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Dietary Patterns for the Reduction of Obesity Using Medicinal Plants in Northern Pakistan

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Abstract

Objective: Different types of studies have indicated an increased risk of obesity and other related diseases in Pakistan. This study examines the rich availability of anti-obesity plants among the local communities. This is the first ethnobotanical study to document folk remedies for the treatment of obesity and overweight disorders in Northern Pakistan.

Methods: Field trips and interviews were carried out for documentation of ethnomedicinal data from local communities of the study area. Information on age, gender, education, anti-obesity medicinal plants, their common name, other diseases and psychosomatic behavior related to obesity was collected. The data was quantitatively analyzed using descriptive statistics and Family Importance Value (FIV) and Relative Frequency of Citation (RFC).

Results: A total of 77 medicinal plants from 38 families were reported against obesity and overweight. Fruits were commonly used plant part and extract was the common mode for herbal preparations while oral intake was the common route of administration. The significant species based on the values of RFC was *Trachyspermum ammi* (0.291) while the significant family regarding FIV was Fabaceae (5.20).

Conclusion: The current knowledge is novel and could be further exploited by carrying phytochemical investigations which may lead to the isolation and characterization of novel agents for the obesity treatment which could improve healthcare systems.

Keywords: Anti-obesity; Medicinal plant; Obesity disorders; Northern Pakistan

Introduction

Obesity is the excessive fat accumulation in the body, chronic and nutritional disorder and insulin resistance metabolic syndrome [1] which indirectly reduced life quality and cause mortality and morbidity [2]. According to WHO, obesity is the weight of a particular individual taken in kilograms divided by the height taken in the square [3]. The causes include excessive intake of calories, physical inactivity, sedentary lifestyles, urbanization, endocrine disorders, irregular metabolism, lack of sleeping time, medications, eating patterns, inheritance and environmental [4-7]. About 53 diseases are directly or indirectly associated with obesity [4, 8]. According to the estimate of WHO (2008), more than 1/10th adults of the world's population are obese [6] while in children about 8 million and 35 million in developed and developing countries are overweight respectively [9].

Obesity is now the global health issue [10-13] and the 5th leading risk for deaths, connected with health problems especially type 2 diabetes, cardiovascular disease, systemic hypertension, cancers, asthma, and sleep apnea [14, 15]. In South Asian countries, obesity in general and the abdominal obesity in specific is rising as a major health problem, more prevalent in women; and mostly in urban areas [16]. Pakistan is the world's 9th obese country [17] but officially this is still the neglected health problem [18-20]. The scenario becomes more complicated due to various environmental, medical, socioeconomic, nutritional, genetically causative factors and lack of data regarding its prevalence.

Dietary and traditional behavioral treatments of obesity are current conventional methods but failed in long-term management. To manage obesity, dietary strategies include the use of high fiber, low carbohydrates, and fats diets are commonly used [21]. There exists a heterogeneous collection of volatile and non-volatile chemicals in dietary spices, for example, in the dried aromatic parts of plants like seeds, berries, roots, pods, and more often in leaves and people who use these spices and herbs regularly in their diets have been shown less chronic diseases [22].

Many substance and diets used for weight reduction have been marketed aggressively but in methodologically rigorous trials few have been evaluated as; combination of exercise, dietary modification and selected supplements with the method of hypnotherapy [2]. In traditional medicine, treatment of different diseases is done by using different herbal drugs [23]. The use of natural remedies are good and are on rise because it is considered that natural remedies and use of herbs are safer and reliable than any surgery or chemical drugs [24, 25]. Medicinal plants of any area are blessings because many diseases can be treated easily and efficiently [26]. Two third of the world population are dependent on traditional medical therapies [27].

Various medicinal plants have been reported for the treatment and control of obesity [1, 27] and extraction and isolation of various plant-

based natural products are used worldwide [28-31]. In developed countries, the option of weight loss runs out and the people shift towards the use of synthetic drugs but synthetic drugs and surgical procedures involve high cost and high toxicity. In developing rural areas, unavailability of orthodox drugs and clinical limitations are the major risk reported in various case studies. Therefore, people rely on natural remedies for weight loss [32]. Pakistan is a developing country which is blessed with a varied climatic and ecological zones- ranging from tropical, subtropical to temperate conditions, with vast floral diversity [33]. A number of medicinal plants have also been listed from Northern Pakistan [34, 35] but no study has been conducted on anti-obesity plants and the associated folk remedies present in the area. The aim of the present work is, therefore, the documentation of such plants and preservation of related indigenous knowledge.

Methods and Materials

Study area

Northern Pakistan (South Asia) covers Khyber Pakhtunkhwa (KPK), Azad Kashmir, Federally administered Northern areas (FANA) and central Punjab (Figure 1). The northern-Pakistan includes the world's three great mountain ranges i.e. Himalaya, Hindukush, and the Karakoram. The confluence of these ranges form a unique geographical pattern on earth [36] which support diverse flora. Climatically, three seasons are present in these high and sub-mountain regions include hot weather (April-June), rainy season (July-September) and cooler season (October-March). In KPK, the climate varies immensely with a region like from 0 - 30°C in North Region (Chitral District), 5-38°C in South Region (Dir, Swat and Hazara) and 20-45°C in Southern North-West areas.

In FANA, the maximum temperature ranges from 30-40°C and the minimum 1-19°C. In Azad Kashmir, it ranges from 20-30°C in summers and 0-4°C in winters. In Central Punjab, it ranges from 2-45°C. The average rainfall ranges from 152-203 cm in lower Himalayan valleys during July-August [37,38]. Various ethnic groups are living in northern Pakistan including Kashmiri, Balti, Chitrali, Kalashi and Shina in Kashmir and FANA, Pakhtuns in Khyber Pakhtunkhwa (KPK) while Punjabi in central Punjab. All these ethnic groups have a diverse culture and the predominant majority are Muslims. Agriculture is the major source of income which roughly accounts 50% for their income (Figure 1).

Figure 1: Map of Northern Pakistan.

Data collection

Ethnobotanical field trips were conducted at different seasons of the year at different localities. The data collection methods included semi-structures interviews, group discussions, and field observations. The sample size was 192, of native informants, which were purposively selected. The recorded data included demographic characters of the informants i.e. age, gender, education, experience (Table 1) and anti-obesity plants, their local name, part(s) used, mode of utilization, route of administration, and detail recipe for the reduction of obesity and overweight. The consent was taken from informant before the interview and the aims and procedure of the study were explained to them. The interviews were mostly conducted near the homes of the informants and each interview lasted for 1-2 hours. The national and international laws, especially the ethical guidelines adopted by the Society of Ethnobiology (2006) were strictly followed.

