Mphuthi and Husaini
Bulletin of the National Research Centre (2022) 46:107
https://doi.org/10.1186/s42269-022-00789-x

Bulletin of the National Research Centre

RESEARCH

Open Access

Traditional medicinal plants used by hypertensive patients in Belize: a qualitative evaluation of beliefs and practices

David D. Mphuthi[1] and Danladi Chiroma Husaini[2*]

Abstract

Background: Belize is rich in rainforest and vast medicinal plants that have the potential for drug discoveries. Few studies have examined the use of medicinal plants in the management of chronic diseases in Belize. The present study appraised indigenous Belizeans' opinions, beliefs, and practices of medicinal plants used for hypertension management. Twenty-four hypertensive patients were interviewed using a semi-structured interview guide from January to May 2019. Interview results were transcribed using Microsoft Excel and loaded into qualitative data analysis (QDA) Miner Lite version 2.0.6 online software for coding. The integrated themes and sub-themes generated were presented in narrative passages and used to summarize study findings on medicinal plants used in the management of hypertension in Belize.

Results: Fifteen medicinal plants belonging to 15 plant families were reported by the participants as medicinal plants used to manage hypertension. The plants include *Annona muricata*, *Artocarpus altilis*, *Cecropia peltata*, *Ananas comosus*, *Cymbopogon andropogoneae*, *Uncaria tomentosa*, *Allium sativum*, *Bixa orellana*, *Moringa oleifera*, *Momordica charantia*, and *Cassia grandis*. Leaves were the most commonly used plant part; decoction was the most common method of preparation, while ½ to 1 glass was the daily recommended dose. Mild side effects were reported, while antioxidant activity was the perceived efficacy.

Conclusion: Hypertensive patients in Belize opined that medicinal plants and herbs were efficacious in lowering blood pressure, as evidenced by home monitoring and regular checkups at the hospital. They also reported minimal side effects in the use of the medicinal plants. There is a need for a comprehensive evaluation of Belize's medicinal plants to unravel their potential for drug discovery.

Keywords: Belize, Herbal remedies, Hypertension, Medicinal plants, Herbal remedies, Indigenous knowledge, Traditional medicine

Background

Medicinal plants have been used to treat illnesses in many communities since ancient times (Ekor 2014; Mordeniz 2019; Shaikh et al. 2020). Despite their global popularity, medicinal plants have not developed the same way as Western medicines because of the lack of policies and procedures for testing their effectiveness (Ekor 2014). Those trained in Western medicine often have taken this to mean that medicinal plants are ineffective in treating diseases. However, the apparent absence of techniques for testing its effectiveness should not be seen as evidence of its ineffectiveness. In many countries, society determines the effectiveness of these therapies based on the number of recovered patients (Ekor 2014; WHO 2015). While some healing aspects of indigenous medicine are not yet fully understood, many communities have faith in the efficacy of their therapeutic benefits because they are

*Correspondence: danhusaini@yahoo.com
[2] Allied Health Department, Faculty of Health Sciences, University of Belize, Belmopan, Belize
Full list of author information is available at the end of the article

attuned to their culture and beliefs (Ekor 2014; Mordeniz 2019; Frazão-Moreira 2016). The present global increase in the awareness of medicinal plant remedies is due to perceived safety and efficacy because medicinal plants are perceived from natural products. In addition, the long ancestral history of linkage to folklore beliefs and practices has led to people consuming indigenous remedies (Mordeniz 2019; Mans et al. 2017a). In Belize, for instance, it is a common practice for people to try medicinal plants before coming to the hospital or before seeking Western medical intervention.

As a developing nation, Belize is progressively joining developed nations to prevalence non-communicable diseases, especially diabetes and hypertension. Previously in 2009, the Pan American Health Organization (PAHO) reported a rise in mortality rates and hospitalizations due to hypertension and diabetes (PAHO 2019). Several modifiable risk factors for developing hypertension, such as sedentary lifestyle, poor diet, and excessive alcohol consumption, are prevalent in Belize (PAHO 2019; Rosendorff et al. 2015). As described by other authors, the observable consequences of these modifiable factors are on the rise in the country of Belize (Mishra et al. 2015; Biraguma et al. 2019; Shayo 2019).

The increase in mortality and morbidity rates from non-communicable diseases and the African and East Indian ancestral linkage of Belizeans' traditional therapies, make medicinal plants an option in managing hypertension in Belize. Medicinal plants' beneficial effects and interest in managing hypertension are increasing globally (Al Disi et al. 2016; Baharvand-Ahmadi et al. 2016; Meresa et al. 2017; Malik et al. 2018). Furthermore, some reasons why people engage in traditional and complementary therapies have been enumerated (Mans et al. 2017b). Some of the reasons given are that patients feel very uncomfortable talking about their health problems and fear that there will be a lack of confidentiality in handling information related to their health when they visit Western practitioners. Additionally, fear of misdiagnosis, wrong treatment with Western medications, and lack of enough time by the physician to see the patients were reasons provided for the increased patronage of medicinal plants (Ekor 2014).

The current study was conducted qualitatively to examine hypertensive patients' opinions, beliefs, and experiences using medicinal plants to manage hypertension. Consequently, the study sought to gain insight into the sources, preparation methods, dosing, administration, shelf-life, and perceived effectiveness. The results of this study will provide baseline documentation on medicinal plants used for hypertension by indigenous Belizeans. The study will further inform the design, development, and implementation of larger-scale research while providing initial awareness on Belizes' medicinal plants used for hypertension.

Research questions

1. Do hypertensive Belizeans use medicinal plants to manage their hypertension?
2. What are the common medicinal plants used by hypertensive patients in Belize?
3. How are the medicinal plants prepared, dosed, and administered?
4. What are the perceptions of the effectiveness of the medicinal plants in the management of hypertension?
5. What are the opinions and beliefs of hypertensive Belizeans toward medicinal plants used to manage hypertension?

