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Medicinal Plants and Health Sovereignty in Badakhshan, Afghanistan: Diversity, Stewardship, and Gendered Knowledge

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Abstract

Medicinal plants are fundamental to health sovereignty, providing vital healthcare and livelihood options for rural mountain communities. We conducted 284 interviews with 416 participants in Badakhshan Province of northeastern Afghanistan focusing on the collection, use, sale, and management of medicinal plants. Participants identified 48 plants within 45 categories of treatment and prevention. The greatest number of plants were used to treat hypertension (14 plants), followed by kidney aids (12), analgesics (11), gastrointestinal aids (11), and dermatological aids (9). Comparisons with hospital records suggest that medicinal plants treat common ailments and preempt the need for some hospital visits. In addition, medicinal plants provide a source of livelihood for approximately 25% of participants. Many gatherers are concerned about the impacts of harvesting on medicinal plant resources. Collaborative research and knowledge exchange are necessary to enhance health sovereignty and community-based stewardship that sustain medicinal plant diversity in the context of increasing commercialization.

Keywords Indigenous ecological knowledge · Medicinal plants · Market opportunity · Intergenerational knowledge transmission · Pamir Mountains · Badakhshan Province · Northeastern Afghanistan

Introduction

Globally, communities use and depend upon medicinal plants as a basis for healthy living (Dar *et al.,* 2017; Gurib-Fakim, 2006; Halberstein, 2005; Jonas, 1998; Petrovska, 2012; Sen & Samanta, 2015; Singh, 2015; van Wyk & Wink, 2019). For centuries, scholars have demonstrated the significance of plant diversity to the world's traditional health systems, identifying thousands of species used to treat a wide variety of ailments (Chen *et al.,* 2016). More than 80% of member-states of the World Health Organization (WHO, 2019) acknowledge long-term significance of traditional medicine, which has always included the use of plants. Between 1996 and 2013, global trade in medicinal and aromatic plants increased from US$2.4 to US$6.2 billion (Tripathi *et al.,* 2017). Furthermore, knowledge and use of medicinal plants is often based on long-standing relations between humans and their habitats, and therefore holds cultural significance. Based on this, medicinal plants are fundamental to health sovereignty, which we have previously defined as the right and capacity of communities and nations to affirm and adapt their own health systems according to their own knowledge, values, and ecological context (Kassam *et al.,* 2010).

We explore the contributions of medicinal plants to restoring health sovereignty in northeastern Afghanistan. Most knowledge on Afghanistan's plant diversity was documented prior to 1978. Since then, political instability has constrained the ability to collect more up-to-date medicinal plants data (Saidajan, 2012), especially outside of formally protected areas (NEPA, 2019). Although Afghanistan is not considered a biodiversity hotspot (its biodiversity index is lower than the global median), the country is home to high diversity of plants found in four distinct biomes: desert/semi-desert (39% of Afghanistan's land area), open woodlands

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(37%), closed woodlands (7%), and alpine and subalpine zones (16%) (MAIL, 2009; NEPA, 2019). Estimates of plant species richness range from 3,500 to 5,000 species, of which 25 to 35% are endemic (Breckle, 2007; Breckle *et al.,* 2013; MAIL, 2017; NEPA, 2019; UNEP, 2008). Major plant families include over 500 Compositae/Asteraceae species, 400–500 Leguminosae/Fabaceae species, 250 Brassicaceae/Cruciferae species, 150 Gramineae species, 180 Lamiaceae species, and 100 Apiaceae/Umbelliferae species (Breckle, 2007). Many of these plants are used as food and medicine, revealing interdependencies between food culture, public health and the ecosystem to which communities belong (LaDuke, 2005).

Although Afghanistan's state and traditional health systems have suffered from conflict and violence, some health outcomes have improved in recent years, partially owing to policy interventions (Newbrander *et al.,* 2014) and increased healthcare sector expenditures (NSIA, 2019a). Provision of Basic Package of Health Services (BPHS), including maternal and child health, nutrition, and regular supply of drugs (Newbrander *et al.,* 2014) has contributed to higher life expectancy, and lower maternal and infant mortality (Britten, 2017; World Bank, 2017, 2018). Nonetheless, healthcare expenditures amount to only US$8 per capita (World Bank, 2019). Furthermore, in 2017, 55% of the 29.2 million population were living below the national poverty line (Babury, 2019; CSO, 2018) and 51.7% experienced 'multidimensional poverty' (an index based on health, education, living standards, work, and shocks) (NSIA, 2019b). The substantial costs of traveling and treatment care limit access to public health systems, and many families are only "one illness away" from falling back into poverty – because the sick lose income due to inability to work and incur medical costs, and in case of death funeral expenditures (Krishna, 2011). In this context, traditional medicine, including the use of medicinal plants, remains a primary source of healthcare in Afghanistan, particularly in areas with limited access to public clinics and hospitals. The WHO (2019) recognized the significance of traditional and complementary medicine in Afghanistan's health systems, while critiquing the lack of information and status of these practices. Our research contributes to knowledge about Afghanistan's medicinal plants, and we hope will attract other scholars' interest in conducting further studies. We aim to raise awareness among government agencies and development organizations about the role medicinal plants can play in providing culturally relevant healthcare options. Furthermore, while the selling of medicinal plants could improve people's economic conditions, there is a clear risk that higher market demand driven by international buyers such as the neighboring People's Republic of China could lead to overexploitation and local extirpation of useful species (He *et al.,* 2018; Hinsley *et al.,* 2020).

By investigating the contributions of plants to health sovereignty in northeastern Afghanistan, we aim to (1) briefly review the previous studies of Afghanistan's medicinal plant diversity, (2) document and analyze the diversity of medicinal plants known and used within our study area, followed by data related to the collection and use of plants as medicine, with particular attention to notion that 'food is medicine',[1] and (3) explore the relationship between sale of medicinal plants and their conservation, and the potential for gendered ecological knowledge to promote sustainable use. Our findings may provide key insights on health sovereignty through use of medicinal plants and offer recommendations for future research and policy initiatives.

Medicinal Plants in Afghanistan

Afghanistan has long been recognized for its medicinal plants (see Breckle, 2016 for an extensive review). While local or other international scholars had certainly conducted prior studies in other languages, to our knowledge Aitchison (1890) was the first European scholar to categorize uses of plants in what is now Afghanistan, including their medicinal applications. Fischer (1943) described the 'medicinal lore' of Afghanistan. Volk (1955, 1961) and Pelt *et al.* (1965) documented medicinal plants available at local bazaars. Younos *et al.* (1987) identified 215 medicinal plants, reporting that 29% were imported, 24% cultivated and 20% indigenous.

During the 1990s, in the midst of civil war, the only study of medicinal plants focused on veterinary medicines used by Pashtun Kuchi nomads in southern Afghanistan (Davis *et al.,* 1995). After the removal of the Taliban by American and coalition forces in 2001 (Babury, 2019), relative stability allowed for more research about medicinal plants, ranging from chemical analysis to marketing and sustainable management. Ottens et al. (2006) examined the production and marketing of medicinal species. Kassam *et al.* (2010) focused on medicinal plants of the Pamir Mountains, primarily in the Gorno-Badakhshan Autonomous Oblast (GBAO) of Tajikistan, but including some communities in northeastern Afghanistan, west of the Panj River, and in the Wakhan Corridor. Katawazy (2013) analyzed the markets for an important medicinal plant species, *Crocus sativus* (saffron). Mohibbi and Cochard (2014) found that over 60% of households living within Band-e-Amir National Park in central Afghanistan reported collecting 12 medicinal plant species. Soelberg and Jäger (2016) studied the use of plants in the Wakhan

[1] We build on our previous study (Kassam *et al.,* 2010) to discuss this notion that many medicinal plants also provide nutrition and some communities do not distinguish between plant use as food or medicine.

Corridor, including 32 plants used as medicine by the Wakhi and 15 by the Kyrgyz. Amini and Hamdam (2017) reported 68 plants used as medicine in the Guldara District of Kabul, including 62 genera in 30 families. Ahmady *et al.* (2019) examined the protective properties of *Hippophae rhamnoides, Olea europea, Sesamum indicum, Alhagi pseudalhagi* and *Elaeagnus angustifolia* used as herbal sunscreens. Finally, the most recent study of Afghanistan's medicinal plants is a doctoral dissertation by Babury (2019), which provides an extensive literature review as well as focused studies of the management of four species.

The value of medicinal plants and associated indigenous knowledge is recognized not only by scientists, but also by some in the Afghan government. The Ministry of Agriculture, Irrigation and Livestock (MAIL) published a National Natural Resource Management Strategy (2017) which, among other things, aimed to improve management of medicinal plants and expand indigenous knowledge through community-based approaches. While the importance of medicinal plants to traditional health systems is acknowledged, the MAIL's Strategy focused on enhancing economic opportunities through commercialization and export. Indeed, the sale of medicinal plants to international markets is a substantial source of income. One study by the FAO (2005) found that between 1998 and 2002, Afghanistan sold 23% of the total volume of medicinal plants exported by Least Developed Countries (second only to the Sudan), comprising 55.4 thousand tons valued at US$31 million. While the export of medicinal plants may offer economic opportunities to rural communities, overexploitation could lead to their local extirpation, resulting in the loss of local healthcare resources.

Methods

The study was conducted in the Shugnan, Ishkashim,[2] Zebak, and Wakhan districts of Badakhshan Province of northeastern Afghanistan (36° 2′ 21″ to 38° 2′ 30″ N; 70° 48′ 4″ to 73° 7′ 8″ E; Fig. 1). The study area lies along the Panj River, a major tributary to the Amudarya River, which serves as a natural border with the GBAO in Tajikistan. Badakhshan Province occupies an area of 44,836 km^2 with mountains rising above 6,000 masl and narrow river valleys around 1,000 to more than 6,000 masl (GIAJ, 2014). Climate is highly variable depending on elevation, but is generally characterized by cold winters and short summers (Ahmad *et al.,* 2018). The total population of Badakhshan exceeds one million, of which more than 95% live in rural areas (NSIA, 2019a). The most populous of the four districts in the study area is Shugnan (30,411), followed by Ishkashim (15,141), Wakhan (16,296) and Zebak (8,598) (CSO, 2019). Most residents of all four districts speak the national language (Dari, or Persian), as well as a local language (Shugnani in Shugnan; Ishkashimi in Ishkashim and Zebak; Wakhi in Wakhan). Minority groups include Kirghiz (Kyrgyz) in the Pamir Mountains and Pashtuns, Uzbeks, and Turkmen at lower elevations (Soelberg & Jäger, 2016).

In 2014, people in Badakhshan were mostly employed in agriculture (42%), followed by service industries (31%) and manufacturing (27%). About 59% of households produce rain-fed crops, 29% cultivate irrigated land, and 12.3% use garden plots. In 2017, the average landholdings per household were 1.4 ha of rain-fed land, 0.6 ha of irrigated land, and 0.3 ha of garden plots. Wheat is by far the most common crop, grown by 92% of all households, followed by barley, rice, and maize. Badakhshani farmers also produce large quantities of fruit; the most productive is apple, followed by peach, almond, grape, and pomegranate (CSO, 2018).

By multiple measures, quality of life in Badakhshan Province is below national averages (Kanji *et al.,* 2012) and lower than in the neighboring GBAO region of Tajikistan (Sherbut *et al.,* 2015). The poverty rate had risen from 63.3% in 2012 to 81.5% by 2017. While 79% of residents had access to improved drinking water sources, only 46% had improved sanitation systems; a majority (63.8%) suffers from calorie and/or protein deficiencies (NSIA, 2018).

Data Collection

We conducted semi-structured interviews in the summers of 2014 and 2015 and winter of 2016. Participants included a diverse range of local community members, including household heads, female farmers, teachers, NGO staff, pastoralists as well as herbalists and healers. Interviews took place in participants' homes and fields, as well as in mountain pastures, along roadsides, and at markets along the border with Tajikistan. Some interviews were undertaken while the participants were resting from agricultural work, others while traveling in vehicles. Some interviews were conducted with individuals, others with ad hoc small groups when the researcher's presence attracted others to listen and contribute. These two interview types are respectively characterized as 'individual interviews' and 'small group interviews' following Kassam *et al.* (2010). Interviews typically lasted between 30 and 60 min, and were conducted in either Dari (in Ishkashim, Wakhan and Zebak) or Shugnani (in Shugnan). Since the lead author is fluent in these languages, no translator was employed. Oral informed consent was obtained from participants prior to each interview.

