



Ethnobotanical survey of medicinal plants used to manage High Blood Pressure and Type 2 Diabetes Mellitus in Bitterfontein, Western Cape Province, South Africa

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Abstract

Ethnopharmacological relevance: The aim of this study was to identify and document medicinal plants used to manage High Blood Pressure and Type 2 Diabetes Mellitus in Bitterfontein, Western Cape Province, South Africa.

Methods: One hundred and twelve (112) respondents were interviewed between August 2014 and September 2015 through semi-structured surveys to gather data on the percentage of people who had been diagnosed with High Blood Pressure and/or Type 2 Diabetes Mellitus and to determine the frequency of medicinal plant and allopathic medicine use. Twelve (12) key respondents were subsequently selected, using a non-probability snowball sampling method. They were interviewed in-depth concerning their plant practices and assisted with plant collection.

Results: Twenty-four plant (24) species belonging to 15 families were identified for the management of High Blood Pressure and Type 2 Diabetes Mellitus. The most frequently reported families were Asteraceae (20.8%), Lamiaceae (16.67%), Crassulaceae (8.33%) and Aizoaceae (8.33%). The remaining (45.54%) were evenly split over eleven families- Fabaceae, Amaryllidaceae, Anacardiaceae, Capparaceae, Geraniaceae, Apiaceae, Convolvulaceae, Apocynaceae, Rutaceae, Asphodelaceae and Thymelaeaceae. The most commonly used plant species overall was *Lessertia frutescens* (96.55%). The most frequently used plant parts included leaves (57.63%) roots/bulbs (15.25%) and stems (11.86%), mostly prepared as infusions or decoctions for oral administration.

Conclusions: Medicinal plants are widely used by High Blood Pressure and Type 2 Diabetes Mellitus sufferers. They employ diverse plant species to manage both conditions. In addition, some sufferers often use prescribed allopathic medication, as well as medicinal plants, but at different intervals. Despite high usage the plants identified are not currently threatened (Red Data list status: least concern).

1. Introduction

High Blood Pressure (HBP) and Type 2 Diabetes Mellitus (T2DM) are growing concerns worldwide. The rate of new cases and number of deaths caused by these two non-communicable diseases are a public health concern: alongside infectious diseases such as human immuno-deficiency virus (HIV) and tuberculosis (TB) (Cheung and Chao, 2012). According to the World Health Statistics Report, one in three adults worldwide has HBP and one in ten has T2DM (World Health Organisation (2003, 2012)). There is substantial overlap between the two conditions in aetiology and disease mechanisms. Many of those affected by T2DM also have, or go on to develop, HBP - a condition known as Diabetic Hypertensive (Balogun and Salako, 2011). The latter is a common condition in which the flow of blood through the arteries occurs at pressures higher than normal. In its chronic state it is called Hypertension, i.e. when the blood pressure is higher than 140 over 90 mmHg (Carretero and Oparil, 2000). South Africans over the age of 50 are especially at risk and currently have one of the highest occurrences of HBP in the world (Lloyd-Sherlock et al., 2014a).

T2DM is defined as a random blood glucose level (RGB) above P11.1 mmol/L, or RBG < 11.1 mmol/L (Bailey et al., 2016). T2DM is a chronic condition that affects the way in which the body metabolizes sugar (glucose). The prevalence of T2DM is escalating worldwide (Kadima and Tumbo, 2013). In South Africa, approximately 6% of the population suffers from T2DM (Bertram et al., 2014). According to the World Health Organisation's (WHO) (2016), this condition is the fifth leading cause of death in South Africa. In the Western Cape Province, however, little information is available on the occurrence of T2DM. In prevalence surveys conducted in the Province, the statistics of T2DM fluctuates from rural to urban areas and among different population groups (Erasmus et al., 2012; Hughes et al., 2013; Health24, 2014; Bailey et al., 2016). The prevalence of T2DM is thought to be especially high among the coloured¹ population (Erasmus et al., 2012). This was the case in our study site, Bitterfontein. T2DM is also one of the biggest causes of natural death in the Western Cape (Bothma, 2014). HBP and T2DM are risk factors for an array of associated conditions such as cardiovascular disease, renal, neurovascular and retinal complications ((Balogun and Salako, 2011; Bertram et al., 2014). Given that there is a high correlation between HBP and T2DM, it is important to consider their co-occurrence, since they are pre-eminent in relation to morbidity and mortality.

It is not clear from available literature how HBP and T2DM are managed in semi-rural areas in the Western Cape where access to health care facilities, diagnosis and treatment may not be optimal (Health24, 2014). Little is known about the use of traditional herbal medicine (THM) to manage the above conditions and ethnobotanical studies do not always compare their findings with scientific studies that investigate the phytochemical effects of THM. The use of THM in combination with allopathic medicine has also not been studied extensively. At the

same time, there has been increased concern about the cost and availability of pharmaceuticals, especially in rural areas. Prescribed medicines used for HBP and T2DM can produce side effects such as headaches, nausea, vomiting, stomach pain, constipation, diarrhoea, weakness and fatigue. People often turn to THM to combat such symptoms and to manage their health, contributing to a growing tendency to consider THM that is known to promote good health, with minimal side effects. This trend has led academic researchers, as well as the pharmaceutical industry, to consider THM as a potential source of new, safe and affordable alternatives (Day, 1998). THM, on the whole, are also believed to be relatively safe and harmonious with biological systems (Atal, 1983; Erasto, 2003). The practice of using nature as a source of medicine dates back in history and various current medicines were originally derived from plants. As many herbal remedies have not been clinically tested, they are classified as complementary and alternative medicines and are considered to be generally affordable and accessible. In South Africa a big informal market in THM exists (Street and Prinsloo, 2013).

South Africa has a pluralistic health care system (Levine, 2012; Wreford et al., 2006) and the usage of what is referred to as “traditional” medicines is often reported to be as high as 80%, although the frequency of use fluctuates from one province to another and between rural and urban areas (Dold and Cocks, 2002; Nxumalo et al., 2011; Davids et al., 2014; Hughes et al., 2013). In the Western Cape, and especially in the Matzikama district, knowledge and usage of medicinal plants is often associated with the knowledge of elderly people (Davids, 2012), bossiesdokters (bush doctors/herbalists) (Cohen, 2009, 2013) and Rastafari bush doctors (Nortje, 2011; Philander, 2011; Philander et al., 2014) and it is often intermingled with a range of knowledge heritages. The most prevalent in Matzikama is frequently termed Khoisan medicine (Low, 2007) or “Cape herbal medicine” (van wyk, 2008). The latter nomenclature intimates the intermixing of Khoisan ancestral healing knowledge and practices concerning medicinal plants with historical “Cape Dutch” influences in the Western Cape. Locally sourced medicinal plants fall under the rubric of “traditional” medicine in South Africa. Although the reality of pluralistic healing systems is accepted, notions of “traditional” medicine are nonetheless fraught with epistemological dilemmas (Ellen and Harris, 2000; Gibson, 2011). South African discourses on traditional medicine tend to draw on “traditional” knowledge/s in contradistinction to “Western” or “scientific” knowledge. HBP and/or T2DM sufferers, however, are often informed by both in their health care choices. This paper draws on the aforementioned debates to define THM as local knowledge, principally orally transmitted, which is common practice in the everyday life of users. THM knowledge is empirical and its display is somewhat repetitive but it is also transformative, it is produced and reproduced, and can be lost. The knowledge is dispersed, practical, and broadly holistic (Ibid: 5). For the purpose of this study and to avoid confusion, traditional herbal medicine utilised in the Matzikama district will hereafter be referred to as THM.

