

1 **Epidemiological analysis of snakebites and faunal assessment of venomous and semi-**
2 **venomous snakes in Fars Province (Southern Iran)**

3
4 **Azim Paksa¹, Ali Bakhish², Mozaffar Vahedi², Kourosh Azizi^{1,3}, Aboozar Soltani^{1,3}, Zahra**
5 **Gheibi⁴, Ebrahim Rahimi⁵, Ahmad Reza Rezaei⁶, Saeed Shahabi^{*1,2}**

6 *1-Department of Biology and Control of Disease Vectors, School of Health, Shiraz University of*
7 *Medical Sciences, Shiraz, Iran.*

8 *2-Student Research Committee, School of Health, Shiraz University of Medical Sciences, Shiraz,*
9 *Iran*

10 *3-Research Center for Health Sciences, Institute of Health, Department of Biology and Control*
11 *of Disease Vectors, School of Health, Shiraz University of Medical Sciences, Shiraz, Iran.*

12 *4-Department of Epidemiology, School of Health, Shiraz University of Medical Sciences, Shiraz,*
13 *Iran*

14 *5-Department of Public Health, Mamasani Higher Education Complex for Health, Shiraz*
15 *University of Medical Sciences, Shiraz, Iran.*

16 *6- Shiraz university of medical science, Health Minister center for disease control and prevention*
17 *ward, over expert CDC.*

18
19 **Abstract**

20 **Introduction:** Snakebites are a major global health challenge, especially in underdeveloped
21 countries. According to a report by the Vice Chancellor of Health at Shiraz University, snakebites
22 are a health problem in Fars Province. This study aimed to assess the species composition of
23 venomous and semi-venomous snakes caught over a year in Shiraz and to analyze the
24 epidemiological data of snakebites in the region from 2016 to 2023 in Fars Province.

25 **Material and Methods:** Snakes were caught with the help of firefighters and environmentalists
26 from different areas in and around Shiraz, and with the permission of the Environment
27 Organization. The caught specimens were then transferred to the entomology and zoology
28 laboratory. The snake specimens were identified to the species level by examining taxonomic
29 indicators and using valid diagnostic keys. In addition, snakebite statistics during these years were
30 collected from the Health Office of Shiraz University of Medical Sciences and were statistically
31 analyzed.

32 **Results:** The results showed that out of a total of 12 snakes caught in Shiraz in one year, two were
33 semi-venomous *Telescopus tessellatus*, seven were venomous *Macrovipera razi*, and three were
34 *Pseudocerastes persicus*. Furthermore, the study showed that between 2016 and 2023, a total of
35 3,958 individuals fell victim to snakebites, and snakebites were more common among men than
36 women; most bites occurred on the hands or feet. In addition, snakebites were more common in
37 rural areas than urban areas.

38 **Conclusion:** Agricultural activities and poor housing conditions in villages increase the risk of
39 snakebite exposure. Implementing preventive measures and improving treatment options can help
40 reduce the burden of snakebite in Fars Province, ultimately saving lives and improving public
41 health.

42
43 **Keywords:** Epidemiology, Fars Province, Snakebite, Venomous Snake.
44

45 **1- Introduction**

46 Snakebites represent a significant global health concern, with the World Health Organization
47 (WHO) prioritizing prevention strategies to reduce fatalities. WHO estimates that 5.4 million
48 people worldwide suffer from snakebites annually, resulting in 1.8 to 2.7 million cases of
49 envenoming and 81,410 to 137,880 deaths each year [1,2] Due to under-reporting in developing
50 countries with limited access to medical care, the incidence and severity of snakebite envenoming
51 are underestimated [3–7]. Recognizing the severity of the issue, the WHO officially classified
52 snakebite envenomation as a Category A Neglected Tropical Disease on June 9, 2017 [7] Several
53 African countries have reported snakebite incidence estimates, despite the rarity of solid research
54 [4,5,8,9]. The majority of snakebites occur in South Asia, Southeast Asia, Sub-Saharan Africa,
55 and Latin America [10].

56 The effects of snakebites can range from a dry, asymptomatic bite to severe envenomation,
57 leading to shock, bleeding, limb necrosis, organ failure, and death [11]. Envenomation can also
58 result in tissue injury, neurological disorders, and systemic effects [11–13].