[2] Shughnan, Shignan, Shighnan, Shegnan, Sheghnan and Eshkashim are alternative transliterations. We use Shugnan and Ishkashim as these terms are linguistically accepted.

Fig. 1 Interview locations in Badakhshan, northeastern Afghanistan

Interviews focused on the diversity of medicinal plants, including their local names and habitat associations. We specifically inquired about collection of medicinal plants, including the seasons of gathering, the various parts used, methods and the quantity of plants collected. We further asked whether the plants are kept for household use or sold to others, and about stewardship practices intended to maintain availability and access. We then addressed the use of medicinal plants, including how they are prepared and consumed; the ailments they are used to prevent and/or treat; the duration of treatment; and any known side effects from use. Finally, we asked about gender roles related to medicinal plants and transmission of knowledge to future generations.

In addition to interviews, the lead researcher observed the local vegetation and photographed some plants for identification. It should be noted that voucher specimens were not collected due to insecurity in the study area and restrictions prohibiting their transport to the lead author's home institution in Tajikistan. In winter, travel was hindered by snowfall and avalanches that blocked main roads. Ensuring personal security was challenging throughout the data collection period. Therefore, the ability to visit communities was influenced by physical access and the security situation. As a result, we cannot claim that the sample of individuals interviewed is representative. Nonetheless, our findings contribute to knowledge on medicinal plants in Afghanistan and we hope our work will attract the attention of other researchers to conduct a more thorough survey of the area.

Data Analysis

Information obtained during interviews was recorded as field notes in the local language, then prepared in Microsoft Excel for visualization and cross-tabulation, followed by statistical analysis in R (version 3.6). The names of medicinal plants documented in local languages were used to determine botanical names in consultation with experts at the Pamir Biological Institute and University of Central Asia in Khorog, Tajikistan, and Philipps University in Marburg, Germany, and by reference to previous studies in overlapping and adjacent study areas (e.g., Kassam *et al.,* 2010; Keusgen *et al.,* 2006). All scientific names were confirmed using the World Flora Online database (2020). Frequency of listing for each plant was calculated by dividing the number of interviews at which the plant was named by the total number of interviews; listings from individual and small group interviews were analyzed separately and in combination.

Medicinal uses of plants were categorized according to Moerman (1998) following modifications by Kassam *et al.* (2010). We modified one category of plant use: 'cold remedy' was expanded to include plants used to treat influenza, a disease with somewhat similar symptoms that is often indistinguishable and is therefore renamed 'cold and flu remedy.' Scientific names and medicinal uses of plants were compared with relevant previous studies, namely, Kassam *et al.* (2010), Amini and Hamdam (2017), and Soelberg and Jäger (2016), particularly on diversity and medicinal use of plants. To classify the medicinal uses of plants in those previous studies, we added six new categories: altitude sickness aid, antibacterial, cholera medicine, leishmaniosis medicine, typhoid medicine, and vasopressor (used to treat hypotension,); we also modified the category 'bite remedy' to include tick bites as well as other insect bites. Reclassification of Amini and Hamdam (2017) and Soelberg and Jäger (2016) according to Moerman's categories are included as Supplementary Materials 1 and 2.

We used Jaccard's similarity index to approximate the number of genera, medicinal use categories, and plants uses (i.e., plants associated with a category of use) shared between the current and each previous study:

$$J_{(A,B)} = \frac{|A \cap B|}{|A \cup B|}$$

where A is the number of plant species documented in the current study and B is the corresponding number in one of the previous studies; $|A \cap B|$ is the number of plant species documented in both studies, whereas $|A \cup B|$ is the total number of plant species documented in either study, equivalent to the sum of the number of plant species found in each study less the number found in both studies (also $|A \cap B|$).

Medicinal plant uses are widely known in the region. Here we report the uses of specific plants to treat certain ailments without mentioning the part used or the method of preparation to avoid divulging community knowledge that could be used for commercialization without mutual benefit sharing, and to prevent irresponsible use of medicinal plants.

Results and Discussion

Demographics

Altogether 416 people participated in the research, including 236 who were interviewed individually and 180 who contributed to 48 small group interviews (Table 1). Both kinds of interviews were conducted in the four districts, with the exception of Zebak, where no small group interviews were conducted. Participants ranged from 9 to 92 years old; 18% of participants were under 30, 21% aged 31 to 40, 27% aged 41 to 50, 14% aged 51 to 60, and 20% older than 60. Out of 416 participants, 265 (64%) were women and 151 (36%) were men. Women participation was especially high in Zebak district (81%). The lead author is female, and therefore had greater access to women than would have been possible for most male researchers.

Table 1 Number of female and male participants in individual and small group interviews in Badakhshan, Afghanistan

Location (district)	Individual Interviews		Small Group Interviews		All Interviews			
	Female	Male	Female	Male	Female		Male	
Shugnan	82	30	50	34	132	67%	64	33%
Ishkashim	33	21	40	25	73	61%	46	39%
Wakhan	23	20	15	16	38	51%	36	49%
Zebak	22	5	NA	NA	22	81%	5	19%
Total:	160	76	105	75	265	64%	151	36%

Diversity of Medicinal Plants

A total of 58 plants were reported during individual and small group interviews (Table 2). Of these, 51 were associated with a single botanical species, two with a genus, and five could not be associated with any scientific taxon. At least 32 families are represented, of which Compositae (Asteraceae) was the largest (6 plants) followed by Apiaceae (5 plants), Lamiaceae (4 plants) and Polygonaceae (also 4 plants). Altogether, 49 genera were identified, with few plants belonging to the same genus; the list included two *Allium*, three *Ribes*, and two *Polygonum* species. Of the 53 species and genera identified, 41 are herbs (including one parasitic species), eight are shrubs, and only four are trees.

Most (44) plants were mentioned in both individual and small group interviews; nine plants were mentioned only during individual interviews and five only during small group interviews. Species accumulation curves (based on the cumulative number of plants listed over the course of interviews) indicate that the research team had documented most of the plants known within the study area (Fig. 2). In Shugnan, Wakhan, and Zebak, the number of new plants per interview declined to less than one, as seen where the slope approaches 0, resulting in a 'plateau' shape, indicating that researchers have documented most of the plants known to people in those districts. The slope of the accumulation curve for Ishkashim continues to climb (albeit at a low rate), indicating that there may be yet undocumented medicinal plants known to the people of that district.

Of the 58 plants named in this study, a small number were listed by a majority of participants (Fig. 3). Only 13 plants were listed during more than 25% of interviews (Table 2), and more than half of all plants were listed in less than 10% of interviews, indicating that knowledge of plants is sparsely and unevenly distributed among community members. Furthermore, small group interviews resulted in higher frequencies of listing than individual interviews. No plant was listed by more than 50% of individual interviewees, whereas five were listed during more than 50% of small group interviews. Small group interviews tend to elicit longer lists of plants based on the contributions of multiple knowledge holders.

Of the 51 species identified, nearly half (22) were previously reported by Kassam *et al.* (2010) in the GBAO in Tajikistan, whereas only 10 were the same species identified by Amini and Hamdam (2017) in Kabul and eight by Soelberg and Jäger (2016) in Wakhan. Given the lack of voucher specimens to confirm species identifications and the possibility that similar species are not differentiated by local people, we compared genera as well as species. The current study shares 31 genera with those of Kassam *et al.,* 21 with Amini and Hamdam, and 14 with Soelberg and Jäger. Using Jaccard's similarity index, the genera documented in the current study is much more similar to Kassam *et al.* (J = 0.46) than Amini and Hamdam (J = 0.25) or Soelberg and Jäger (J = 0.23).

Collection of Medicinal Plants

Villagers gather medicinal plants from diverse habitats within their landscapes. Specifically, 32 plants (55%) were reported as collected from mountains, to which they travel as they herd livestock. Of these, *Ziziphora pamiroalaica*, *Nepeta glutinosa,* and *Ribes meyeri* were said to be found at the highest elevations. Other plants are gathered from hillsides, valleys, and roadsides. Participants mentioned water as a determinant of medicinal plant distribution; for example, *Mentha longifolia* is ubiquitous in wet areas, while *Peganum harmala* prefers much drier conditions. Eight plants were reported as being cultivated in gardens, most frequently mentioned was *Ribes janczewskii*, a species of currant. Several species (including *Ribes meyeri* and *Menta longifolia*) are both gathered from non-cultivated areas and cultivated in gardens. As in many other parts of the world (e.g., Chen *et al.,* 2016), interviewees reported that they prefer the plants they gather to those they cultivate because they believe them to be more potent for use as medicine.

In many cases, interviewees reported that they collect the whole plant, but in others they harvest specific plant parts (Fig. 4). The most commonly used parts are leaves (27), fruits (17), and flowers (15). By comparison, Kassam *et al.* (2010) also found that leaves were the most commonly collected parts in the GBAO of Tajikistan, followed by stems, which were not mentioned in Badakhshan. The

Table 2 Medicinal plants reported in Ishkashim, Shugnan, Wakhan, and Zebak districts of Badakhshan province, Afghanistan

No	Botanic name[a]	Local name(s)[b]	English name	Family	LF[c]	Count of listings (frequency)		
						Individual (n = 236)	Small group (n = 48)	Combined (n = 284)
1	*Achillea arabica* Kotschy[d]	ZARDADAVS (R,W), ZARDSARAK (D), ZIRDOSK (S)	yarrow	Compositae	H	51 (22%)	20 (42%)	71 (25%)
2	*Alcea nudiflora* (Lindl.) Boiss.	GHARMASH (S), ZHIRMESK (S)	hollyhock	Malvaceae	H	35 (15%)	6 (13%)	41 (14%)
3	*Allium chitralicum* F.T.Wang & Tang[e]	SIRI KUHI (D)	wild garlic	Amaryllidaceae	H	35 (15%)	11 (23%)	46 (16%)
4	*Allium oschaninii* O. Fedt.[f]	PIYOZI KUHI (D), PIYUZI KUHI (R,S,W)	wild onion, scallion	Amaryllidaceae	H	66 (28%)	14 (29%)	80 (28%)
5	*Amaranthus retroflexus* L.	TOJI KHURUS (D,R,S,W)	red-root amaranth, common tumbleweed	Amaranthaceae	H	8 (3.4%)	2 (4.2%)	10 (3.5%)
6	*Anaphalis virgata* Thomson	ARAQI RASUL (D), STRAKHM (R,S)	pearly everlasting	Compositae	H	7 (3%)	2 (4.2%)	9 (3.2%)
7	*Angelica ternata* Regel et Schmalh	CHIRIFTS (S), ISHIM (W), KIRIFTS (R), KRAFCH (W)	type of angelica	Apiaceae	H	16 (6.8%)	2 (4.2%)	18 (6.3%)
8	*Arnebia euchroma* (Royle) I.M.Johnst.[g]	KHIPEKH (R,S), SURKHCHUB (D), SURKHCHUK (S,W)	pink arnebia	Boraginaceae	H	57 (24%)	23 (48%)	80 (28%)
9	*Artemisia sieversiana* Ehrh.	KUNDUKAK (D), SADAKHTS (R), SIDIKHTS (S), ZIDAKHTS (R)	wormwood	Compositae	H	27 (11%)	10 (21%)	37 (13%)
10	*Berberis heterobotrys* E.L.Wolf[h]	ZARGUL (D,R,S), ZIRK (W), THERB (W)	barberry	Berberidaceae	S	43 (18%)	10 (21%)	53 (19%)
11	*Bunium persicum* (Boiss.) B.Fedtsch.	ZIRA (D,R,S,W)	black caraway, black cumin	Apiaceae	H	61 (26%)	28 (58%)	89 (31%)
12	*Capparis sicula* subsp. *herbacea* (Willd.) Inocencio, D.Rivera, Obón & Alcaraz[i]	KAPER/KIPER (W), KAVAR (D)	caper	Capparaceae	S	49 (21%)	3 (6.3%)	52 (18%)
13	*Carum carvi* L.	CHARMAK (W), MAGHJIRAK (S), PISHPIKHOK (S), PUSHPIKHOK (R)	caraway	Apiaceae	H	3 (1.3%)	2 (4.2%)	5 (1.8%)
14	*Cichorium intybus* L.	KIZNACH (R,S), KOSNI (D,W)	common chicory	Compositae	H	59 (25%)	12 (25%)	71 (25%)
15	*Crataegus korolkowii* hort. ex L.Henry[j]	GHIFTS (S), GHITHTS (S)	hawthorn	Rosaceae	T	0 (0%)	1 (2.1%)	1 (0.4%)
16	*Cucurbita pepo* L.	KADU (D,W)	pumpkin	Cucurbitaceae	H	1 (0.4%)	0 (0%)	1 (0.4%)
17	*Cuscuta europaea* L.	ZARDPECHAK (R,S), VARNI (W)	greater dodder, European dodder	Convolvulaceae	P	3 (1.3%)	1 (2.1%)	4 (1.4%)
18	*Delphinium brunonianum* Royle	AMBAR (D)	musk larkspur	Ranunculaceae	H	2 (0.8%)	0 (0%)	2 (0.7%)
19	*Elaeagnus rhamnoides* (L.) A.Nelson[k]	ANGAT (D), CHUNG (W), GULGUTAK (S), KHINSHUTH (S)	sea buckthorn	Elaeagnaceae	S	31 (13%)	4 (8.3%)	35 (12%)
20	*Ephedra intermedia* Schrenk & C.A.Mey.	AMOJAK (S,R) EMUK/EMONEMUK (W), MODRAGHN (D)	zhong ma huang (Chinese)	Ephedraceae	S	59 (25%)	19 (40%)	78 (27%)
21	*Ferula* sp.	HING (D), KAMOL (R), ROV (S)	asafetida	Apiaceae	H	20 (8.5%)	2 (4.2%)	22 (7.7%)
22	*Gentiana olivieri* Griseb.	NIZHORGULAK (S)	gentian	Gentianaceae	H	1 (0.4%)	0 (0%)	1 (0.4%)
23	*Glycyrrhiza glabra* L.	MALAKHCH (D,W), MATK (W), MUTHQ (R,S), SHIRINBUYA (D)	licorice	Leguminosae	H	77 (33%)	22 (46%)	99 (35%)
24	*Juglans regia* L.	BOJAK (S)	Persian walnut	Juglandaceae	T	4 (1.7%)	0 (0%)	4 (1.4%)
25	*Leptorhabdos parviflora* (Benth.) Benth.	MUKHOLIFKA (D,R,S)	feather-leaf broom herb	Orobanchaceae	H	11 (4.7%)	1 (2.1%)	12 (4.2%)
26	*Linum usitatissimum* L.	ZAGHER (S,W), ZAGHIR (D)	common flax, linseed	Linaceae	H	11 (4.7%)	2 (4.2%)	13 (4.6%)