In South Africa, recent studies suggest that THM is used to manage the symptoms of HBP. For instance, a study conducted by [Hughes et al. \(2013\)](#) in Langa, Cape Town, found that 51% of their study sample used THM for HBP. Forty eight percent (48%) used THM between one and three times a day over extended periods. There is also increased interest in the use of THM for the management of T2DM ([Erasto et al., 2005](#)). The aim of this study was to identify and document medicinal plants used to manage HBP and T2DM in Bitterfontein, Matzikama municipal district, Western Cape Province, South Africa. Since much of the research conducted in the Western Cape Province on HBP and T2DM focuses on the Cape Metropole, are older studies and/or are population specific ([Levitt et al., 1999](#); [Idemyor, 2010](#); [Erasmus et al., 2012](#); [Bailey et al., 2016](#)), information about the prevalence of both conditions varies. The number of people medically diagnosed with one, or both, of these conditions therefore had to be ascertained and the utilisation of allopathic medicines as well as medicinal plants had to be deduced. The latter was subsequently compared with extant literature to gain insight into related scientific research, as well as to establish the plants' conservation status.

2. Materials and methods

2.1 Study design and sample size

A cross sectional descriptive research methodology was used to explore THM use and practices. The study was designed to gather data at three different levels in three progressive phases. First, a semi-structured survey was designed and used to gather data on the number of people previously diagnosed by health care providers with the target conditions, as well as the frequency of THM use over the previous four weeks. A simple random sampling method was used to screen all households and select one hundred and twelve (112) eligible participants. Eligibility criteria included participants who were above eighteen (18) years of age and had previously been medically diagnosed with the target condition(s).² A blood pressure reading higher than 140 over 90 mmHg and a RBG < 7.8 mmol/L in participants with previous diagnoses of T2DM were considered acceptable levels for participation. These readings were initially done at the clinic and are then regularly tested by home based care staff. Participants were also questioned about allopathic medicine and THM use. Secondly, in-depth semi-structured interviews were conducted with twelve (12) key participants, selected through a non-probability "snowball" sampling method ([Heckathorn, 2011](#)). The municipal councillor for the Bitterfontein ward initially mediated the researchers into the local community, and assisted in identifying key participants who were especially knowledgeable about THM. These participants included community elders, practising bossiesdokters and Rastafari bush doctors. These key participants were also regularly consulted by locals about THM to manage HBP and T2DM. The third and final phase comprised two rounds of plant collection during the spring and summer months of 2014 and 2015.

2.2 Study area

Bitterfontein is a small semi-rural village situated in the Matzikama municipal area. The village is the northernmost settlement on the border of the Western and Northern Cape Provinces and lies three hundred and eighty six (386) kilometres from Cape Town. Bitterfontein is surrounded by different landscapes, from the flowing granite hills of the Knersvlakte to the Hardeveld with its hard, dry soil and scattered bushy quartz fields. According to the 2011 Census, Bitterfontein had a population of 986 in an area of 39.90 km². There are 231 households. The majority of the population is “coloured” (91.28%) and most of the inhabitants are Afrikaans speaking (97.34%). More than half (50.71%) of the population are female and 49.29% are male ([Statistic South Africa, 2011](#)). Economic activity in the area comprises tourism, agriculture and mining. Poverty and high rates of unemployment (67%) are often seen as contributing factors in studies of poor health and non-communicable diseases such as HBP and T2DM ([Matzikama Municipality, 2013](#)). The village is serviced by a small satellite clinic. ([Fig. 1](#)).

2.3 Data collection

The first round of data collection began with surveys in August 2014 and ended in September 2014. The surveys were administered by eight trained field workers with background training in medical anthropology and ethnobotany. One local fieldworker acted as a field guide and assistant. Field workers screened all houses in Bitterfontein, asking the screening questions: are you above the age of eighteen years? have you or anyone in the household been medically diagnosed with HBP and or T2DM? If a person answered yes to the above, (s)he was asked whether they had used THM and/or allopathic medicines during the previous four weeks. The aims and objectives of the study were explained, an information leaflet was provided and informed consent recorded if the person was willing to participate in the study. If a participant did not wish to sign a consent form, verbal consent was accepted and audio-recorded. Interviews were conducted in the preferred language of the participant (English or Afrikaans).

In the second round of data collection, selected participants were revisited. This key group included six bossiesdokters, three Rastafari bush doctors and three knowledgeable old people. There was an equal number of male and female participants. Written informed consent was again confirmed by each participant after the aims and objectives of the study were explained in the participants' preferred language (mostly Afrikaans). The interviews were tape recorded and extensive field notes and photographs were taken with the consent of the participants. The topic schedule for the interviews included probing questions to enhance consistency and accuracy in participants' responses and to compare responses. The second round of data collection took place from September 2014 to April 2015.

The third round of research involved plant collection from November to December 2014 and March 2015. Because the research site was visited during all the seasons, the plants were observed in drought conditions and rainy season. The plant collection was undertaken with the assistance of a botanist and all of the key participants on different occasions. Plants were collected three-fold, numbered and dry-pressed in the field. Together with plant pressings, the collection team noted vernacular plant names, their locality, GPS coordinates, habitat, plant distribution when collected, plant parts used, preparation and administration methods. Each collected specimen included leaves, stems, flowers and fruits where available. For small herbaceous plants, the whole plant was collected. The collected specimens were deposited at the Herbarium of the University of the Western Cape (UWC) together with collection/field notes and a comprehensive reference collection with representative specimens. The plant names were updated using Kew's plant list <http://www.theplantlist.org/> (accessed and updated: 28.02.2016).

2.4 Data analyses

After the surveys were completed, they were checked for quality and completeness. Data was analysed using IBM SPSS V.22.0. Standard descriptive measures were used to describe the study sample and responses to the questionnaire. Chi-square tests were used when making comparisons between two groups. All percentage distributions were calculated based on non-missing values. No amendments were made for missing data or multiple comparisons.

The in-depth, semi-structured interviews were analysed using a thematic content analysis method (Heckathorn, 2011). After the interviews, the derived data underwent numerous stages of analysis, initially transcribing the material and then checking for coherence and saturation. The material from different respondents were compared with each other to identify patterns and themes. Segments of data were then coded. The emerging themes were linked to sections of data with associated codes such as plant practices, method of administration and path of knowledge. When no new information arose from the material and when no new codes or themes emerged, the authors agreed that saturation had been achieved.