Methods

Research design

A qualitative explorative, descriptive research design with the narration was employed in this study. The methodology described by Malik et al. (2018) and Baharvand-Ahmadi et al. (2016) was adapted and modified for this study. This approach explored and described medicinal plants usage by hypertensive patients in the management of hypertension. The methodology was employed to provide plausible, accurate, and authentic outcomes on the use of medicinal plants by indigenous Belizean hypertensive patients.

Study population

The population for this study comprised confirmed diagnosed hypertensive patients who do not have comorbidities.

Sample and sampling techniques

A non-probability purposive sampling technique was used for this study, as described by Creswell (2015). The study participants, in this case, were selected based on pragmatic considerations, such as their availability and willingness to participate in the research. The participant must be 18 years and above, confirmed to be hypertensive by a certified medical practitioner, prescribed antihypertensive medications for at least two years, and does not have other comorbidities. Patients that do not meet these criteria were excluded from the study. A total of 24 hypertensive patients using medicinal plants were selected to participate in the study. Eligible participants were drawn from each district to participate in the study. Although the study was baseline with small sample size, getting participants from different districts became

paramount because of the diversity in cultural beliefs and usage of medicinal plants.

Data collection

Qualitative data were collected from diagnosed hypertensive patients who used medicinal plants in the management of their hypertension. A semistructured face-to-face interview guide was developed and used for data collection (Additional file 1: S1_Interview guide). The interview guide was adapted and modified from previous studies Malik et al. (2018) and Baharvand-Ahmadi et al. (2016). Professional colleagues reviewed the interview guide at the University of Belize and the University of South Africa. The interview guide was pilot tested and validated before it was executed. The interviews were conducted both at the participants' homes, workplaces, and hospital or pharmacy outlets using the interview guide and field notes. The interview lasted for 15–20 min. Data were collected from October 2018 to May 2019.

Data analysis

As Vaismoradi and Snelgrove (2019) described, thematic analysis was used for data management and analysis of interviews conducted for this study. The results of the 24 interviews with hypertensive patients using medicinal plants were transcribed using Microsoft Excel and loaded into qualitative data analysis (QDA) Miner Lite version 2.0.6 online software for coding. The integrated themes and sub-themes generated (Table 1) were presented in narrative passages to summarize study findings.

Results

The participants for this study comprised 14 (58%) females and ten (42%) males. The average age of the participants was 56 years. The majority, 17 (71%) of the participants, reported an average medicinal plant use of 9 years, while seven (29%) did not specify how long they used medicinal plants to manage hypertension.

The themes and sub-themes that emerged from data analysis are presented in Table 1.

Medicinal plants and herbs for hypertension

The participants interviewed revealed the medicinal plant they used to manage hypertension (Table 2), the sources of their knowledge, and the duration they had taken medicinal plants for the treatment and management of hypertension.

Medicinal plants used for hypertension

The participants from this study reported using a variety of medicinal plants for the management of hypertension. The different therapies used in hypertension management are listed in Table 2. Medicinal plants have been reportedly used either as a single plant or as a mixture of plants and herbs. The quotations below substantiate some medicinal plants used to manage hypertension and are listed in Table 2.

> *I take garlic and moringa in tea to treat my blood pressure.* **P10.**
> *I use breadfruit leaves for my pressure.* **P22.**

Based on the quotations from the participants above, a variety of medicinal plants were reported to manage hypertension. Some participants used single medicinal plants to manage hypertension, while others used a combination of plants.

Knowledge and sources of medicinal plants for hypertension

Hypertensive participants were asked how they acquired their knowledge of medicinal plants. Most of the participants indicated that the knowledge of medicinal plants was passed down from generation to generation. The participants reported their sources of knowledge about medicinal plants to come from family members, community, practitioners, or other sources, as evidenced by the participant's quotation.

Table 1 Themes and sub-themes revealed during data analysis of hypertensive patients

Themes	Sub-themes
1. Medicinal plants and herbs for hypertension	i. Medicinal plants used for hypertension ii. Knowledge and sources of medicinal plants for hypertension iii. Duration of use for medicinal plants in hypertension
2. Preparation of medicinal plants and herbs used for hypertension	i. Plant parts used for hypertension therapy ii. Preparation of medicinal plants used in hypertension iii. Administration of medicinal plants for hypertension therapy
3. Efficacy of medicinal plants used for hypertension	i. Beliefs on the effectiveness of hypertensive medicinal plants and duration of use ii. Safety and adverse effects of hypertensive medicinal plants iii. Availability and cost of hypertensive medicinal plants iv. Concomitant use of hypertensive medicinal plants with Western medications

Table 2 Medicinal plants and herbs used by hypertensive patients

Scientific names/family of plant/herb	Local names	Part of plant
Annona muricata (Annonaceae)	Soursop	Leaves and fruit
Moringa oleifera (Moringaceae)	Moringa tree	Leaves and pods
Allium sativum (Amaryllidaceae)	Garlic	Fresh bulb or powder
Citrus aurantiifolia (Rutaceae)	Lime tree	Leaves and fruit
Zingiber officinale (Zingiberaceae)	Ginger	Fresh or dried roots
Cymbopogon andropogoneae/citratus (Poaceae)	Lemongrass	Leaves
Artocarpus altilis (Moraceae)	Breadfruit tree	Leaves
Uncaria tomentosa (Rubiaceae)	Cat's Claw (Samento)	Seeds
Ananas comosus (Bromeliaceae)	Pineapple	Skin
Bixa orellana (Bixaceae)	Annatto	Leaves
Cassia grandis (Leguminosae)	Bukut	Pods
Momordica charantia (Cucurbitaceae)	Serosi (Cerasee)	Leaves
Cecropia peltata (Cecropiaceae)	Trumpet tree	Leaves
Cinnamomum verum (Lauraceae)	Cinnamon	Stem, powder

I learned from my grandmother. From I was a little girl, she always boiled bush for us to drink. We live on the bush, and it helps with many things. P9

The quotation from a participant supported that most of the information on medicinal plants is from within the community.

