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Research Article

Species diversity of fleas (Siphonaptera) and hard ticks (Ixodidae) infesting wild caprids (*Capra aegagrus*, *Rupicapra rupicapra*) and some other mammals in Türkiye

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Abstract

Ectoparasites are arthropods that threaten human and animal health by causing infestations. They are also considered a global health concern due to diseases transmitted by fleas and ticks. The impact of wild animals (mammals, birds, and reptiles) on ectoparasite infestations and the epidemiology of ectoparasite-borne diseases is undeniable. The study material consists of ectoparasite specimens (ticks and fleas) collected from individuals of wild goat (*Capra aegagrus*, n: 2), chamois (*Rupicapra rupicapra*, n: 3), golden jackal (*Canis aureus*, n: 2), and roe deer (*Capreolus capreolus*, n: 2) that were found dead during field studies conducted in the Artvin and Erzurum provinces of Türkiye. As a result of the microscopic examination, the tick specimens collected from the wild goats were identified as *Haemaphysalis kopetdaghica* Kerbabaev, 1962, *Ixodes gibbosus* Nuttall, 1916, and *Rhipicephalus bursa* Canestrini & Fanzago, 1878. In addition, the flea specimens collected from the golden jackals (*C. aureus*) were identified as *Ctenocephalides canis* (Curtis, 1826) and *Ctenocephalides felis* (Bouché, 1835), while the tick specimens collected from the roe deer (*C. capreolus*) were identified as *Ixodes ricinus* (Linnaeus, 1758). *Haemaphysalis kopetdaghica* and *I. gibbosus,* detected on chamois (R. rupicapra), and *Ctenocephalides felis,* detected on golden jackal (C. aureus), are new host-parasite associations for the ectoparasite fauna of Türkiye.

Keywords: *Ctenocephalides felis*, ectoparasites of wild animals, *Haemaphysalis kopetdaghica*, *Ixodes gibbosus*

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Introduction

Studies conducted worldwide on the host-parasite relationships of hematophagous ectoparasites (e.g., ticks, fleas, mosquitoes, and mites) and the pathogens they carry indicate that wild animals play a crucial role in the epidemiology of arthropod-borne diseases (3, 13, 14, 16, 39, 40, 47). It is reasonable to consider ectoparasites, such as ticks and fleas, among the most important arthropod groups infesting domestic and wild animals, as well as humans. Recent studies conducted both in Türkiye and globally support this view (1, 13, 17, 32, 42). To date, more than 900 tick taxa and nearly 3,000 flea taxa (species and subspecies) have been identified worldwide as ectoparasites of domestic and wild animals. Ticks—and, to a lesser extent, fleas—are, after mosquitoes, the most significant ectoparasitic arthropod groups affecting both human and animal health because they act as vectors of numerous viral, bacterial, and protozoan pathogens (4, 5, 9, 26, 50). In addition to their role as vectors, they can cause anaemia, pruritus, redness, inflammation, restlessness, and erythematous lesions on their hosts (3, 39). For these reasons, studies aimed at elucidating the relationships between ectoparasites and their wild hosts (mammals, birds, and reptiles) have been ongoing for decades, leading to the publication of multiple checklists at different time points (17, 35, 37).

Türkiye's terrestrial vertebrate fauna comprises 834 species, of which 173 (20.74%) belong to the class Mammalia (28). Although research on ectoparasites infesting mammals, birds, and reptiles has increased in recent years (17, 30**,** 33, 48, 62), it remains insufficient. Current studies indicate that a significant portion of the mammalian fauna remains unexamined.

The present study aims to contribute to ectoparasitic research globally and within the mammalian fauna of Türkiye by reporting ectoparasitic infestations detected on wild goat (*Capra aegagrus*), chamois (*Rupicapra rupicapra*), roe deer (*Capreolus capreolus*), and golden jackal (*Canis aureus*).