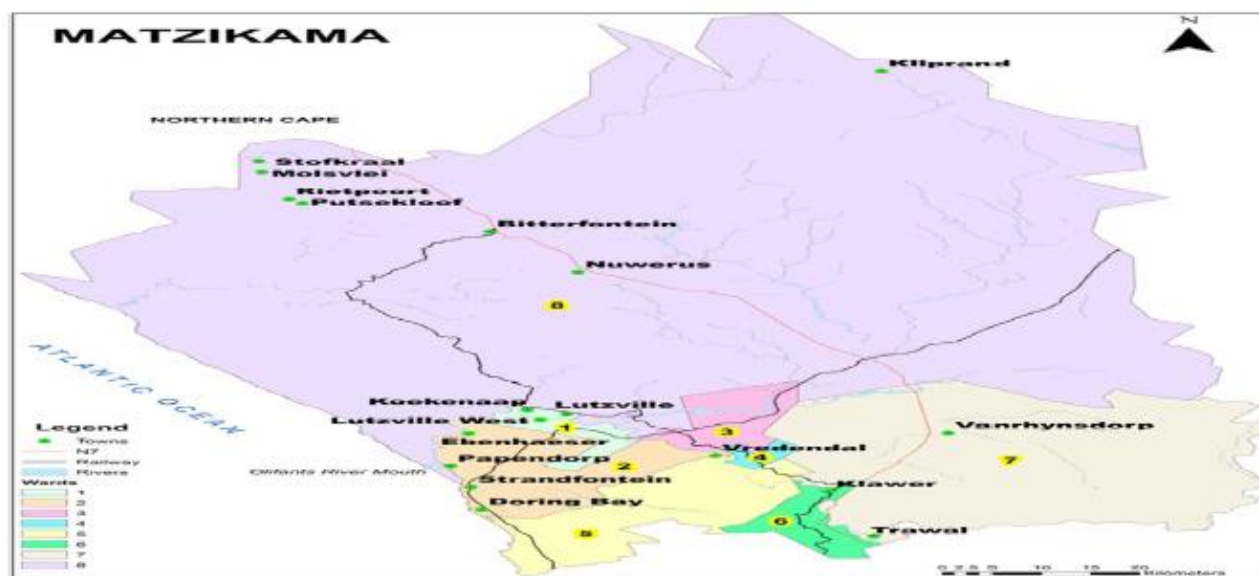


Fig. 1. Bitterfontein, Matzikama Municipality, Western Cape Province. Source: Lionel Phillips.

2.5. Ethical approval and considerations

Ethical approval for this study was obtained from the Senate Ethics Committee, University of the Western Cape (Project ethics number: 13/8/3). A plant collection permit was acquired from Cape Nature (Permit number: 0028-AAA008-00221). Informed consent was obtained from each participant. Participants were informed of the aims and objectives of this research and interviewed in their preferred language (Afrikaans or English).

Before the research began the local Councillors representing the Bitterfontein constituency, employees of the Matzikama Municipality and the local community participated in a seminar in which a Memorandum of Understanding was agreed on and signed, and the community's participation and benefit sharing discussed. It was made clear that the study was for research purposes only, and not for product development.

3. Results and discussion

3.1 Socio-demographics of participants

In the study sample, 34.8% of participants were male and 65.2% were female. The majority of participants spoke Afrikaans (98.2%) and most were of the Christian denomination (94.6%). Participants' ages ranged from 19 to 87 years. Forty per cent (40.2%) of the participants had primary education, 43.8% secondary education, 3.6% tertiary education and 12.5% had no formal education. More than half of the sample population (50.9%) relied on state funded grants such as pensions (33.93%) and disability grants (16.97%). Only 10.7% held full-time jobs and a further 34.8% were unemployed. The remaining cohort were employed part-time (1.8%) or self-employed (1.8%). The total sample of participants who were

employed (14.3%), derived their income from work as farm labourers, keeping and selling livestock, informal trade and providing labour for mines in the region. A large proportion of participants (59.8%) fell within the R0≤R1999 per month income category. None of the participants in this study had medical aid insurance. [Table 1](#) specifies the socio-demographic characteristics of participants in Bitterfontein.

3.2 Medicinal plants used for HBP and T2DM

Twenty-four (24) plant species belonging to 15 families were documented for the management of HBP and T2DM. The plant species, family, vernacular names (specific to the study area), reported use and part of plant used are presented in [Table 2](#). More than half (52.79%) of the study sample reported the active use of THM, i.e. they had utilised THM at least once a day for the previous two weeks at the time of interview. Non-active users (21.11%) utilised THM at least once a week in the four weeks prior to the interviews. *L. frutescens* was the most commonly reported plant species (96.55%) among all THM users in this study. The other plant species were not as significantly reported, and were often used in concoctions together with *L. frutescens*. The most frequently reported families were Asteraceae (20.8%), Lamiaceae (16.67%), Crassulaceae (8.33%) and Aizoaceae (8.33%). The remaining (45.54%) were evenly split over eleven families-Fabaceae, Amaryllidaceae, Anacardiaceae, Capparaceae, Geraniaceae, Apiaceae, Convolvulaceae, Apocynaceae, Rutaceae, Asphodelaceae and Thymelaeaceae. Some of these families have been documented and researched for their anti-hypertensive and anti-diabetic potential ([Sunmonu and Afolayan, 2010](#); [Hughes et al., 2013](#); [Chethan et al., 2014](#)), suggesting their importance for the management of HBP and T2DM.

3.3 Inventory of plant species used for HBP and T2DM

The claimed therapeutic indications of some of the plants reportedly used to manage HBP and T2DM in this study have partially been validated by studies in experimental animals, while others have been documented for their medicinal use in ethnobotanical studies. *L. frutescens* for example, is the most frequently used plant species in this study, widely utilised in the Western Cape and along the west coast of South Africa for the treatment of T2DM ([van wyk and Albrecht, 2008](#); [Rood, 1994](#); [van wyk and Gericke, 2000](#); [van wyk et al., 1997](#)). *L. frutescens* has been investigated as a possible hypoglycaemic agent for managing T2DM, through stimulating glucose uptake in pre-diabetic rats ([Chadwick et al., 2007](#)). Because of its capacity to normalize insulin levels in diabetic patients, *L. frutescens* is considered to be a promising anti-diabetic agent ([Sia, 2004](#)). High levels of pinitol in *L. frutescens* leaves were proposed by [Moshe \(1998\)](#) as a possible explanation for the anti-diabetic effect of its extract. [Tai et al. \(2004\)](#) found that *L. frutescens* contained not only pinitol, but also non-protein amino acid L-canavanine, gamma aminobutyric acid (GABA) and asparagine. The presence of pinitol in *L. frutescens* leaves was shown in studies to be most probably responsible for the anti-diabetic effects of plant extracts. It is reportedly efficacious in decreasing blood

sugar levels and improves the availability of glucose for metabolic reactions to occur (Bates et al., 2000; van wyk and Albrecht, 2008; Van-Wyk et al., 2005; Deutschländer et al., 2009). The Gamma-aminobutyric acid (GABA) in *L. frutescens* could be of benefit by lowering HBP (Abe et al., 1995; Dalvi, 2003).

There is always concern regarding the safety of THM. Studies on *L. frutescens*, however, have indicated little to no side effects.

Table 1
Socio-demographic characteristics of participants (n=112).

| Characteristics | Frequency | Percentage (%) |
|---------------------------------|-----------|----------------|
| Age group (Years) | | |
| Less than 20 | 3 | (2.7) |
| 21–30 | 8 | (7.1) |
| 31–40 | 22 | (19.6) |
| 41–50 | 22 | (19.6) |
| 51–60 | 19 | (16.9) |
| 61–70 | 22 | (19.6) |
| 71–80 | 13 | (11.6) |
| 81–90 | 3 | (2.7) |
| Gender | | |
| Male | 39 | (34.8) |
| Female | 73 | (65.2) |
| Language | | |
| English | 2 | (1.8) |
| Afrikaans | 110 | (98.2) |
| Religion | | |
| Christian | 106 | (94.6) |
| Rastafarian | 5 | (4.5) |
| ATB* | 1 | (0.9) |
| Level of education | | |
| Primary | 45 | (40.2) |
| Secondary | 49 | (43.8) |
| Tertiary | 4 | (3.6) |
| No education | 14 | (12.5) |
| Employment status | | |
| Full-time | 12 | (10.7) |
| Part-time | 2 | (1.8) |
| Self-employed | 2 | (1.8) |
| Unemployed | 39 | (34.8) |
| Other (SFG)* | 57 | (50.9) |
| Monthly household income | | |
| R0≤R1999 | 67 | (59.8) |
| R2000≤R4999 | 12 | (10.7) |
| R5000≤R10999 | 1 | (0.9) |
| DND* | 32 | (28.6) |
| Total | 112 | (100) |

* ATB: African traditional beliefs * SFG: State funded grant * DND: Did not wish to disclose.