Duration of use of medicinal plants in hypertension

The duration of medicinal plant use among hypertensive patients was explored. Most of the participants claimed that the duration of medicinal plant used for the management of hypertension was largely dependent on the number of years diagnosed with hypertension. Whereas some of the participants did not specify the duration of usage, most participants reported short-term, medium-term, and long-term use of medicinal plants to manage hypertension. A participant's quotation below supports the claim.

I started taking herbs when I found out I had high blood pressure, which was about ten years ago, and since then, I have been taking herbs for my pressure. **P7**

Preparation of medicinal plants and used herbs for hypertension

The preparation of medicinal plants is described as the different methods employed to extract the active ingredients from parts of plants, plant materials, or a combination thereof from a medicinal plant (WHO 2015; Malik et al. 2018). Different preparation methods for medicinal plants have been described to include extracts, powder, boiled teas, scorched, steamed, poultice, infusions, and decoctions (Baharvand-Ahmadi et al. 2016; Malik et al. 2018; Boadu and Asase 2017). In this study, the identification and documentation of medicinal plants for hypertension were vital for preserving and sustaining indigenous knowledge.

Plant parts used for hypertension therapy

Most participants reported leaves as the common part of the medicinal plant used to manage their hypertension. In addition to leaves, fruits, roots, seeds, stems, and whole herbs have been reported by the participants as parts of plants used to manage their hypertension. A few of their quotes supported the participants' responses.

I use soursop leaves…. **P6.**
I use ginger, garlic, lime, cinnamon stick. **P18.**

Reports by the hypertensive participants on the medicinal plant part used to treat hypertension showed that a single part of a medicinal plant such as leaves can be used for hypertension or a combination of leaves. Seeds, roots, stem sticks, and pods were also reported to manage hypertension in Belize.

Preparation of medicinal plants used in hypertension

Details of preparation methods for medicinal plants used by the hypertensive participants to manage their hypertension were evaluated. Although the study participants reported no standardized method, boiling medicinal plant parts was the commonly described preparation method, as evidenced by a participant's quotations.

I take breadfruit leaves for my pressure. I get the leaves from my farm. Dry them first for about a week in a special container, out in the sun. I then weigh about one pound of it and boil it in a stainless steel pot. I will use like ten leaves for about a liter of water. **P3**

A few participants reported decoctions as the means of medicinal plant preparation for managing hypertension, while others expressed that they prepare their medicinal plants by boiling them in a pot filled with water for an average of 5 to 30 min. After it was boiled, they would leave the drink to cool and be strained before drinking.

Administration of medicinal plants for hypertension therapy

The main route for the administration of medicinal plants in the management of hypertension was the oral route. The dosage of the medicinal plant taken by the participant seems conflicting among participants. The frequency of intake of the medicinal plant for hypertension was also reported based on the interview analysis. The quotation below shows evidence of routes, dosage, and duration of intake as described by a participant.

I use the fruit Annato. I always boil the fruit and drink the juice throughout the day. I take like half a glass. **P5**

The majority of the participants reported the oral route as the primary route for medicinal plant intake. Participants take the medicinal plant therapies as decoctions, teas, juices, mixtures of boiled plant parts, or herbs to manage their hypertension. Between half a glass to full glass of medicinal plant therapies are taken either once or twice per day, as stated by most participants. A few participants indicated taking the therapy anytime and for the entire day. Apart from one participant (P8) who reported refrigerating the therapy, most participants were silent about the shelf life of the preparation, while others seemed to prepare fresh teas or decoctions each day. The respondents indicated varying dosages for medicinal plants in this study; this corroborated similar research reports conducted in other places (Ahmed et al. 2015; Malik et al. 2018).

Efficacy of medicinal plants used for hypertension

Participants in this study indicated that their health condition improved as a result of medicinal plant usage. Improvements in health were reported based on the perceived feeling of wellness, blood pressure measurement apparatus, and physician visits for checkups. In addition, the beliefs about the efficacy of medicinal plants, safety, concomitant use with Western medications, and availability of medicinal plants as reported by participants are discussed below. Undoubtedly, it can be stated that participants are confident about the efficacy of medicinal plants in the management of hypertension, as evidenced by a participant's quote.

Anytime I check my hypertension, it is under control. My daughter bought me a pressure-measuring instrument that I use, and my pressure is under control. So, I know that the herbs are effective. **P20**

Beliefs on the effectiveness of hypertensive medicinal plants and duration of use

The participants in this study reported that medicinal plants used to manage hypertension effectively lower blood pressure, based on their perceived general well-being, personal measurements of blood pressure using personal devices, and reports from their physician during medical visits as indicated by a participant's quote.

Herbal medicines come from nature, and they are the best. Every time I go to the doctor, my blood pressure is normal. It has to be the herbs I take because I do not take the other medicines. However, I still go to the doctor and check my pressure, and they give me the hospital medications, but I do not take them. I only use my herbs. **P6**

In addition, most of the participants indicated that they had been consuming the medicinal plant therapies for different lengths of time. The participants mentioned a duration between 3 months and over ten years. The quotes from a few of the participants expressed some of their opinions and beliefs.

The herbs make you feel good fast. I do not think it will cure the pressure, but they work fast. **P6**
The herbs are to be taken for the rest of your life.

P15.

Although the majority of the participants confessed that the therapies are very effective in controlling high blood pressure, one common consensus among participants is that medicinal plants do not cure hypertension.

Safety and adverse effects of hypertensive medicinal plants

Regarding side effects with the medicinal plants, the majority of the participants reported that they are not experiencing any side effects. However, a few (6) of the respondents reported dizziness, stomach upset and burns, bad feeling, drop in blood pressure and sugar, and a few (4) participants were not sure (Fig. 1).

Availability and cost of hypertensive medicinal plants

The claim on the availability and cost of medicinal plants among participants in the present study is supported by the participant's quotes.