Table 2 (continued)

No	Botanic name[a]	Local name(s)[b]	English name	Family	LF[c]	Count of listings (frequency)		
						Individual (n = 236)	Small group (n = 48)	Combined (n = 284)
27	*Mentha longifolia* (L.) L.	PUDINA (D), VUTHN (R), WITHN (S), VADN (W)	mint	Lamiaceae	H	104 (44%)	27 (56%)	131 (46%)
28	*Morus alba* L.	TUT (D), TUTI MUZAFARI (D)	white mulberry	Moraceae	T	12 (5.1%)	5 (10%)	17 (6%)
29	*Nepeta glutinosa* Benth.	KHICHIFKHORTH (R,S), KHICHIFKHARTH (R), MURMITSEK (W), QAUSANQORA (W), SHIKASTABAND (D)	catnip, cat mint	Lamiaceae	H	73 (31%)	24 (50%)	97 (34%)
30	*Origanum vulgare* L.	PUDINAI KUHI (D)	Russian oregano	Lamiaceae	H	25 (11%)	5 (10%)	30 (11%)
31	*Peganum harmala* L.	ISPAND (D), SPAND/SIPAND (S,R,W)	wild rue, Syrian rue, African rue	Nitrariaceae	H	83 (35%)	22 (46%)	105 (37%)
32	*Plantago major* L.	KALGHATSAK (R,S), RAGAKVOKH (S), ZUF/BARGI ZUF (D), RISHTAKASHAK (D,W), SHIMOG (W), SIPOGHGUL (R)	English plantain	Plantaginaceae	H	41 (17%)	14 (29%)	55 (19%)
33	*Polygonum aviculare* L.	ROHDAVAK (D), SAVSANGUL (S), SHURA (S), TALKHAKA (D), TAVDAK (W), TEZDAVAK (D)	common knotgrass	Polygonaceae	H	12 (5.1%)	8 (17%)	20 (7%)
34	*Polygonum coriarium* Grig.	TORON (D,W)	type of knotgrass	Polygonaceae	H	1 (0.4%)	0 (0%)	1 (0.4%)
35	*Prangos pabularia* Lindl.	VARKH (S), VARTH (S)	prangos, yugan	Apiaceae	H	2 (0.8%)	0 (0%)	2 (0.7%)
36	*Primula macrophylla* D. Don	GULI BUNAFSH (D,R,S), PULPUL (W)	large leaf primrose	Primulaceae	H	43 (18%)	13 (27%)	56 (20%)
37	*Prunus armeniaca* L.[l]	NOSH (S)	apricot	Rosaceae	T	13 (5.5%)	5 (10%)	18 (6.3%)
38	*Pyrethrum pyrethroides* (Kar. & Kir.) B.Fedtsch. ex Krasch.	KAKHCHIVIR/KAKHCHIVER (R), KUKH-CHIVIR (S), SHIRVISH (W), SUPURGAK (W)	Himalayan chrysanthemum	Compositae	H	30 (13%)	3 (6.3%)	33 (12%)
39	*Rheum maximowiczii* Losinsk.[m]	CHUKRI (D), SHITORTHK (S), SHPOD (W), ULYUK (W)	type of rhubarb	Polygonaceae	H	22 (9.3%)	4 (8.3%)	26 (9.2%)
40	*Rhodiola heterodonta* (Hook. f. & Thomson) Boriss.	ZARDCHUB (D,S,W)	toothed rhodiola	Crassulaceae	H	1 (0.4%)	0 (0%)	1 (0.4%)
41	*Ribes janczewskii* Pojark.[n]	ORTI (D,W)	type of gooseberry	Grossulariaceae	S	58 (25%)	17 (35%)	75 (26%)
42	*Ribes meyeri* Maxim.	KHINUD (R), KHITSITS (R,S), QARAQOT (D,R,S)	Meyer's currant	Grossulariaceae	S	71 (30%)	31 (65%)	102 (36%)
43	*Ribes trilobum* Meyen[o]	AKHMAN (D), CHILAZM/CHIRAZM (W), SHIRIZM (R,S), UMBUK (W)	Chilean currant	Grossulariaceae	S	29 (12%)	4 (8.3%)	33 (12%)
44	*Rosa huntica* Chrshan.	GULKHOR (D), KHAR (D), KIKAK (S),	type of rose	Rosaceae	S	15 (6.4%)	4 (8.3%)	19 (6.7%)
45	*Rumex crispus* L.	SHULKHA/SHILKHA/SHALKHA (D,R,S)	curly dock	Polygonaceae	H	8 (3.4%)	2 (4.2%)	10 (3.5%)
46	*Sisymbrium brassiciforme* C.A. Mey.	CHAROGH (D), GAZG (W), LATOK (W), SHARSHAM (S)	Himalayan tumble-mustard	Brassicaceae	H	9 (3.8%)	3 (6.3%)	12 (4.2%)
47	*Solanum americanum* Mill.[p]	KIRYUPCH (S)	black nightshade	Solanaceae	H	0 (0%)	2 (4.2%)	2 (0.7%)
48	*Taraxacum campylodes* G.E.Haglund[q]	GULI BORON (D), GULI QOQU (D), QOQU (D), SHIRGULAK (S)	dandelion	Compositae	H	11 (4.7%)	2 (4.2%)	13 (4.6%)
49	*Tribulus terrestris* L.	KHORI MARGELON (D,R)	caltrop, cat's-head, devil's-thorn	Zygophyllaceae	H	5 (2.1%)	2 (4.2%)	7 (2.5%)
50	*Urtica dioica* L.	CHIDGHINTS (S), PECHPECHONAK (D,W), TSAGHINTS (R)	stinging nettle	Urticaceae	H	37 (16%)	11 (23%)	48 (17%)
51	*Vicia sativa* L.	MUSHUNG (D)	common vetch	Leguminosae	H	0 (0%)	1 (2.1%)	1 (0.4%)

Table 2 (continued)

No	Botanic name[a]	Local name(s)[b]	English name	Family	LF[c]	Count of listings (frequency)		
						Individual (n = 236)	Small group (n = 48)	Combined (n = 284)
52	*Zea mays* L.	KHARBINJ (S), RISHI JUVORIMAKKA (D)	maize, corn	Poaceae	H	3 (1.3%)	1 (2.1%)	4 (1.4%)
53	*Ziziphora pamiroalaica* Juz.	JAMBILAK (D,R,S,W)	type of mint bush	Lamiaceae	H	115 (49%)	37 (77%)	152 (54%)
54	unknown	LUNDURK (W)	unknown	unknown	unk	19 (8.1%)	1 (2.1%)	20 (7%)
55	unknown	HOJ (S)	unknown	unknown	unk	1 (0.4%)	0 (0%)	1 (0.4%)
56	unknown	SHUTURKHOR (D)	unknown	unknown	unk	1 (0.4%)	0 (0%)	1 (0.4%)
57	unknown	CHALVAY (S)	unknown	unknown	unk	0 (0%)	1 (2.1%)	1 (0.4%)
58	unknown	JOJI (W)	unknown	unknown	unk	0 (0%)	1 (2.1%)	1 (0.4%)

[a]Botanic names confirmed at the World Flora Online (WFO, 2020)

[b]Languages: D = Dari, R = Rushani, S = Shugnani, W = Wakhi

[c]Lifeforms: T = tree; S = shrub; H = herb (annual or perennial); P = parasitic herb (eFloras.org, 2008)

[d]Synonym: *Achillea biebersteinii* Afan.

[e]Keusgen *et al.,* (2006)

[f]Keusgen *et al.,* (2006)

[g]Synonym: *Macrotomia euchromon* Paulsen

[h]Botanic name is ambiguous

[i]Synonym: *Capparis herbacea* Willd.

[j]Botanic name is ambiguous

[k]Synonym: *Hippophae rhamnoides* L.

[l]Synonym: *Armeniaca vulgaris* Lam.

[m]Botanic name is ambiguous

[n]Botanic name is unresolved

[o]Synonym: *Ribes villosum* Wall. ex Roxb.

[p]Synonym: *Solanum nigrum* L.

[q]Synonym: *Taraxacum officinale* (L.) Weber ex F.H.Wigg.

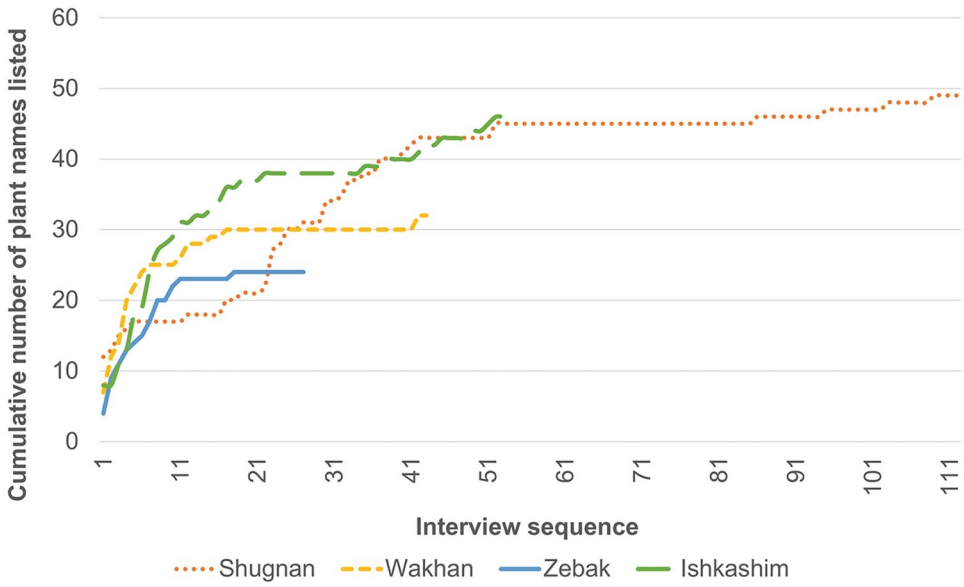

Fig. 2 Cumulative number of plants listed during individual interviews in four districts of Badakhshan Province, Afghanistan

need for certain parts of the plant influences the timing of collection. Plants are most often gathered in summer (49%) and autumn (39%), when leaves and fruit are available, and fewer in spring (11%), when we would expect the most flowers. Only one species (*Peganum harmala*) was said to be gathered in early winter (1%). These findings align with Kassam *et al.* (2010), who found that nearly all medicinal plants were collected in the summer (June, July, and August) or early autumn (September). The use of medicinal plants in winter and spring – when most infectious diseases are more common – typically requires drying and storing plant materials for later use.