S. No.	Variable	Categories	No. of Persons	Percentage
1	Informant category	Traditional health practitioners	15	7.81
		Indigenous people	177	92.18
2	Gender	Female	102	53.12
		Males	90	46.87
3	Age	Less than 20 years	8	4.1
		20–30 years	32	16.6
		30–40 years	40	20.8
		40–50 years	44	22.9
		50–60 years	52	27

		More than 60 years	16	8.3
4	Educational background	Illiterate	54	28.12
		Completed five years education	20	10.4
		Completed eight years education	4	2
		Completed 10 years education	32	16.6
		Completed 12 years education	24	12.5
		Graduate	16	8.3
		Higher education	42	21.87
5	Experience of the traditional health Practitioners	Less than 2 years	2	13.33
		2–5 years	5	33.33
		5–10 years	4	26.66
		10–20 years	2	13.33
		More than 20 years	2	13.33

Table 1: Demographic data of informants in Northern Pakistan.

Collection and identification of plant specimens

The specimens were collected in triplicate and processes following slandered procedure. The identification was made using several sources, i.e. through the taxonomist in the Department of Plant Sciences, Quai-i-Azam University Islamabad, by comparing with the already identified specimen in the herbarium and through the matching of specimens' characters with the flora of Pakistan [39, 40]. The species names were assigned in accordance to "Medicinal Plant Names Services" while the families names in accordance to the "Angiosperm Phylogeny Group, 2009". The dried specimens were mounted on herbarium sheets and deposited in the Herbarium of Pakistan (ISL) for future reference.

Statistical Analysis

Frequency of Citation

The collected data were arranged in excel spreadsheets (MS office 2013). The Frequency of citation (FC) was determined using formula;

(FC=ni/N),

where 'ni' is the number of informants mentioning the use of the species and 'N' is the total number of informants participated in the study.

The Relative frequency of citation (RFC) was determined using the formula;

RFC=FC/N (0<RFC<1) × 100

Whereas FC is the number of informants mentioned the species as useful and N is the total number of informants enquired in the study. The index of relative frequency will be zero if nobody reports the use of plant and unlikely could be 1 when all the informants mention the plant as useful [41,42].

Family importance value

Family importance value (FIV) was calculated [43] using formula;

FIV=(No. of informants who cite the family/Total no of informants) × 100.

Results

Study Population

A total of 192 informants were interviewed. Among them, 15 informants (7.81%) were traditional healers and the rest of the informants include Punjabis, Pathans, Potoharis, Kashmiris, Chitralis, Kalash and Hindkowans people. Majority of the informants were females 102 (53.12%) followed by males 90 (46.87%). The high percentage of informants was about 50-60 years old while the lowest percentage of informants was about more than 60 years (8.3%). The experimental periods of traditional healers were also mentioned in study and in (Table 1) and the preponderance of traditional healers had at least 2-5 years of practice (33.33%).

Documentation of anti-obesity plants diversity and habit

In this scrupulous survey, 77 medicinal plant species from 38 families were documented for the treatment and prevention of obesity (Table 2). The dominant families regarding number of species were Fabaceae (10 spp. having FIV 5.20) followed by Apiaceae (6 spp. having FIV 3.12; Figure 2). The reported species were found to be of different habits where 48% spp. were herbs followed by trees (36%), shrubs (11%) and climbers (5%) (Figure 3). In current study, the value of RFC ranges from 0.036 to 0.291 where the highest RFC were reported for the species Trachyspermum ammi (0.291), followed by Mentha arvensis and Coriandrum sativum (0.265 each; Figure 4).

S. No.	Plant names with authority citation, voucher specimen no., Family, local and common name	Habit Part used	Status	Distribution in Pakistan	GENERAL USE	Preparation	Recipe	FC*	RFC*	Marketable	Reported in literature?
1	*Acacia nilotica* (L.) Delile MNR-05 **Fabaceae** Kikar/ Gum Arabic tree	Tree/ Leaf	Wild	Central Punjab, Northern areas, FATA	Shade tree	Juice	Fresh leaves are crushed to obtain juice, little amount of water and Trachyspermum ammi seeds (125gm) are added and boiled for 15 mins.1 teaspoon of this juice is recommended thrice/day for the loss of appetite.	19	0.09	-	+
2.	*Allium cepa* L. MNR-18 **Amaryllidaceae** Piyaz/ Onion	Herb/ Bulb	Cultivated	Central Punjab, Northern areas, FATA	Spice	Paste	Fresh leaves of Mentha, coriander, onion bulb, green chili and tomato are grind with little salt. Take this paste with meal twice/day for weight loss and digestion.	33	0.17	+	+
3.	*Allium sativum* L. MNR-19 **Amaryllidaceae** Lehsan/ Garlic	Herb/ Bulb	Cultivated	Central Punjab, Northern areas, FATA	Spice	Paste	Garlic cloves (200mg) are crushed to make paste. Pills are made of it and dried for 2 days. Take 1pill with water after meal thrice/day.	36	0.18	+	+
4.	*Aloe vera* (L.) Burm.f. MNR-42 **Sapindaceae** (Kanwargandal/ Aloe	Shrub/ Leaf	Cultivated	Central Punjab, Northern areas, FATA	Medicinal	Extract	To the fresh leaves extract *China berry soft stem juice and powder of Nigella sativa seeds are properly mixed. 1 teaspoon is prescribed to take once/day with water for the reduction of fats*	29	0.15	+	+
5.	*Alstonia scholaris* (L.) R.Br. MNR-20 *Apocynaceae* Phulai/ Blackboard tree	Tree/ Flower	Cultivated	Central Punjab, Northern areas, FATA	Ornamental	Powder	Dried flowers powder is made. 2 tablespoon lemon juice and extract of Trachyspermum ammi seeds are added in it. 1 teaspoon twice/day are taken for the reduction of abdominal obesity.	11	0.05	-	+
6.	*Ananas comosus* (L.) Merr. MNR-25 **Bromeliaceae** Ananas/ Pineapple	Herb/ Fruit	Cultivated	KPK, Punjab foot-hills, Baluchistan	Fruit	Decoction	Boil the fruit of plant species in water for 10 minutes. 1 teaspoon honey is added. 1 cup of lukewarm tea once/day is taken for reducing excessive fats.	15	0.07	+	+
7.	*Andrographis paniculata* (Burm.f.) Nees MNR-10 **Acanthaceae** Chooraita/ Green chirayta	Herb/ Bark	Wild	Central Punjab	Medicinal	Infusion	The fresh bark is soaked in water overnight and strains it in morning. ½ cup of this solution is prescribed (before breakfast) to drink for reducing fats and gastric problems.	39	0.20	-	+
8.	*Anethum graveolens* L. MNR-04 **Apiaceae** Sowa/ Dill	Herb/ Leaf	Wild and cultivated	Central Punjab, Northern areas, FATA	Spice	Cooked	The fresh leaves of this plant, fenugreek, Spinacia oleracea and coriander are cooked together for 15 minutes in soybean oil. It is then taken at lunch and dinner as it prevents fats formation and loss weight.	36	0.18	+	+
9.	*Arachis hypogaea* L. MNR-31 **Fabaceae** Moong phalli/ Peanut	Herb/ Fruit	Cultivated	Central Punjab, FATA	Nuts	Raw	The nuts are eaten raw as suppresses appetite and reduced obesity	17	0.08	+	+
10.	*Azadirachta indica* A.Juss. MNR-32	Tree/ Leaf	Wild and cultivated	KPK, Central Punjab	Ornamental	Extract	The fresh leaves extract (after adding some water) is strained through soft batiste cloth. Black chili seeds powder and	43	0.22	-	+