> *The only thing I buy is garlic. I have everything else available. The garlic costs about $6 or $8 for the month.* **P4**
> *I do not spend any money since it grows in the wild and is readily available.* **P5.**

Most participants reported that they did not spend money to purchase the herbs because they either grew them at home or were found within the community. Friends and family members also supply medicinal plants to their relatives at no cost. Some participants reported that when they do not have a supply, they buy from the market, and the cost is reported to be less than 50 Belizean dollars in a month.

Concomitant use of hypertensive medicinal plants with Western medications

The majority (14) of the participants expressed that medicinal plants were the only therapy they used to manage their hypertension, while few (7) others acknowledged that they combined the medicinal plants with prescribed Western therapies. Some of the participants who used only medicinal plants still visited their doctors to check their blood pressure. The same participants felt that combining both medicinal plants and prescribed Western medications would help in better management of their blood pressure. Furthermore, as a precautionary measure, a few (7) participants reported taking both medicinal plants and western medications just in case the medicinal plant does not work to lower their blood pressure. The following quote by a participant substantiate such claims.

> *I take both the herbs and the hospital medicines. I take both so that they will work better.* **P7**

A few (8) participants in this study reported the concomitant use of indigenous and western therapies.

Discussion

Many medicinal plants have been reported to manage hypertension (Al Disi et al. 2016; Rawat et al. 2016; Landazuri et al. 2017). Although some of the reported medicinal plants have verifiable scientific evidence regarding their pharmacological activity, many medicinal plants are still being studied, and information obtained from indigenous users provides valuable insights for scientific research into such medicinal therapies (Mordeniz 2019). The results obtained in this study showed that participants used various medicinal plants to manage hypertension (Table 2).

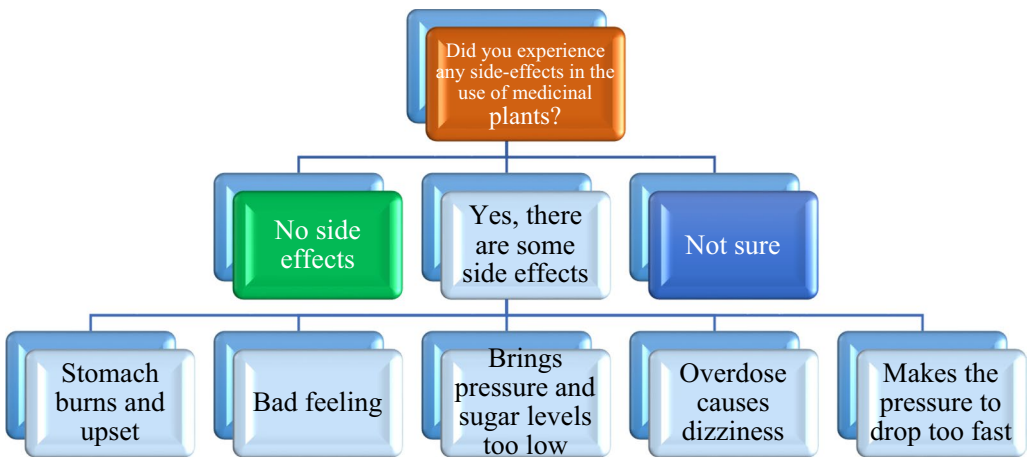

Fig. 1 Reported side effects in the use of medicinal plants for hypertension

The participants described the knowledge and sources of medicinal plants used to manage hypertension to emanate from the community and passed down from generation to generation. The World Health Organization (WHO) (2015) describes traditional medicine as the total knowledge and practices of indigenous people used to diagnose, prevent, treat, or manage diseases. In many communities such as Saudi Arabia, Pakistan, India, and China, knowledge of medicinal plants has been received from ancestors and communities (Petrovska 2012; Inoue et al. 2019). This reliance on medicinal plants was reported in older people who inherited the knowledge from their ancestors, as reported by participants in this study. Even though medicinal plants have been used for generations, and most of the knowledge is passed from one generation to another, the challenge is often that such information is not adequately documented. Hence, some vital ingredients are likely to be lost along the line over the years (Baharvand-Ahmadi et al. 2016; Meresa et al. 2017; Malik et al. 2018; Petrovska 2012). The dynamics of migration from rural to urban communities by the younger generation, the advent of education, and the knowledge of Western therapies play vital roles in the plant knowledge being lost (Malik et al. 2018). In addition, the outright lack of interest in some younger generations could play a significant role in the ineffective transmission of medicinal plant knowledge from older folks. For instance, a lack of interest in indigenous therapies among young people has been reported (Malik et al. 2018). This lack of interest by young people is making transmission of indigenous knowledge from older people difficult, especially because younger people have ease of access to readily available Western medications (Malik et al. 2018). The results from the present study will serve as useful baseline documentation of medicinal plants, particularly those perceived to be helpful in the management of hypertension in Belize.

The duration of medicinal plants in the management of hypertension was also explored in this study. The study participants stated that using medicinal plants for less than a year to as many as ten years and beyond to manage their hypertension, possibly because of generational use, availability, and culture. The desire to use medicinal plants to manage a variety of diseases has significantly increased. Although many factors are responsible for this, the main reasons are the perceived safety of medicinal plants and their cheapness compared to Western medications (Ekor 2014; Shaikh et al. 2020). In Belize, for instance, the provision of Western medications from government-owned hospitals is accessible and free to all hypertensive patients. However, because the use of medicinal plants in Belize is a deeply rooted culture in almost all ethnic groups, especially among the Maya, Kechi, Garinagu, and East Indians, the habit is difficult to let go of even with freely accessible Western medications. The desire to maintain the originality of cultural and ethnobotanical practices among natives has strengthened cultural and ethnic identities from the colonial era (Mans et al. 2017a; b). In addition, the extensive rainforest of Belize and biodiversity provide the right environment and atmosphere for the use of many medicinal plants to treat hypertension and other diseases.

