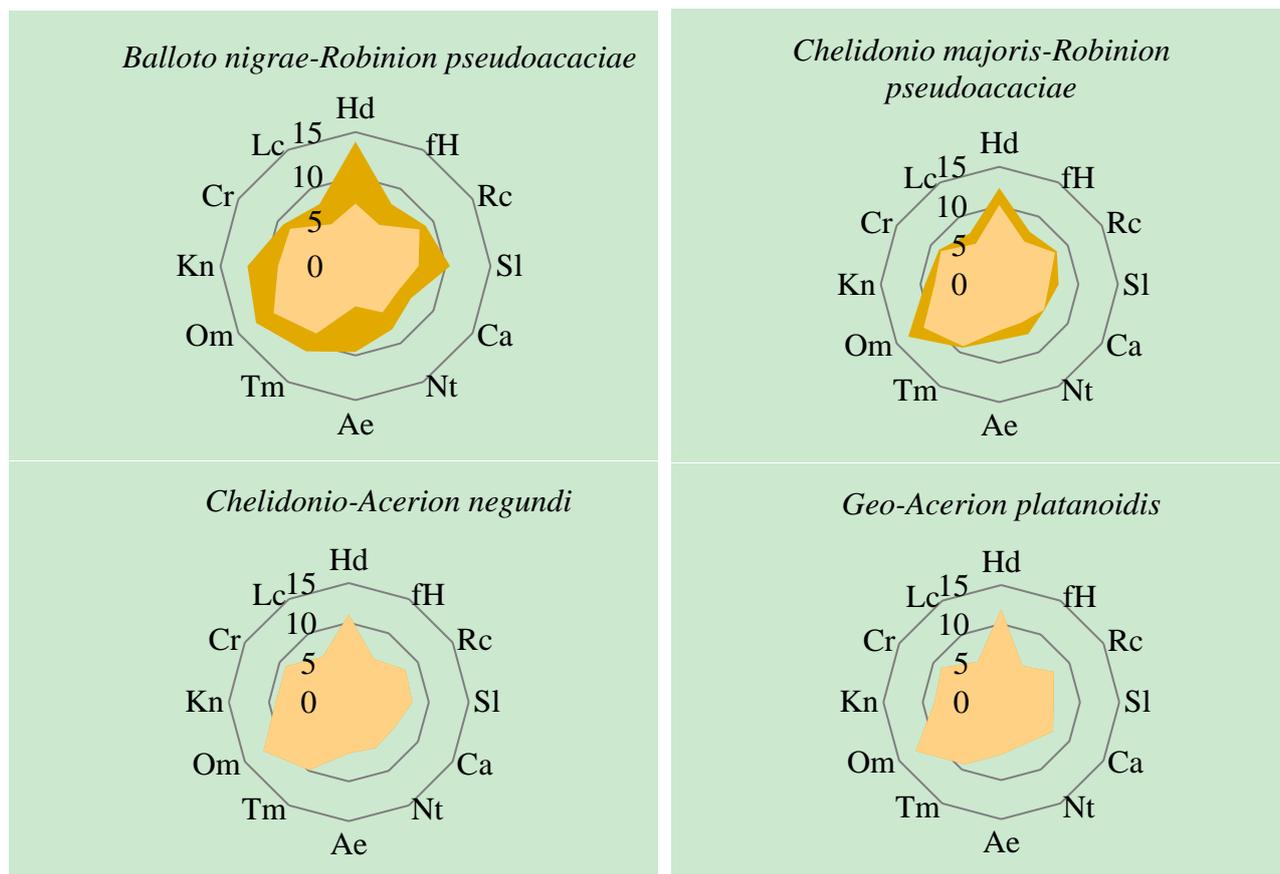


Figure 1. Map of the recreational zones of Kharkiv.