	Meliaceae Neem/ Neem tree						half teaspoon of salt is mixed in it and 1 cup of this juice is taken a day for weight loss.				
11.	*Bauhinia variegata* L. MNR-02 **Fabaceae** Kachnar/ Variegated Bauhinia	Shrub/ Root	Wild and cultivated	Central Punjab, KPK	Ornamental, vegetable	Decoction	The roots decoction (in water) is prescribed to take daily for the prevention of obesity.	13	0.06	+	+
12.	*Brassica nigra* (L.) K.Koch MNR-22 **Brassicaceae** Kali sarson/ Black mustard	Herb/ Leaf	Cultivated	Central Punjab, Northern areas, FATA	Oil yielding plant	Cooked	The fresh leaves are boiled in water and crushed in pestle mortar. The extract of onion, Garlic, Zingiber officinale, green chili, coriander powder and salt is added and cooked for 5 min. This is recommended (with bread) for old age people twice/day for maintaining body fats.	20	0.10	-	+
13.	*Brassica oleracea* L. var. capitata L. MNR-36 **Brassicaceae** Band gobhi/ Borecole	Herb/ Leaf	Cultivated	Central Punjab, KPK, Northern areas	Vegetable	Raw	The fresh leaves are used as a salad which is a good diet for obese people and also helps in reducing obesity.	27	0.14	+	-
14.	*Calotropis procera* (Aiton) Dryand. MNR-44 **Apocynaceae** Desi aak/ Ak	Herb/ Root bark	Wild	Central Punjab, KPK, Northern areas	No use	Extract	The fresh root bark exudation is boiled with sesame oil and 1 teaspoon honey is added for sweetness. Taking ½ teaspoon twice/day reduces abdominal viscera fats.	26	0.13	-	+
15.	*Cannabis sativa* L. MNR-09 **Cannabaceae** Bhang/ Marijuana	Herb/ Leaf, Buds	Wild and cultivated	Central Punjab, KPK	Drug	Oil	A single drop of essential oil obtained from fresh leaves and mature buds, is recommended once/day for the suppression of hunger and indigestion. It also decreases insulin level.	18	0.09	-	+
16.	*Capsicum annuum* L. MNR-72 **Solanaceae** Mirch/ Green chili	Climber/ Fruit	Cultivated	Central Punjab	Spice	Juice	The fresh fruit is crushed in a juicer with water; add powder of ajwain & some sugar. 2 teaspoons of this solution twice/day prevent obesity in childhood.	26	0.13	+	+
17.	*Carica papaya* L. MNR-17 **Caricaceae** Papeeta/ Papaya	Tree/ Fruit	Cultivated	Central Punjab	Fruit	Juice	One glass of fresh fruit juice is taken twice/day for controlling obesity.	28	0.14	+	+
18.	*Carum carvi* L. MNR-56 **Apiaceae** Kala zeera/ Caraway	Herb/ Seed	Cultivated	KPK	Spice	Decoction	Cumin, coriander and fennel seeds are collectively boiled in 2 cups of water, for 10 minutes which is then strained. 1 cup of this warm tea in taken at morning.	36	0.18	+	+
19.	*Cassia fistula* L. MNR-13 **Fabaceae** Amultas/ Golden Shower	Tree/ Fruit	Wild and cultivated	Central Punjab	Ornamental & medicinal	Decoction	The fruit decoction is mixed with jiggery. Taking twice/day before meal are recommended for hunger satisfaction.	17	0.08	+	+
20.	*Catharanthus roseus* (L.) G.Don MNR-01 **Apocynaceae**	Herb/ Flower	Wild and cultivated	Central Punjab	Ornamental	Raw	Fresh 5-7 white flowers (not pink flowers) are recommended to take with water in morning with empty stomach, for 7 consecutive days. It reduces abdominal obesity.	15	0.07	-	+