Table 2
Medicinal plants used for the management of HBP and T2DM.

| Family | Species | Voucher number | Vernacular names (Specific to Bitterfontein) | Reported use | Part of plant used | Notes |
|----------------|---|----------------|--|----------------------------------|----------------------------------|---|
| Fabaceae | <i>Lessertia frutescens</i> (L.) Goldblatt & J.C. Manning | P03_01 (UWC) | Kankerbos/bitterbos/kiertjies/blaasiebos | High Blood Pressure and Diabetes | Leaves | Mostly prepared as a single remedy. |
| Lamiaceae | <i>Leonotis leonurus</i> (L.) R.Br. | P25_06 (UWC) | Wilde dagga | High Blood Pressure and Diabetes | Leaves, roots and flowers | The, leaves, roots and flowers are used in a decoction to treat pain and inflammation associated with HBP and T2DM. The plant is also reportedly used as a pain reliever. |
| Asteraceae | <i>Artemisia afra</i> Jacq. ex Willd. | P06_04 (UWC) | Wilde als | High Blood Pressure and Diabetes | Leaves | <i>A. afra</i> is widely used to treat a variety of ailments and as a general tonic. A strong infusion of <i>A. afra</i> is said to drastically reduce blood pressure and sugar levels. |
| Thymelaeaceae | <i>Gnidia deserticola</i> Gilg | P11_02 (UWC) | Koorsbos | Diabetes | Leaves, stems and roots | <i>G. deserticola</i> is used as a blood purifier, for respiratory problems, skin rashes, ulcers, snake bites, colds and flu. A remedy of <i>L. frutescens</i> , <i>G. deserticola</i> and <i>B. africana</i> are used for diabetes and pain relief. |
| Lamiaceae | <i>Salvia africana-caerulea</i> L. | P10_04 (UWC) | Blousalie/bloublomsalie | High Blood Pressure | Leaves | Combined with Epsom salts and lemon juice to treat colic, diarrhoea, flatulence, heartburn and indigestion. Mixed with <i>L. frutescens</i> to treat fever, rashes and headaches associated with HBP. |
| Lamiaceae | <i>Ballota africana</i> (L.) Benth | P18_02 (UWC) | Kattekruid | High Blood Pressure | Leaves | As a tea to treat coughs, colds, sore throats, influenza, asthma, bronchitis, colic and fever. |
| Asphodelaceae | <i>Aloe ferox</i> Mill. | P10_02 (UWC) | Bitter alwyn | Diabetes | Leaves/sap | The sap of <i>A. ferox</i> is widely used for cuts, sores and burns, as strong laxative and blood purifier. |
| Rutaceae | <i>Diosma oppositifolia</i> L. | P07_02 (UWC) | Skaapbos | High Blood Pressure | Leaves, stems and flowers | Used with <i>E. rhinocerotis</i> as a remedy for acute cases of HBP. As a general tonic it is used for pain, coughs and colds and for stomach complaints. |
| Asteraceae | <i>Dicerthamnus rhinocerotis</i> (L.f.) Koek. | P16_02 (UWC) | Ranosterbos | High Blood Pressure and Diabetes | Leaves and stem | Used in a remedy together with <i>D. oppositifolia</i> to treat stomach complaints including indigestion, stomach cancer and a lack of appetite. The dried stems are used to treat diarrhoea. Also used for fever and inflammation associated with HBP. |
| Aizoaceae | <i>Sceletium tortuosum</i> (L.) N.E. Br. | P15_02 (UWC) | Kougoed | High Blood Pressure | Leaves and roots | <i>S. tortuosum</i> is used as a single remedy for pain, stress and anxiety. Although not directly associated with HBP reduction, it is used to reduce anxiety and therefore reduce blood pressure. |
| Asteraceae | <i>Tagetes minuta</i> L. | P25_10 (UWC) | Koebiebos | Diabetes | Leaves | The sap and stems are poisonous. Dried leaves are used to make a tea to manage pain, inflammation and as a blood purifier. |
| Crassulaceae | <i>Crassula muscosa</i> L. | P03_02 (UWC) | Akkedisbos | High Blood Pressure and Diabetes | Leaves, stems, roots and flowers | A decoction of the leaves in boiling water is used for colds, flu, fevers and stomach complaints. The flowers and roots are dried, grated and consumed with thick milk for stomach complaints. |
| Crassulaceae | <i>Tylecodon paniculatus</i> (L.f.) Toelken | P25_2 (UWC) | Bees se bal | Diabetes | Leaves and stem | The heated leaves and stems are placed on wounds, rashes and sores. The sap from leaves and stems are used as a purgative and blood purifier. |
| Asteraceae | <i>Chrysocoma ciliata</i> L. | P02_05 (UWC) | Bitterbos | High Blood Pressure and Diabetes | Leaves and roots | A decoction of the leaves and roots are used for gout, rheumatism, fever and constipation. |
| Apocynaceae | <i>Hoodia gordonii</i> (Masson) Sweet ex Decne | P26_01 (UWC) | Bitterghaap | Diabetes | Inner stem | Inner stem is consumed as a blood purifier and to control blood sugar. |
| Asteraceae | <i>Euryops abrotanifolius</i> (L.) DC. | P08_02 (UWC) | Harpuisbos | High Blood Pressure and Diabetes | Stem and leaves | Mixed with <i>E. rhinocerotis</i> and <i>D. oppositifolia</i> as a general tonic for HBP and T2DM. <i>E. abrotanifolius</i> is also known for treating chest complaints. |
| Lamiaceae | <i>Mentha longifolia</i> (L.) L. | P01_01 (UWC) | Ballerja | High Blood Pressure and Diabetes | Stem and leaves | A decoction of the leaves are used for headaches, respiratory ailments, coughs and colds and for general stomach complaints. <i>M. longifolia</i> is added to other plant combinations to reduce side effects and improve taste. |
| Convolvulaceae | <i>Convolvulus capensis</i> Burm. f. | P25_05 (UWC) | Bitterpatat | High Blood Pressure and Diabetes | Bulb | The bulb of <i>C. capensis</i> is dried, grated and boiled as a general tonic for stomach ailments and blood purification. |
| Apiaceae | <i>Lichtensteinia lacera</i> Cham. & Schltl. | P18_04 (UWC) | Kaalmoes | High Blood Pressure and Diabetes | Stem and leaves | <i>L. lacera</i> is drank as a tea for stomach ailments and a general tonic for cold and flu. |

(continued on next page)

Table 2 (continued)

| Family | Species | Voucher number | Vernacular names (Specific to Bitterfontein) | Reported use | Part of plant used | Notes |
|----------------|--|----------------|--|----------------------------------|------------------------|---|
| Geraniaceae | <i>Pelargonium antidyentericum</i> (Eckl. & Zeyh.) Kostel. | P04_05 (UWC) | Rooistorm | Diabetes | Roots | A tea made of the dried roots is taken for a variety of stomach ailments. The same tea is consumed once a day as a general tonic for T2DM. |
| Aizoaceae | <i>Carpobrotus edulis</i> (L.) N.E.Br. | P25_07 (UWC) | Suurvye/hotnotsvye | Diabetes | Leaves/sap/fruit | The leaf juice is said to act as a laxative. A mixture of leaf juice, sugar and milk is used as a remedy for TB. The sap and fruit is used to manage T2DM. |
| Capparaceae | <i>Cadaba aphylla</i> (Thunb.) Wild | P25_12 (UWC) | Swartstorm | High Blood Pressure and Diabetes | Stem and leaves | The dried leaves and stem are drunk as a tea for stomach complaints and as a general tonic. |
| Anacardiaceae | <i>Searsia burchellii</i> (Sond. ex Engl.) Moffett. | P09_02 (UWC) | Taaibos | High Blood Pressure and Diabetes | Leaves, stem and roots | The leaves and stem of <i>S. burchellii</i> are used raw to treat cuts and sores. The fresh leaves are drunk as a tea for stomach complaints and fever. |
| Amaryllidaceae | <i>Tulbaghia violacea</i> Harv. | P01_03 (UWC) | Wilde knoffel | High Blood Pressure and Diabetes | Leaves and roots | The roots of <i>T. violacea</i> are used in a bath to ease rheumatism and fever. A tea of roots and leaves are used to treat coughs and colds and also to manage HBP. |