Participants were cognizant of the impact collection could have on the availability of medicinal plants in the future, i.e., the sustainability of their practices. Some participants noted that they collect only for their own use (not for sale), which means they collect only small amounts. The most frequent method of collection is by hand (70%), but some participants reported using a shovel (20%) to harvest roots and bulbs, or a sickle (10%) for leaves. The long-term impact of collection depends on the parts taken, the season of collection (e.g., before or after seeds have been released), and the collection method. According to some participants, use of shovels to uproot plants may adversely impact availability of plants in the future.

Use of Medicinal Plants

Altogether participants described 14 methods to prepare medicinal plants for use as medicine (Fig. 5). The most frequently cited methods of preparation were making tea (228 interviews), infusion (213 interviews) and consuming as is (140 interviews). In preparing tea from medicinal plants, participants said they pour hot water over the plant in a tea

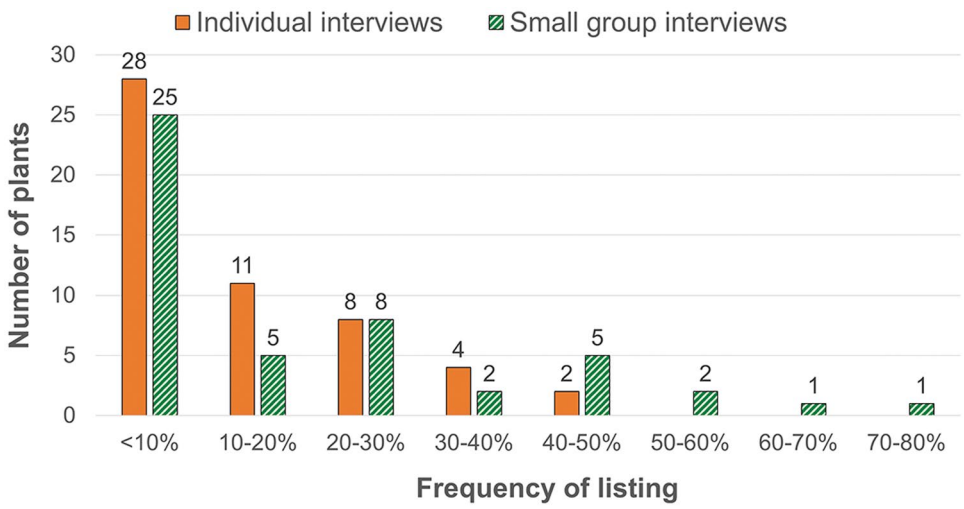

Fig. 3 Frequency of listing of plants during individual and small group interviews

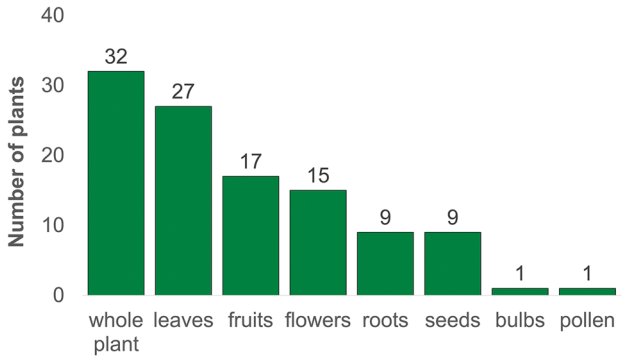

Fig. 4 Parts of plants collected for use as medicine

pot and let it steep for a relatively short period before drinking it. By contrast, an infusion is prepared by soaking the medicinal plant in hot water in a container such as a thermos, allowing it to steep for a longer period, and drinking it throughout the day. A third method involving hot water is decoction, when the plant is boiled in the water, although many participants said that this results in loss of active compounds.

It is noteworthy that most of the methods of preparation of medicinal plants involve consumption, with only a few requiring inhalation (smoking or burning) or application (oil). Tea is an important part of cultures in the study area, so preparing tea from medicinal plants is integrated into people's socio-cultural practice, meaning they can be part of a daily routine as opposed to a separate practice. It should be noted that participants who described the method of preparation as 'raw' or 'boil' did not always mean that these plants are consumed; for example, some plants are boiled before external application to a body part so that the skin can absorb the active compounds more easily.

Participants described medicinal uses for 48 of the 58 plants in the study. The remaining ten plants were listed as medicinal; however, no specific medicinal use was identified.

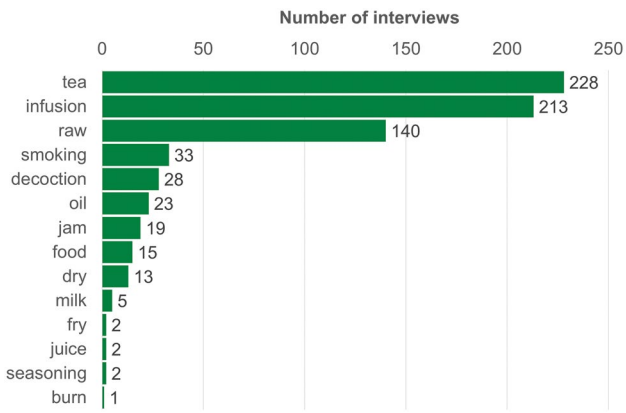

Fig. 5 Methods of preparing medicinal plants mentioned during interviews

Specific medicinal uses were assigned to 45 categories of treatment and prevention, for a total of 160 distinct medicinal plant uses (Table 3). In terms of the number of plants listed per category, five topped the list: hypotensive (used to treat high blood pressure, 14 plants), kidney aid (12), analgesic (11), gastrointestinal aid (11), and dermatological aid (9). On the other end of the spectrum, more than half (28) of the categories of use included three or fewer plants, and 16 only a single plant. For the most part, the categories of use that included the most plants were also mentioned most frequently; for example, hypotensives comprised 21.2% of the treatments described. There are some interesting exceptions to this rule; for example, only one plant was cited as a lactation aid (*Bunium persicum*) but its use was mentioned in 10 interviews, indicating a greater significance than might have been assumed based on the number of plants in the category.

The categories of use we list here are similar to those mentioned in previous studies. As in the survey by Younos *et al.* (1987), plants used to treat digestive ailments (gastrointestinal aids) figure prominently, comprising 5% of all plant uses mentioned, but are far surpassed by hypotensives (21%). Of the 45 categories of use discussed by participants, 39 were also mentioned in the GBAO (Kassam *et al.,* 2010), 32 in Kabul (Amini & Hamdam, 2017), and 26 in Wakhan (Soelberg & Jäger, 2016). Jaccard similarity index values show the greatest similarity with the GBAO (J = 0.57), followed by Kabul (J = 0.52) and Wakhan (J = 0.52). Many of the categories with the greatest number of plants correspond to those of other studies including gastrointestinal aids (Fig. 6). However, plants to treat hypertension are more prominent in this study than in any of the other three. These similarities indicate persisting kinds of ailments affecting people in this area for which many plants are used as treatment.

Medicinal plants are often used for more than one purpose, i.e., to prevent or treat more than one ailment. On average, each medicinal plant was reported within 3.3 categories of use (Fig. 7). Fourteen plants were associated with only one category of use, whereas one plant (*Artemisia sieversiana*) was reported within 12 categories. Other versatile plants include *Urtica dioica* (9 categories), *Peganum harmala* (8 categories), *Arnebia euchroma* (7 categories), *Plantago major* (7 categories), and *Glycyrrhiza glabra* (also 7 categories). Plants that have many uses are often widely known and highly valued.

Of the 10 most frequently listed plants, eight are included in the most frequently mentioned categories. *Ziziphora pamiroalaica*, the most frequently mentioned plant (listed in 54% of interviews (Table 2), is the most commonly cited treatment for hypertension (Table 4). *Mentha longifolia,* the second most frequently mentioned plant (46%), is similarly used, as well as a gastrointestinal and kidney aid. *Peganum harmala*, the third most frequently mentioned plant (37%),

Table 3 Number of medicinal plants within each categories of use and the number of times each category was mentioned (in association with a plant) during interviews

Category of use[a]	Number of plants named	% of all plant uses	Number of mentions	% of all mentions
hypotensive	14	8.8%	184	21.2%
kidney aid	12	7.5%	41	4.7%
analgesic	11	6.9%	55	6.4%
gastrointestinal aid	11	6.9%	43	5.0%
dermatological aid	9	5.6%	75	8.7%
liver aid	7	4.4%	29	3.3%
anthelmintic	6	3.8%	33	3.8%
laxative	6	3.8%	16	1.8%
antidiarrheal	5	3.1%	60	6.9%
toothache remedy	5	3.1%	51	5.9%
heart medicine	5	3.1%	14	1.6%
burn dressing	5	3.1%	6	0.7%
cough medicine	4	2.5%	52	6.0%
cold and flu remedy	4	2.5%	36	4.2%
orthopedic	4	2.5%	32	3.7%
cathartic	4	2.5%	13	1.5%
gynecological aid	4	2.5%	6	0.7%
respiratory aid	3	1.9%	4	0.5%
throat aid	3	1.9%	4	0.5%
expectorant	3	1.9%	3	0.3%
eye medicine	2	1.3%	31	3.6%
pulmonary aid	2	1.3%	12	1.4%
malaria medicine	2	1.3%	11	1.3%
psychological aid	2	1.3%	5	0.6%
febrifuge	2	1.3%	3	0.3%
stimulant	2	1.3%	3	0.3%
ear medicine	2	1.3%	2	0.2%
urinary aid	2	1.3%	2	0.2%
lactation aid	1	0.6%	10	1.2%
antihemorrhagic	1	0.6%	2	0.2%
contraceptive	1	0.6%	2	0.2%
cuts, ;bruises, ;and wounds	1	0.6%	2	0.2%
dietary aid	1	0.6%	2	0.2%
diuretic	1	0.6%	2	0.2%
gland medicine	1	0.6%	2	0.2%
insect repellent	1	0.6%	2	0.2%
poultice	1	0.6%	2	0.2%
strengthener	1	0.6%	2	0.2%
antiemetic	1	0.6%	1	0.1%
blood medicine	1	0.6%	1	0.1%
oral aid	1	0.6%	1	0.1%
pediatric aid	1	0.6%	1	0.1%
reproductive aid	1	0.6%	1	0.1%
tuberculosis remedy	1	0.6%	1	0.1%
other	3	1.9%	6	0.7%

[a]Based on Moerman (1998) with modifications by Kassam *et al.* (Kassam *et al.,* 2010) and for the present study

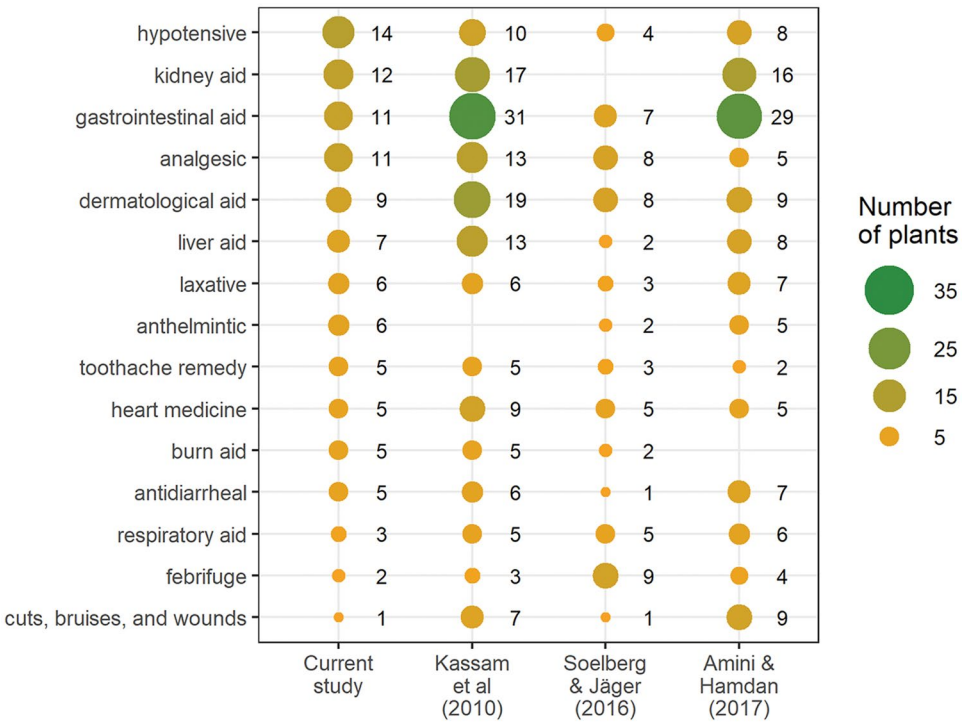

Fig. 6 Comparison of the number of plants in categories of use as documented in Badakhshan current study, in the GBAO by Kassam *et al.* (Kassam *et al.,* 2010), in Wakhan by Soelberg & Jäger (Soelberg & Jäger, 2016), and Kabul by Amini & Hamdam (Amini & Hamdam, 2017). Selected categories of use include the ten largest categories in Badakhshan as well as the five largest categories in each previous study

is the most frequently mentioned as a cold and flu remedy as well as an anthelmintic. *Ribes meyeri*, the fourth most frequently mentioned (36%), is also frequently cited as a cold and flu remedy. *Glycyrrhiza glabra*, the fifth most frequently mentioned (35%), is most commonly used as a cough medicine. Finally, *Nepeta glutinosa*, the sixth most frequently mentioned (34%), is the species most often referred to as an orthopedic aid; the Persian/Dari name for this species is *shikastaband*, which can be translated as 'broken' (*shikasta*), 'tie' or 'bond' (*band*), referring to its properties to heal broken bones.