	Sada bahar/ Rosy										
21.	*Chamaemelum nobile* (L.) All. MNR-06 **Asteraceae** Babuna/ Chamomile	Herb/ Flower	Wild	KPK	Spice	Oil	The massage of essential oil of this plant reduced hunger and stress in teenage mothers.	13	0.06	-	+
22.	*Cedrus deodara* (Roxb. ex D.Don) G.Don MNR-03 **Pinaceae** Deodar/Himalayan cedar	Tree/ Stem bark	Wild	Central Punjab, KPK	Timber	Oil	The bark oil of this species is blended with liquorice oil, sesame seeds oil and castor oil and warm it. Massage whole body with this tepid oil helps in reducing obesity.	16	0.08	-	+
23.	*Cichorium intybus* L. MNR-64 **Asteraceae** Kasni Blue daisy	Herb/ Leaf, seed	Wild and cultivated	Kashmir, Central Punjab, KPK	Vegetable	Extract	Fresh leaves extract (200mg) and seeds extract (300mg) of this plant is mixed. Taking ½ teaspoon of this extract twice /day after meal is recommended for the digestion of food and prevents the fats formation.	28	0.14	+	+
24.	*Cinnamomum verum* J. Presl MNR-76 **Lauraceae** Darchini/ Cinnamon	Tree/ Bark	Cultivated	Sindh	Spice	Decoction	A mix decoction is made from the small bark part of this species with cardamom, sugar and green tea, by boiling in 2 cups of water for 5-7 minutes. 1 cup of this tea is taken once/day for reduction of fats.	45	0.23	+	+
25.	*Citrus aurantium* L. MNR-46 **Rutaceae** Malta/ Citrus	Tree/ Fruit	Cultivated	Central Punjab	No use	Juice, Raw	Taking 2-3 fruits orally with water or 1 glass fruit juice is to take daily for the suppression of appetite.	37	0.19	-	+
26.	*Citrus limon* (L.) Osbeck MNR-08 **Rutaceae** Lemo/ Lemon	Tree/ Fruit	Cultivated	Central Punjab, KPK	Flavoring agent	Juice	Two teaspoons of lemon juice is properly mixed with a glass of water and 1 teaspoon of honey. Take it empty stomach once/day in morning.	47	0.24	+	+
27.	*Citrullus colocynthis* (L.) Schrad. MNR-49 **Cucurbitaceae** Tumba/ Bitter apple	Climber/ Seed	Cultivated	KPK	Fruit	Powder	To the seed powder of this plant are added to ajwain seeds powder, black chili powder and *neem tree leaves powder (with some salt) & properly mixed it. Taking 1 teaspoon with water is prescribed twice/ day.*	24	0.12	+	-
28.	*Cocos nucifera* L. MNR-07 **Arecaceae** Narial/	Tree/ Fruit	Cultivated	Central Punjab	Fruit	Oil	Take 2-3 teaspoon of coconut oil daily or cooked cereals in it. The diet rich with this oil can control hunger.	35	0.18	+	+
29.	*Coriandrum sativum* L. MNR-12 **Apiaceae** Dhania/ Coriander	Herb/ Leaf	Cultivated	Central Punjab, KPK, Baluchistan	Spice	Paste	Grind fresh leaves of coriander, Mentha, bulb of onion, green chili & fruit of tomato with little salt. Take this paste with meal twice/day for weight loss & digestion.	51	0.26	+	+
30.	*Cucumis sativus* L. MNR-15 **Cucurbitaceae** Kheera/ Cucumber	Climber/ Fruit	Cultivated	Central Punjab, KPK	Vegetable	Raw	The fruit of this plant is used as a salad which is a best vegetable for the *maintenance of diet.*	32	0.16	+	-

31.	*Cucurbita moschata* Duchesne **Cucurbitaceae** MNR-61 Ghia kaddu/ Winter Squash	Herb/ Fruit	Cultivated	Central Punjab	Vegetable	Cooked	The fruit is cooked & prescribed to eat twice/day with bread. It does not allow body fats to increase and maintain diet.	23	0.11	+	+
32.	*Cuminum cyminum* L. MNR-33 **Apiaceae** Zeera/ Cumin	Herb/ Seed	Cultivated	KPK, Central Punjab, Baluchistan	Spice	Powder	To the seeds powder of this plant are added cardamom powder, Piper longum, cinnamon bark and black chili. It is used in different dishes to reduce their effect to cause obesity.	29	0.15	+	+
33.	*Curcuma longa* L. MNR-54 **Zingiberaceae** Haldi/ Tumeric	Herb/ Rhizome,Root	Cultivated	Gilgit, Baltistan	Spice	Extract	The roots (208mg) are crushed within little amount of water and make small pills of it. 1 pill is recommended to take with water twice/day after meal.	19	0.09	+	+
34.	*Cyamopsis tetragonoloba* (L.) Taub. MNR-77 **Fabaceae** Guar/ Guar	Herb/ Beans , Gum	Cultivated	Central Punjab	Fodder & cash crop	Cooked	Add little amount of water in the guar gum obtained from the beans of this plant. Add glucomannan in it and cook for 5 minutes.1 teaspoon of it is recommended to take twice/day before meal to suppress appetite.	16	0.08	+	+
35.	*Elettaria cardamomum* (L.) Maton MNR-67 **Zingiberaceae** Ilaichi/Cardamom	Herb/ Leaf	Cultivated	KPK	Spice	Decoction	Put dried leaves of green tea, fennel seeds powder, cardamom fruit in 2 cups of warm water and boil for 5 minutes. Take 1 cup of this tea in a day for reducing extra fats.	49	0.25	+	-
36.	*Phyllanthus emblica* L. MNR-51 **Phyllanthaceae** Amla/ Emblic	Herb/ Fruit, Seed	Cultivated	Central Punjab	Pickles & jam	Extract	The fruit (250gm) extract is left open to get dry for a day. 1 teaspoon of this dried extract is prescribed to take with water after meal twice/day to reduce obesity.	29	0.15	+	-
37.	*Eriobotrya japonica* (Thunb.) Lindl. MNR-11 **Rosaceae** Loquat/ Japanese plum	Tree/ Fruit	Cultivated	Central Punjab	Fruit	Raw	The fresh fruit is eaten in raw form which has fibers like pectin which reduce appetite.	22	0.11	+	+
38.	*Eruca vesicaria* (L.) Cav. MNR-29 **Brassicaceae** Tara meera/ Arugula	Herb/ Leaf	Cultivated	Central Punjab, KPK	Salad	Raw, Oil	The fresh leaves of this plant are used as salad which reduces excessive body fats.	41	0.21	+	-
39.	*Euphorbia neriifolia* L. MNR-60 **Euphorbiaceae** Thohr/ Milk Hedge	Shrub/ Leaf	Wild	Central Punjab	No use	Extract	To the leaves extract of this plant add some water and strain it. ½ teaspoon is recommended to take with empty stomach in morning. It prevents the accumulation of excessive fats.	07	0.03	-	+
40.	*Ficus religiosa* L. MNR-41 **Moraceae** Peepal/ Sacred fig	Tree/ Leaf	Wild and cultivated	Central Punjab	Shade tree	Powder	To the dried leaves powder of this plant, add equal amount of Fennel seed powder and some cardamom powder and mix it. 1 teaspoon of this is prescribed to take twice/day for obesity reduction.	26	0.13	-	+
41.	*Foeniculum vulgare* Mill. MNR-73	Herb/ Seed	Cultivated	Plains	Spice	Powder	To the dried seeds powder (250gm) of this plant, add 3-4 fruit powder of cardamom, sugar candy (350gm) and seed powder of	46	0.23	+	+