The plant parts used for hypertension therapy by the participants were also assessed. The majority of the participants in this study reported using the leaves of a medicinal plant to manage their hypertension. The results observed in the current study support the research on ethnobotanical antihypertensive plants used in northern Pakistan (Malik et al. 2018). The study reported that stem, root, flower, bark, leaves, seed, aerial parts, fruit, and whole herbal plant were used by indigenous Pakistani people for the management of hypertension. Their report further indicated that most respondents (55.1%) reported using leaves to manage their hypertension. Similar studies have shown that leaves are the highest plant part used compared to other medicinal plants, with 57% and 36% reported by Boadu and Asase (2017) and Baharvand-Ahmadi et al. (2016), respectively.

Additionally, the preparation methods of medicinal plants used for the management of hypertension in Belize were evaluated. In order to ensure the quality and consistency of medicinal plants, methods of preparation, quality control, and standardization of medicinal plants are fundamental (Nafiu et al. 2017). As noted in this study, hot water extraction of leaves resonates with previously reported studies, where participants indicated hot water extraction as the most used preparation method (Malik et al. 2018). Different preparation methods for medicinal plants have been described to include infusions, decoctions, boiling, teas, syrups, concoctions, powders, and chemical extractions (WHO 2015; Nafiu et al. 2017; Shaikh et al. 2020). Variations in medicinal plants, the identity of the plants, and adulteration have been reported to be some of the factors that affect medicinal plant preparation (Nafiu et al. 2017). When a plant part is boiled in water until the volume is approximately half, the extract is considered decoction. Similarly, soaking a plant part in water at room temperature for more than an hour is called infusion. Juice is made from medicinal plants by blending the fresh part of the medicinal plant with water (Malik et al. 2018). The lack of standardization in the preparation of medicinal plants was observed in this study. For instance, only a few (6) participants indicated the number of leaves they used to prepare medicinal plant therapies for hypertension. Some participants indicated mature or large-sized leaves, while

others did not. The sizes of leaves of different medicinal plants vary according to the developmental stage of the tree. In addition, only a few (5) participants indicated the amount of water used to boil the medicinal plant part. The duration of boiling the medicinal plant mentioned by a few (4) participants ranged from 15 to 20 min of boiling. Despite the lack of standardized reporting on the preparation methods for medicinal plants used to manage hypertension observed in this study, decoctions of medicinal plants for hypertension are standard practices reported globally (Baharvand-Ahmadi et al. 2016; Boadu and Asase 2017; Malik et al. 2018). The results seen in the current study support these findings.

Furthermore, the methods of administering medicinal plant therapies for hypertension management were evaluated in this study. The majority of the participants reported the oral route as the main route for administering medicinal plants in hypertension management. Boadu and Asase (2017), in a study of herbal medicines used in the treatment of human diseases in Ghana, reported oral administration as the typical route for herbal administration. Other routes of medicinal plant administration have been described to include topical, rectal, inhalational, and drops. The active ingredient in a medicinal plant and the disease being treated usually determines the route of administration (Busia 2016; Boadu and Asase 2017). Boadu and Asase (2017) further reported that medicinal plants' absorption of alkaloids is readily absorbed from the gastrointestinal tract system, while the best routes for administering essential oils of terpenoids are nasal and dermal routes. Even though infusions can be administered rectally and nasally, most infusions and decoctions have been reported to be best administered orally (Busia 2016; Boadu and Asase 2017).

The primary issue with the dosing of medicinal plants is knowing the correct concentration to use. Such challenges were encountered in this study, where no standardized dosing was reported among participants. The time of the year herbs or plants are harvested presents a unique challenge in the concentration of active ingredients found in medicinal plants. For instance, during the rainy season, the active ingredients found in plants and herbs are diluted due to the availability of rain, whereas in the dry seasons, plants seem to conserve water as such have a higher concentration of active ingredients compared to the rainy season (Lawson and Rands 2019; Nascimento et al. 2019). Depending on the season, plant or herb is harvested for medicinal usage; therefore, what is extracted and used varies. Additionally, the extraction method, the amount of water used for the extraction, and the size or weight of the leaves could all play a role in the dosage and potency that the patient eventually consumed. The results observed in this study resonate with previously published studies where the season and time when medicinal plants are harvested affect their concentration (Nare et al. 2018; Lawson and Rands 2019; Nascimento et al. 2019). In this study, participants reported drinking "half or full glass" and that they drink the extracted therapy "every day, all day or when they feel the pressure."

Participants' opinions on the effectiveness of medicinal plants and the duration of their use in hypertension management were assessed. The majority of the participants believe that medicinal plants are effective in lowering blood pressure. Many medicinal plants have traditionally shown great potential in managing various diseases, and historically, many Western medications have been discovered from medicinal plants (Petrovska 2012; Al Disi et al. 2016; Mordeniz 2019). Nevertheless, with the growing use of medicinal plants in both developed and developing nations, there is still insufficient knowledge about how they produce their mechanism of action in treating or preventing disease progression (Ekor 2014; Shaikh et al. 2020). In Belize, traditional and cultural beliefs on medicinal plants are robust and have been preserved from the pre-colonial era. Subsequently, ethnic heritage is passed on to generations as a means of strengthening communities. This tradition has also been reported in South Africa (Mphuthi and Pienaar 2017; Nare et al. 2018) and Suriname (Mans et al. 2017b). Some of the claims on the biological efficacy of the medicinal plants by the participants in this research have been scientifically verified in a few studies (Somparn et al. 2014, 2018; Anggraeni et al. 2018). Although very few scientific studies on antihypertensive medicinal plants uniquely native to Belize are currently available, the reports from hypertensive patients in this study give insight and raise the need for extensive scientific documentation and evaluations of medicinal plants native to Belize. A comprehensive pharmacological evaluation of these medicinal plants native to Belize will provide further guidelines for their practical usage and prevent the unforeseen risks of adverse effects to public health. Ultimately, although large ranges of antihypertensive medications are available for managing hypertension, no cure has been found (Esler et al. 2010; Bakris n.d). The choice of medicinal plants as a substitute for the management of hypertension may have its value, especially since it is related to cultural perceptions. However, no cure has been reported with medicinal plants or any medication to treat hypertension (Esler et al. 2010). Lifestyle modification and the administration of scientifically approved antihypertensive medications are still the best recommendations for managing hypertension (Bakris n.d). The inability of medicinal plants to cure hypertension,

as reported by the participants in this study, supports previously reviewed studies (Baharvand-Ahmadi et al. 2016; Malik et al. 2018; Boadu and Asase 2017).