59 Snakebites are also a significant health problem in Iran, particularly in the rural areas of the
60 southern and southwestern regions. Among Middle Eastern countries, Iran has the highest
61 diversity of venomous snakes [14], with approximately 86 species distributed across nine families
62 [15,16]. From 2002 to 2011, hospitals and health centers in Iran reported 53,787 cases of
63 snakebites, with an annual incidence rate ranging from 4.5 to 9.1 per 100,000 people and
64 approximately 67 recorded deaths [17].

65 Shiraz, the capital of Fars Province, is a bustling city renowned for its tourism. The surrounding
66 areas, especially the foothills along the Zagros Mountains, provide suitable habitats for various
67 animals, including rodents and reptiles. The presence of rodents and favorable ecological
68 conditions create ideal environments for both venomous and non-venomous snakes [18].

69 A recently published checklist of reptiles for Fars Province identifies a total of 63 reptile species,
70 distributed across 41 genera, 17 families, and two orders. Among these, the suborder of serpents
71 is the most diverse, with 23 species. The families Colubridae and Viperidae are particularly rich,
72 with 15 and four species, respectively [19].

73 Factors such as climate change, droughts, habitat destruction, and urbanization have been
74 identified as potential drivers for the movement of rodents, which in turn attract venomous snakes
75 toward Shiraz. Recent reports have highlighted an increase in snakebites, leading to
76 hospitalizations and prompting snake-catching efforts by the fire department [18].

77 Although snakebites are recognized as a health issue in Iran, detailed epidemiological data for
78 southern Iran—particularly Fars Province—remain limited, and information on the local species
79 composition of venomous snakes around Shiraz is restricted. This gap hinders timely diagnosis,
80 appropriate antivenom selection, and effective public health planning. The present study aims to
81 address these deficiencies by identifying the species composition of venomous and semi-
82 venomous snakes in Shiraz and analyzing recent epidemiological trends of snakebites in Fars
83 Province. By clarifying the dominant species responsible for envenomation and evaluating

84 regional snakebite patterns, the study contributes essential evidence for improving prevention
85 strategies, guiding the targeted distribution of monovalent and polyvalent antivenoms, and
86 ultimately reducing the public health burden of snakebite incidents in southern Iran.

87 **2- Materials and Methods**

88 **2_1 Ethics Approval for Research**

89 This study was reviewed and approved by the Research Ethics Committees of the Schools of
90 Health and Nutrition at Shiraz University of Medical Sciences (SUMS), Iran. The approval
91 identification number for this research is IR.SUMS.SCHEANUT.REC.1400.106.

92 **2_2 Faunistic Study**

93 Snakes were captured in the spring and summer with the assistance of firefighters and
94 environmental guards from various areas in and around Shiraz, under permission from the
95 Environmental Organization. Once captured, the snakes were transferred to the Entomology and
96 Zoology Laboratory. There, they were anesthetized with ether and placed in clear tubes for
97 morphological examination. Following identification using valid taxonomic keys (Latifi, M., 2000.
98 The Snakes of Iran. Iran Department of the Environment, 3rd Edition, Tehran, 478 pp. [In
99 Persian] and Snakes of Iran; Mehdi Rajabizadeh. 2018. Iranshensai Publishing, Tehran, Iran. 496
100 pp. Softback. [in Persian].) Select specimens (one from each species) were preserved in formalin
101 and stored in the Museum of Zoology and Entomology (ZEMSUMS) within the Department of
102 Biology and Disease Vector Control for future educational and research purposes. The remaining
103 specimens were safely released back into their natural habitats, far from urban areas.

104 **2_3 Epidemiological Study**

105 Epidemiological data on snakebites in Fars Province were collected from 2016 to 2023. The data
106 was provided by the Vice Chancellor of Health at Shiraz University of Medical Sciences.
107 Information was meticulously documented in Excel, capturing various aspects of snakebites and
108 their victims.

109 The data included details such as the bite location (rural, urban, suburban, residential, desert, and
110 mountain areas), as well as victim characteristics (gender, age, occupation, education level,
111 nationality). Other recorded information included the bite site on the body, number of bites,
112 treatment outcomes, recovery status, previous bite history, disease symptoms, snake species
113 identification (if known), underlying conditions, post-bite symptoms, and hospitalization duration.
114 For data analysis, SPSS software was used for statistical analysis, while Geographic Information
115 Systems (GIS) software was employed to create detailed maps of snakebite occurrences.