Materials and Methods

During mammal field studies conducted in the Artvin and Erzurum provinces of northeastern Türkiye between 2022 and 2025, five wild goats (*Capra aegagrus and Rupicapra rupicapra*), two golden jackals (*Canis aureus*), and two roe deer (*Capreolus capreolus*) were found dead in natural habitats and along highways. Ectoparasite infestation was detected in all cadavers during the ectoparasitological examination. Tick and flea specimens were collected using blunt-tipped forceps and stored in Eppendorf tubes containing 70% ethanol until identification. Subsequently, the specimens were identified using relevant literature (10, 18, 24, 50, 60) and examined under a light microscope (CX23 Binocular Microscope, Olympus Corporation, Tokyo, Japan) and a stereo microscope (Nikon SMZ 745T, Tokyo, Japan). Finally, all specimens were photographed using the microscope's integrated camera (Figures 1 and 2).

Results

During macroscopic examination, infestation was detected in all wild-animal cadavers; a total of 229 ticks (92 females, 56 males, and 81 nymphs) and five fleas (three females and two males) were collected (Table 1). Additionally, the number of ectoparasite specimens collected from dead hosts varied depending on the post-mortem interval and the stage of cadaver decomposition. By detailed microscopic examination, the tick specimens were morphologically identified as *Haemaphysalis kopetdaghica* Kerbabaev, 1962 (Figure 1C–F), *Ixodes gibbosus* Nuttall, 1916 (Figure 1A–B), *Ixodes ricinus* (Linnaeus, 1758) (Figure 2D–G), and *Rhipicephalus bursa* Canestrini & Fanzago, 1878 (Figure 1G–E). The flea specimens were morphologically identified as *Ctenocephalides canis* (Curtis, 1826) (Figure 2B–C) and *Ctenocephalides felis* (Bouché, 1835) (Figure 2A).