Just as important, the participants' opinions on the safety and adverse effects of medicinal plants used to manage hypertension were explored. The majority of the participants indicated that the medicinal plants are safe and only produce mild to moderate adverse effects (Fig. 1). The primary concern in the use of medicinal plants is that of safety. The global increase in the awareness of medicinal plants results from their ease of accessibility, cheapness, and the perception of their safety because they are natural (Ekor 2014). For instance, in many communities where medicinal plants are used as therapies, it is common for people to try medicinal plants before coming to the hospital (Ekor 2014; Mphuthi and Pienaar 2017), which is also a common practice in Belize because of cultural beliefs linked to their African and East Indian ancestry. In so doing, some patients may be tempted to combine medicinal plants with Western medications to treat diseases. While therapies using medicinal plants have always been reported to have potential efficacy, most such remedies remain untested, with their use remaining poorly monitored (Ekor 2014; Shaikh et al. 2020). The resulting consequences are inadequate knowledge of their possible adverse reactions, mode of action, possible contraindications, and possible interactions with the already existing Western pharmaceuticals and functional foods that can promote the rationale and safety of medicinal plants. Consequently, the utilization of medicinal plants and supplements has expanded tremendously in recent years, with over 80% of individuals depending on them as part of primary healthcare (Ekor 2014; Al Disi et al. 2016; Shaikh et al. 2020). Although medicinal plants have demonstrated promising potential, the efficacies of a decent number of such therapies remain untested, and their utilizations are either inadequately checked or not observed by any means (Ekor 2014; Shaikh et al. 2020). Consequently, it results in insufficient information on medicinal plants' biological activity, potential adverse responses, contraindications, and interactions with existing pharmaceutical products. It is crucial for studies into their activities and for regulatory bodies to put in place measures for the safety of public health (Ekor 2014; Shaikh et al. 2020). Additionally, concerns with medicinal plants' adverse effects and interactions are because medicinal plants have not been refined and processed for toxicity; therefore, drug-herb or herb-herb interactions and adverse effects are likely to occur (Ekor 2014; Shaikh et al. 2020). The general perception that medicinal plants are safe because they are natural has been reported (Ekor 2014; Baharvand-Ahmadi et al. 2016; Boadu and Asase 2017; Malik et al. 2018; Shaikh et al. 2020; Husaini et al. 2020). The results of this study support these previous studies.

Next, the availability and cost of medicinal plants used in the management of hypertension were assessed. The majority of the participants indicated that the medicinal plants they used were readily available and affordable. The patient's choice to use indigenous therapies is informed by availability, religion, cultural beliefs, the cost of those therapies, and the perceived efficacy of such herbs in treating the ailment (Petrovska 2012; Ekor 2014; Al Disi et al. 2016). Medicinal plants are affordable and readily available, making them the first line of treatment in many communities (Ekor 2014; Shaikh et al. 2020). Furthermore, high morbidity and mortality rates with most diseases have always been associated with high hospitalization rates and an increase in the cost of therapy (McPhail 2016). In addition, long-term management of diseases such as hypertension and other comorbidities has been reported to be the greatest challenge for patients and healthcare givers (McPhail 2016). Hypertension and related diseases have been reported to have a high cost of management, especially as prescribed Western medications are expected to be taken for life (Kastor and Mohanty 2018). In addition, the cost of Western medications, cultural beliefs, and the perception that medicinal plants are harmless because they are natural are excellent incentives to make people with hypertension explore alternative methods for hypertension management (Ekor 2014; Shaikh et al. 2020). The report by hypertensive patients on the cost of medicinal plants in Belize confirms its ease of availability, accessibility, affordability, and perhaps effectiveness as a drive for usage. This study resonates with previously published studies on the availability and affordability of medicinal plant therapies to manage hypertension and other diseases (Baharvand-Ahmadi et al. 2016; Malik et al. 2018; Boadu and Asase 2017).

Lastly, the concomitant use of medicinal plants and Western medications for the management of hypertension was evaluated among participants. A few participants reported that they combine medicinal plants with Western medications in the management of their hypertension. The wide acceptance and usage of medicinal plants in different cultures provide a growing habit of concurrent herb-drug use, which raises the concern of pharmacokinetic interactions (Parvez and Rishi 2019). In many communities, administering medicinal plant extracts in combination with therapeutic drugs is a common practice, raising the potential for herb-drug interactions. Furthermore, the rising interest in natural products for disease management has reawakened natural product research in drug discovery, necessitating pharmacokinetic studies of phytochemicals, including their potential

for drug interactions (Parvez and Rishi 2019; Kahraman et al. 2020). Although therapies involving these agents have shown promising potential with the efficacy of many medicinal plant products, thereby establishing clear therapeutic use potentials. However, many of these indigenous products are yet to be scientifically tested, and a large portion of them are either not monitored or poorly monitored scientifically (Shaikh et al. 2020; Kahraman et al. 2020). The lack of adequate knowledge of indigenous products, especially their pharmacokinetics and pharmacodynamics with existing Western medications and other food products, calls for caution and a more rational approach in their usage (Kahraman et al. 2020). Accordingly, the availability of Western medicines in the market follows rigorous laboratory and clinical investigations and goes through stringent regulatory scrutiny; it cannot be said of medicinal plants. A wide variety of acclaimed herbal products currently lack sufficient scientific data on the safety or efficacy of such products (Parvez and Rishi 2019; Kahraman et al. 2020). The concomitant use of Western medications and medicinal plants reported in this study could result in drug-herb interactions that could result in clinical outcomes that are beneficial, unwanted, or toxic. To make matters worse, most individuals consuming both Western and medicinal plants do not provide vital documentation of such usage, thereby making clinical decisions on interactions complicated (Parvez and Rishi 2019; Kahraman et al. 2020). The same challenge might be the case in Belize.