116

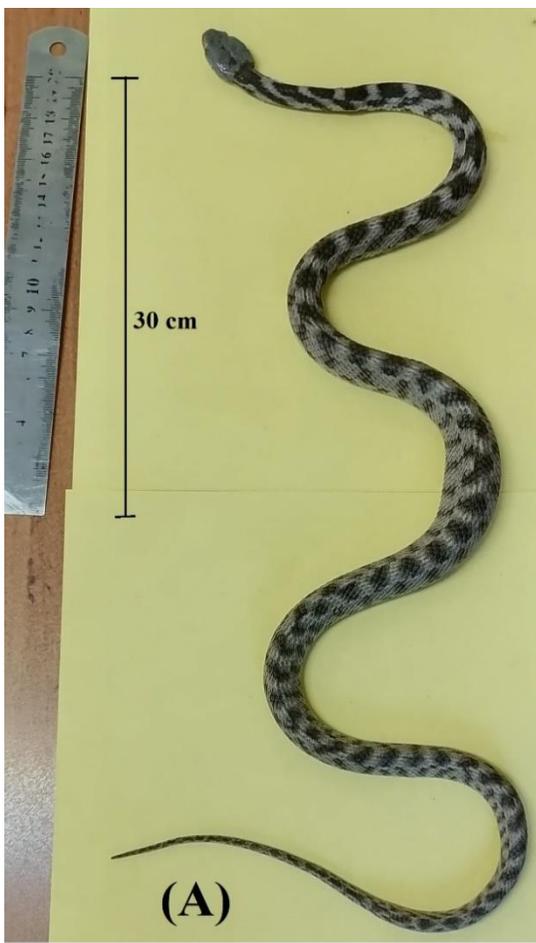
117 **3- Results**

118 **3_1 Venomous and Semi-Venomous Snakes**

119 The majority of the collected samples were non-venomous snakes, which were promptly released
120 back into their natural habitat and excluded from the study. A total of ten venomous and two semi-
121 venomous snakes were captured, as shown in Figure 1. The species identified in Shiraz included

122 two specimens of the semi-venomous *Telescopus tessellatus* (Figure 1-A), seven specimens of the
123 venomous *Macrovipera razi* (Figure 1-B, C, E, F), and three specimens of the venomous
124 *Pseudocerastes persicus* (Figure 1-D).

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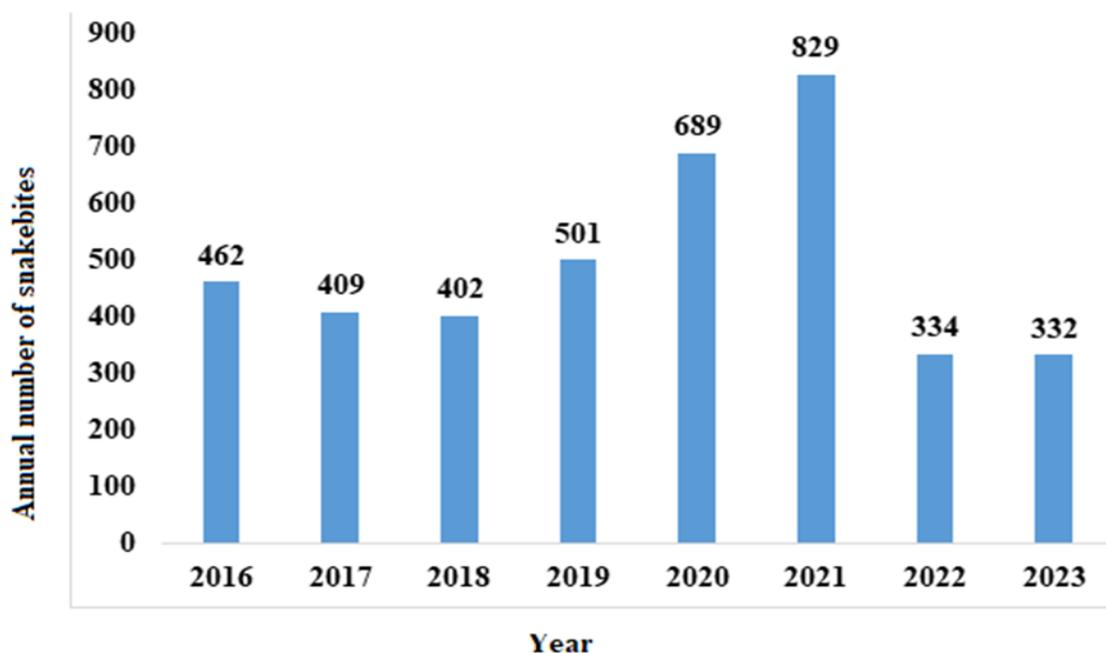


