Study about Compliance, Follow Up and Blood Pressure Control among Hypertensive Sudanese Patients in Khartoum State Hospitals in 2018

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Abstract

Background: High blood pressure is a major risk factor for many cardiovascular diseases leading to significant life threatening complications and comorbidities, that can be prevented if the blood pressure is adjusted to the normal ranges through medications and life style changes. In addition to proper knowledge about the disease and good health seeking behavior through regular follow up visits. The new 2018 European recommendations for high blood pressure emphasized the importance of improving the patients' compliance toward their antihypertensive therapy.

Objective: The purpose of this study is to assess the compliance to the antihypertensive therapy, the degree of commitment in this compliance, follow up behavior visits among hypertensive patients in the Khartoum State hospitals and whether their blood pressure is controlled or not at the time of the study.

Methods: The study was a hospital based case series research conducted on 212 hypertensive patients from November 2018 to December 2018.

Self-administered structured questionnaire was used including the Morisky scale questions after some modifications to fit the study, followed by blood pressure measurement, demi_span, and mid upper arm circumference measurement for BMI calculations, the blood pressure records were checked whenever there were available.

Results: The participants mean age was (Mean = 60.490 ± SD = 11.552) years (Mean ± SD). Hypertensive Sudanese patients have suboptimal compliance to their antihypertensive medications with good knowledge and average commitment toward medications compliance.

The follow up behavior approximately equal between those who regularly go for follow up and those who not

Conclusion: The rate of suboptimal antihypertensive medications adherence is quite high, many people presented with life threatening complications. Medication adherence has to be increased in order to reach the target of blood pressure control. The importance of regular follow up visits has to be addressed with other strategies to control the comorbid diseases so as the overall level of complications decreases.

Keywords: *Compliance, Antihypertensive, Follow Up, Morisky Scale, Commitment Toward Medications Compliance, Blood Pressure Control*

Abbreviations

ANOVA: Analysis of Variance; BMI: Body Mass Index; BP: Blood Pressure; DALY: Disability Adjusted Life Year; SD: Standard Deviation; SPSS: Statistical Package for the Social Science; MAP: Mean Arterial Pressure; MMA8: Morisky Medications Adherence Scale8 Items; SD: Standard Deviation

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Introduction

Background

Hypertension is a disease characterized by raised systolic and/or diastolic blood pressure to a value of 140/90 or above.

It is a known risk factor for cerebrovascular accidents, coronary artery diseases and major multisystem complications.

Despite of the complications of the diseases it is one of the most significant preventable causes of premature morbidity and mortality in both developed and developing countries.

The cardiovascular risks associated with raised blood pressure depend on the combination of risk factors in an individual such as age, gender, weight, physical activity, smoking, family history, serum cholesterol level, diabetes mellitus, and preexisting vascular diseases.

Pathogenesis of the disease

Regarding the pathogenesis of the disease, many factors may contribute to the regulation of blood pressure and the development of hypertension, including renal dysfunction, peripheral resistance, vessel ton, endothelial dysfunction, autonomic tone, insulin resistance and neurohumeral factors.

Those factors may act at the level of blood vessels or heart or even affecting the cardiorespiratory center directly.

95% of the cases of hypertension have no identified risk factors, those categories of patients are said to have essential hypertension while 5% of patients develop hypertension secondary to an underlying disease.

Etiological factors

Essential hypertension has a multi factorial etiology

Genetic factors

Blood pressure tends to run in families and children of hypertensive parents tend to have higher blood pressure than age-matched children of parents with normal blood pressure.

This familial concordance of blood pressure may be explained, at least in part, by shared environmental influences. However there still remains a large, still largely unidentified genetic components.

Fetal factors

Low birth weight is associated with subsequent high blood pressure.

This relationship may be due to fetal adaptation to intrauterine undernutrition with long term changes in blood vessel structure or in the function of crucial hormonal system.

Environmental factors

Among the environmental factors that have been proposed, the following seem to be the most significant:

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- Obesity: Fat people have high blood pressure than thin people. Sleep disordered breathing may be an additional risk factor.

- Alcohol intake: Most studies have shown a close relationship between the consumption of alcohol and blood pressure level. However, subjects who consume small amounts of alcohol seem to have lower blood pressure level than those who consume no alcohol.

- Sodium intake: A high sodium intake has been suggested to be a major determinant of blood pressure differences between and within populations around the world. Populations with higher sodium intakes have higher average blood pressure than those with lower sodium intake.

Migration from rural to an urban environment have been associated with an increase in blood pressure that is in part related to the amount of salt in the diet. Studies of restriction of sodium intake have shown a beneficial effect on blood pressure in hypertensive. There is some evidence that a high potassium diet can protect against the effects of high sodium intake.

- Stress: While acute pain or stress can raise blood pressure, the relationship between chronic stress and blood pressure is still uncertain.

Numeral mechanisms

Renin angiotensin aldosterone system, atrial natriuretic peptide, kallikrein-kinin system plays a role in the physiological regulation of blood pressure and has been implicated in the pathogenesis of essential hypertension.

Insulin resistance as part of the metabolic syndrome have a great association with hypertension, which is a major risk factor for cardiovascular diseases.

Secondary hypertension is when blood pressure arises as a result of a specific and potentially treatable disease [1].

The structural changes produced by hypertension in the vessel walls will aggravate the condition in a viscous cycle.