In a study conducted on Vervet monkeys, no adverse reactions were reported to high dosages of aqueous extracts of *L. frutescens* (Seier et al., 2002). In South Africa a Phase I double-blind, placebo-controlled study on healthy individuals found that 400 mg of leaf powder capsule twice a day for three months was tolerated without adverse effects (Johnson et al., 2007). A preclinical study by Minocha et al. (2011) does however indicate that the co-administration of *L. frutescens* with nevirapine could affect the pharmacokinetics of this drug in rats. Wilson et al. (2015) reported that in a clinical trial on *L. frutescens* two participants developed tuberculosis while also taking isoniazid preventive therapy (IPT). According to the study the THM may have reduced the efficacy of IPT.

Diosma oppositifolia was also frequently used for the management of HBP and/or T2DM in this study. This species has been described as a broad-spectrum tonic, used in the treatment of intestinal discomfort, kidney problems, occasionally for external sprains and flatulence (Nortje, 2011; Philander, 2011). The leaves are sometimes infused in brandy or vinegar, and synthesizing tinctures used for bruises and sprains (Philander, 2011). At present, there is no available literature on scientific studies concerning anti-diabetic or antihypertensive properties, nor is there any information regarding the toxicity of this plant.

Gnidia deserticola is a member genus of the family Thymelaeaceae, consisting of approximately 152 species (Bhandurge et al., 2013). There is no information in the literature of *Gnidia* being used to treat HBP and T2DM, though members of the genus are used for a wide array of conditions, ranging from asthma to nightmares, to yellow fever (e.g. Borris et al., 1998; Van-Wyk et al., 2005). Some *Gnidia* species have displayed severe irritant properties, leading to death in animals and humans owing to the prevalence of toxic coumarins and diterpene esters. Adverse symptoms resulting from *Gnidia* intake include inflammation of the larynx, edema

of the islands, vomiting, discharge of blood upon desiccation, rapid pulse, moist skin, muscular twitching and delirium. These symptoms are followed by convulsion and death in 20–25% of cases (Bhandurje et al., 2013). The toxicity of the genus raises some concern as it is readily used in plant preparations in Bitterfontein.

Tulbaghia violacea has reportedly been used to treat HBP and T2DM, but also fevers, influenza, intestinal worms, oral infections, asthma and tuberculosis (Raji et al., 2015; Lyantagaye, 2011; Moodley et al., 2015). *T. violacea* falls within the same family as *Allium sativum* L., a species utilised as a remedy for T2DM in traditional Indian medicine (Mukherjee et al., 2006). Other members of the family possess similar phytochemical compounds (Cox and Ballick, 1994; Motsei et al., 2003), such as *T. violacea*, which contains sulphur compounds: often accounting for the distinguishing odours and the medicinal potential of both the *Tulbaghia* and *Allium* species (Lyantagaye, 2011). Aqueous extracts of *T. violacea* show substantial glucose uptake in Chang liver cells. *T. violacea* contains phytochemical components such as steroidal saponins, quercetin, kaempferol, sugars, and/or sulphur-containing compounds (Duncan et al., 1999) which could have potential glucose-lowering effects. Similarly, sulphur containing compounds in this species have been found to result in hypoglycemic effects in diabetic animals, arising from their antioxidant activity (Mukherjee et al., 2006).

Infusions of *T. violacea* extracts have been found to decrease systolic blood pressure (SBP) in male spontaneously hypertensive Wistar rats (SHR) (Raji et al., 2015) and in normotensive male Wistar rats (Ramesar et al., 2008), compared to the corresponding values in the control rat groups in experiments. A study by Lyantagaye (2011) examined the effects of *T. violacea* methanolic extract on blood glucose, serum lipids and anti-oxidative status in streptozotocin induced diabetic rats. Plasma insulin levels were found to be significantly reduced in the diabetic control and treated diabetic groups compared to the non-diabetic control group ($p < 0.001$). *T. violacea* treatment produced a notable hypoglycemic effect by dropping fasting glucose levels and cultivating glucose tolerance. The antioxidant activity of *T. violacea* has been attributed to the presence of organo sulphur compounds, which are believed to possess powerful antioxidant properties capable of stimulating liver antioxidant enzymes (Günthner, 2009). It has been noted that prolonged and excessive use of *T. violacea* bulbs causes gastrointestinal distress and may be related to acute inflammation and sloughing off of intestinal tissue, as well as the interruption of peristalsis (Lyantagaye, 2011). *Artemisia afra* is extensively utilised in Southern Africa for the treatment of T2DM, as well as for coughs, colds, headaches, loss of appetite, gastric imbalances, colic, gout, asthma, malaria, kidney and bladder disorders, influenza, convulsion, fever, heart inflammation, rheumatism and as a purgative (Watt and Breyer-Brandwijk, 1962; Thring and Weitz, 2006; Patil et al., 2011; Afolayan, 2013; Mukinda et al., 2010; Mukina and Syce 2007). Sunmonu and Afolayan (2010) evaluated the antioxidant properties of aqueous extract of *A. afra* leaves on the kidney and liver of rats with

streptozotocin-induced diabetes. Its effectiveness was found to be comparable to glibenclamide, a standard hypoglycaemic drug. Several of the complications of T2DM have been associated with oxidative stress and antioxidants have been considered as potential treatments (Reaven et al., 1995; Cunningham, 1998). As such, antioxidant action could play a significant role in the treatment of diabetes through THM with this property. This may be an indication that *A. afra* extract could potentially be a useful therapeutic instrument for treating oxidation-related pathological damage (Wongkham et al., 2001). Issa and Bule (2015) found that blood glucose levels in Alloxan induced diabetic Swiss albino mice significantly decreased (by 24%) in groups that were given *A. afra* doses of 500 mg/Kg and by 56.9% in groups that received 750 mg/Kg, respectively. The methanolic extract of *A. afra* also lowered blood glucose by 49.8% in doses of 1000 mg/Kg. The same study also found that *A. afra* was non-toxic. Other studies pertaining to the bioactivity of *A. afra* include its potential use as an antifungal agent (Gundidza, 1993), its antibacterial activity (Rabe and van Staden, 1997), as an antioxidant (Burits et al., 2001), its potential toxicity (Elgorashi et al., 2003), and its anti-cancer (Fouche et al., 2008), anti-tuberculous (Mativandlela et al., 2008) and anti-malarial (Van der Kooy et al., 2008) effects. It has also been studied for its protective myocardial uses (Sunmonu, Afolayan, 2010), and its influence on the central nervous system (Nielsen et al., 2004). Guantai and Addae-Mensah (1999) found that aqueous *A. afra* extract (10–45 mg/kg) had a hypotensive effect when tested in vivo (Patil et al., 2011).