126 **Figure 1.** Semi-venomous (A) and venomous snakes (B, C, D, E, F) sampled in the present study
127 (original photos by Dr. Shahabi). A - *Telescopus tessellatus* ; B, C - *Macrovipera razii* ; D -
128 *Pseudocerastes persicus* ; E, F - *Macrovipera. razii*.

129 The venomous snakes were predominantly found in the mountainous regions, foothills, and
130 outskirts of the city. Notably, one *Macrovipera razii* specimen was discovered inside a building
131 under construction by a companion of a snakebite victim (Figure 1-C). The snake was safely
132 transported to the hospital for treatment and later transferred to the laboratory for identification
133 and preservation in the ZEMSOMS museum. It is important to note that three individuals were
134 bitten by *Macrovipera razii*.

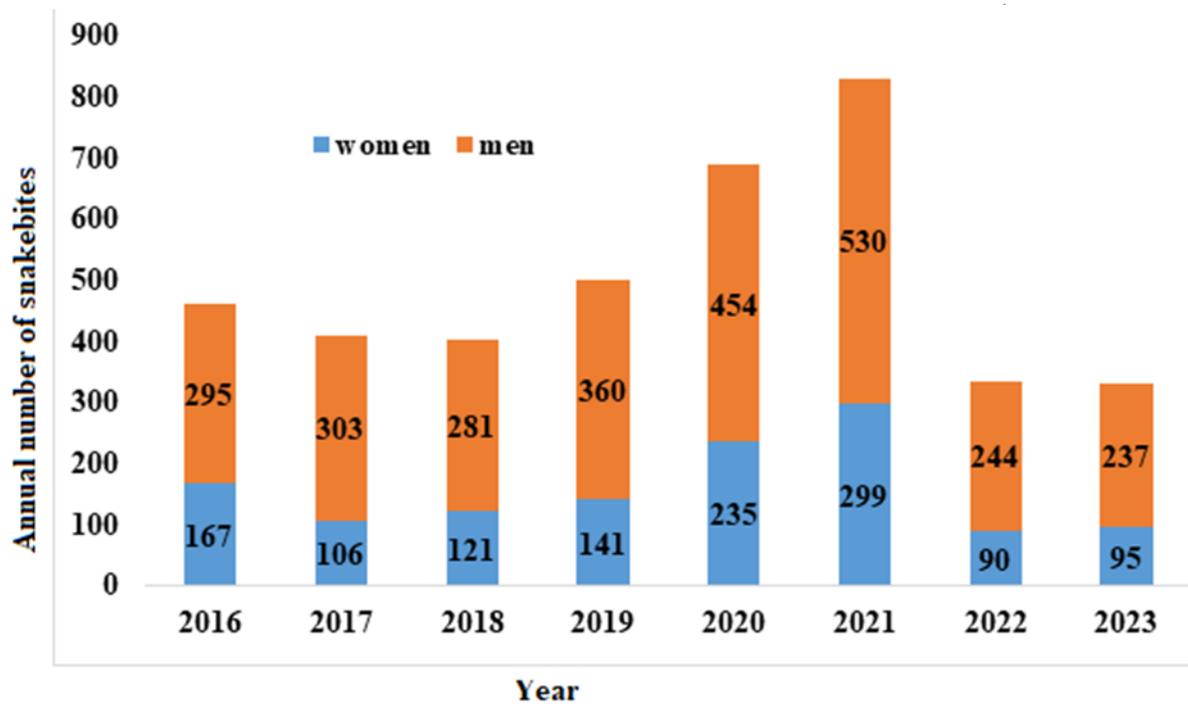
135 3_2 Epidemiology of Snakebites

136 Between 2016 and 2023, a total of 3,958 individuals fell victim to snakebites. Initially, the
137 incidence of snakebites remained relatively stable during the first three years, but a noticeable
138 increase has been observed since 2019 to 2021. Although the peak of snakebites was recorded in
139 2021, accounting for 20.98% of the total cases (Fig. 2), but the snakebites decreased in recent years
140 of 2022 and 2023.



