Ethnobotanical Investigation of *Ferula tadshikorum* Pimenov in Surkhandarya Region, Uzbekistan

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Research

Abstract

Background: This article presents the results of an ethnobotanical study of *Ferula tadshikorum* Pimenov, a plant widely used by the inhabitants of the Surkhandarya region as a green vegetable and medicinal herb. It has been established that *F. tadshikorum* plays a positive role in the socio-economic life of the population in the mountainous and foothill villages of Surkhandarya region, with its aerial parts being widely consumed as both medicine and food. The destruction of the plant due to resin collection and the cutting of aerial organs during the generative period are the main causes of the decline in its natural reserves.

Methods: The ethnobotanical study was carried out using the methodology recommended by T.P. Lebedeva. Initially, 20 villages with a population of more than 50,000 people were selected from four districts of the Surkhandarya region (Uzun, Kumkurgan, Baysun, Sherabad). These villages were chosen based on their proximity to natural populations or plantations of *F. tadshikorum*. From February 2021 to November 2023, 706 randomly selected respondents aged 20 to 83 were surveyed. Before the questionnaire was conducted, a group discussion was held in each village to explain that the survey was for research purposes. To clarify which species was being discussed, respondents were shown herbarium samples and photographs of *F. tadshikorum*. The collected questionnaires were analyzed, and the Fidelity Level (FL) was calculated as a quantitative ethnobotanical parameter.

Results: The ethnobotanical analysis has revealed a wealth of information about the potential medicinal uses of *F. tadshikorum*. Based on the analysis, the plant has been documented to be used for eight types of pathological conditions:

helminthiasis, flu (acute respiratory viral infections), colds, coughs, constipation, intestinal inflammation, toothache, and oncological diseases. These findings are consistent with studies on the medicinal properties of other Ferula species. Limited research conducted so far has shown that *F. tadshikorum* possesses cytotoxic, antibacterial, antifungal, and anti-osteoporotic properties.

Conclusion: Based on these results, the study concludes that there is a need to promote the rational use of the plant among the local population and to conduct phytochemical and pharmacological research on *F. tadshikorum*.

Key words: Ferula tadshikorum Pimenov, Ethnobotanical knowledge, Surkhandarya region, Uzbekistan.
Figure 2. Relative frequency citation (RFC) of wild edible fruits in the study area

Background

Ethnobotanical studies make it possible to record folk knowledge about the beneficial properties of plants and process it from a scientific perspective (Sakhobiddinov 1947, Nurlyeva 2024). Especially in today's rapidly developing information era, the collection, synthesis, and analysis of unique ethnobotanical data have become more relevant than ever (Tkachenko 2018). In this regard, the collection, synthesis, and analysis of unique ethnobotanical information about *Ferula tadshikorum* Pimenov, which is widely harvested by the inhabitants of the Surkhandarya region for use as a green vegetable and medicine, is of particular importance.

At one time, A.A. Fedorov recognized the importance of collecting and preserving knowledge and information available to the population for the conservation of useful plants (Fedorov 1966). Residents of remote areas, through their many years of experience, have acquired deep knowledge about the therapeutic effects of medicinal plants on certain diseases. This knowledge has shaped practical skills that help in understanding the properties of plants that grow primarily in natural conditions and in effectively using them in traditional medicine. Documenting and utilizing all this information requires systematic ethnobotanical research (Bibi *et al.* 2014, Gillani *et al.* 2023, Manzoor *et al.* 2023).

The Apiaceae (Umbelliferae) family consists of approximately 3780 species and varieties, distributed across 434 genera, and is found worldwide (Ahmad *et al.* 2017). These species are widely used for both culinary and medicinal purposes. The Apiaceae family includes several medicinally valuable species, such as fennel (*Foeniculum vulgare*), caraway (*Carum carvi*), coriander (*Coriandrum sativum*), angelica (*Angelica archangelica*), and wild carrot (*Daucus carota*). These species are widely used for their therapeutic properties, including digestive aid, anti-inflammatory effects, and antimicrobial activity (Khojimatov *et al.* 2023).