	Apiaceae Sonf/ Fennel						Pomegranate (250gm). This powder can be used thrice/day, for loss of appetite.				
42.	*Gardenia jasminoides* J.Ellis MNR-21 **Rubiaceae** Chambaeli/ Gardenia	Shrub/ Flower	Cultivated	Central Punjab	Ornamental	Juice	The flower petals juice (in water) of this plant is added Aloe and ajwain seeds and boil it for 5-7 minutes. Take 1 teaspoon after meal thrice/day for the reduction of abdominal obesity.	26	0.13	+	+
43.	*Glycyrrhiza glabra* L. MNR-66 **Fabaceae** Mulethi/ Liquorice	Shrub/ Root	Cultivated	KPK, Kashmir, Baluchistan	Medicinal	Decoction	Take 1teaspoon liquorice, 1 ½ cups of boiling water	43	0.22	+	+
44.	*Glycine max* (L.) Merr. MNR-65 **Fabaceae** Soya bean/ Soya bean	Herb/ Beans	Cultivated	Central Punjab	Oil yielding	Oil	Soybean oil is considered to have no cholesterol so it is recommended to use for cooking different dishes to control obesity.	18	0.09	+	+
45.	*Juglans regia* L. MNR-52 **Juglandaceae** Akhrot/ Walnut	Tree/ Fruit	Wild and cultivated	KPK, Baluchistan	Nut	Raw	The nuts endocarp is to be eaten to satisfy hunger and it helps in weight loss.	20	0.10	+	+
46.	*Lepidium sativum* L. MNR-34 **Brassicaceae** Hailon/ Garden cress	Herb/ Seed	Wild	KPK, Central Punjab, Baluchistan	No use	Extract	Mixed ½ teaspoon of honey, ½ teaspoon powder of b in aqueous seed extract of this plant. Take one spoon of this extract in a day before meal.	23	0.11	-	+
47.	*Linum usitatissimum* L. MNR-14 **Linaceae** Alsi/ Linseed	Tree/ Seed	Cultivated	KPK	Fibers for cloths	Oil	The seed oil of this plant is recommended to take half an hour before meal, as it reduces hunger.	16	0.08	+	+
48.	*Malus sylvestris* (L.) Mill. MNR-50 **Rosaceae** Saib/ Apple	Tree/ Fruit	Cultivated	Kashmir, Central Punjab	Fruit	Raw	Taking one fruit of this plant at dinner suppresses appetite and reduces obesity.	34	0.17	+	+
49.	*Mangifera indica* L. MNR-30 **Anacardiaceae** Aam/ Mango	Tree/ Seed	Cultivated	Central Punjab	Fruit	Extract	Take 100gm of mango seeds extract, 30 minutes before lunch and dinner. It reduced hunger.	31	0.16	+	+
50.	*Melia azedarach* L. MNR-43 **Meliaceae** Dharek/ China berry	Tree/ Leaf, Stem	Wild and cultivated	Kashmir, Central Punjab, Baluchistan	Ornamental	Juice	To the soft stem and leaves juice (in water) of this plant, add e	47	0.24	-	+
51.	*Mentha arvensis* L. MNR-68 **Lamiaceae** Pudina/ Mentha	Herb/ Leaf	Wild and cultivated	Central Punjab, KPK	Spice	Paste	Take fresh leaves of this plant add small pieces of peel tomato and pieces of green chili with ½ teaspoon of salt. Grind all these together and take this paste with meal for fats reduction.	51	0.26	+	-
52.	*Momordica charantia* L. MNR-75	Herb/ Fruit, Leaf	Cultivated	Central Punjab	Vegetable	Powder, Extract	To the dried leaves powder and fruit extract of this plant are added ajwain seeds, black pepper and cardamom. Take	23	0.11	+	+

	Cucurbitaceae Karela/ Bitter gourd						1 teaspoon of this extract thrice/day for reducing fats.				
53.	*Morus alba* L. MNR-23 **Moraceae** Toot/ White mulberry	Tree/ Leaf	Wild and cultivated	Central Punjab	Fruit	Decoction	The dried leaves of this plant are slightly crushed. To this 1½ cup of boiled water, green cardamom and fennel seeds are added and boiled for 10 minutes. Take 1 cup of this tea a day, for losing weight.	31	0.16	+	+
54.	*Nigella sativa* L. MNR-53 **Ranunculaceae** Kalonjī/ Fennel flower	Herb/ Seed	Cultivated	Central Punjab	Medicinal	Oil	To the ½ teaspoon of this plant seed oil are added 1 teaspoon honey and a glass of warm milk. Taking this twice/day cause lack of appetite.	36	0.18	+	+
55.	*Ocimum tenuiflorum* L. MNR-40 **Lamiaceae** Tulsi/ Common basil	Tree/ Leaf	Cultivated	KPK	Ornamental	Decoction	The leaves decoction of this plant and is strained and cumin, black chili, salt and ajwain seeds powder are added in it and properly mixed. ½ teaspoon is recommended before meal. It prevents the accumulation of excessive body fats.	25	0.13	+	+
56.	*Olea ferruginea Wall. ex Aitch.* MNR-45 **Oleaceae** Zaetoon/ Wild olive	Tree/ Fruit	Wild and cultivated	FATA, KPK, Baluchistan	Fruit	Oil	Scallions, tomatoes and green chilies are fried in olive oil. Add salt and lemon juice in it. Eat it with bread twice/day is recommended for weight loss in obese people.	27	0.14	-	-
57.	*Origanum vulgare L.* MNR-58 **Lamiaceae** Sathar/ Oregano	Herb/ Leaf	Wild and cultivated	Kashmir, Sindh	Spice	Powder	To the powder of dried leaves (15gm) of this plant and seeds (10gm) of ajwain, rose petals (20gm) decoction is mixed. Taking 1 teaspoon after meal, twice/day prevents excessive body fat formulation.	22	0.11	+	+
58.	*Papaver somniferum* L. MNR-35 **Papaveraceae** Khaskhas/ Opium poppy	Herb/ Seed	Cultivated	KPK	Medicinal	Infusion	The seeds of this plant are soaked in water overnight and then grind them with equal amount of Citrullus lanatus seeds. 1 teaspoon of this mixture is to be taken in morning with empty stomach for fats reduction.	32	0.16	+	-
59.	*Piper nigrum* L. MNR-28 **Piperacea** Kali mirch/ Black chili	Shrub/ Seed	Cultivated	Central Punjab	Spice	Decoction	Take the powder of; seed (4gm) of this plant, curcuma root (1.5gm), pods of Moringa oleifera (10gm) and seed (6gm) of coriander and boil in water (130ml). Take ½ cup of this tea once/day for weight loss.	41	0.21	+	+
60.	*Pistacia vera* L. MNR-57 **Anacardiaceae** Pista/ Pistachio	Tree/ Fruit	Wild and cultivated	KPK	Fruit/nut	Raw	The regularly intake of 3-4 fruits (breaking fruits) of this plant are eaten raw. It improves satiety AND gives energy.	24	0.12	+	+
61.	*Plantago ovata Forssk.* MNR-70 **Plantaginaceae** (Ispaghol)	Herb/ Seed	Wild	Central Punjab	Medicinal	Raw	Take 1 teaspoon of seed husk of this plant with water half an hour before meal. It fulfills the feeling of hunger.	31	0.16	+	+
62.	*Pongamia pinnata* (L.) Pierre MNR-69 **Fabaceae** Sukh chain/ Pongam oil tree	Tree/ Leaf	Cultivated	Central Punjab	Shade tree	Extract	The fresh leaves extract is strained through batiste cloth to obtain juice. Add 2 teaspoon lemon juice, ½ teaspoon of salt and 1 teaspoon of seed powder of Emblic and mixed them well. Take 1 teaspoon with water before meal.	23	0.11	-	+