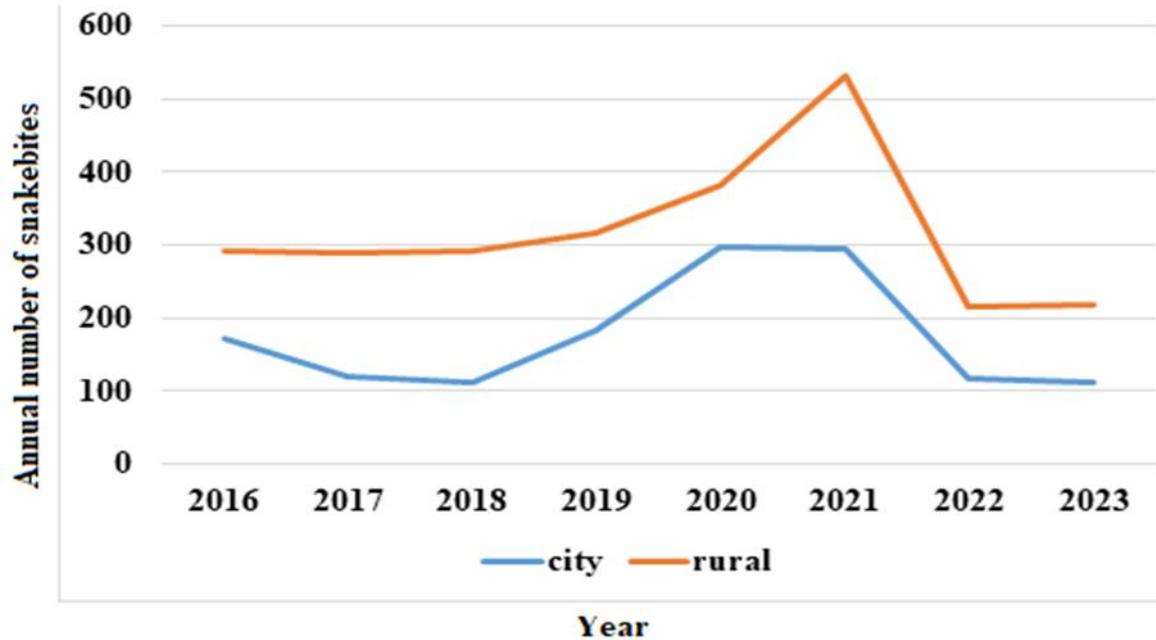
141 **Figure 2.** Annual number of snakebites in Fars Province, Iran, from 2016 to 2023.

142 There has been a significant difference in the trend of snakebites between men and women in
143 recent years (Fig. 3). The percentage of snakebites in women and men was 32% and 68%,
144 respectively. Figure 3 illustrates that men have been bitten by snakes significantly more than
145 women ($P < 0.001$).



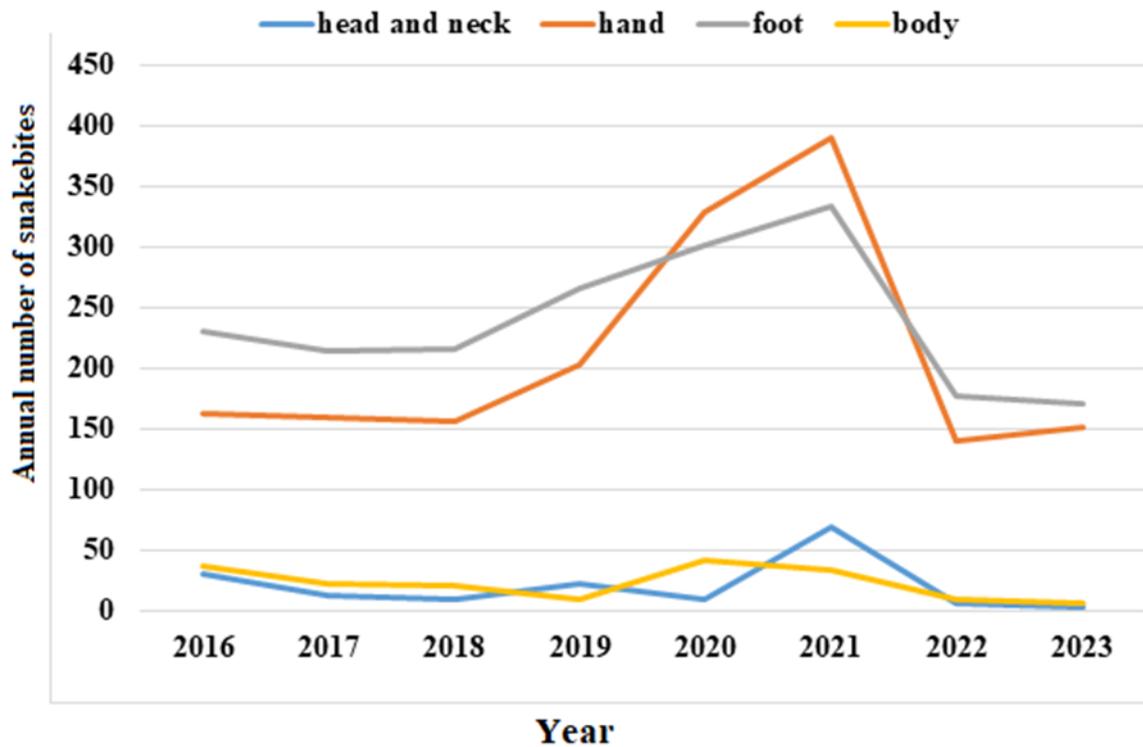
146 **Figure 3.** Trend of snakebites among women and men from 2016 to 2023 in Fars Province, Iran.