To some degree, the number of plants within a category of use indicates the prevalence of ailments within that category. For example, the large number of plants used to treat high blood pressure suggests that hypertension is a relatively common problem in the study area. Furthermore, by comparing the uses of medicinal plants with data obtained from local clinics and hospitals, we gain some understanding of their significance. A study of patient diagnoses in the northern provinces of Kunduz, Takhar, and Badakhshan found that over a 12-month period in 2008, approximately 30% of over 260,000 medical diagnoses were for acute respiratory

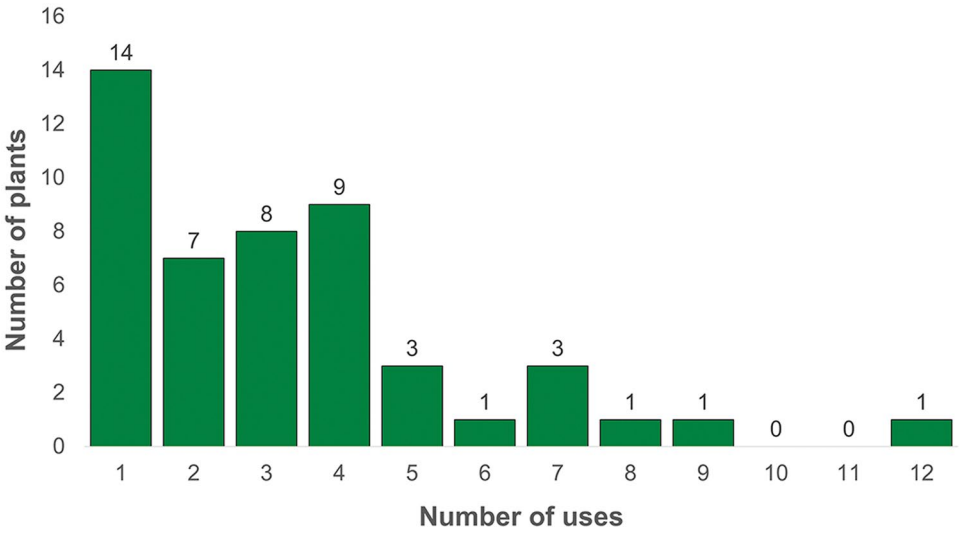

Fig. 7 Multifunctionality of medicinal plants in Badakhshan, showing the number of plants reported within a certain number of use categories. For example, 14 plants were reported to have only one use, whereas nine plants were reported within four categories of use

Table 4 Most frequently mentioned ailments and plants used for their treatment

Category of medicinal use[a]	Number (%) of interviews	Plants listed within category (% of interviews in which category was mentioned)[b]
hypotensive	137 (48.2%)	*Ziziphora pamiroalaica* (39.7%), *Mentha longifolia* (17.9%), *Bunium persicum* (10.3%)
dermatological aid	68 (23.9%)	*Capparis sicula* subsp. *herbacea* (37.3%), *Alcea nudiflora* (20.0%), *Urtica dioica* (16.0%), *Elaeagnus rhamnoides* (10.7%)
antidiarrheal	59 (20.8%)	*Achillea arabica* (63.3%), *Cichorium intybus* (30.0%)
analgesic	52 (18.3%)	*Arnebia euchroma* (63.6%)
cough medicine	50 (17.6%)	*Glycyrrhiza glabra* (92.3%)
toothache remedy	47(16.5%)	*Berberis heterobotrys* (49.0%), *Ephedra intermedia* (43.1%)
gastrointestinal aid	41 (14.4%)	*Plantago major* (44.2%), *Mentha longifolia* (16.3%)
kidney aid	37 (13.0%)	*Alcea nudiflora* (22.0%), *Polygonum aviculare* (14.6%), *Mentha longifolia* (12.2%), *Rosa huntica* (12.2%)
cold and flu remedy	34 (12.0%)	*Peganum harmala* (72.2%), *Ribes meyeri* (22.2%)
anthelmintic	32 (11.3%)	*Peganum harmala* (81.8%)
orthopedic aid	32 (11.3%)	*Nepeta glutinosa* (90.6%)
eye medicine	30 (10.6%)	*Primula macrophylla* (90.3%)
liver aid	29 (10.2%)	*Ribes trilobum* (69.0%), *Urtica dioica* (10.3%)

[a]Includes categories of use mentioned during more than 10% of all interview

[b]Includes plants listed within the category of use in more than 10% of interviews in which that category of use was mentioned

tract infections (ARIs) followed by 12% for diarrhea and dehydration (Morikawa *et al.,* 2011). We see a similar trend in national statistics from 2016/17 (Table 5), with diarrhea and ARIs the most common diagnoses for out-patient visits (CSO, 2018). These two ailments were also frequently mentioned in relation to medicinal plants. Five plants used as antidiarrheals were discussed in 20.8% of interviews. Only three species were described as respiratory aids, but plants in several other categories of use (e.g., pulmonary aids; cough medicines; cold and flu remedies) might be used to address ARIs. As noted above, Younos *et al.* (1987) identified 53 species used to treat respiratory illnesses across Afghanistan.

It is also important to consider why the uses of medicinal plants might differ from diagnoses made during hospital visits. When medicinal plants are effective, they may reduce hospital visits. For example, the availability of 14 plants used to treat hypertension could explain why it is a relatively uncommon reason for in- or out-patient visits (5.3 and 5.9%, respectively). On the flip side, the botanical pharmacopeia is unlikely to address all public health needs. National statistics (Table 5) reveal that highest number of in-patient visits are associated with pregnancy and childbirth. A recent survey of households in Shugnan (Polansky & Laldjebaev, 2021) reveals fewer than 33% of pregnant women receive antenatal care, and fewer than 25% of deliveries were attended by a doctor, nurse, or midwife; both these figures are even lower in communities lacking electricity. By comparison, at a national level, 70.2% of women received antenatal care and 54.3% of births were attended by a skilled health professional in 2017 (CSO, 2018). Many communities in Badakhshan are several hours away from even a small hospital; the hospital in Shugnan, for example, has 20 beds for a population exceeding 30,000, and the next closest hospital is a 14-h drive. Nationwide, 93.2% of the population lives within a two-hour drive from a public clinic (CSO, 2018). Even though most women give birth at home, relatively few participants mentioned medicinal plants associated

Table 5 Diagnoses made during in-patient and out-patient hospital visits in Afghanistan in 2016–2017 (CSO, 2018)

Diagnosis	In-patient visits (%)	Out-patient visits (%)
Intestinal infectious disease; diarrhea	11.2	15.7
Acute respiratory infection	6.6	13.0
Disease of the digestive system	6.5	6.5
Pregnancy; delivery post-natal	15.0	6.3
Hypertensive disease	5.3	5.9
Malaria	3.1	4.3
Asthma	4.7	4.0
Injury poisoning; other external influences	4.9	3.7
Mental/behavioral disease	3.5	3.3
Heart disease	5.4	2.7
Diabetes	2.6	1.8
Disease of the genitourinary system	3.5	1.6
Tuberculosis	2.7	1.3
Nutrition	0.7	1.3
Neoplasms (tumor); endocrine; nutritional & metabolic disease	1.9	1.2
Other	22.4	27.2
Total	100	100

with pregnancy or birth: only four plants were described as gynecological aids, and these were mentioned during six of 284 interviews. Although the lead researcher in this case was female, participants may have hesitated to discuss this category of use, possibly because she was from outside the region. Furthermore, knowledge of plants associated with pregnancy and birth is often highly specialized (Ahmed *et al.,* 2018; Muñoz Balbontín *et al.,* 2019; van Andel *et al.,* 2014). It is important to note that not all plants are safe for use during pregnancy (Bruno *et al.,* 2018), and research on the safety of herbal and homeopathic remedies during pregnancy remains inconclusive (Boltman-Binkowski, 2016). Enhancing access to antenatal care and delivery services at hospitals is of paramount importance.

Comparison with previous studies reveals that medicinal plants are rarely used in the same ways, i.e., the same plants within the same categories of use. Comparison with Kassam *et al.* (2010) revealed 44 cases where a plant in the same genus was reported in the same category of use. Given the high number of uses reported, this results in a low Jaccard's similarity index (J = 0.11). Similarly, comparison with Amini and Hamdam (2017) revealed only 26 cases of the same genus in the same category of use, while Soelberg and Jäger (2016) showed only 14 such cases (J = 0.072 and 0.061, respectively). These differences are surprising given the similarities in both plants and categories of use described earlier, and suggest that the knowledge and use of medicinal plants is highly context specific. These findings also reveal opportunities for knowledge exchange about uses of medicinal plants between remote communities, thereby enabling their use to prevent and treat a wider array of ailments.

Medicinal Plants as Food

Beyond the use of medicinal plants to cure illnesses, many are an important part of people's diets (Ayyanar & Ignacimuthu, 2013; Kassam *et al.,* 2010). Many of the medicinal plants mentioned during interviews are familiar food plants, such as walnut, maize, flax, and pumpkin. Medicinal plants were described by participants as 1) food, 2) something to be consumed *with* food, 3) tea, or 4) something to be drunk *with* tea. The difference between consuming plants *as* or *with* food is more than semantic; although both are ultimately ingested, local people understand their role quite differently. For example, *Urtica dioica* is regarded as food and is therefore consumed on its own. Other medicinal plants are used to substitute for common foods and are, therefore, described as foods. For example, *Capparis sicula* subsp. *herbacea* is used as a meat substitute, seeds of *Plantago major* are used in place of eggs, and *Glycyrrhiza glabra* instead of sugar. In standing in for other foods, these medicinal plants are contributing to the needs of the household based on local knowledge of their nutritional values. By contrast, *Mentha longifolia* and *Allium oschaninii* are used as spices to flavor soup and other foods and, consequently, considered something to be consumed *with* food; these plants are used to enhance the nutritional or other medicinal value of foods. A similar pattern holds for plants used *as* or *with* tea; *Ziziphora pamiroalaica* is drunk as tea, whereas the leaves of *Ribes janczewskii* are added to tea (usually black tea). In this case, it may be that the combination of tea and *Ribes* has desirable effects.