Studies conducted over the past two decades have confirmed that more than 160 natural compounds based on coumarins, isolated from representatives of the Ferula genus, have positive effects on tumor cells, inflammation, and viruses (Curini 2006). It has been shown that coumarin compounds extracted from Ferula species possess antiviral activity, inhibit cytokine release, and suppress the early stages of carcinogenesis (Abd El-Razek 2003). The chemical composition of 50 species of the Ferula genus growing in Central Asia has been studied, with about 250 terpenoid compounds identified. More than 90 species contain sesquiterpenoid compounds, 55 species contain terpenoid coumarins, 34 species contain esters, and 18 species contain sesquiterpene lactones (Rakhmonkulov & Avalboev 2016).

F. tadshikorum was first described and introduced into science by M.G. Pimenov in 1974, based on a herbarium specimen collected in 1971 at the Shar-Shar Pass in the Vakhsh River Valley, Tajikistan (Pimenov 1974). It has been included in the Red Book of Uzbekistan with category 3 status (Red Book of the Republic of Uzbekistan 2019). Initially, a terpenoid of the coumarin series was isolated from its roots (Vandyshev 1975), while two new terpenoid coumarins—Tajiferin (I) and Tajikorin (II)—were later isolated from its fruits (Perelson *et al.* 1976). Additionally, dihydroconferin was extracted from its roots (Kiryalov 1980), followed by deacetyl-tajikorin (Beselovskaya & Sklyar 1984).

F. tadshikorum grows in the foothills and mountainous regions of southwestern Gissar, Pandjoldy, and Gissaro-Darvaz at an altitude of 700–1800 meters above sea level (Sharipov 2024). In natural conditions, it is an ephemeral, monocarpic plant with a short growing season in early spring. Vegetation begins in late February and lasts until May. The plant grows intensively during this short vegetative period. In May, the leaves begin to yellow, fall off in summer, and the basal part of the plant enters dormancy. Growth resumes in February of the following year. This cycle continues until the plant enters the generative

phase, which occurs at 8–9 years of age. When the plant reaches the generative period, it forms a floral bud in spring, produces fruit, and then dies. According to Rakhmonov (2017), full flowering of the population occurs every 4–6 years.
A study by Sharopov *et al.* (2019) identified 26 compounds in the essential oil extracted from the underground parts of *F. tadshikorum* collected in Tajikistan, accounting for 94.4% of its total composition. Among them, sulfur compounds were predominant: (Z)-1-propenyl sec-butyl disulfide (37.3%), (E)-1-propenyl sec-butyl disulfide (29.9%), and (E)-1-propenyl as the dominant component.

It has been established that the volatile substances of *F. tadshikorum* resin grown in Uzbekistan exhibit high antimicrobial properties. The resin contains elevated levels of calcium (24,196.216 mg/L), iron (484.702 mg/L), and magnesium (843.269 mg/L), along with 9.76% protein, 1.56% protein nitrogen, 24.32% light volatile components, and 3.53% ash. The amount of toxic elements (As, Hg, Pb) does not exceed permissible limits (Barakaeva *et al.* 2024).

The biomorphological characteristics of the plant under introduction conditions have been studied in the Arnasay district of the Jizzakh region (Halkuzieva *et al.* 2022) and in the Tashkent Botanical Garden (Khamraeva *et al.* 2022) in Uzbekistan. It has been established that the plant can be cultivated even on non-irrigated lands (Halkuzieva *et al.* 2022, Khamraeva *et al.* 2022).

Ethnobotanical studies conducted in various regions of Uzbekistan (Boboev *et al.* 2023, Islomova *et al.* 2023, Khojimatov *et al.* 2023, Gafforov *et al.* 2024, Makhkamov *et al.* 2023, Makhkamov *et al.* 2024, Tayjanov *et al.* 2021), but targeted ethnobotanical studies on *F. tadshikorum* have been practically absent. In an article by Khamraeva *et al.* (2023) dedicated to the introduction of the plant in the Tashkent Botanical Garden and the study of protein and polysaccharide content in its leaves and roots, only brief information was provided about the purposes for which the plant is used by the local population.

Materials and Methods

Study Area

The ethnobotanical research was conducted in the Surkhandarya region, located in the south of Uzbekistan. The region covers an area of 20.1 km² and has a population of 2,945,512 people as of January 1, 2025. The region features elevations ranging from 400 to 4,643 meters above sea level, with diverse and unique landscapes. It is home to one nature reserve and two natural parks (Figure 1).