The pharmacology of *Chrysocoma ciliata* L. has not been significantly studied in South Africa. *C. ciliate* has however been documented in ethnobotanical studies in the north west region of South Africa (Nortje, 2011; De Beer and van Wyk, 2011) for its use for stomach complaints, colds and pain. Afolayan et al. (2009) studied the anti-fungal activity of *C. ciliate*. The species exhibited a strong anti-fungal propensity in relatively low doses. The plant's possible toxicity has not been investigated.

Leonotis leonurus is a widespread species found all over the Cape floristic region. Studies have documented its use and efficacy for both HBP (Kenechukwu, 2004) and T2DM (Afolayan and Sunmonu, 2010). Studies have reported on the anti-diabetic, hypoglycemic, anti-convulsant, anti-nociceptive, anti-inflammatory, and anthelmintic activities and properties of *L. leonurus* (Kuate, 2013). Mnonopi et al. (2012) tested marrubiin, a constituent of *L. leonurus* and an organic extract of the plant in vitro and in vivo for their antidiabetic propensity and found that it alleviated diabetic symptoms. Further studies have also reported on the immune modulatory effects of *L. leonurus* (Hurinanthan, 2009). The main psychoactive component of *L. leonurus* is leonurine. In a medicinal species review, Mazimba (2015) notes that the species has 37 isolated phytochemicals consisting of flavanoids, labdane type diterpenoids and other phenolics detected in acetone and methanol extracts. The essential oils of *L. leonurus* were also shown to have anti-oxidant and anti-bacterial

properties. Studies have been done on the plant's toxicology in rats (Kuetze, 2014). It showed possible adverse effects on organs, red blood cells and white blood cells (Maphosa et al., 2008).

Although no studies have been done on the anti-diabetic potential of *Tagetes minuta* it is reported as a “traditional” medicine. Its leaves and stem are used to make a decoction for pain, inflammation, and as a blood purifier in the case of T2DM. A study conducted by Al-Musayeb et al. (2014) documented *T. minuta*'s anti-oxidative and anti-inflammatory effects. A phytochemical investigation of the methanolic extract of *T. minuta* leaves resulted in the isolation and identification of new compounds: 5-methyl-2,2',5',2'',5'',2''',5''',2''''-quinquethiophene (1) and quercetagetin-6-O-(6-Ocaffeoyl- β -D-glucopyranoside)- (9) (Karimiana et al., 2014). While *T. minuta* is widely used and considered to be safe, its oil and extracts can cause photo-toxicity (Scientific Committee on Consumer Safety, 2015).

Hoodia gordonii is native to the Kalahari desert in southern Africa (van Heerden, 2008). The species has received a lot of media and scientific scrutiny as an appetite suppressant and dietary supplement, but not for the management of HBP or T2DM. The active ingredient in *H. gordonii* is the appetite-suppressing molecule, P57, or oxypregnane steroidal glycoside P57AS3.3 (Madgula et al., 2008). In clinical studies, P57 has been evaluated for its potential as an anti-obesity drug. It is argued that P57 mimics the action of glucose on the brain. Clinical studies have found that *H. gordonii* is non-toxic (Maharajah, 2001), although side effects of *H. gordonii* based products have been reported. In a study conducted by Roza et al. (2013), an *H. gordonii* product was tested for sympathomimetic activity. Through isolated organ experiments on rat uterine rings, the product was found to have smooth muscle relaxant effects with a substantial component mediated through β -adrenergic receptors. It was also argued that cardiovascular effects of the product may be linked to the *H. gordonii* compounds. Studies have associated the administration of *H. gordonii* extract with an increase in blood pressure and pulse rate.

Aloe ferox has traditionally been used for cuts, sores and burns. It is also a strong laxative and blood purifier. Much of the clinical data available for *A. ferox* is based on other studies done on *Aloe vera* and *Aloe arborescens* species. Loots et al. (2011) for example conducted a study to investigate the possible anti-diabetic effects of ethanol extracts of *A. ferox* and *A. greatheadii* var. *davyana* leaf gel in a streptozotocin (STZ)-induced T2DM rat model. It was found that supplementation with the species *A. greatheadii* and *A. ferox* moderately increased serum insulin with minor corrections in ALP and HDL-C and no change to end-point plasma glucose values which resulted in a clinically relevant improved diabetic state, suggesting that these *Aloe* species may show promise for managing T2DM. The literature does not refer to it as possible treatment for HBP per se although *A. ferox*

leaf gel has promise for the prevention or alleviation of symptoms associated with cardiovascular diseases (Du et al., 2007). *A. ferox* has a laxative effect but is safe for human use (Celestino et al., 2013; Mahomoodally, 2013).

At present, there is little information available on the anti-diabetic and antihypertensive activity of *Convolvulus capensis* Burm. f., *Pelargonium antidysentericum* (Eckl. & Zeyh.), *Carpobrotus edulis* (L.) L. Bolus, *Salvia africana-caerulea* L, *Mentha longifolia* L., *Euryops abrotanifolius* (L.) DC., *Ballota Africana* (L.) Benth, *Tylecodon paniculatus* (L.f.) Toelken and *Crassula muscosa* (Linnaeus, 1760) and *Searsia burchellii* (Sond. ex Engl.) Moffett reportedly used in this study. Many of these species have however been documented in ethnobotanical surveys for their use against HBP and T2DM (Nortje, 2011; Mintsa Mi Nzue, 2009; van wyk and Albrecht, 2008; Arendse, 2013; Philander, 2011). They are also widely used as tonics for stomach complaints, colds, fever, rheumatism and many other illnesses. In literature some have been mentioned anecdotally for their traditional uses. For example, *Cadaba aphylla* (Thunb.) Wild has been documented for its anti-cancer activity (Fouche et al., 2008) and *Dicerotheramnium rhinocerotis* (L.f.) Koek., for its anti-carcinogenic activity (Dwarka, 2012). *Lichtensteinia lacera* Cham. & Schltldl. has been listed as a plant frequently used for T2DM, but there is no scientific endorsement of its safety or efficacy (Patil et al., 2012). *Scelletium tortuosum* (L.) N.E. Br. has been documented for its use in managing T2DM (Semenya and Potgieter, 2014), and for HIV and TB in the Eastern Cape, South Africa (Lawal et al., 2014) This species has also traditionally been used to treat chest complaints, colds, fevers and coughing (Philander, 2011). The plant has been found to be safe in a clinical trial (Nell et al., 2013).

3.4. Diagnoses

In the study sample, sixty five (65) participants had previously been medically diagnosed with HBP, 27 with T2DM and 20 were simultaneously diagnosed as diabetic hypertensive. All of these participants were diagnosed by health care professionals at the Bitterfontein satellite clinic, prior to being interviewed. Blood pressure and blood sugar are regularly tested and monitored by clinic and home-based care staff. Similar studies conducted in the Western Cape Province have also reported high occurrence of HBP (Lloyd-Sherlock et al., 2014b), and in T2DM, prevalence's of between 4.4% and 9.4% respectively (Erasmus et al., 2012; Bailey et al., 2016).