63.	*Prunus dulcis* (Mill.) D.A.Webb MNR-5 **Rosaceae** Badam/ Almond	Tree/ Fruit	Cultivated	KPK	Fruit/nut	Juice	Soaked Chrysopogon zizanioides seeds in water overnight. In morning grind them with almond fruit. Drink 1 cup of this juice for loss of appetite.	37	0.19	+	-
64.	*Psidium guajava* L. MNR-63 **Myrtaceae** Amrood/ Guava	Tree/ Fruit	Cultivated	Central Punjab, KPK	Fruit	Paste	Green fruits of this plant are crushed and fennel seeds powder, cardamom and black chili seeds powder are mixed with it. Eat it twice/day for lack of appetite.	35	0.18	+	+
65.	*Punica granatum* L. MNR-37 **Lythraceae** Anar/ Pomegranate	Tree/ Fruit	Wild and cultivated	KPK, Central Punjab	Fruit	Juice	One cup each of pomegranate fruit juice, Fragaria ananassa, lemon, olive oil and 1 teaspoon of Garlic juice are mixed. I cup of this juice is taken at morning for weight loss.	21	0.10	+	+
66.	*Raphanus* raphanistrum subsp. sativus (L.) Domin MNR-24 **Brassicaceae** Mooli/ Radish	Herb/ Root	Cultivated	KPK, Central Punjab	Vegetable	Raw	The underground part of this plant is used as a salad which satisfies hunger and reduces obesity.	37	0.19	+	+
67.	*Solanum americanum Mill.* MNR-74 **Solanaceae** Mako/ Black nightshade	Herb/ Fruit	Wild	Central Punjab	No use	Paste	To the crushed fruit of this plant, black chili seeds powder and some salt are added. Eat this at lunch and dinner prevents excessive body fats formation.	18	0.09	+	+
68.	*Solanum melongena* L. MNR-71 **Solanaceae** Baingan/ Eggplant	Herb/ Fruit	Cultivated	Central Punjab	Vegetable	Cooked	1 teaspoon of cumin seeds and chili powder each, 2 teaspoon powder of coriander leaves and dried mango each and 5 teaspoon gram flour paste is made, which is applied on slit eggplant (4 pieces) and cooked for 10 minutes in pressure cooker. Also, warm them in non-stick pan for 5 mints. The cholesterols in eggplant get finished.	24	0.12	+	+
69.	*Syzygium cumini* (L.) Skeels MNR-4 **Myrtaceae** Jaman/ Black plum tree	Herb/ Fruit	Wild & cultivated	Plains, Central Punjab	Ornamental	Juice	To the fruit vinegar of this plant are added 1 teaspoon honey and lemon juice, each. Take 1 teaspoon thrice/day (after meal) helps in weight loss.	29	0.15	+	+
70.	*Tamarindus indica* L. MNR-59 **Fabaceae** Imli/ Tamarind	Tree/ Seed	Cultivated	Central Punjab	Spice	Infusion	Soaked 2 teaspoon tamarind overnight in 2 cups of water and strained it at morning. 1 teaspoon honey and lemon juice each, are added. Take half cup of this (with empty stomach) in morning for weight loss.	31	0.16	+	+
71.	*Terminalia chebula* Retz. MNR-39 **Combretaceae** Hareer/ Myrobalan	Tree/ Seed	Wild & cultivated	Sindh	Medicinal	Cooked	Onions are fried in oil and Terminalia chebula seeds and Emblic fruits are put in it. The Fennel seeds, Black chili *seeds, Coriander dry leaves and* Pomegranate dried seeds are grinded together are also added (with some salt and chilies) and fried for 10-15 minutes. Take this twice/day for weight loss.	20	0.10	+	+
72.	*Trachyspermum ammi* (L.) Sprague MNR-38 **Apiaceae**	Herb/ Seed	Cultivated	KPK, Central Punjab, Kashmir	Medicinal	Powder	To the seed powder (12mg) of this plant, fruit powder of fennel, emblic, seeds powder of Black chili (10 gm) & black salt	56	0.29	+	+

	Ajwain/ Ajwain						(10gm) are added. 1 teaspoon of this powder is taken thrice/day before meal.				
73.	*Trigonella foenum-graecum* L. MNR-16 **Fabaceae** Methi/ Fenugreek	Herb/ Stem, Leaf	Cultivated	Baluchistan, Central Punjab	Spice	Extract, Powder	The soft stem extract (150mg) and dried leaves powder (350mg) of this plant is mixed and small pills are made of it. 2 capsules are recommended (with water) in a day for reduction of obesity.	45	0.23	+	+
74.	*Vitis vinifera* L. MNR-62 **Vitaceae** Angoor/Grapes	Climber/ Fruit	Cultivated	Central Punjab	Fruit	Juice	Mix 1 glass of grape fruit juice with 1 teaspoon of lemon juice and drink it once/day for lack of appetite.	36	0.18	+	-
75	*Withania somnifera* (L.) Dunal MNR-27 **Solanaceae** Asgand/ Winter cherry	Shrub/ Root	Wild	KPK, Central Punjab	No use	Extract	The roots (250gm) extract is obtained and form pills of it with are dried for 2 days. 1 pill twice/day is taken before meal.	14	0.07	-	+
76.	*Zingiber officinale* Roscoe MNR-26 **Zingiberaceae** Adrak/ Ginger	Herb/ Root	Cultivated	Central Punjab	Spice	Decoction	To the 1 teaspoon of ginger root powder, 1 teaspoon of honey is added which is boiled in 2 cups of water for 10 minutes. 1 cup of this tea twice/day is taken.	42	0.21	+	+
77.	*Ziziphus jujuba* Mill. MNR-48 **Rhamnaceae** Bair/ Jujube	Tree/ Fruit	Wild	Central Punjab	Fruit	Raw	The 5-6 fruits are eaten raw which suppress appetite.	27	0.14	+	+

Table 2: Medicinal plants used for obesity disorders in Northern Pakistan.