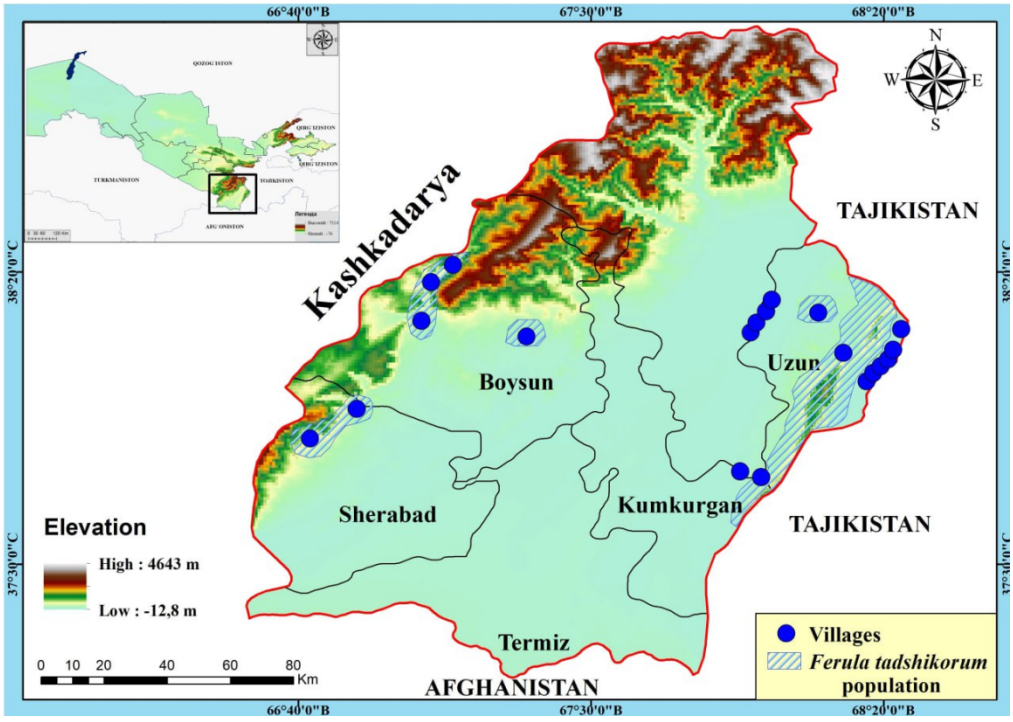

Figure 1. Map of the study area: Villages in the Surkhandarya region where residents participated in the ethnobotanical study

Data Collection

Initially, 20 villages with a population of more than 50,000 people were selected from four districts of the Surkhandarya region (Uzun, Kumkurgan, Baysun, Sherabad districts). These villages were chosen based on their proximity to natural populations or plantations of *F. tadshikorum*.

From February 2021 to November 2023, 705 randomly selected respondents aged 20 to 83 were surveyed. Before the questionnaire was conducted, a group discussion was held in each village to explain that the survey was for research purposes. To clarify which species was being discussed, respondents were shown herbarium samples and photographs of *F. tadshikorum*.

The ethnobotanical study was carried out using the methodology recommended by T.P. Lebedeva (Lebedeva 2017). The first, "socio-demographic," section of the questionnaire collected information about the informant's name, surname, nationality, year and place of birth, marital status, education, and duration of residence in the village. The second section focused on the local name of the plant, its uses, the diseases it is used for, where and when it is harvested (from nature or purchased at the market), which parts (leaves, roots, or resin) are used, and whether there were cases of poisoning associated with its consumption. This section also included a part where respondents could suggest conservation measures for the plant.

The participants included herbalists, entrepreneurs, herb and spice sellers, doctors, shepherds, farmers, foresters, elderly retirees and teachers, according to an analysis of the social status of the informants (Table 1). 705 informants (650 men and 55 women) were chosen at random for ethnobotanical research, which covered all of the districts in the Surkhandarya region. The informants who took part in the ethnobotanical surveys were between the ages of over thirty and under eighty. The majority of informants, or 32% of the total, were in the 51–60 age range.