## 3. Results and Discussion

In the composition of the synanthropic vegetation of recreational zones of Kharkiv, we have found 15 invasive plant species. Most of them, according to the degree of invasive potential, belong to the group with high invasive capacity (11 species) [9]. Invasive plant species of the family *Asteraceae* (8) dominate in taxonomic spectrum, which is characteristic of the synanthropic flora of Ukraine [10]. The families *Balsaminaceae*, *Vitaceae*, *Fabaceae*,

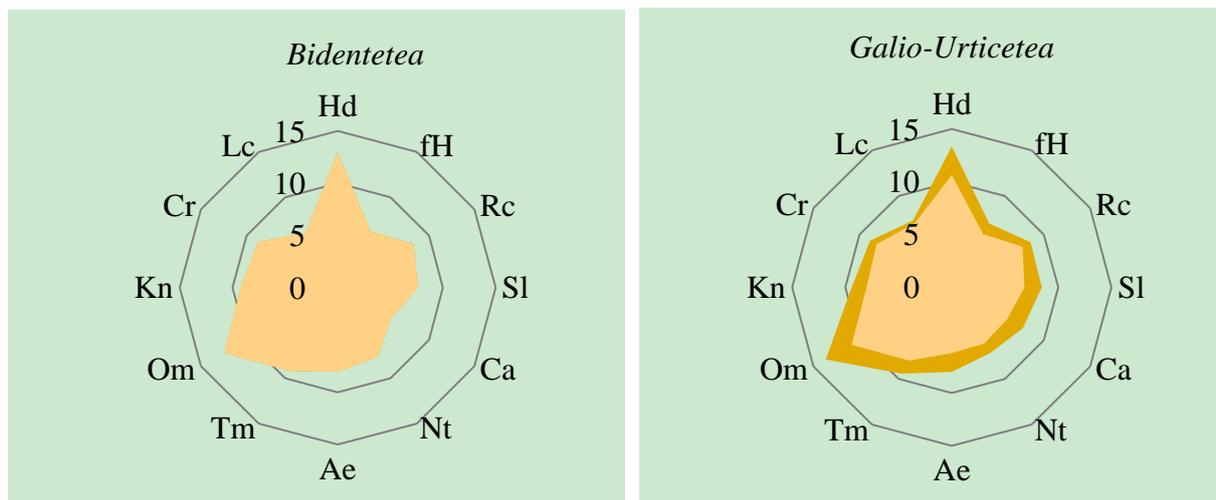
*Aceraceae*, *Amaranthaceae*, *Portulacaceae*, *Nyctaginaceae* have only one plant species each. The biomorphic analysis shows the dominance of therophytes (8 species), which is typical for recreational zones of Kharkiv. Hemicryptophytes take the second place (4 species), phanerophytes—the third (3 species). Among the invasive plant species there are dominate mesophytes (14), species of North American origin (13), kenophytes (15), xenophytes (6) and ergasiophytes (5), epecophytes (7). Using ecological scales, we calculated the tolerance zones of the identified plant communities in the hyperspace of 12 ecological factors. The class *Robinietea* Jurko ex Hadač et Sofron 1980 is represented by plant communities of unions *Balloto nigrae-Robinion pseudoacaciae* Hadač et Sofron 1980, *Chelidonio majoris-Robinion pseudoacaciae* Hadač et SofronexVítková in Chytrý 2013, *Chelidonio-Acerion negundi* L. Ishbirdina et A. Ishbirdin 1991 nom. inval. (art. 3o, 5), *Geo-Acerion platanoidis* L. Ishbirdina et A. Ishbirdin 1991 nom. inval. (art. 3o, 5), which include invasive species *Acer negundo* L., *Robinia pseudoacacia* L., *Parthenocissus inserta* (A. Kern.) R. M. Fritsch, *Conyza canadensis* (L.) Cronquist, *Erigeron annuus* (L.) Desf. (*Phalacrolooma annuum* (L.) Dumort), *Grindelia squarrosa* (Pursh) Dun., *Impatiens parviflora* DC., *Solidago canadensis* L. The studied synanthropic woody phytocenoses are distributed in recreational zones of the city, along roads, streams. They have narrow tolerance zones to soil acidity and carbonate content in soil, to thermal and cryo-climate (Figure 2).