Conclusions

The present study examined the opinions, beliefs, and practices on medicinal plants used by hypertensive patients to manage hypertension in Belize. Fifteen medicinal plants belonging to 15 plant families were reported by the participants as medicinal plants used to manage hypertension. The leaves were reported as the most common part of the medicinal plant used, while decoction and oral route were the methods for extraction and administration, respectively. Participants believed in the effectiveness of the therapies, and a few reported concurrent use with Western antihypertensive medications. The study provides the necessary baseline data for future large-scale quantitative, ethnobiological, and phytochemical studies to explore the potential of Belize's rainforest with a view to drug discovery. The data obtained from this study was self-reported, hence capable of recall bias. Also, the small sample size calls for caution in generalizing the results. There is a need for a comprehensive evaluation of Belize's medicinal plants from the traditional healers and the general public to unravel their potentials for drug discovery.

Abbreviations

WHO: World Health Organization; PAHO: Pan American Health Organization; QDA: Qualitative Data Analysis.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s42269-022-00789-x.

Additional file 1. S1_Interview Guide; Interview guide for hypertensive patients

Author contributions

DDM Participated in study conceptualization, design, coordination, supervision, helped to draft the manuscript, validation, and project administration. DCH Participated in study conceptualization and design and carried out the investigation, data curation, formal analysis, writing, review, editing, and resources. All authors read and approved the final manuscript.

Funding

No funding was received for this study.

Availability of data and materials

All data generated or analyzed during this study are included in this published article.

Declarations

Ethics approval and consent to participate

The study was approved by the Faculty of Health Sciences, University of Belize, and by the Research Ethics Committee of the Health Sciences Faculty at the University of South Africa (Ethics approval # HSHDC/761/2017). Before and during the conduct of the study, the participant's general welfare was respected. Participants were first informed about the study and their written consent was obtained before they were included in the study. Those that could not read or write, provided verbal consents. As described in the World Medical Association Declaration of Helsinki's "Ethical Principles for Medical Research Involving Human Subjects" as amended in October 2013, Ethical conduct involving human research was strictly observed and applied. All information regarding the research was filed and kept in a secured place as required by the institutional research ethics board.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

Author details

[1]Faculty of Health Studies, College of Human Sciences, Muckleneuk Campus, University of South Africa, Pretoria, South Africa. [2]Allied Health Department, Faculty of Health Sciences, University of Belize, Belmopan, Belize.

Received: 20 October 2021 Accepted: 1 April 2022
Published online: 13 April 2022

References

Ahmed N, Mahmood A, Ashraf A, Bano A, Tahir S, Mahmood A (2015) Ethnopharmacological relevance of indigenous medicinal plants from district Bahawalnagar, Punjab. Pakistan J Ethnopharmacol 175:109–123. https://doi.org/10.1016/j.jep.2015.08.011

Al Disi SS, Anwar MA, Eid AH (2016) Anti-hypertensive herbs and their mechanisms of action: Part I. Front Pharmacol 6:323. https://doi.org/10.3389/fphar.2015.00323

Anggraeni NI, Hidayat IW, Rachman SD, Ersanda H (2018) Bioactivity of essential oil from lemongrass (*Cymbopogon citratus* Stapf) as antioxidant agent. https://doi.org/10.1063/1.5021200