Table 1. Demographic features of informants, gender ratio, age level, education level, and socio-economic background

Information about informants	**The number of informants is 705, N=705**	**% 100**	**Age indicators**				
			31-40	**41-50**	**51-60**	**61-70**	**71-80**
The gender of informants							
Male	650	92,2	182	198	207	35	28
Female	55	7,8	7	10	18	9	11
The educational level or knowledge of informants							
Highly educated	29	4.1	21	4	2	1	1
Moderately educated	187	26.5	87	44	19	21	16
Completed school	489	69.3	91	118	216	52	12
The social status of informants							
Local Hakims	8	1.1	1	2	3	2	-
Traders or sellers of herbs and spices	12	1.7	5	4	3	-	-
Doctors (Physicians)	12	1.7	7	2	2	1	-
Shepherds	238	33.8	23	132	45	28	10
Farmers	296	42	7	194	65	25	5
Foresters	7	1	3	3	1	-	-
Retired elderly people	110	15.6	-	-	9	64	37
Teachers	22	3.1	8	8	4	2	-

Data Analysis

The collected questionnaires were analyzed, and the Fidelity Level (FL) was calculated as a quantitative ethnobotanical parameter. FL is an index used to measure the importance of a specific plant usage within a certain category. The index values range from 0% to 100%, calculated using the following formula:

$$FL = \left(\frac{Ni}{N}\right) \times 100$$

where:

Ni = the number of informants who mentioned a specific use;

N = the total number of informants (Friedman *et al.* 1986).

Results and Discussion

The survey participants included livestock breeders, farmers, retirees, *Ferula* plantation workers, housewives, forestry and national park employees, shepherds, and others. They referred to *F. tadshikorum* by various local names such as "Chayir," "Rova," "Sassik," and "Uljon." No respondents were unfamiliar with the plant, which can be explained by the long-standing use of *F. tadshikorum* in the region and local involvement in its plantation cultivation under Presidential Decree No. PP-4670 of the Republic of Uzbekistan (2020).

Analysis of the survey responses revealed six main categories of plant use:

1. As herbal medicine:
2. As food (greens);
3. As a spice;
4. As gum-based medicine;
5. As an economic resource (greens);
6. As an economic resource (gum) (Figure 2).

According to the survey results, the aerial parts of the plant are primarily used for medicinal and dietary purposes. Residents of the Uzun and Kumkurgan districts mainly consumed it as food, whereas in the Sherabad district, it was predominantly used as medicine. This can be attributed to the relatively higher number of traditional healers in Sherabad and the population's greater awareness of the plant's medicinal properties (Table 2).

Table 2. The results of the ethnobotanical survey of the population of the Surkhandarya region on *Ferula tadshikorum*

Village	**Number of Respondents**	**Usage Purpose**					
		As Medicine		**As Food**		**As an economic resource**	
		As Greens (%)	As Gum (%)	As Greens (%)	As Spice (%)	As Greens (%)	As Gum (%)
Uzun District							
Akmachit	117	94	6	100	17	17	48
Korongul	21	100	9	100	24	24	5
Yukori Toltugoy	35	94	6	100	86	16	3
Pasgi Toltugoy	25	88	-	100	80	40	5
Yangi Turmush	18	94	5	100	61	44	5
Tojik	78	100	6	100	49	19	10
Chagam	22	95	5	100	45	9	4
Kurasay	20	90	-	100	25	15	10
Besh Tom	44	69	-	55	9	11	-
Akhunbabayev	30	17	-	83	-	10	-
Oktumshuk	20	15	-	85	-	10	-
Kizil Shark	25	28	-	72	-	8	-
Total	**455**	**73,66**	**3,08**	**91,25**	**33,0**	**18,58**	**7,5**
Kumkurgan District							
Koshka	35	55	-	100	35	-	10
Besh Archa	30	80	-	100	50	-	10
Total	**65**	**67,5**	**0**	**100**	**42,5**	**0**	**10,0**
Baysun District							
Darband	30	83	-	83	40	13	3
Pastki Machay	20	90	-	70	20	10	10
Yukori Machay	40	77	5	83	37	5	7
Dashtigaz	20	30	-	50	20	-	20
Total	**110**	**70,0**	**1,25**	**71,5**	**29,25**	**7,0**	**10,0**

Sherabad District								
Kizil Olma		35	80	-	53	20	27	-
Khatak		40	80	-	70	30	30	-
	Total	**75**	**80,0**	**0**	**61,5**	**25,5**	**28,5**	**0**

The proportion of respondents from Uzun and Sherabad districts who cut the aerial parts of plants in natural populations and sell them at the market (18.58% and 28.5%, respectively) is higher than those who collect gum from plantations for financial gain (7.5% and 0%, respectively). It was found that respondents from Kumkurgan and Baysun districts are more likely to collect gum for economic purposes (10.0% and 10.0%, respectively) than respondents from other districts, whereas the level of harvesting and selling the aerial parts of the plant was 0% and 7.0%, respectively. This can be explained by the higher number of unemployed respondents, as well as the lack of buyers and markets for the aerial parts of the plant in these regions.