**Figure 2.** The tolerance zones of *Robinietea* phytocenoses in the hyperspace of ecological factors. Legend: Hd—soil water regime, fH—variability of damping, Rc—soil acidity, Sl—total salt regime, Ca—carbonate content in soil, Nt—nitrogen content in soil, Ae—soil aeration, Tm—thermal climate, Om—humidity, Kn—continentality of climate, Cr—cryoclimate, Lc—light.

In the composition of vegetation of unions *Bidention tripartitae* Nordhagen ex Klika et Hadač 1944 and *Chenopodion rubri* (Tx. in Poliet J. Tx. 1960) Hilbig et Jage 1972 of class *Bidentetea* Tx. et al. ex von Rochow 1951 we have found *Bidens frondosa* L., *Ambrosia artemisiifolia* L., *Acer negundo*, *Impatiens parviflora*, *Erigeron annuus*, *Parthenocissus inserta*.

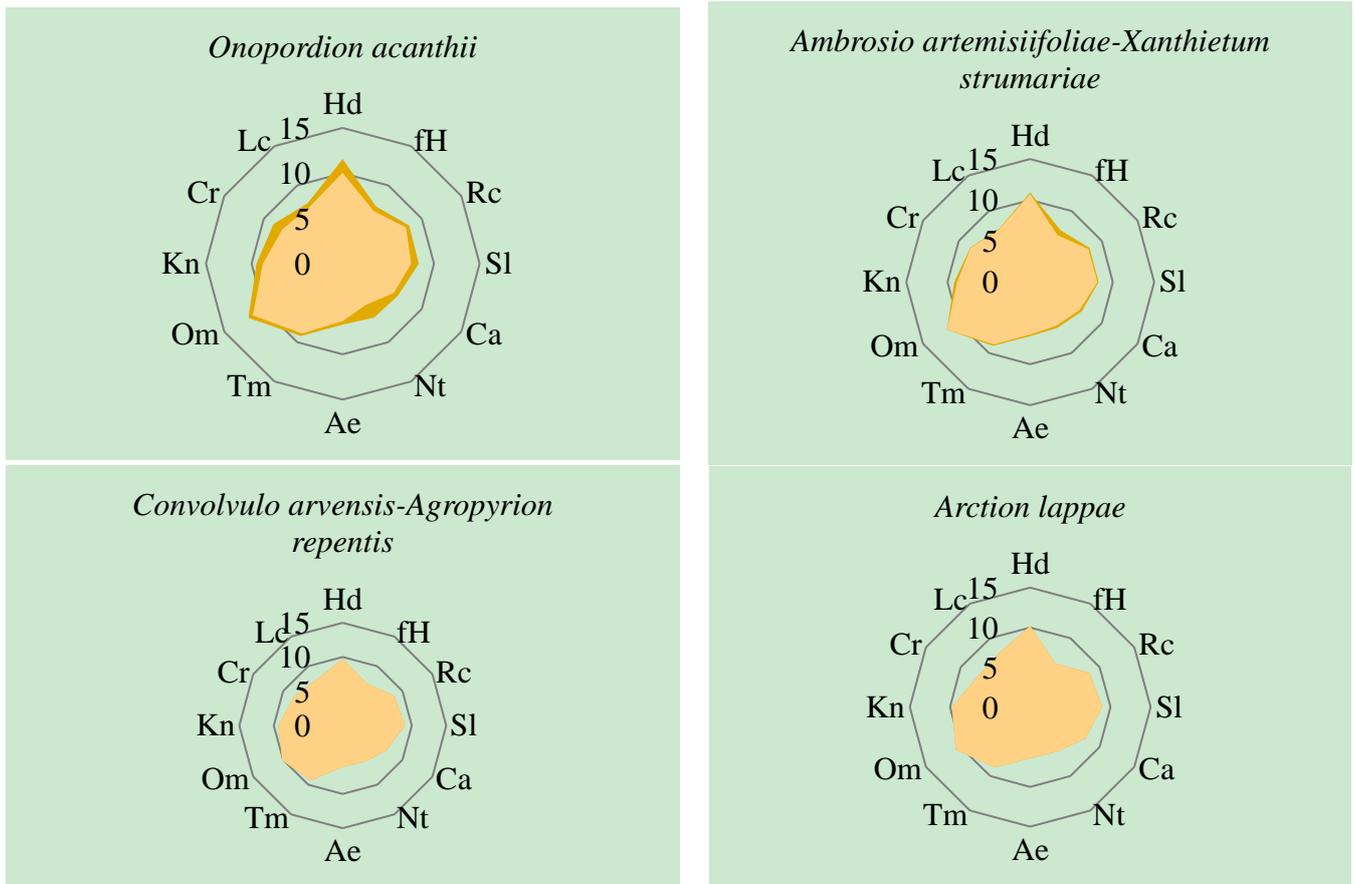
This pioneer vegetation near water bodies have a fairly wide tolerance zones, withstand fluctuations in edaphotope damping, slight shading (Figure 3). Similar environmental parameters have ruderal communities of the remains of oak forests and wetlands along watercourses (rivers, streams) of class *Galio-Urticetea* Passarge ex Kopecký 1969. These cenoses include *Ambrosia artemisiifolia*, *Grindelia squarrosa*, *Erigeron annuus*, *Solidago canadensis*, *Iva xanthiifolia* (Nutt.) Fresen. The vegetation of both classes is adapted to the variability of damping, nitrification of the edaphotope.