Baharvand-Ahmadi B, Bahmani M, Tajeddini P, Rafieian-Kopaei M, Naghdi N (2016) An ethnobotanical study of medicinal plants administered for the treatment of hypertension. J Renal Inj Prev 5(3):123–128. https://doi.org/10.15171/jrip.2016.26
Bakris GL (n.d) Overview of hypertension. Merck manual online. http://www.merckmanuals.com/professional/cardiovascular-disorders/hypertension/overview-of-hypertension. Accessed 7 Jan 2019
Biraguma J, Mutimura E, Frantz JM (2019) Knowledge about modifiable risk factors for non-communicable diseases adults living with HIV in Rwanda. Afr Health Sci 19(4):3181–3189. https://doi.org/10.4314/ahs.v19i4.41
Boadu AA, Asase A (2017) Documentation of herbal medicines used for the treatment and management of human diseases by some Communities in Southern Ghana. eCAM. https://doi.org/10.1155/2017/3043061
Busia K (2016) Fundamentals of herbal medicine. 1 & 2. Lightning Source UK Ltd, Milton Keynes
Creswell JW (2015) A concise introduction to mixed methods research. SAGE, Thousand Oaks
Ekor M (2014) The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. Front Pharmacol 4:177. https://doi.org/10.3389/fphar.2013.00177
Esler M, Lambert E, Schlaich M, Schlaich L (2010) Point: chronic activation of the sympathetic nervous system is the dominant contributor to systemic hypertension. J Appl Physiol 109:1996–1998 (**discussion 2016**). https://doi.org/10.1152/japp-lphysiol.00182.2010
Frazão-Moreira A (2016) The symbolic efficacy of medicinal plants: practices, knowledge, and religious beliefs amongst the Nalu healers of Guinea-Bissau. J Ethnobiol Ethnomed 12(1):24. https://doi.org/10.1186/s13002-016-0095-x
Husaini DC, Bush CJ, Coc I, Guerra E, Perez AW, Wu C-Y (2020) Poisonous plants of Belize: a mini toxicological review. Adv Tradit Med. https://doi.org/10.1007/s13596-020-00486-y
Inoue M, Hayashi S, Craker LE (2019) Role of medicinal and aromatic plants: past, present, and future. Pharmacognosy Med Plants. https://doi.org/10.5772/intechopen.82497
Kahraman C, Arituluk ZC, Cankaya II (2020) The clinical importance of herb-drug interactions and toxicological risks of plants and herbal products. Med Toxicol [working Title]. https://doi.org/10.5772/intechopen.92040
Kastor A, Mohanty SK (2018) Disease and age pattern of hospitalisation and associated costs in India: 1995–2014. BMJ Open 8(1):e016990. https://doi.org/10.1136/bmjopen-2017-016990
Landazuri P, Chamorro NL, Cortes BP (2017) Medicinal plants used in the management hypertension. J Anal Pharm Res 5(2):00134. https://doi.org/10.15406/japlr.2017.05.00134
Lawson DA, Rands SA (2019) The effects of rainfall on plant–pollinator interactions. Arthropod Plant Interact 13(4):561–569. https://doi.org/10.1007/s11829-019-09686-z
Malik K, Ahmad M, Bussmann RW, Tariq A, Ullah R, Alqahtani AS, Shahat AA, Rashid N, Zafar M, Sultana S, Shah SN (2018) Ethnobotany of antihypertensive plants used in Northern Pakistan. Front Pharmacol 9:789. https://doi.org/10.3389/fphar.2018.00789
Mans DRA, Ganga D, Kartopawiro J (2017a) Meeting of the minds: traditional herbal medicine in multiethnic Suriname (chapter 6). In: El-Shemy H (ed) Aromatic and medicinal plants—Back to Nature. InTech, Rijeka, pp 111–132. https://doi.org/10.5772/66509
Mans DRA, Grant A, Pinas N, (2017b) Plant-based ethnopharmacological remedies for hypertension in Suriname, Herbal Medicine. Philip F. Builders, IntechOpen. https://doi.org/10.5772/intechopen.72106
McPhail SM (2016) Multimorbidity in chronic disease: impact on health care resources and costs. Risk Manag Healthc Policy 9:143–156. https://doi.org/10.2147/RMHP.S97248
Meresa A, Fekadu N, Degu S, Tadele A, Geleta B (2017) An Ethno Botanical review on medicinal plants used for the management of hypertension. Clin Exp Pharmacol 7:228. https://doi.org/10.4172/2161-1459.1000228
Mishra SR, Neupane D, Shakya A, Adhikari S (2015) Kallestrup P (2015) Modifiable risk factors for major non-communicable diseases among medical students in Nepal. J Community Health 40(5):863–868. https://doi.org/10.1007/s10900-015-0012-6
Mordeniz C (2019) Introductory chapter: traditional and complementary medicine. Traditional and Complementary Medicine. https://doi.org/10.5772/intechopen.86373
Mphuthi D, Pienaar J (2017). Hybrid Method for Exploring Efficacy of Indigenous Management of Common Cold through African Therapy. https://doi.org/10.4018/978-1-5225-0833-5.ch016
Nafiu MO, Hamid AA, Muritala HF, Adeyemi SB (2017) Preparation, standardization, and quality control of medicinal plants in Africa. Academic Press. https://doi.org/10.1016/B978-0-12-809286-6.00007-8
Nare NE, Pienaar AJ, Mphuthi DD (2018) Conceptualisation of African primal health care within mental health care. Curationis 41(1):1–11. https://doi.org/10.4102/curationis.v41i1.1753
Nascimento AAlves do, Luiz JC, Vega MRG, Villela DM, Nascimento MT (2019) Effect of leaf quality on herbivory of three atlantic forest species. Floresta e Ambiente 26(4):e20170810. https://doi.org/10.1590/2179-8087.081017
Pan American Health Organisation (PAHO) Survey of Diabetes, Hypertension and Chronic Disease Risk Factors Belize. https://iris.paho.org/bitstream/handle/10665.2/7687/9789275132869_eng.pdf?sequence=1&isAllowed=y Accessed 22 Mar 2019
Parvez MK, Rishi V (2019) Herb–drug interactions and hepatotoxicity. Curr Drug Metab 20(4):275–282. https://doi.org/10.2174/1389200220666190325141422
Petrovska BB (2012) Historical review of medicinal plants' usage. Pharmacogn Rev 6(11):1–5. https://doi.org/10.4103/0973-7847.95849
Rawat S, Jugran AK, Bahukhandi A, Bahuguna A, Bhatt ID, Rawal RS, Dhar U (2016) Antioxidant and anti-microbial properties of some ethnotherapeutically important medicinal plants of Indian Himalayan Region. Biotech 6(2):154. https://doi.org/10.1007/s13205-016-0470-2
Rosendorff C, Lackland DT, Allison M, Aronow WS, Black HR, Blumenthal RS, Cannon CP, De Lemos JA, Elliott WJ, Findeiss L, Gersh BJ (2015) Treatment of hypertension in patients with coronary artery disease. Hypertension 65(6):1372–1407
Shaikh AS, Thomas AB, Chitlange SS (2020) Herb–drug interaction studies of herbs used in treatment of cardiovascular disorders—A narrative review of preclinical and clinical studies. Phytother Res 34(5):1008–1026. https://doi.org/10.1002/ptr.6585
Shayo FK (2019) Co-occurrence of risk factors for non-communicable diseases among in-school adolescents in Tanzania: an example of a low-income setting of sub-Saharan Africa for adolescence health policy actions. BMC Public Health 19:972. https://doi.org/10.1186/s12889-019-7320-1
Somparn N, Saenthaweesuk S, Naowaboot J, Thaeomor A (2014) Effects of *Cymbopogon citratus* Stapf water extract on rat antioxidant defense system. J Med Assoc Thai 97(Suppl 8):S57–S63
Somparn N, Saenthaweeuk S, Naowaboot J, Thaeomor A, Kukongviriyapan V (2018) Effect of lemongrass water extract supplementation on atherogenic index and antioxidant status in rats. Acta Pharm (zagreb, Croatia) 68(2):185–197. https://doi.org/10.2478/acph-2018-0015
Vaismoradi M, Snelgrove S (2019) Theme in qualitative content analysis and thematic analysis. https://www.qualitative-research.net/index.php/fqs/article/view/3376/4470 Accessed 04 Feb 2020
WHO traditional medicine strategy: 2014–2023 (2015, November 20). https://www.who.int/medicines/publications/traditional/trm_strategy14_23/en/ Accessed 03 Aug 2020

Publisher's Note