Each spring, until the 8th or 9th year of life, *F. tadshikorum* produces rosette leaves. Leaf collection does not negatively impact the plant. In its final year, during spring, the plant produces a rapidly growing flowering stalk. The edible parts include the leaves and very young generative shoots, no longer than 20–30 cm. As these organs develop, the concentration of biologically active compounds in them significantly increases. Consuming fully developed flowering stalks longer than 30 cm can cause severe poisoning, with symptoms such as vomiting, diarrhea, dizziness, and general weakness (Rakhmonov 2017). Unfortunately, cut flowering plants are sold in markets. The primary reason for the depletion of natural *F. tadshikorum* resources is the harvesting of plants that have entered the generative phase by local populations (Sharipov 2024).

None of the respondents reported cases of poisoning. However, some respondents aged 50 to 83 were seriously concerned about the sale of flowering plants in markets (Figure 2).

They also stated that in the past, natural plant reserves were abundant, and flowering individuals could be found in nearly all populations. However, nowadays, they are mainly found only in border areas, where access is restricted. Older respondents possess greater knowledge about the medicinal properties of the plant. They believe that the leaves should be consumed raw in the spring months, mainly for the prevention of respiratory inflammation and viral diseases, as well as for boosting immunity.

Of the 705 respondents surveyed, 92,5% (652 people) reported using the plant for disease prevention and treatment (Table 3).

It was reported that the aerial parts of the plant are mainly consumed raw or added to food in spring for medicinal purposes. In summer, autumn, and winter, dried and ground aerial parts of the plant were consumed, or resin extracted from the root was drunk with water.

Based on the analysis, the plant was reported to be used for treating eight pathological conditions: helminths, flu (acute respiratory viral infections), colds, coughs, constipation, intestinal inflammation, toothaches, and cancer. It was found that the plant is most frequently used to treat colds (64%). A total of 23.6% of respondents reported using the plant as an anthelmintic. This relatively low percentage can be explained by the fact that the local population rarely suffers from helminth infections due to their constant consumption of the plant.

The information provided by respondents about the medicinal properties of the plant is partially confirmed by several studies on the medicinal properties of other representatives of the *Ferula* genus. In particular, it has been noted that members of this genus have detrimental effects on bacteria, tumor cells, helminths, and viruses (Nazari & Iranshahi 2011). Mohammadhosseini *et al.* (2019), summarizing the results of numerous studies, reports that species of the *Ferula* genus possess properties against cancer, tumor cells, worms, protozoa, epilepsy, inflammation, microbes, mycobacteria, viruses, fungi, hypertension, depression, seizures, etc. It has been found that essential oils and extracts of various *Ferula* species exhibit a broad spectrum of action against Gram-positive and Gram-negative bacteria, fungi, parasitic helminths, and viruses (Boghrati & Iranshahi 2019).

Additionally, it has a positive effect on human physiological functions, such as the immune, gastrointestinal, genitourinary, endocrine, respiratory, cardiovascular, nervous systems, as well as bones and teeth (Sabzehzari *et al.* 2020). An analysis of research results on the anti-inflammatory, antioxidant, and immunomodulatory activity of the genus under *in vivo* and *in*

vitro conditions showed that substances derived from it have hypotensive, neuroprotective, memory-enhancing, antioxidant, hepatoprotective, antimicrobial, anticancer, anticytotoxic, anti-obesity, and antiemetic properties (Ghasemi *et al.* 2021, Daneshniya *et al.* 2021).

Figure 2. Ways to use of *F. tadshikorum.* (A) Generative and (B) vegetative individuals. (C) Sale of the aerial part of young plant seedlings by the local population as food and medicinal purposes. (D-E) Gum extraction process.