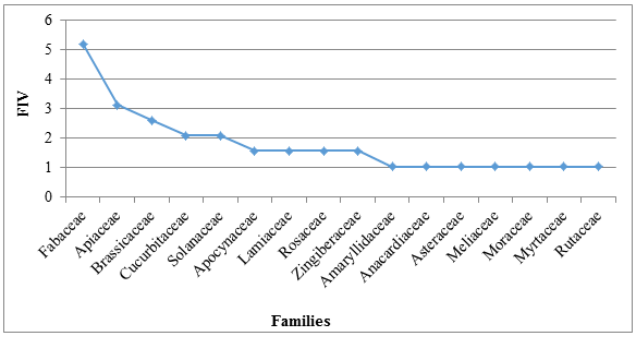

Figure 2: Anti-obesity medicinal plant families with higher Family Importance Value (FIV).

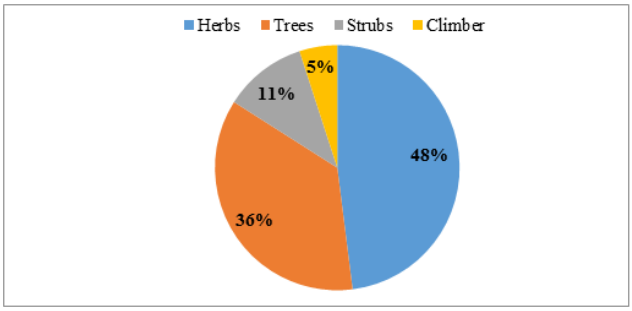

Figure 3: Life forms of anti-obesity medicinal plants of study area.

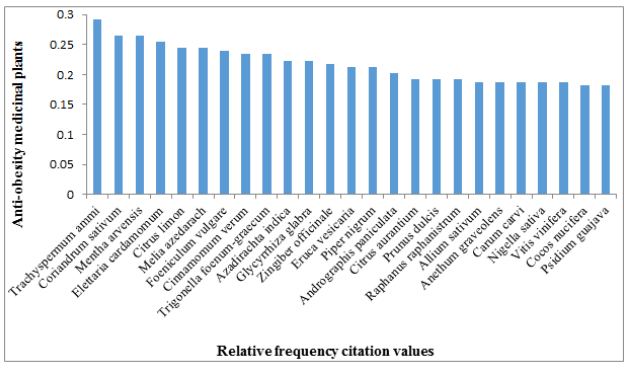

Figure 4: Anti-obesity medicinal plant species with higher RFC values.

Plant part used and modes of utilization

Fruits (35%) were the major plant part used among nine different parts of plants followed by leaves (26%) (Figure 5). Also, 29% species were used in fresh forms while 71% were used in dried or semi-dried form. The people were found to use a total of 9 different modes of preparations where the most common were plant extract and raw form (16% each) followed by decoction and juice (14% each; Figure 6). All the species (except *Chamaemelum nobile* and *Cedrus deodara*) were taken orally while 57% species recipes were based on the combination of different species.

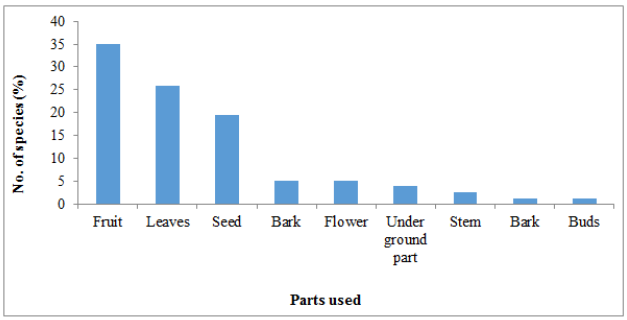

Figure 5: Plant parts used in treatment of Obesity.

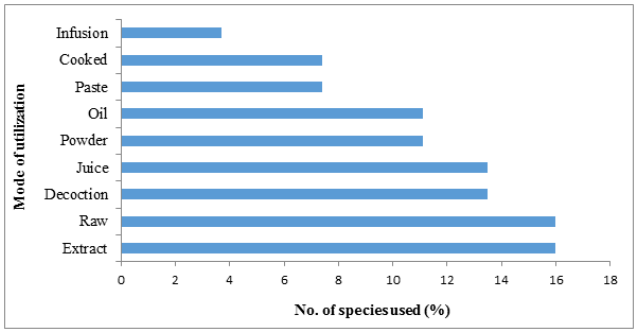

Figure 6: Mode of utilization of anti-obesity medicinal plant species of Northern Pakistan.

Among the reported species 62% were cultivated and 14% were wild while 23% were available in both i.e. cultivated and in wild too. 77% species were marketable while 23% were non-marketable. Regarding general use of the reported species, 22% were used as fruits/nuts, 12% as vegetables/salad and 23% as spice/condiments/flavoring agent while the remaining 31% were either of no special use or were miscellaneously used. Fresh parts were preferred to use by the local people (Table 2) as possibly some phytochemical constituents may be changed on drying. The predominantly oral route of administration like in present study (Table 2) has been reported from different regions [44-46].

Variations in traditional knowledge among informants

Age wise variation in traditional knowledge is a common ethnobotanical phenomenon reported in different studies [47-49]. Regarding gender, older women were more familiar with the nutritional preparation of different recipes while older men knew a longer list of species used. The herbalists were having some special expertise in identifying some wild species with their detailed recipes including number and amount of doses to be used. The knowledge of urban people about anti-obesity plants was not only indigenous, as the role of print and electronic media about nutritional diet for maintaining body weight was not negligible.

Other diseases related to obesity

Obesity and overweight cause many disturbances in body and results in many other diseases. Seven different types of diseases/syndromes were related to obesity and overweight in the study area. In the study area, obese and overweight people were found to have many other diseases as hypertension, cardiovascular and cerebrovascular diseases, diabetes, arthritis, sleep apnea, cancer and psychological disorders (Figure 7). The psychological disorders like social phobia, avoidant personality disorder, major depressive disorder and obsessive-compulsive disorder were also observed in obese and overweight people.