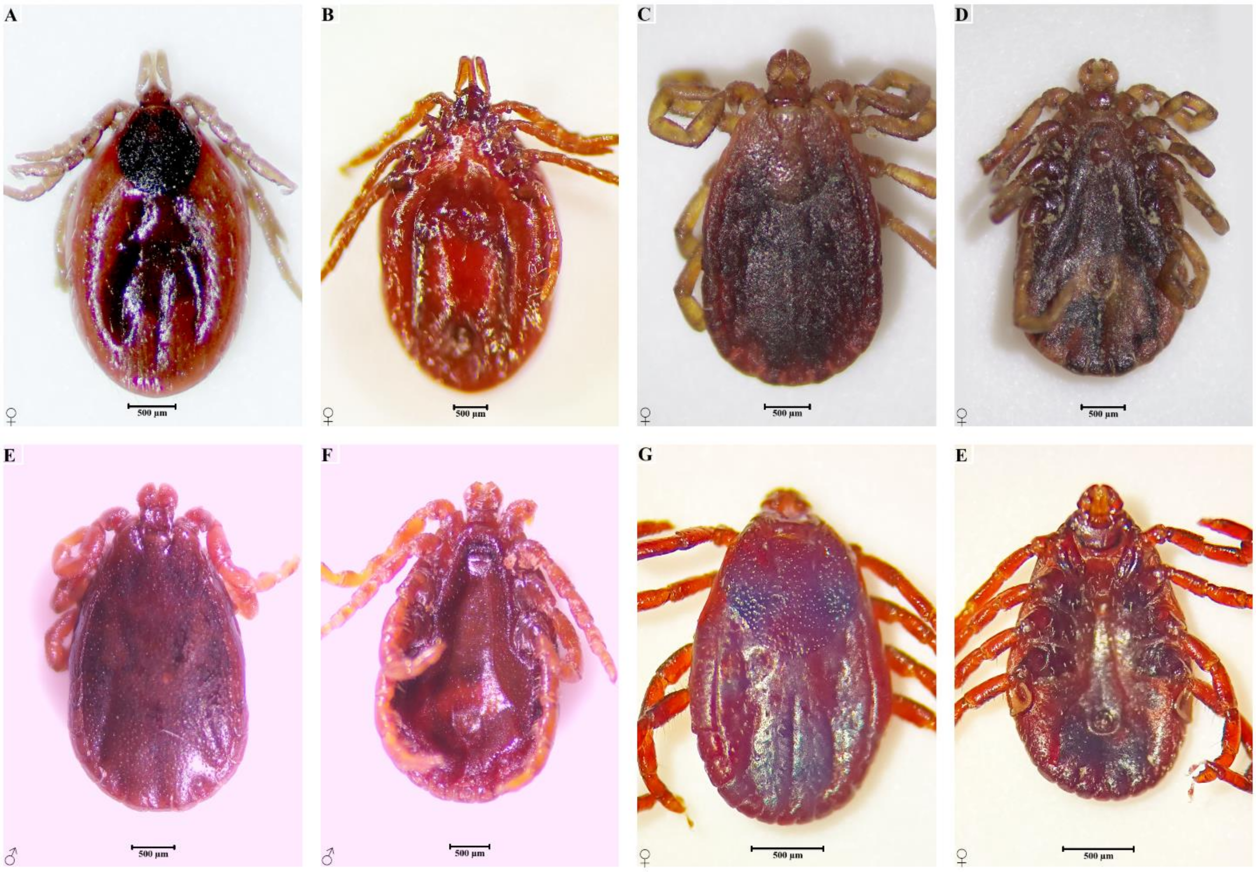

Figure 1. Original photographs of hard ticks detected on wild goats in the present study: *Ixodes gibbosus* (A-B), *Haemaphysalis kopetdaghica* (C-F) and *Rhipicephalus bursa* (G-E).