Whether they are eaten as or with food, medicinal plants play an important role in addressing malnutrition. A study in Badakhshan found evidence of stunting resulting from chronic malnutrition in about 50% of children under the age of 5 (Kanji *et al.,* 2012). Crop failures resulting from highly variable weather conditions have led to widespread food shortages (Bhattacharyya *et al.,* 2004; Muhammad *et al.,* 2017; Savage *et al.,* 2009). Furthermore, access to markets is frequently interrupted by floods, avalanches, mudflows, or rockfalls that block roads (Sumar *et al.,* 2012; Tasal, 2019). In 2017, 45% of Afghanistan's population or 13 million people experienced food insecurity (up from 30% in 2011–12), of which 13% were very severely food insecure; within Badakhshan, food insecurity was over 60% (CSO, 2018). In this and many other remote, mountainous regions, non-cultivated plants serve as supplementary sources of food and reduce pressure on limited food stores (Ahmad & Pieroni, 2016; Aryal *et al.,* 2018; Glew *et al.,* 2009; Harisha & Padmavathy, 2013; Ju *et al.,* 2013; Kassam *et al.,* 2010; Lulekal *et al.,* 2011; Powell *et al.,* 2013; Rivera *et al.,* 2005). A review of 36 studies conducted in 22 countries identified 90–100 non-cultivated food plants per location, with 300–800 species in some countries (Bharucha & Pretty, 2010: 2913). Globally, there are over 7,000 non-cultivated plant species used as food, particularly in poor communities (Ahmad & Pieroni, 2016). Even in times of plenty, medicinal plants can provide essential micronutrients (e.g., iron, iodine, folic acid, vitamin A), which are particularly important to the health of pregnant and nursing women, as well as the physical and cognitive development of children (Ali-Shtayeh *et al.,* 2015; Huskisson *et al.,* 2007; Lamxay *et al.,* 2011; McDade *et al.,* 2007; Raja, 2015; Romero-Benavides *et al.,* 2017).

Sale and Conservation of Medicinal Plants

Most of our respondents said that they do not sell medicinal plants. A few emphatically denied selling, saying "God forbid!" when asked. Instead, most participants report that they share the medicinal plants they grow or gather with relatives and friends. The adamant responses of participants in response to this question suggests a resistance to

the commodification of medicinal plants and that these plants play an important role in preserving and strengthening social ties within the community through acts of sharing. Nonetheless, approximately one quarter of participants (70 out of 284) reported selling medicinal plants, either from home or at a local market. Some participants reported giving medicinal plants to a market vendor to sell on their behalf. In addition to local markets, cross-border markets between Afghanistan and Tajikistan include trade in medicinal plants. Eleven plants were mentioned as being sold: *Ribes meyeri*, *Glycyrrhiza glabra*, *Bunium persicum*, *Nepeta glutinosa*, *Capparis sicula* subsp. *herbacea*, *Ribes janczewskii*, *Peganum harmala*, *Arnebia euchroma*, *Linum usitatissimum*, *Pyrethrum pyrethroides,* and *Prunus armeniaca*.

The sale of medicinal plants raises concerns that overexploitation could lead to diminished populations and local extirpation. Several of the species that participants reported selling, including *Glycyrrhiza glabra, Bunium persicum, Nepeta glutinosa,* and *Peganum harmala,* are overexploited in other parts of Afghanistan (Shirzai, 2016). It is difficult to estimate the volume of plants participants are collecting because they use a wide range of non-standard local measures. While participants did not mention specific instances of overexploitation, several expressed concern about plants that are harvested for their roots; one respondent said that "nature will cry!" if plants are uprooted. For example, many participants reported digging and using the roots of *Glycyrrhiza glabra*. Babury (2019) argued that populations of *Glycyrrhiza* sp. are not threatened by overharvesting because they have a wide geographic dispersion across several habitat types. However, increased demand as a result of commercialization could threaten their long-term survival and limit their availability to local communities.

Few participants (in 14% of interviews) mentioned management of non-cultivated medicinal plants, although the topic was more frequently raised in Ishkashim (21%) and Shugnan (15%) than in Wakhan (6%) and Zebak (4%). Various forms of management were described, including practicing self-restraint when gathering plants, community discussions where transgressors of customary rules are held accountable, and official restrictions on selling medicinal plants. Management based on local rules and norms appear more common than formal regulations established by government authorities, which may exist but are rarely enforced. Across Afghanistan, the lack of regulation of plant and animal collection has led to overharvest and extermination of endemic species (Saba, 2001). For the past two decades, the Afghan government has played an increasingly limited role in conservation, resulting in a lack of regulatory and monitoring measures (Babury, 2019).

Government records from 2015 to 2018 report that medicinal plants comprise 15 to 20% of Afghanistan's exports, valued at US$130 to 133 million (MAIL, 2017; NSIA, 2019a).

Table 6 Export of medicinal plants from Afghanistan by amount and value in 2017 and 2018 (NSIA, 2019a, 2019b)

Medical herbs	Amount (tons)		Value ('000 US$)	
	2017	2018	2017	2018
Licorice root	9,201	5,419	10,570	5,729
Asafetida	1,275	1,518	91,046	99,403
Saffron	6	21	6,541	21,235
Yarleng	608	424	545	502
Poppy	1,722	1,120	1,479	713
Other medical herbs	7,061	6,035	5,331	5,611

For purposes of comparison, the total budget expenditure for healthcare in the same year was US$237 million. Of the 20 species documented in official export records, the largest volumes are for licorice root (*Glycyrrhiza* sp.), asafetida (*Ferula* sp.), saffron (*Crocus sativus*), yarleng (*Alkanna tinctoria* (L.) Tausch), and poppy (*Papaver* sp.) (Table 6). Afghanistan is a major producer of licorice and asafetida, for which there is a growing international demand (MAIL, 2017).

Afghanistan's Ministry of Agriculture, Irrigation and Livestock published a National Natural Resource Management Strategy for 2017–2021 (hereafter the NRM Strategy) (MAIL, 2017) that includes plans to conserve and restore non-cultivated medicinal plants. Given rising international demand for licorice and asafetida, the NRM Strategy targets these species, but estimates that an additional 650 species of medicinal plants could be commercialized in the future. The NRM Strategy develops new policies, laws, and bylaws, as well as capacity building along the value chain to improve stewardship (MAIL, 2017). By 2021, the NRM Strategy aimed to approve a medicinal plants law and work with local communities to establish procedures for sustainable harvest. In terms of capacity building, the goal is to train 5,000 people in sustainable management and construct 10 facilities to package and process medicinal plants. Collection and sale of medicinal plants are recognized as an important alternative livelihood for Afghanistan's northern provinces, including Badakhshan (MAIL, 2017). For example, collection and sale of 70–105 kg of licorice can fetch a daily income of AFG600-800 (US$8.5–11.5). An internationally funded project aimed at improving people's livelihoods through sustainable production and marketing of medicinal plants led to sizeable exports of several species, including 739 tons of caraway (*Carum carvi*), 377 tons of asafetida, 141 tons of licorice root, and 90 tons of cumin (*Cuminum cyminum*) (Ottens *et al.,* 2006). Although it was not listed in our survey, other districts in Badakhshan Province allegedly produce high quality cumin (MAIL, 2017). Finally, the well-known food and medicinal plant saffron (*Crocus sativus*) is also important for trade and cultivation could contribute to

people's livelihoods. The Afghanistan Investment Support Agency (Katawazy, 2013) reported that saffron was cultivated in Herat and six other provinces, employing 1,300 farmers who produced an estimated three tons with a value of US$3,900,000 (at an average price of US$1,300 per kg); the same report estimated 7,000 to 10,000 ha of suitable area could produce 50 to 70 tons of saffron annually.

The NRM Strategy acknowledges that commercialization could lead to overexploitation of medicinal plants and ultimately jeopardize local people's livelihoods. Therefore, the strategy advocates for community-based management that builds on indigenous ecological knowledge to develop policies that can support sustainable use, conservation, and restoration (MAIL, 2017). Such policies will need to be mindful of climate change. For example, the government aims to increase the hectarage of medicinal plants (including licorice and asafetida) by 2,500 ha. However, in selecting restoration sites, agencies need to consider current as well as projected climate conditions and whether they can support self-propagating populations over the long term.

Gender Roles and Knowledge

Sustainable use of medicinal plants relies on place-based ecological knowledge maintained and adapted through practice (Chen *et al.,* 2016). When asked about gender roles related to medicinal plants, a little more than half of participants (52%) reported that both men and women gather plants, whereas 36% identified women and only 12% men. Most participants (81%) said that women process plants as medicine, with 14% mentioning both genders and only 5% identifying men. Accordingly, when it comes to knowledge about medicinal plants, 53% said that women are most knowledgeable, 42% mentioned both genders, and only 4% identified men. These findings correspond to analyses indicating that on a global scale, gender roles and knowledge related to medicinal plants differ according to country and continent (Torres-Avilez *et al.,* 2016).

Gender roles and knowledge were significantly different among the study districts, with tests of homogeneity showing p-values less than 0.001 for gathering, processing, and knowledge (Fig. 8). For example, participants in 69% of interviews conducted in Shugnan said that women know how to use medicinal plants, whereas 85% of interviews in Wakhan indicated that both genders know how. Notably, there were few instances in which men were believed to gather, process, or know more about plants than women; most significant differences can be attributed to the experience and knowledge being shared by both genders or only among women.

Women are often responsible for taking livestock to pastures, which allows for observation and collection of non-cultivated medicinal plants along the way. Participants

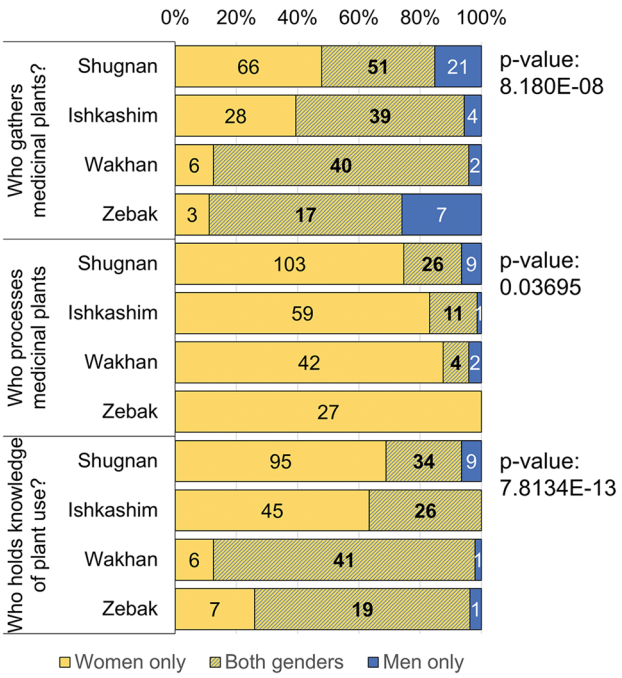

Fig. 8 Comparison of gender roles in gathering, processing, and knowing how to use medicinal plants across four districts of Badakhshan, Afghanistan. Data labels indicate the absolute number of interviews. P-values are based on a chi-square test statistic from a test of homogeneity of the distribution of the three gender categories across the four districts

reported that women are responsible for taking care of sick household members, meaning they are more likely to apply their knowledge of medicinal plants. Women are almost always in charge of food preparation and are thereby more knowledgeable about the use of food as medicine (Voeks, 2007; Wayland, 2001). Given these critical contributions to the well-being of their families and communities, women's knowledge of medicinal plants is fundamental to health sovereignty in the region.

All the respondents said that knowledge of medicinal plants is being passed down from older to younger generations, and recognized the importance of transmission of knowledge. Some respondents said that they had learned from grandparents, rather than from their parents, who sometimes know less about medicinal plants. A similar characteristic of intergenerational transmission of ethnobiological knowledge has been observed in other indigenous cultures that have faced colonization, economic instability, and war (Kassam *et al.,* 2010; Wyndham, 2010). Only one respondent lamented that their children were not interested in learning about medicinal plants. Unlike many other parts of the industrialized world where knowledge of medicinal plants has disappeared as communities come to rely on centralized health care systems (Ramirez, 2007; Stephens *et al.,* 2006; Vandebroek & Balick, 2012), medicinal plants

continue to serve as primary health care options in Badakhshan. Increasing access to 'formal' health care might result in a devaluation of local ecological knowledge associated with medicinal plants, as occurred in the neighboring GBAO of Tajikistan during industrialization of the Soviet period (Kassam *et al.,* 2010).

A policy brief by Karamkhudoeva *et al.* (2017) provides a set of recommendations for the revitalization of indigenous knowledge of medicinal plants in Badakhshan. These include: (a) fostering holistic and culturally-relevant approaches to improving human health, including supporting the use of medicinal plants in isolated communities; (b) preventing the decline of medicinal plants through explicit government policies to manage medicinal plant populations in mountain pastures; (c) revitalizing knowledge of medicinal plants through community-led training focusing on cultivation, processing and local marketing; and (d) assessing and identifying plant species that contribute to food and health and conducting detailed scientific studies to develop strategies for sustainable management by custodian communities. Likewise, the NRM Strategy discussed earlier recognizes the critical role of local communities, particularly women, in the sustainable use of natural resources, including medicinal plants (MAIL, 2017). These policy ideas and initiatives highlight the need to strengthen local knowledge systems to improve health and livelihoods, supporting the notion that place-based knowledge systems are fundamental to health sovereignty.