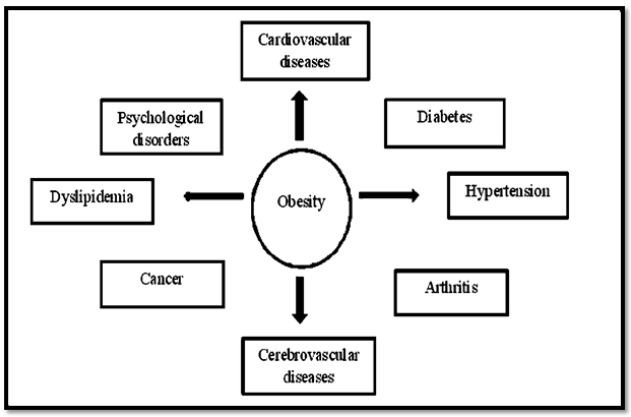

Figure 7: Other diseases related to obesity and overweight in the study area.

Comparison with previous studies and novelty index

Extensive literature search including ethnobotanical work and biological screening were performed which demonstrate that a 86% anti-obesity plant species are already reported from different parts of the world but 11 species (14%) are new reports in the study (Table 2). The relative frequency of citation (RFC) describes the local importance of plant species with reference to informants in the study area. Based on the RFC values, the most commonly used species includes Trachyspermum ammi and Coriandrum sativum which are also reported by Chandrasekaran [50] and by George and Nimmi [51] respectively. But Mentha arvensis (RFC 0.26) and Elettaria cardamomum (RFC 0.25) are reported for the first time. Other frequently used species are Citrus limon, Melia azedarach, Cinnamomum verum (0.234), Foeniculum vulgare (0.239) and Trigonella foenum-graecum (Table 2) are also reported from different parts of the world[6,50,52-54]. The highest FIV was reported for family Fabaceae (5.20) followed by Apiaceae (3.1), Brassicaceae (2.60), Solanaceae (2.08) and Cucurbitaceae (2.08) according to the present results. The calculations taken from literature review shows that approximately 354 species from 137 families are reported against obesity in which the Fabaceae (30 spp.) has the highest number of species followed by Asteraceae (28 spp.) and Lamiaceae (17 spp.) while the reported number of species from family Apiaceae, Brassicaceae, Solanaceae, and Cucurbitaceae are 15, 3, 6 and 8 respectively.

Discussion

The results indicated that 77 anti-obesity medicinal plants of high nutritional value from 38 families were documented. In villages people were found to be more rely on nutritional herbal medicines as compared to large cities where people preferred to use pharmaceuticals. But in Pakistan, ethnomedicines were found to be a part of culture as the nutritional herbal remedies was found to be recommended by old people present in each home as a blessing.

The reported anti-obesity medicinal plant species of high nutritional value were dominantly herbs followed by trees and shrubs. The dominance of herbs in the area was probably due to easy collection and preparation as compared to other life forms. Herbs as dominant life form have been reported in other studies for reducing weight by acting on metabolism and digestion [51] and for antilipase activity [55]. Fruits followed by leaves were the major parts used because of its effortless plucking, market availability, usage without processing and its less effects plant life. The major use of same plant parts have been reported by the Chandrasekaran [50]. Similarly, the extract and raw form as dominant mode of utilization in present study have been shown in other studies [52, 55]. Above half of the recipes (i.e. 57%) were prepared by the combination of multiple plant species of nutritional value which is considered as good by having high therapeutic power [56] but according to Kazemipoor [53] single plant preparations have higher degree of safety and efficacy. The combinations of some medicinal plants may result either in lowering efficacy or cause unexpected side effects.

To overcome excess weight gain, the uses of allopathic and pharmacological drugs are popular ways in developed countries but adverse toxicities limit their overall usefulness [6]. Also, the high cost and adverse side effects in long term usage are other limiting factors. The uses of natural products for treating obesity are under exploration, which is an alternative way for developing safe anti-obesity drugs [57-59]. The present study includes mostly the edible species which are safe and could be the best an inexpensive alternative in weight loss and management [6]. A variety of natural products, like crude extracts and isolated compounds from plants, can cause a reduction in body weight and could prevent diet-induced obesity. Therefore, for treating obesity they have been widely used [60]. The majority of the species in the present study were vegetables and fruits (Table 2) which are low in calories and fats but contain good amounts of minerals and vitamins.

Researchers consider botanical sources as more safe, reliable and cheaper than synthetic chemical drugs and surgical procedures having an adverse effect [53]. Recent preliminary reports suggested that herbs with natural substances and with a long history of use produce less toxicity which is effective in reducing appetite and also aid in weight loss [6]. The anti-obesity plant preparations exhibit their effects in many ways, including stimulating thermogenesis, enhancing lipolysis, lowering lipogenesis, suppressing appetite and decreasing absorption of lipids [53].

The understanding of heterogeneity in knowledge and practices within a given area is important for sustaining knowledge transmission in relation to resource management [61]. Medicinal plants knowledge was passing mostly in vertical form from generation to generation but also horizontally within the community. Such transmission of knowledge has been reported by Monigatti [62] while dealing with medicinal plant use in Andean communities of Peru. The people having stronger link with the ancestors (age, living in rural area and economic dependency on natural resources) were more knowledgeable and it was vice versa in case of higher income and education and living in urban areas. There was considerable age wise difference in knowledge of individuals and its vertical transfer was getting slow.

The majority of the people in the study area were found to be affected by obesity due to their lifestyle, medications, and dietary patterns. Other studies conducted in different countries [4,8,51,63,64] linked obesity with several other diseases. The psychological disorders were also observed in obese people due to poor mobility which reduce their social interaction results in depression, also reported in other [65, 66]. Obesity, being a prominent syndrome in Pakistani society but up till there is no existing ethnobotanical surveys on medicinal plants used for this purpose so the present work in the first step towards this direction. This survey would facilitate the investigation of health status

of people and will provide robust data for future evaluation and preparation of herbal drugs for obesity and overweight.

Conclusion

The use of traditional medicines for the treatment of various ailments and their importance are well recognized in Pakistan. This study shows that indigenous knowledge about medicinal plants is still practiced in many parts of Northern Pakistan. Obesity is the major and growing problem in the country and also associates with many other diseases, therefore there is a dire need to emphasize on weight management for the prevention of obesity and many other related diseases. This study provides us the recognition and documentation of anti-obesity plants knowledge which could further be exploited by phytochemical investigations that may lead to isolation and characterization of new possible novel agents.

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