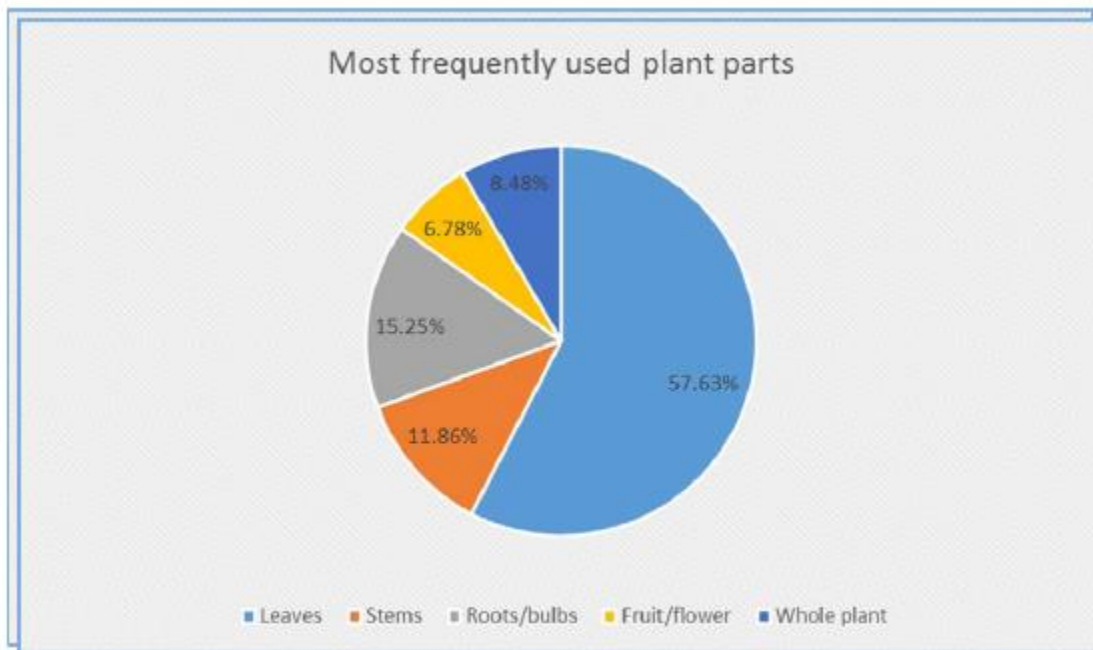


Fig. 2. Plant parts used.

The reported prevalence of HBP (8.62%) and especially T2DM in this study (4.77%) is comparable. In the Bitterfontein study, 70.4% of participants with either, or both, conditions are over 40 years of age. Studies have shown that age is a risk factor for HBP and T2DM (Ibid.). Although access to diagnoses, treatment and management of both conditions are generally good in South Africa, a systematic review showed that less than 10% of T2DM sufferers still do not have access to diagnoses and treatment (Health24, 2014). Between 12.7% (Erasmus et al., 2012) and 18.1% (Bailey et al., 2016) were undiagnosed. A large proportion of diagnosed participants in prevalence studies do not manage their conditions with allopathic medicine or refuse to do so (Erasmus et al., 2012; Hughes et al., 2013; Bailey et al., 2016). This may result in the search for alternative therapies and diagnoses, which is often the case in South Africa.

Diagnosed participants generally collected, prepared and consumed plant remedies on their own, or obtained it from knowledgeable elderly family members, neighbours, bossiesdokters or Rastafari bush doctors. They used it for general well-being and to manage symptoms of HBP such as feelings of heat/flushing or sweating, headache, sleeplessness, anxiety and occasional nosebleeds, and for T2DM symptoms such as tiredness, frequent urination, increased hunger and/or thirst, weight loss, dark patches on the skin, blurred vision and lesions that did not heal easily. Plant remedies were also consumed to combat side-effects from their prescribed allopathic medication. These included headaches, dizziness, nausea, stomach pain, tingling in fingers and toes and erratic heart rate. Participants displayed a good understanding of the symptoms of HBP and T2DM based on responses to a range of

possible symptoms presented to them in the survey questionnaire. Much of the understanding of their conditions is drawn from public information available from the clinic, library and media (radio, television, magazines). Experienced symptoms are explained to them by health care staff.

Since both HBP and T2DM are considered to be linked to lifestyle (poor nutrition, excess salt or sugar, hard labour, stress, etc.) and genetic factors, participants regarded these conditions as natural and did not consult bossiesdokters or Rastafari bush doctors for diagnosis. Instead, bossiesdokters and Rastafari bush doctors were consulted for their specialist knowledge of medicinal plants to use for these (already diagnosed conditions) or for specific and/or persistent symptoms. Although bossiesdokters and Rastafarian bush doctors treated and recommended plant remedies for HBP and T2DM, they generally relied on the information given by a client about a medical diagnosis, or attended to the symptoms a client presented with, before providing a plant remedy. The use of plant remedies, their dosage, mode of administration and duration of use was thus found to be aimed at and dependent on the presence and severity of symptoms.

3.5 Preparation and administration

The preparation and administration of each mixture depends on the severity and duration of symptoms. Plants are collected from the commons of Bitterfontein, provided by the elderly or bossiesdokters or bought from Rastafari bush doctors. Sometimes plants are purchased from Rastafari bush doctors in bigger town centres. Here plants are displayed and sold as part of an informal market in THM. In cases where a specific plant is neither available in the area nor present in the veld,³ participants travel to neighbouring areas to collect them, or order them from bossiesdokters and Rastafari bush doctors who occasionally travel to other areas to collect them. Some of the plants used, such as *Tagetes minuta*, have been naturalised and often grow in gardens. Elderly participants, who are unable to walk to the veld, often cultivate medicinal plants in their gardens for ease of access. Participants generally preferred to collect plants in the wild, in the spring and summer months when they were more readily available. These seasons are also considered to yield strong plants with high potency.

Plant mixtures varied from one participant to the next as did the use of fresh and dried plant material. When fresh plant material was available, it was generally first dried, as such plants were believed to be stronger. Plants collected from the veld are generally considered more potent and the plant species were mostly used in combinations. Participants did not make a distinction between plants used to treat HBP and T2DM individually. Instead, plant preparations contained up to five plants to address the symptoms of both conditions. Many of the reported preparations included *L. frutescens*. In some instances, plants were added to combat different symptoms or to make a more potent decoction which would possibly work faster. Plants were also added to a mixture to mediate the side-

effects of another plant, e.g. *G. deserticola*, to improve taste and/or as a general tonic. The traditional practice of using multiple plants in a combined decoction has been documented in other studies (Alarcon-Aguilara et al., 1998; Davids et al., 2014; Hughes et al., 2014; Hughes et al., 2015). There is evidence to suggest that the use of multiple plants decreases the probability of resistance to it for a singular condition. In this study, participants explained that multiple plants were used because they complemented one another.

Most of the plant preparations were taken orally, usually prepared as decoctions or infusions. In addition, mixtures were sometimes used for bathing or for inhalation. Topical application of plants were used to treat rashes and sores which took long to heal, especially as a result of T2 DM. The duration of treatment lasted until symptoms or side-effects cleared up, generally within two weeks, at which time the strongest infusions were consumed one to three times a day. Thereafter, preparations were consumed less frequently.

3.6 Part of plant used

The leaves (57.63%) were the most frequently used plant part in preparations for the management of HBP and T2DM. Other plant parts (Fig. 2) were also utilised, but to a lesser extent. The widespread use of leaves in medicinal preparations is well documented in ethnobotanical studies (Hughes et al., 2013; Davids et al., 2014; Hughes et al., 2015). The traditional belief that leaves are the strongest part of the plant, offering the most potency in relation to other parts, has encouraged their extensive use. It also raises potential concerns about over-use and conservation (Loundou, 2008; Mintsu Mi Nzue, 2009; Street and Prinsloo, 2013).