Conclusions

Our study reveals a wealth of local indigenous knowledge about medicinal plants used to treat a wide range of ailments in the rural communities of Badakhshan Province, Afghanistan. We identified 48 plants with specific medicinal uses that we assigned to 45 standard categories of treatment and prevention. The use of medicinal plants is integrated into people's daily routines as opposed to a distinct practice. Plants are collected in the midst of other activities, for example as they herd livestock to higher elevations. Moreover, medicinal plants are consumed on a regular basis, and are often described as both food and medicine, and likely provide important nutrients otherwise lacking in people's diets. In remote mountain communities where agriculture relies on favorable weather, and crop failures can be devastating, especially if roads are blocked by floods, avalanches, mudflows, or rockfalls, the availability of non-cultivated plants serving as food and medicine can prevent starvation. Although some people reported selling medicinal plants, most expressed resistance to commodification, and emphasized their role in maintaining social ties through acts of sharing. Furthermore, the sustainable use of medicinal plants requires and therefore reflects these communities' intimate knowledge of their ecosystem; their use reinforces vital relations with their habitat.

Conservation of medicinal plants contributes to the health sovereignty of these rural communities by maintaining options for culturally relevant health systems. Community-based research is required to measure the impacts of gathering medicinal plants to develop stewardship strategies. At the national level, medicinal plants are a promising area of economic growth, with exports valued at over US$130 million per annum, and market integration could enhance livelihoods in many rural communities. At the same time, Afghanistan's Ministry of Agriculture, Irrigation and Livestock has acknowledged the risk that overexploitation could ultimately undermine any such effort; its NRM Strategy aims to pass a medicinal plants law by 2021. With increasing trade opportunities driven by the "Belt and Road Initiative" of the People's Republic of China (Hinsley *et al.,* 2020), which shares borders with Badakhshan, Afghanistan in Wakhan, and whose demand for medicinal plants is immense, overexploitation driven by these external market forces poses an imminent threat to health sovereignty. Our interviews suggest that local people are already taking some measures to prevent overexploitation of medicinal plants. Local governance systems (such as community discussions where transgressors are held accountable) may prove more effective than national regulations, which are difficult and expensive to enforce. Women typically collect, process, and administer medicinal plants and should lead efforts to enhance their conservation and management.

Health sovereignty in Badakhshan requires that younger generations learn to use and steward medicinal plants. Unlike most other parts of the world, participants reported that knowledge of medicinal plants is passed down from older to younger generations, demonstrating the continued significance of plants as primary health care options. The development of 'formal' health care systems – while critically important for many reasons – may result in the loss of medicinal plant knowledge. There may be opportunities to incorporate medicinal plants into formal systems. For example, experimental studies of medicinal plants could cross-validate their traditional use, identify potential side effects, and facilitate their use in hospital settings. Of course, the use of plants must benefit the original knowledge holders, recognizing the intellectual property rights of individuals and their communities. Ultimately, all efforts to promote the use of medicinal plants must be taken through partnership with local communities to honor the right of communities to determine their health systems based on local knowledge and values.

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Authors' Contributions MK and KAK designed the interview guides. MK conducted all interviews and KAK supervised field work. MK and ML organized data for analysis. ML and MLR conducted data analysis, prepared figures and tables, and drafted the manuscript. All four authors contributed to revisions of the manuscript.

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Data Availability The datasets generated during and/or analyzed during the current study are not publicly available due to the risk of commercialization without mutual benefit to the communities and individuals who contributed their knowledge, as well as to minimize risks associated with unsupervised use. Some data is available from the corresponding author upon reasonable request.

Declarations

Ethics Approval and Consent to Participate Oral informed consent was obtained from all study participants prior to each interview.

Conflict of Interests The authors have no relevant financial or non-financial interests to disclose.

References

Ahmad, A., Hussan, S., Safiullah, M. (2018). Geographic, ethnic and linguistic composition of Afghanistan: Methodological rich points of language olicy and planning. *Global Social Sciences Review,* 3, 215–243. https://doi.org/10.31703/gssr.2018(III-I).14.

Ahmad, K., & Pieroni, A. (2016). Folk knowledge of wild food plants among the tribal communities of Thakht-e-Sulaiman Hills. *North-West Pakistan Journal of Ethnobiology and Ethnomedicine, 12*, 17. https://doi.org/10.1186/s13002-016-0090-2

Ahmady, A., Amini, M. H., Zhakfar, A. M., Babak, G., & Sediqi, M. N. (2019). Sun protective potential and physical stability of herbal sunscreen developed from Afghani medicinal plants. *Turkish Journal of Pharmaceutical Sciences*. https://doi.org/10.4274/tjps.galenos.2019.15428

Ahmed, S. M., Nordeng, H., Sundby, J., Aragaw, Y. A., & de Boer, H. J. (2018). The use of medicinal plants by pregnant women in Africa: A systematic review. *Journal of Ethnopharmacology, 224*, 297–313. https://doi.org/10.1016/j.jep.2018.05.032

Aitchison, J.E.T. (1890). Notes on the Products of Western Afghanistan and North-eastern Persia, First edition. ed. Edinburgh.

Ali-Shtayeh, M. S., Jamous, R. M., & Jamous, R. M. (2015). Plants used during pregnancy, childbirth, postpartum and infant healthcare in Palestine. *Complementary Therapies in Clinical Practice, 21*, 84–93. https://doi.org/10.1016/j.ctcp.2015.03.004

Amini, M.H., Hamdam, S.M. (2017). Medicinal plants used traditionally in Guldara District of Kabul, Afghanistan. *International Journal of Pharmacognosy & Chinese Medicine 1*, 1–13. https://doi.org/10.23880/IPCM-16000118.

Aryal, K. P., Poudel, S., Chaudhary, R. P., Chettri, N., Chaudhary, P., Ning, W., & Kotru, R. (2018). Diversity and use of wild and non-cultivated edible plants in the Western Himalaya. *Journal of Ethnobiology and Ethnomedicine, 14*, 10. https://doi.org/10.1186/s13002-018-0211-1

Ayyanar, M., Ignacimuthu, S. (2013). Plants as food and medicine: An ethnobotanical survey among Kanikaran community in Southern India. *European Journal of Nutrition and Food Safety*. https://doi.org/10.9734/EJNFS/2013/3642

Aziz Mohibbi, A., & Cochard, R. (2014). Residents' resource uses and nature conservation in Band-e-Amir National Park. *Afghanistan. Environ. Dev., 11*, 141–161. https://doi.org/10.1016/j.envdev.2014.04.003

Babury, M.O. (2019). Sustainable Resource Management of Medicinal and Aromatic Plants of Afghanistan (Doctoral Dissertation). Marburg, Germany.

Bharucha, Z., & Pretty, J. (2010). The roles and values of wild foods in agricultural systems. *Philosophical Transactions of the Royal Society b: Biological Sciences, 365*, 2913–2926. https://doi.org/10.1098/rstb.2010.0123

Bhattacharyya, K., Azizi, P.M., Shobair, S.S., Mohsini, M.Y. (2004). Drought impacts and potential for their mitigation in southern and western Afghanistan (Working Paper No. 91), Drought Series Paper 5. Colombo, Sri Lanka.

Boltman-Binkowski, H. (2016). A systematic review: Are herbal and homeopathic remedies used during pregnancy safe? *Curationis, 39*, 1–8. https://doi.org/10.4102/curationis.v39i1.1514

Breckle, S.-W. (2016). Halophytes and saline vegetation of Afghanistan, a potential rich source for people, in: Khan, M.A., Ozturk, M., Gul, B., Ahmed, M.Z. (Eds.), *Halophytes for Food Security in Dry Lands* (pp. 49–66). New York.

Breckle, S.-W. (2007). Flora and vegetation of Afghanistan. *Basic and Applied Dryland Research, 1*, 155–194. https://doi.org/10.1127/badr/1/2007/155

Breckle, S.-W., Hedge, I. C., Rafiqpoor, M. D., & Dittmann, A. (2013). *Vascular Plants of Afghanistan: An Augmented Checklist*. Bonn.

Britten, S. (2017). Maternal mortality in Afghanistan: Setting achievable targets. *The Lancet, 389*, 1960–1962. https://doi.org/10.1016/S0140-6736(17)31284-9

Bruno, L. O., Simoes, R. S., de Jesus Simoes, M., Girão, M. J. B. C., & Grundmann, O. (2018). Pregnancy and herbal medicines: An unnecessary risk for women's health—A narrative review. *Phytotherapy Research, 32*, 796–810. https://doi.org/10.1002/ptr.6020

Chen, S.-L., Yu, H., Luo, H.-M., Wu, Q., Li, C.-F., & Steinmetz, A. (2016). Conservation and sustainable use of medicinal plants: Problems, progress, and prospects. *China Medecine, 11*, 37. https://doi.org/10.1186/s13020-016-0108-7

CSO. (2019). Afghanistan Population Estimates 2018–19. Kabul.

CSO. (2018). Afghanistan Living Conditions Survey 2016–17. Kabul.

Dar, R. A., Shahnawaz, M., & Qazi, P. H. (2017). General overview of medicinal plants: A review. *Jornal of Phytopharmocology, 6*, 349–351.

Davis, D. K., Quraishi, K., Sherman, D., Sollod, A., & Stem, C. (1995). Ethnoveterinary medicine in Afghanistan: An overview of indigenous animal health care among Pashtun Koochi nomads. *Journal of Arid Environments, 31*, 483–500. https://doi.org/10.1016/S0140-1963(05)80131-4

FAO. (2005). Trade in Medicinal Plants. Rome.

Fischer, L. (1943). Medical folk lore in Afghanistan. *Dtsch. Tropenmedizinische Z., 47*, 346–354.

GIAJ. (2014). Global Map of and around Badakhshan, Afghanistan.

Glew, R. S., Amoako-Atta, B., Ankar-Brewoo, G., Presley, J., Chuang, L.-T., Millson, M., Smith, B. R., & Glew, R. H. (2009). Non-cultivated plant foods in West Africa: Nutritional analysis of the leaves of three indigenous leafy vegetables in Ghana. *Food, 3*, 39–42.

Gurib-Fakim, A. (2006). Medicinal plants: Traditions of yesterday and drugs of tomorrow. *Molecular Aspects of Medicine, 27*, 1–93. https://doi.org/10.1016/j.mam.2005.07.008

Halberstein, R. A. (2005). Medicinal plants: Historical and cross-cultural usage patterns. *Annals of Epidemiology, 15*, 686–699. https://doi.org/10.1016/j.annepidem.2005.02.004

Harisha, R. P., & Padmavathy, S. (2013). Knowledge and use of wild edible plants in two communities in Malai Madeshwara Hills, southern India. *International Journal of Botany, 9*, 64–72.

He, J., Yang, B., Dong, M., & Wang, Y. (2018). Crossing the roof of the world: Trade in medicinal plants from Nepal to China. *Journal of Ethnopharmacology, 224*, 100–110. https://doi.org/10.1016/j.jep.2018.04.034

Hinsley, A., Milner-Gulland, E. J., Cooney, R., Timoshyna, A., Ruan, X., & Lee, T. M. (2020). Building sustainability into the Belt and Road Initiative's traditional Chinese medicine trade. *Natural Sustainability, 3*, 96–100. https://doi.org/10.1038/s41893-019-0460-6

Huskisson, E., Maggini, S., & Ruf, M. (2007). The influence of micronutrients on cognitive function and performance. *Journal of International Medical Research, 35*, 1–19. https://doi.org/10.1177/147323000703500101

Jonas, W. B. (1998). Alternative medicine: Learning from the past, examining the present, advancing to the future. *Journal of the American Medical Association, 280*, 1616–1618. https://doi.org/10.1001/jama.280.18.1616

Ju, Y., Zhuo, J., Liu, B., & Long, C. (2013). Eating from the wild: Diversity of wild edible plants used by Tibetans in Shangri-la region, Yunnan. *China Journal of Ethnobiology and Ethnomedicine, 9*, 28. https://doi.org/10.1186/1746-4269-9-28

Kanji, N., Sherbut, G., Fararoon, R., & Hatcher, J. (2012). Improving quality of life in remote mountain communities. *Mountain Research and Development, 32*, 353–363. https://doi.org/10.1659/MRD-JOURNAL-D-12-00012.1

Karamkhudoeva, M., Kassam, K.-A.S., Ali, A. (2017). Revitalization and retention of indigenous knowledge of medicinal plants in Afghanistan.