147 The number of snakebites in villages is significantly higher than in cities, with an increasing trend
148 in the years of 2020 and 2021 (Fig. 4).

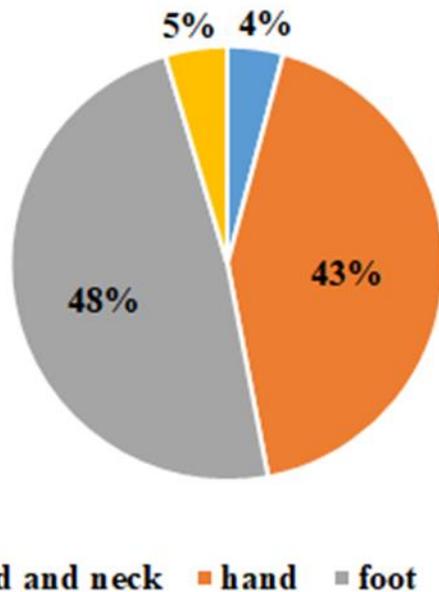


149
150 **Figure 4.** Trend of snakebites in urban and rural areas from 2016 to 2023 in Fars Province, Iran.

151 The location of snakebites on the body varies significantly, with more reported bites occurring on
152 the hands and feet ($P < 0.001$) (Figs. 5 and 6).



153 **Figure 5.** Trend of snakebites by body part bitten from 2016 to 2023 in Fars Province, Iran.



154 ■ head and neck ■ hand ■ foot ■ body
 155 **Figure 6.** Percentage of snakebites based on the body part bitten from 2016 to 2023 in Fars
 156 Province, Iran.

157 During the study period, a noticeable variation in the timing of snakebites was observed. Most
 158 incidents occurred during daylight hours, with fewer cases recorded between midnight and 6:00
 159 AM. However, in 2021, snakebites at night sharply increased, surpassing other times of the day.
 160 The highest recovery rate was observed in individuals who sought medical assistance within 1.5
 161 hours of being bitten. Moreover, more people were successfully treated when they received
 162 medical care within six hours of arriving at hospitals or health centers.

163 **4- Discussion**

164 Our research aimed to assess the species composition of venomous and semi-venomous snakes in
 165 Fars Province and to analyze the epidemiological data of snakebites in the region over recent years.
 166 The incidence of snakebites has been rising throughout the study from 2019 to 2021, but decreasing
 167 in recent years of 2022 and 2023. The increase in snakebites from 2019 to 2021 was likely due to
 168 climate change, monsoon effects, and human activities, while the decrease in 2022 and 2023 may
 169 be attributed to public awareness campaigns, improved healthcare access, and stabilization of
 170 environmental conditions [20,21]. The Ghatrouyeh Desert, located in the eastern region of Fars
 171 Province, has experienced an increase in snakebites in recent years, likely due to global warming

172 and heatwaves. Recent studies have identified Fars Province as a high-risk area for snakebites due
173 to its abundance of endemic snake species and unique climatic conditions [22].