Table 3. Purposes of Using the Medicinal Properties of *F. tadshikorum*

Pathological Conditions	No of Respondents	Part used		Number of Respondents by District				FL (%)
		Shortened shoot with leaves	Gum from roots	Uzun	Kumkurgan	Baysun	Sherabad	
Helminth Infections	122	+	+	70	20	20	12	23,6
Influenza	78	+	+	56	4	8	10	15,1
Common Cold	331	+	+	210	30	53	38	64,0
Cough	51	+	+	34	4	5	8	9,9
Constipation	17	+		12	2	-	3	3,3
Intestinal Inflammation	40	+	-	18	3	12	7	7,7
Toothache	10	-	+	4	2	2	2	1,9
Oncological Diseases	3	-	+	2	-	-	1	0,58

There are also research results on the healing properties of individual species within the genus. For instance, *Ferula asafoetida* (Falc.) H.Karst. has relaxing, neuroprotective, memory-enhancing, digestive, antioxidant, spasmolytic, hypotensive, hepatoprotective, antimicrobial, anticancer, anticytotoxic, anti-obesity, anthelmintic, antiviral, and other properties (Iranshahy & Iranshahi 2011, Mahendra & Bisht 2012, Lee *et al.* 2009). *F. gummosa* Boiss. is used in medicine as an antimicrobial, anti-flatulence, spasmolytic, anti-inflammatory, analgesic, and memory-enhancing agent. Studies have identified its antimicrobial, anti-inflammatory, and spasmolytic properties (Mahboubi 2016).

Research is also being conducted on the medicinal properties of *F. tadshikorum*, which is the subject of this study, but the number of studies is very limited. Sharopov *et al.* (2019) evaluated the antioxidant, antimicrobial, and cytotoxic activity of the essential oil extracted from this species. The antioxidant and antimicrobial properties of the essential oil extracted from the underground organs of *F. tadshikorum* are lower than those of other species, but the essential oil has cytotoxic activity. The essential oil of the plant has been recommended for the development of anticancer drugs (Sharopov *et al.* 2019). It has been established that the benzene extract prepared from the oleo-gum-resin extracted from the plant's root exhibited high activity against Gram-positive bacteria *Bacillus subtilis* and *Staphylococcus aureus* and the fungus *Candida albicans in vitro*. Additionally, the petroleum extract prepared from it showed significant activity against fungi (Sasmakov *et al.* 2019). The resin extracted from the roots of the plant was considered harmless, safe, and beneficial to living organisms. It has been established that volatile compounds contained in the resin have high antimicrobial activity (Barakaeva *et al.* 2023), and the liquid part of the resin exhibits low toxicity, making it potentially useful in bone tissue degradation treatment (Barakaeva 2024).

Conclusion

Thus, *F. tadshikorum* is one of the plants that positively impact the socio-economic life of the mountain and foothill villages of Surkhandarya region. The population predominantly consumes its aerial parts in large quantities as medicine and food. The destruction of the plant for gum collection and the cutting of aerial organs of plants that have entered the generative period are the main reasons for the depletion of *F. tadshikorum*'s natural resources. An analysis of the ethnobotanical study revealed extensive information on the potential medicinal uses of *F. tadshikorum*. The diseases reported by the population align well with research results on the healing properties of other *Ferula* species. The limited studies conducted by scientists so far have demonstrated that *F. tadshikorum* possesses cytotoxic, antibacterial, antifungal, and anti-osteoporotic effects. The obtained results necessitate the organization of initiatives promoting the rational use of the plant among the local population and serve as fundamental information for future phytochemical and pharmacological research on *F. tadshikorum*.

Declarations

List of abbreviations: Not applicable.

Ethics approval and consent to participate: All participants provided oral prior informed consent.

Conflict of interest: The authors have no conflict of interest to declare.

Consent for publication: All participants shown in images gave their consent to have the images published

Availability of data and materials: All data generated or analyzed during this study are included in this published article.

Competing interests: The authors have no relevant financial or non-financial interests to disclose.

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Authors' contributions: T.M. and R.B. designed and supervised the entire study, A.S., S.S. and T.M. conducted field surveys and collected data. Ab.S., T.M., S.S., F.C., Al.S., M.M. and G.K. contributed in data arrangement, presentation and analysis. R.B., A.S., G.K. and T.M., played a role in the statistical interpretation of data. S.S. and T.M. wrote the first draft of the manuscript.

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