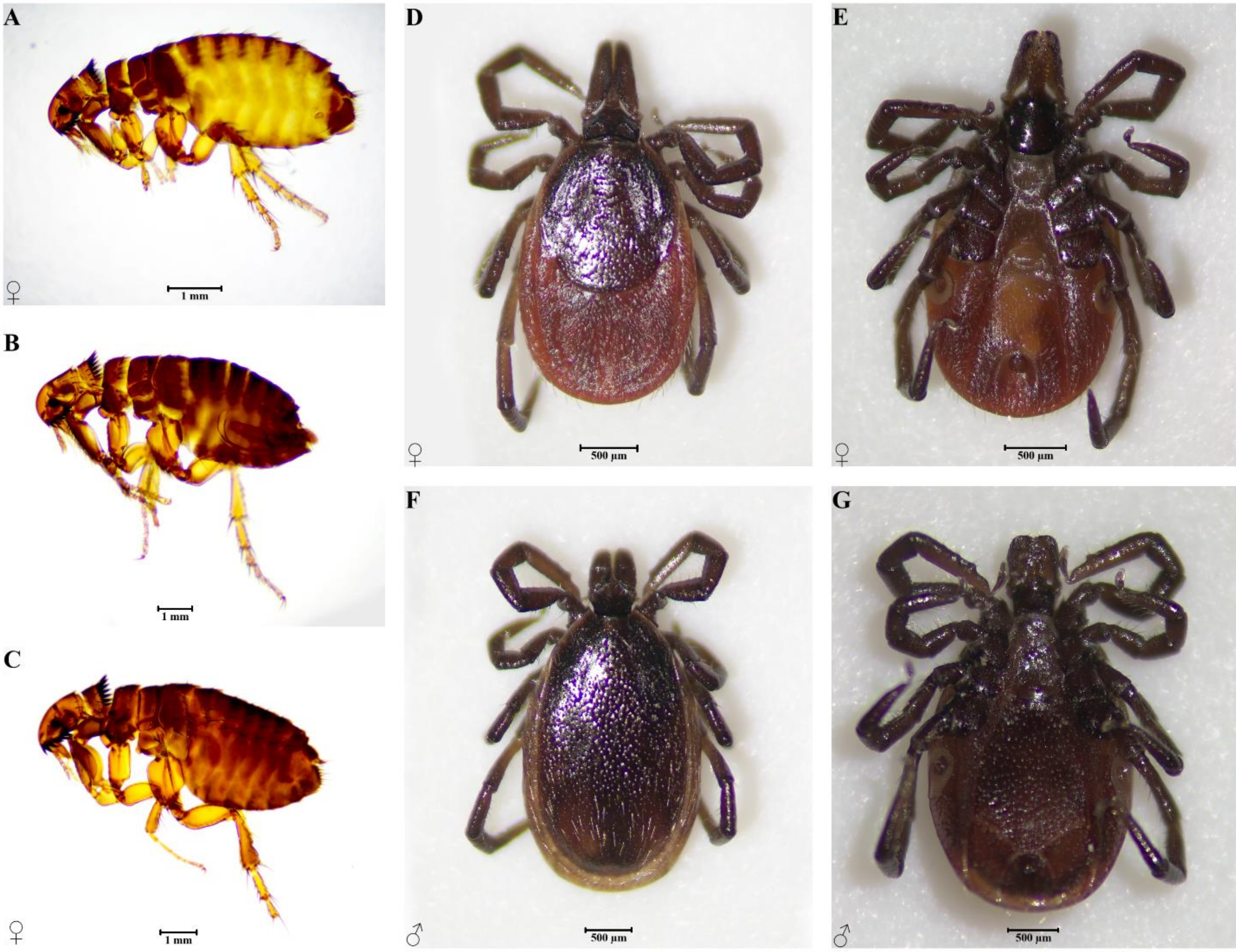

Figure 2. Original photographs of hard ticks and fleas detected on golden jackal and roe deer in the present study: *Ctenocephalides felis* (A), *Ctenocephalides canis* (B-C) and *Ixodes ricinus* (D-G).

Table 1. Hard tick and flea species detected on wild animal cadavers in the present study.

Hosts	Ectoparasite species		Locations	Date
	Species	Number of ectoparasites (n)**		
Canis aureus	*Ctenocephalides canis*	♀ (n: 3) ♂ (n: 1)	Artvin	November 2024
	Ctenocephalides felis	♂ (n: 1)	Artvin	October 2022
Capra aegagrus	*Haemaphysalis kopetdaghica*	♀ (n: 11) ♂ (n: 6) N (n: 1)	Artvin	April 2024
		♀ (n: 2) ♂ (n: 1)	Erzurum	December 2024
	Rhipicephalus bursa	♀ (n: 3)	Artvin	April 2024
Capreolus capreolus	*Ixodes ricinus*	♀ (n: 8) ♂ (n: 11)	Artvin	December 2023
		♀ (n: 56) ♂ (n: 37) N (n: 76)		May 2025
Rupicapra rupicapra	*Haemaphysalis kopetdaghica**	♀ (n: 8) ♂ (n: 1) N (n: 4)	Artvin	January 2023
	*Ixodes gibbosus**	♀ (n:1)	Artvin	November 2022
		♀ (n:3)		March 2024

*new host-parasite association for tick fauna of Türkiye; **Number of ticks collected by life stage and sex. Female (♀), male (♂), and nymph (N)

Table 2. Hard tick species that have been reported on wild goats in Türkiye up to now.

Genus	Species	Hosts	Locations	References
Dermacentor	*D. raskemensis*	*Capra aegagrus*	Erzincan	48
Haemaphysalis	*H. kopetdaghica*	*Capra aegagrus*	Artvin	Present study
			Erzincan	48
			Hatay	62
		Rupicapra rupicapra	Artvin	Present study
Ixodes	*I. gibbosus*	*Capra aegagrus*	Erzincan	49
			Hatay	62
		Rupicapra rupicapra	Artvin	Present study
Rhipicephalus	*R. bursa*	*Capra aegagrus*	Artvin	Present study
			Erzincan	49
	R. kohlsi		Erzurum	22
			Erzincan	48
			Hatay	62

Discussion and Conclusion

A review of the literature indicates that studies on hard ticks infesting wild goats and other mammals are limited in both Türkiye and worldwide. A limited number of studies have been conducted on the two wild goat species distributed in Türkiye (*C. aegagrus* and *R. rupicapra*). Including the present study, five tick species have been reported to date (Table 2). The genus *Capra* currently consists of nine species and is distributed across various mountainous habitats in the Old World (Europe, Asia, and Africa) (41, 53, 57). In the study conducted by Hoogstraal and Valdez (25), *Ornithodoros canestrinii* (Argasidae), *Dermacentor raskemensis, Haemaphysalis kashmirensis, H. kopetdaghica, H. punctata, Hyalomma asiaticum, H. kumari, Ixodes ricinus*, and *Rhipicephalus sanguineus* (Ixodidae) have been reported on the wild goat (*C. aegagrus*) in Iran. Subsequently, *Rhipicephalus kohlsi* was detected on the same host by Rahbari and Nabian (54). *Hyalomma anatolicum excavatum, H. marginatum rufipes, and Rhipicephalus* (Boophilus) *annulatus* have been reported on Nubian ibexes (C. ibex nubiana) in Israel (61). Tsapko (59) stated that *Haemaphysalis pospelovashtromae* had been reported on East Caucasian tur (*C. cylindricornis*) in previous studies from the Caucasus region. *Hyalomma anatolicum, H. excavatum, Rhipicephalus microplus,* and *R. appendiculatus* have been reported from the Chiltan ibex (C. aegagrus chialtanensis) in Pakistan (23). Bernal et al. (7) reported the presence of *Rhipicephalus bursa, Haemaphysalis sulcata, Hyalomma marginatum marginatum,* and *Ixodes ricinus* on the Iberian ibex (*C. pyrenaica victoriae*) in Spain.