3.7 Allopathic medication and THM co-utilisation

In this study, 48.21% of diagnosed participants used only allopathic medication for HBP and T2DM. A further 20.11% of this group had reportedly used THM in the previous four weeks (non-active use). Approximately one third of participants (34.82%) who had previously been diagnosed with HBP and/ or T2DM used THM along with prescribed allopathic medication, although not simultaneously. While minimal reports (11.6%) of minor side effects such as nausea and headaches from using both were reported, participants took caution to consume THM at different intervals from their prescribed allopathic medication. They argued that this prevented any potential effects of the plants on the drugs. Similar findings have been reported in other studies. Hughes et al. (2013) found that THM was frequently used together with allopathic medication amongst hypertensives living in South African communities. Liwa et al. (2014) found that 47.5% of HBP sufferers in sub-Saharan Africa use allopathic medication together with THM. Davids et al. (2014) showed that traditional health practitioners from Strand, Western Cape readily treat HIV and related opportunistic infections with medicinal plant preparations, while patients are on antiretroviral therapy. Hughes et al.

(2015) found that HIV positive patients used THM in conjunction with allopathic medication, with no reported side-effects.

At present, allopathic medication as a single or in multi-drug therapies cannot return blood glucose levels to normal or maintain blood pressure and there are many reported side-effects of its use (Chethan et al., 2014). Plants are therefore a potentially useful source of complementary supplements for maintaining blood pressure, blood glucose levels and preventing chronic complications in T2DM (Gallagher et al., 2003). In this regard, recent studies have investigated the synergistic use of plant products in combination with allopathic medication. For example, Aiyegoro and Okoh (2009) conducted research on the bio-microbial activity of plant products in combination with allopathic medication against anti-microbial chemotherapy and they argue that plant products can potentially act as synergistic enhancers when used in combination with allopathic medication. Sibanda and Okoh (2008) investigated the interactions between acetone extracts of *Garcinia kola* seeds and antibiotics. Oliveira et al. (2015) found that there was a possibility of interaction when using medicinal herbs and allopathic medication together.

Despite its occurrence, concurrent use of THM and allopathic medication has not received much scientific scrutiny (Amira and Okubadejo, 2007; Olisa and Oyelola, 2009; Hughes et al., 2015). In part, the concurrent use of allopathic medication and THM is attributed to the limitations of allopathic medication, shortages of health care service providers (Steyn et al., 2008), insufficient access to allopathic medication, patient perceptions about allopathic medication and how it interacts with bodily processes (Cohen, 2009), and the adverse side-effects of some allopathic medications. Plant preparations are generally believed to be effective with fewer side-effects (Erasto, 2005). In this study, 16.97% of diagnosed participants used only THM, to manage HBP and T2DM. Health care practitioners, service providers and users alike should be made aware of the possible implications for using THM as the sole form of therapy.

3.8. Conservation

In South Africa, numerous biodiversity and conservation strategies, organizations such as Cape Nature, the Plant Conservation Alliance (PCS), the Global strategy for plant conservation (GSPC) and the South African National Biodiversity Institute's Red List of plants, are in place to protect, preserve and monitor vulnerable plant groups. A national strategy for plant conservation is also being developed (Ralston et al., 2009; SANBI, 2014; Victor et al., 2015). Mountainous habitats and nature reserves are generally well conserved in South Africa, but lowland regions and especially the Renosterveld area is prone to biodiversity pressures such as fire, agriculture, invasive alien species, pollution, urbanization and climate change (Kemper et al., 1999; Von Staden et al., 2013). In relation to medicinal plants, several studies in South Africa have shown the impact of over-harvesting in the

trade of such plants (Cocks and Dold, 2004; Cunningham, 2003; Mander et al., 2007; Street et al., 2008; Loundou, 2008; Moeng and Potgieter, 2011). Many medicinal plants are threatened and some are extinct (Street et al., 2008).

The extensive use (35.59%) of roots/bulbs, stems and the whole plant (Fig. 2) in this study pose a potential future risk for conservation of some plant species used in the management of HBP and T2DM. Most of the plant species reported in Bitterfontein (87.5%) have been evaluated by the South African National Biodiversity Institute's (SANBI, 2015) threatened species programme (Red data list) and were categorized as 'least concern'. This category includes species which have been evaluated against international conservation standards. The focus of the red list is on monitoring species which are at high risk of extinction and as a result the species categorized as of least concern, may still be of high conservation concern. The species *Chrysocoma ciliate* and *Tagetes minuta* (8.33%) were not assessed according to Red list criteria because they are not indigenous, but can be considered "naturalised exotics." *Hoodia gordonii* (4.17%) was also not evaluated due to insufficient data. Although *H. gordonii* is widespread throughout the Cape Floristic Region, the species has undergone a rapid decline as a result of overharvesting.

The low reported prevalence of some of the plant species in this study may be an indication of its scarcity. Biodiversity and conservation strategies are an important tool for monitoring threatened species and should be advocated in rural areas. The use of plants as medicine is a long-standing practice in areas such as Bitterfontein and is part of the health and well-being of THM users. The sustainable conservation of plants, especially medicinal plant species, is important not only because of their value as a potential source of new medicine, but also to conserve species for future use.

The harvesting of plants is closely monitored by Cape Nature in the Western Cape. In Bitterfontein participants employ a range of practices centered on minimal use and sensitivity to plant harvesting. Similar studies conducted in the Western Cape (Olivier, 2012; Philander, 2011, 2014) and Northern Cape (Cohen, 2009, 2013; Nortje, 2011) have shown that most of the plants harvested, used and sold by bossiesdokters and Rastafari bush doctors are not endangered. Furthermore, these studies have shown that bossiesdokters (Cohen, 2013) and Rastafari bush doctors (Olivier, 2012) have a good sense of awareness of plant conservation. Overall, participants in this study reportedly only collected plant material as they needed it, and in moderate quantities. Most THM users did not harvest plants for sale, nor did they store large quantities of plant material for future use. When collecting plants, participants harvested samples from multiple mature specimens and did not harvest young plants. Although participants collected from Bitterfontein commons, they also varied their collection locations from time to time. They were careful not to disturb the growth of the plant by uprooting it except when the roots

and bulbs were needed for specific remedies and symptoms. Specific species, which are known to be scarce, were often substituted with other species which are believed to possess similar properties. The predominant use of leaves (57.63%) and of multiple plant species for the same application also suggests these as possible conservation strategies by locals to prevent over-harvesting of specific species and to safeguard its future use.

4. Conclusions

Twenty-four plant species belonging to 15 families were identified and documented for the management of HBP and T2DM. *Lessertia frutescens* was the most frequently reported plant species among all THM users in this study. This is suggestive of its importance as ethnomedicine for the management of HBP and T2DM in Bitterfontein. Medicinal plant concoctions contained up to five plant species mostly prepared as infusions and decoctions for oral administration.

Although, HBP and T2DM sufferers consulted and received treatment from bossiesdokters and Rastafari bush doctors, they always relied on biomedical diagnoses before managing the symptoms of either condition with THM. Medicinal plants are widely used by HBP and T2DM sufferers who employ diverse plant species to manage the symptoms of both conditions. Plant collectors employ a range of plant conservation methods to ensure its future use. Although sufferers displayed a good understanding of the symptoms of, and biomedical treatment regime for HBP and T2DM, a large proportion of THM users in this study reportedly used their prescribed allopathic medication together with medicinal plants. They reported minor side-effects. The potential interaction of some of the plant species used with allopathic medication has not received much scientific scrutiny in the past. Health care providers could be sensitized to the pluralistic treatment choices of HBP and T2DM sufferers and to the possibility of herb-drug interaction. Nevertheless, the use of THM continues to be a potential source of new and alternative strategies to manage chronic conditions such as HBP and T2DM.

Author's contributions

DD, DG and QJ conceptualised the study and designed the methods. DD and DG conducted the ethnobotanical survey and collected the plants. DD and DG transcribed and analysed the data. DD, DG and QJ contributed towards the writing and reviewed the manuscript. All authors read and approved the final manuscript.

Declaration of interests

The authors declare that they have no competing interests.

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