**Figure 3.** The tolerance zones of *Bidentetea* and *Galio-Urticetea* phytocenoses in the hyperspace of ecological factors. Legend are in Figure 2.

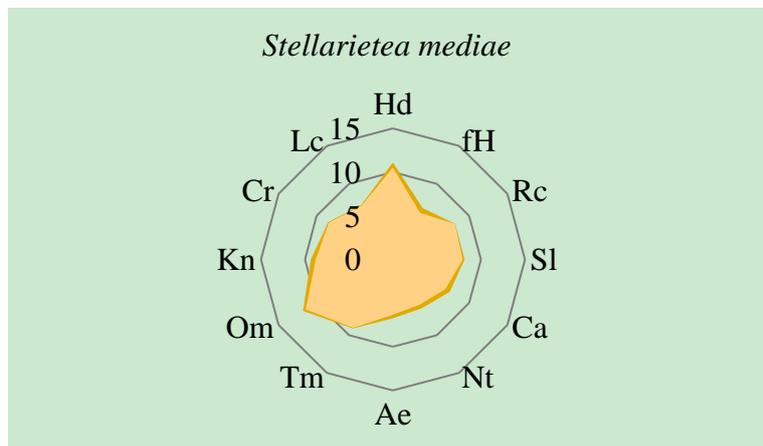
The vegetation of class *Artemisietea vulgaris* Lohmeyer et al. in Tx. ex von Rochow 1951 is represented by unions *Onopordion acanthi* Br.-Bl. et al. 1936, *Convolvulo arvensis-Agropyron repentis* Görs 1967, *Arction lappae* Tx. 1937, in which *Grindelia squarrosa*, *Solidago canadensis*, *Helianthus tuberosus* L., *Ambrosia artemisiifolia*, *Erigeron annuus*, *Oxybaphus nyctagineus* (Michx.) Sweet, *Conyza canadensis* grow. Ruderal xerophytic communities of the class are distributed along roads, paths, in places of active recreation on nitrified soil, have narrow tolerance zones of variability of damping, soil acidity, sensitive to changes in thermal climate and humidity (Figure 3).