The genus *Rupicapra* has a relatively restricted distribution and comprises two species: *Rupicapra pyrenaica* (Southwestern Europe) and *R. rupicapra* (South and Central Europe, Türkiye, and the Caucasus) (12, 57). Tsapko (59) *Haemaphysalis punctata* listed on chamois (*R. rupicapra*) based on studies conducted in the Caucasus region. Subsequently, *Ixodes ricinus* was detected on the Pyrenean chamois (*R. pyrenaica pyrenaica*) in France (4). Dumić et al. (15) reported *Dermacentor marginatus, Haemaphysalis punctata, Ixodes gibbosus, I. hexagonus, I. ricinus,* and *Rhipicephalus bursa* on the Balkan chamois (*R. rupicapra balcanica*) from Croatia. Accorsi et al. (1) reported *Ixodes ricinus* and *Rhipicephalus sanguineus* on the chamois (*R. rupicapra*) in Italy. Finally, *Haemaphysalis sulcata* and *Ixodes ricinus* have been detected on the Alpine chamois (*R. rupicapra rupicapra*) in Italy (47).

Information on ticks infesting both wild goat species in Türkiye appears to have been unavailable until recently. First, Güven et al. (22) reported the detection of *Rhipicephalus kohlsi* on a wild goat (*C. aegagrus*) in Erzurum Province, Türkiye. Subsequently, *Dermacentor raskemensis, Haemaphysalis kopetdaghica, Ixodes gibbosus, Rhipicephalus bursa,* and *R. kohlsi* were reported on the same host by Orkun and Vatansever (49). Finally, *Haemaphysalis kopetdaghica, I. gibbosus,* and *R. kohlsi* were recorded on the same host by Zerek et al. (62). As can be seen, prior to the present study, tick infestations had only been reported on the wild goat (*C. aegagrus*) in Türkiye. In this study, ticks were detected on both goat species studied, and the presence of *Haemaphysalis kopetdaghica* on the chamois (*Rupicapra rupicapra*) represents a novel host-parasite association for Türkiye and worldwide. Additionally, *Rhipicephalus bursa*, which we identified on the same host, represents a new host-parasite association for Türkiye. The tick species detected on wild goats in Türkiye to date are listed in Table 2.

The present study makes important contributions to understanding the host-parasite relationships of hard ticks. *Rupicapra rupicapra asiatica* was examined for the presence of ectoparasites in Türkiye for the first time. *Rhipicephalus bursa* is one of the hard tick species whose host-parasite relationships are well known in Türkiye and worldwide (21), but information on the host-parasite relationships and prevalence of *Haemaphysalis kopetdaghica* and *Ixodes gibbosus* remains limited. In particular, *Haemaphysalis kopetdaghica* is included in the list of endangered hard ticks (44). This species was first described in 1962 in Turkmenistan, based on specimens collected from leopards (*Panthera pardus*), wild goats (*C. aegagrus*), and horses (*Equus caballus*) (29). It was later reported in Iran in wild goats (*C. aegagrus*) (24, 26). This species has been reported in Turkmenistan on both wild goats (*C. aegagrus*) and wild sheep (*Ovis orientalis cycloceros*) (6). It has also been reported in Tajikistan in a domestic sheep (*O. aries*) (36). In subsequent years, wild goats (*C. aegagrus*) in Türkiye were reported twice, in 2021 and 2023. The chamois (*Rupicapra rupicapra*) has also been included among the hosts identified as infested in the present study. In short, the current hosts infested by *Haemaphysalis kopetdaghica* are as follows: wild goat (*C. aegagrus*), chamois (*R. rupicapra*), wild sheep (*O. orientalis cycloceros*), domestic sheep (*O. aries*), horse (*E. caballus*), and leopard (*P. pardus*). Similarly, limited information is available on the host-parasite relationships of the Mediterranean-distributed species *Ixodes gibbosus* (18, 40). This species was first identified based on specimens collected from domestic goats (*C. hircus*) in Izmir province, Türkiye. In subsequent years, it has been reported in Greece (11, 51, 52), Italy (34, 46, 56), Cyprus (58), Israel (20), and Türkiye (27, 49, 62, present study) in domestic animals (goats, sheep, cattle, horses), as well as in wild goats (*C. aegagrus*), chamois (*R. rupicapra*), rabbits (*O. cuniculus*), foxes (*V. vulpes*), and humans. In addition, Morel and Pérez (45) reported observations on herbivores, rabbits, carnivores, hedgehogs, and sometimes birds in the Mediterranean basin (Italy, the Balkans, Türkiye, the Aegean Islands, and Palestine).