Kassam, K.-A.S., Karamkhudoeva, M., Ruelle, M., & Baumflek, M. (2010). Medicinal plant use and health sovereignty: Findings from the Tajik and Afghan Pamirs. *Human Ecology, 38*, 817–829. https://doi.org/10.1007/s10745-010-9356-9

Katawazy, A.S. (2013). A comprehensive study of Afghan saffron (Market research). Kabul.

Keusgen, M., Fritsch, R. M., Hisoriev, H., Kurbonova, P. A., & Khassanov, F. O. (2006). Wild Allium species (Alliaceae) used in folk medicine of Tajikistan and Uzbekistan. *Journal of Ethnobiology and Ethnomedicine, 2*, 18. https://doi.org/10.1186/1746-4269-2-18

Krishna, A. (2011). One illness away: why people become poor and how they escape poverty. Oxford.

LaDuke, W. (2005). Food as medicine: The recovery of traditional foods to heal the people, in: Recovering the Sacred: The Power of Naming and Claiming. Chicago, pp. 191–212.

Lamxay, V., de Boer, H. J., & Björk, L. (2011). Traditions and plant use during pregnancy, childbirth and postpartum recovery by the Kry ethnic group in Lao PDR. *Journal of Ethnobiology and Ethnomedicine, 7*, 14. https://doi.org/10.1186/1746-4269-7-14

Lulekal, E., Asfaw, Z., Kelbessa, E., Van Damme, P. (2011). Wild edible plants in Ethiopia: A review on their potential to combat food insecurity. *African Focus 24*, 71–121. https://doi.org/10.21825/af.v24i2.4998

MAIL (2017). National natural resource management strategy (2017–2021) (Strategy document). Kabul.

MAIL. (2009). Afghanistan's fourth national report to the convention on biological diversity (Government Report). Kabul.

McDade, T. W., Reyes-García, V., Blackinton, P., Tanner, S., Huanca, T., & Leonard, W. R. (2007). Ethnobotanical knowledge is associated with indices of child health in the Bolivian Amazon. *Proceedings of the National Academy of Sciences, 104*, 6134–6139. https://doi.org/10.1073/pnas.0609123104

Moerman, D.E. (1998). Native American ethnobotany. PortlPand, Oregon.

Morikawa, M. J., Schneider, S., Becker, S., & Lipovac, S. (2011). Primary care in post-conflict rural northern Afghanistan. *Public Health, 125*, 55–59. https://doi.org/10.1016/j.puhe.2010.08.021

Muhammad, A., Kumar Jha, S., & Rasmussen, P. F. (2017). Drought characterization for a snow-dominated region of Afghanistan. *Journal of Hydrologic Engineering, 22*, 05017014. https://doi.org/10.1061/(ASCE)HE.1943-5584.0001543

Muñoz Balbontín, Y., Stewart, D., Shetty, A., Fitton, C. A., & McLay, J. S. (2019). Herbal medicinal product use during pregnancy and the postnatal period: A systematic review. *Obstetrics and Gynecology, 133*, 920–932. https://doi.org/10.1097/AOG.0000000000003217

NEPA (2019). Afghanistan's sixth national report to the United Nation's convention on biological diversity (Government Report). Kabul.

Newbrander, W., Ickx, P., Feroz, F., & Stanekzai, H. (2014). Afghanistan's Basic Package of Health Services: Its development and effects on rebuilding the health system. *Global Public Health, 9*, S6–S28. https://doi.org/10.1080/17441692.2014.916735

NSIA. (2019a). Afghanistan statistical yearbook 2018–19 (No. Issue No. 40). Kabul.

NSIA. (2019b). Multidimensional poverty index 2016–2017. Kabul.

NSIA. (2018). Afghanistan provincial profile 2018. Kabul.

Ottens, B. J., Dürbeck, K., & Otten, G. (2006). Alleviating poverty in Afghanistan through sustainable resource management and marketing of medicinal and aromatic plants. *Medicinal Plant Conservation, 12*, 28–31.

Pelt, J.-M., Hayon, J. C., & Younos, M. C. (1965). Plantes de medicinales et drogues de l'Afghanistan. *Bulletin De La Société De Pharmacie De Nancy, 66*, 16–61.

Petrovska, B. B. (2012). Historical review of medicinal plants' usage. *Pharmacognosy Reviews, 6*, 1–5. https://doi.org/10.4103/0973-7847.95849

Polansky, J., & Laldjebaev, M. (2021). Electrifying empowerment in north-eastern Afghanistan: Mixed effects of electrification on education, health and economic outcomes. *Energy Research & Social Science, 73*, e101928. https://doi.org/10.1016/j.erss.2021.101928

Powell, B., Maundu, P., Kuhnlein, H. V., & Johns, T. (2013). Wild foods from farm and forest in the East Usambara Mountains. *Tanzania Ecology of Food and Nutrition, 52*, 451–478. https://doi.org/10.1080/03670244.2013.768122

Raja, R. (2015). Vital role of herbal medicines in womens health: A perspective review. *African Journal of Plant Science, 9*, 320–326. https://doi.org/10.5897/AJPS2015.1315

Ramirez, C. R. (2007). Ethnobotany and the loss of traditional knowledge in the 21st Century. *Ethnobotany Research and Applications, 5*, 245–247.

Rivera, D., Obon, C., Inocencio, C., Heinrich, M., Verde, A., Fajardo, J., & Llorach, R. (2005). The ethnobotanical study of local Mediterranean food plants as medicinal resources in southern Spain. *Journal of Physiology and Pharmacology, 56*, 97–114.

Romero-Benavides, J. C., Ruano, A. L., Silva-Rivas, R., Castillo-Veintimilla, P., Vivanco-Jaramillo, S., & Bailon-Moscoso, N. (2017). Medicinal plants used as anthelmintics: Ethnomedical, pharmacological, and phytochemical studies. *European Journal of Medicinal Chemistry, 129*, 209–217. https://doi.org/10.1016/j.ejmech.2017.02.005

Saba, D. S. (2001). Afghanistan: Environmental degradation in a fragile ecological setting. *International Journal of Sustainable Development & World Ecology, 8*, 279–289. https://doi.org/10.1080/13504500109470086

Saidajan, A. (2012). Effects of war on biodiversity and sustainable agricultural development in Afghanistan. *Journal of Development in Sustainable Agriculture, 7*, 9–13.

Savage, M., Dougherty, B., Hamza, M., Butterfield, R., Bharwani, S. (2009). Socio-economic impacts of climate change in Afghanistan. Stockholm.

Sen, T., & Samanta, S. K. (2015). Medicinal plants, human health and biodiversity: A broad review. In J. Mukherjee (Ed.), *Biotechnological Applications of Biodiversity* (pp. 59–110). Advances in Biochemical Engineering/Biotechnology.

Sherbut, G., Kanji, N., & Hatcher, J. (2015). Linking past and future: Cross-border development and quality of life in the Badakhshans. *Central Asian Survey, 34*, 255–271. https://doi.org/10.1080/02634937.2014.976948

Shirzai, A. (2016). OP6 Landscape / seascape baseline assessment report. Kabul.

Singh, R. (2015). Medicinal plants: *A Review Journal of Plant Sciences 3*, 50–55. https://doi.org/10.11648/j.jps.s.2015030101.18.

Soelberg, J., & Jäger, A. K. (2016). Comparative ethnobotany of the Wakhi agropastoralist and the Kyrgyz nomads of Afghanistan. *Journal of Ethnobiology and Ethnomedicine, 12*, 1–24. https://doi.org/10.1186/s13002-015-0063-x

Stephens, C., Porter, J., Nettleton, C., & Willis, R. (2006). Disappearing, displaced, and undervalued: A call to action for Indigenous health worldwide. *The Lancet, 367*, 2019–2028. https://doi.org/10.1016/S0140-6736(06)68892-2

Sumar, S., Naz Taj, L., & Kermali, I. (2012). Food security assessment of high altitude villages of Badakhshan. *Afghanistan Field Exchange, 44*, 3–6.

Tasal, A. (2019). Agricultural research and development: Policy and program priorities in Afghanistan, in: Shrestha, R.B., Bokhtiar, S.M., Khetarpal, R., Thapa, Y.B. (Eds.), *Agricultural Policy and Program Framework: Priority Areas for Research and Development in South Asia* (pp. 30–45). Bangkok, Thailand

Torres-Avilez, W., de Medeiros, P. M., & Albuquerque, U. P. (2016). Effect of gender on the knowledge of medicinal plants: Systematic review and meta-analysis. *Evidence-Based Complementary and Alternatative Medicine, 2016*, 6592363. https://doi.org/10.1155/2016/6592363

Tripathi, H., Suresh, R., Kumar, S., & Khan, F. (2017). International trade in medicinal and aromatics plants: A case study of past 18 years. *Journal of Medecal and Aromatic Plant Sciences, 39*, 1–17.

UNEP. (2008). Biodiversity profile of Afghanistan. Kabul.

van Andel, T., de Boer, H. J., Barnes, J., & Vandebroek, I. (2014). Medicinal plants used for menstrual disorders in Latin America, the Caribbean, sub-Saharan Africa, South and Southeast Asia and their uterine properties: A review. *Journal of Ethnopharmacology, 155*, 992–1000. https://doi.org/10.1016/j.jep.2014.06.049

van Wyk, B.-E., & Wink, M. (2019). *Medicinal Plants of the World: An Illustrated Scientific Guide to Important Medicinal Plants and their Uses* (2nd ed.). Wallingford.

Vandebroek, I., & Balick, M. J. (2012). Globalization and loss of plant knowledge: Challenging the paradigm. *PLoS ONE, 7*, e37643. https://doi.org/10.1371/journal.pone.0037643

Voeks, R. A. (2007). Are women reservoirs of traditional plant knowledge? Gender, ethnobotany and globalization in northeast Brazil. *Singapore Journal of Tropical Geography, 28*, 7–20. https://doi.org/10.1111/j.1467-9493.2006.00273.x

Volk, O. H. (1961). A survey of Afghan medicinal plants. *Pakistan Journal of Scientific and Industrial Research, 4*, 232–238.

Volk, O. H. (1955). Afghanische drogen. *Planta Medica, 3*, 129–146. https://doi.org/10.1055/s-0028-1101766

Wayland, C. (2001). Gendering Local Knowledge: Medicinal Plant Use and Primary Health Care in the Amazon. *Medical Anthropology Quarterly, 15*, 171–188. https://doi.org/10.1525/maq.2001.15.2.171

WFO. (2020). World Flora Online [WWW Document]. URL http://www.worldfloraonline.org. Accessed 21 May.2020.

WHO. (2019). *Global Report on Traditional and Complementary Medicine*. Switzerland.

World Bank. (2019). Afghanistan: Public expenditure update [WWW Document]. World Bank. URL https://www.worldbank.org/en/country/afghanistan/publication/afghanistan-public-expenditure-update. Accessed 6 Feb 2020.

World Bank. (2018). Mortality rate, infant (per 1,000 live births) - Afghanistan [WWW Document]. World Bank - Data. URL https://data.worldbank.org/indicator/SP.DYN.IMRT.IN?locations=AF. Accessed 6 Feb 2020.

World Bank. (2017). Life expectancy at birth, total (years) - Afghanistan [WWW Document]. World Bank - Data. URL https://data.worldbank.org/indicator/SP.DYN.LE00.IN?locations=AF. Accessed 6 Feb 2020.

Wyndham, F. S. (2010). Environments of learning: Rarámuri children's plant knowledge and experience of schooling, family, and landscapes in the Sierra Tarahumara. *Mexico. Human Ecology, 38*, 87–99. https://doi.org/10.1007/s10745-009-9287-5

Younos, C., Fleurentin, J., Notter, D., Mazars, G., Mortier, F., & Pelt, J.-M. (1987). Repertory of drugs and medicinal plants used in traditional medicine of Afghanistan. *Journal of Ethnopharmacology, 20*, 245–290. https://doi.org/10.1016/0378-8741(87)90052-3