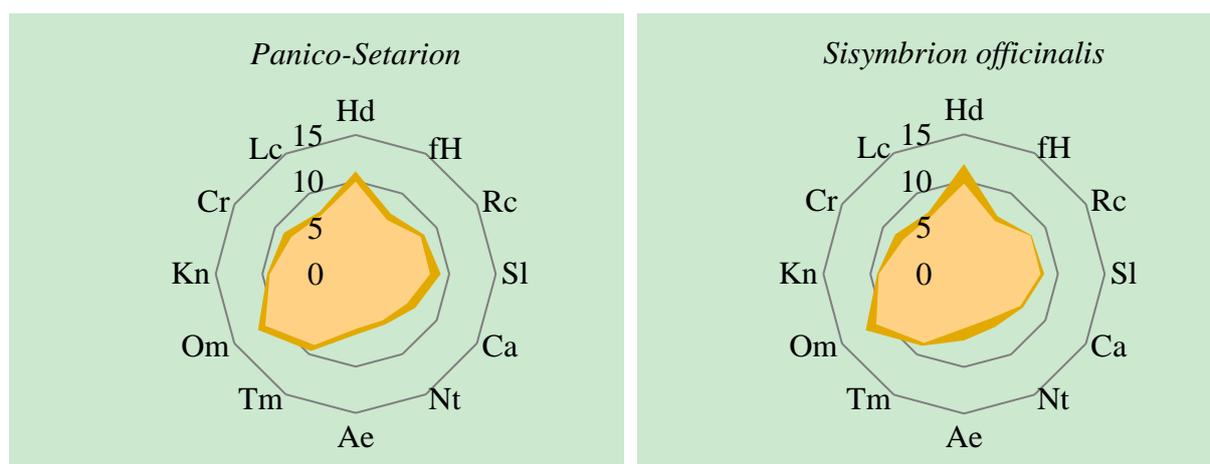
Ruderal vegetation of dry roadside areas and dumps in park zones of class *Stellarietea mediae* Tx. et al. in Tx. 1950 demonstrates sensitivity to soil acidity, total salt regime, nitrogen content in soil, continentality of climate (Figure 4). In the unions *Panico-Setarion* Sissingh in Westhoff et al. 1946, *Sisymbrium officinalis* Tx. et al. ex von Rochow 1951 we have noted *Ambrosia artemisiifolia*, *Amaranthus retroflexus* L., *Conyza canadensis*, *Grindelia squarrosa*, *Erigeron annuus*, *Iva xanthiifolia*, *Portulaca oleracea* L.



**Figure 4.** The tolerance zones of *Artemisietea vulgaris* phytocenoses in the hyperspace of ecological factors. Legend are in Figure 2.

1  
2





**Figure 5.** The tolerance zones of *Stellarietea mediae* phytocenoses in the hyperspace of ecological factors. Legend are in Figure 2.

#### 4. Conclusions

As a result of the study we have identified 15 invasive plant species in 5 classes of synanthropic vegetation of recreational zones of Kharkiv. Analysis of the taxonomic and biomorphic structure revealed a predominance plant species of *Asteraceae* family and herbaceous annuals. Woody phytocenoses the class *Robinietea* are the center of growth of 8 invasive plant species. According to the results of ecological analysis, these plant communities are sensitive to soil acidity and carbonate content in soil, thermal and cryo-climate. There are 9 invasive plant species in the communities of herbaceous annual vegetation of classes *Bidentetea* and *Galio-Urticetea*, which are formed under conditions of variability of damping and nitrification of the edaphotope. Ruderal phytocenoses of classes *Artemisietea vulgaris* and *Stellarietea mediae* are formed with the participation of 10 invasive plant species. These communities are sensitive to the variability of damping, soil acidity, total salt regime, nitrogen content in soil, thermal climate, humidity, as well as to the continentality of climate.

**Institutional Review Board Statement:**

**Informed Consent Statement:**

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**Conflicts of Interest:** The authors declare no conflict of interest.

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