In studies conducted on the ectoparasitic fauna of jackals in Türkiye, the tick species *Ixodes kaiseri* Arthur, 1957; *Rhipicephalus sanguineus* (Latreille, 1806); *R. turanicus* Pomerantsev, 1936 (31, 43, 62); and the flea species *Chaetopsylla globiceps* (Taschenberg, 1880), *Ctenocephalides canis* (Curtis, 1826), and *Pulex irritans* Linnaeus, 1758 (32, 43) have been reported. In this study, *Ctenocephalides canis* and *C. felis* were detected on jackals (Table 1). *Ctenocephalides felis* on jackals represents a novel host-parasite association in the Turkish flea fauna. This flea species is known to be specific to domestic cats but is also commonly found on domestic dogs (38, 55). Previous studies conducted in Türkiye have reported it in domestic cats and dogs, the European polecat (*M. putorius*), the red fox (*V. vulpes*), and hedgehogs (*Erinaceus* spp.) (36). In studies conducted worldwide, this species, similar to the present study, has also been reported in golden jackals (*C. aureus*) in Ethiopia, India, Iran, Israel, Russia, Tajikistan, and Uzbekistan (20).

In studies conducted on the ectoparasitic fauna of roe deer (*C. capreolus*) in Türkiye, the following tick species were reported: *Dermacentor marginatus* Sulzer, 1776; *Haemaphysalis concinna* Koch, 1844; *H. inermis* Birula, 1895; *H. punctata* Canestrini & Fanzago, 1878; *Ixodes ricinus* (Linnaeus, 1758); *Rhipicephalus bursa* Canestrini & Fanzago, 1878; *R. rossicus* Yakimov & Kol-Yakimova, 1911; and *R. turanicus* Pomerantsev, 1936 (2, 62). Additionally, the chewing louse *Damalinia* (Cervicola) *meyeri* (Taschenberg, 1882) and the deer ked *Lipoptena cervi* (Linnaeus, 1758) have been reported (2). Tick infestation was the only ectoparasitic finding on roe deer (*C. capreolus*) in the present study, and the specimens were identified as *Ixodes ricinus*.

In the present study, new host-parasite associations were identified for both Türkiye and the global ectoparasite fauna. Considering the distribution of both wild goat species, jackals, and roe deer in Türkiye, large-scale studies conducted at multiple locations in the coming years that examine many hosts will largely reveal the ectoparasitic load (ticks, lice, fleas, mites, and keds) of these hosts.

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Ethical Statement

Ethical approval is not required because the study materials consist of ectoparasite specimens collected from wild animals found dead in their natural habitats. Additionally, ectoparasite specimens from dead wild animals found in their natural habitats and along highways were collected with permission from the Artvin Directorate of Nature Conservation and National Parks (Permit No: E-10663509-622.03-19777262).

Conflict of Interest

The authors declare no conflicts of interest.

Author Contributions

GE: Conceptualization, data curation, formal analysis, investigation, methodology, visualization, writing - original draft, writing - review & editing; GAK: Conceptualization, investigation, resources, writing - review & editing; AYS: Conceptualization, investigation, resources, writing - review & editing.

Data Availability Statement

The data supporting this study's findings are available from the corresponding author upon reasonable request.

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