174 Furthermore, our study revealed that the incidence of snakebites is higher among males, who are
175 more likely to engage in outdoor activities that increase their risk of encountering snakes. This
176 finding aligns with a study conducted in Haryana, India, which highlighted that men are more
177 involved in outdoor activities such as manual labor and farming. Additionally, snakebite
178 envenomation is more common in rural areas, where agricultural activities and poor housing
179 conditions elevate the risk of snake encounters [23].

180 The majority of snakebites occur on the hands or feet, a trend that is increasing. This pattern is
181 likely due to the frequent exposure of these body parts in farming or other outdoor activities. The
182 incidence of snakebites follows a seasonal pattern, with the highest number of cases reported
183 during the monsoon season. During this time, rainwater floods snake burrows, prompting snakes
184 to seek shelter near human habitats. This proximity increases the likelihood of snakes feeling
185 threatened, startled, or provoked, leading to defensive bites.

186 Moreover, during the monsoon season, the emergence of frogs and toads from hibernation provides
187 snakes with a readily available food source, increasing the chances of contact between snakes and
188 humans. Additionally, farmers engaged in intensive farming activities often find themselves in
189 close proximity to snakes in bushy areas.

190 In Shiraz city, a semi-venomous snake known as *T. tessellatus*, along with two venomous snake
191 species, *M. razii* and *P. persicus*, have been documented. Among these species, *M. razii* is the most
192 commonly encountered. Another viper species, *Echis carinatus*, is also present in Fars Province.
193 *M. razii* is the largest viper species in Iran, with a wide distribution across Central Asia and the
194 Middle East, including the mountainous regions of Elburz and Zagros in Iran, particularly in Fars
195 Province [18,24]. Due to its high levels of polymorphism, up to six distinct subspecies have been
196 identified for this species [24]. Given that *M. razii* is more prevalent than other venomous snakes
197 in Fars Province and thrives in the local environmental conditions[18], it likely plays a significant
198 role in snakebite incidents in the region. Therefore, ensuring the availability of antivenom serum
199 for this species is crucial for hospitals and health centers. While antivenom serum for all viper
200 species in Iran is necessary, prioritizing the availability of antivenom for *M. razii* is essential.

201 In addition, the observed species composition corresponds closely with the ecological
202 characteristics of the Shiraz region. *M. razii* and *P. persicus* were predominantly collected from
203 mountainous and foothill habitats, which align with their preference for rocky terrains, moderate
204 vegetation, and stable microclimates. Seasonal peaks in snakebite incidence also appear strongly
205 influenced by temperature fluctuations and rainfall patterns in Fars Province. Warmer months
206 increase snake activity, surface movement, and hunting behavior, while drought and habitat
207 disturbance may force snakes—particularly vipers—to move closer to human settlements in search
208 of water and prey. These environmental factors likely contributed both to the presence of specific
209 venomous species around Shiraz and to the seasonal rise in human–snake encounters.

210 The findings of this study provide essential ecological and epidemiological insight that can support
211 targeted prevention measures, optimize antivenom allocation, and enhance preparedness of local
212 healthcare facilities for managing snakebite incidents in Fars Province.

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216 **Ethics**

217 The project was found to be in accordance to the ethical principles and the national norms and
218 standards for conducting Medical Research in Iran. Approval ID:
219 IR.SUMS.SCHEANUT.REC.1400.106 Evaluated by: Research Ethics Committees of Schools of
220 Health and Nutrition- Shiraz University of Medical Sciences Approval Date: 2022-02-13

221 **Author Contribution**

222 S.Sh has designed the research strategy, supervised the whole project, and edited the manuscript.
223 A.B, A.P, M.V, K.A, A.S, E.R, and A. R. R participated in data collection and characterization. Z.
224 Gh has participated in data analysis. A.P, A.B, and S. Sh have written the manuscript.

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228 **Conflicts of Interest/Competing Interests**

229 There are no conflicts of interest to disclose. All co-authors have reviewed and approved the
230 manuscript, and there are no financial interests to report.

231 **Consent for Publication**

232 All co-authors confirm that the submitted work is original and not under consideration for
233 publication elsewhere. They have provided consent for the publication of the manuscript in the
234 journal *Archives of Razi Institute Journal*.

235 **Data availability** The dataset generated and/or analyzed during the current study are available on
236 request from the corresponding author.

237

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