Hypertension is more common in some ethnic groups, particularly Asians, Africans and American groups, 40 - 60% is explained by genetic factors and age is considered an important risk factor in all ethnic groups.

Africa is facing an increase in the level of no communicable diseases and this is likely to be due to increase in obesity and lifestyle changes and the burden of no communicable is estimated to be about81% of hospital admissions with CVA admission rate of 25.4% [1].

The rate of hypertension in African countries was found to be 40.2% almost similar to the rate in UK (45.8%).

Sudan is located in the heart of Africa and prevalence of hypertension in different regions and ethnic groups were found to be high. For instance, in Urban population in north of Sudan the prevalence of hypertension was estimated to be more than 30% [8]. While in rural population the prevalence was estimated to be between 15% to 38%.

Symptoms and signs

Clinically the disease can be asymptomatic in many cases until a diagnosis is made at a routine physical examination or till the complications arise.

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Regarding this fact the blood pressure check is advisable every 5 yrs. for all people above 40 yrs. signs in the clinical examination may include radio femoral delay, Cushing features if the cause is endocrinological, signs of coarctation of aorta or aneurysms.

Other clinical features consistent with the diagnosis are the complication signs like left ventricular hypertrophy, 3rd and 4th heart sounds, lower limbs edema and ophthalmologic complications [1].

Diagnosis

Because antihypertensive drugs are lifelong treatments the diagnosis is based on right blood pressure measurements putting in consideration the standardized method with appropriate cuff size after exclusion of the other organic diseases that affect the blood pressure.

White coat hypertension is common, the physician role here is to alleviate the anxiety and advice the patient to have serial blood pressure measurements [1].

Management

The objective of antihypertensive treatment is to reduce the incidence of adverse cardiovascular events, particularly CAD, stroke and HF.

Randomized controlled trials have demonstrated that antihypertensive treatment can reduce the incidence of stroke and CAD in a lesser extent.

The optimum target for blood pressure control is 139/83 or even lower in patients with diabetes mellitus.

Appropriate life style measures (stopping smoking, regular exercise, stopping alcohol intake, low salt intake) may obviate the need for drug therapy in patients with borderline hypertension.

Drug therapy

- Thiazides
- ACE inhibitor
- Angiotensin receptor blocker
- Calcium channel antagonist
- Beta blockers
- Combined beta and alpha blockers
- Aspirin
- Statins.

Although some patients can be treated with a single antihypertensive drug, a combinational treatment may be needed for optimal blood pressure control [1].

Compliance to the antihypertensive medications

Compliance to medication has been defined as the extent to which patients' behaviors coincide with health care providers' recommendations for health and medical advice.

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Poor compliance to medications is a major public health challenge.

Successful control of blood pressure is of paramount importance in the reduction of morbidity and mortality rates and many studies have demonstrated the impact of antihypertensive agents on improving clinical outcomes. However, the effectiveness of antihypertensive agents must be achieved by optimal compliance to prescribed medications according to healthcare providers' instructions.

Still medication compliance is an important obstacle in the achievement of controlled blood pressure.

Barriers to drug compliance consist of multiple factors that include complex medication regimens, dosing frequency, behavioral factors and side effects of treatment. The most typical barriers to drug adherence are under the patient's control, including patient's knowledge and attitudes towards medications.

Poor compliance has been attributed to unnecessary over-prescription of drugs, substantial worsening of diseases, avoidable increases in hospital admission rates, longer hospital stays, leading to a significant medical burden. It is a crucial public health agenda to improve adherence with antihypertensive medications by improvements of medication-taking behavior.

Various methods have been developed to measure medication compliance, and they can be grouped into three categories: subjective (self-report), direct (serum or urine drug-level), and indirect (pharmacy database records, pharmacy refill rates, or pill counts) [2].

Each method has its strengths and drawbacks; and subjective and indirect methods are more frequently used in compliance-related studies. Self-reported measures are a relatively simple and inexpensive method, and it could also include information on social, situational and behavioral factors that affect compliance. Many studies have addressed this topic with some limitations like not involving the private sectors and the follow up behavior of the patients [2].

The scope of this study is compliance to the antihypertensive medications, the follow up behavior of the patients and the relation to control of their blood pressure and arising complications.

Problem statement

Hypertension is a chronic disease with increasing prevalence rate in the last years, patients diagnosed with hypertension and put on treatment will take them for long years in their life.

So, patients need to be more compliant to their medications to prevent the lifelong cardiovascular complications of the disease.

They need to undergo regular follow up for treatment and dose adjustment and need early detection of the complications and prevention of the life threatening ones.

Having controlled blood pressure is a goal of each physician, so compliance is considered an important factor in achieving this.

Justification

There are numbers of studies internationally addressing this topic but little ones addresses the magnitude of problem in Sudan, this study fulfils these gaps, including the private sectors in the research sampling and assessing the frequency of follow up behavior of the

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patients. In addition to that it takes the different factors affecting blood pressure control and follow up behavior of the hypertensive Sudanese populations.

Objectives of the Study

General objectives

To assess the compliance state of the Sudanese hypertensive patients and its associated factors, the follow up behavior of the patients, and to determine whether their blood pressure is controlled or not at the time of the study.

Specific objectives

- To study the socio demographic background of the participants.
- To assess the compliance using 7 item questions including recurrent forgetting to get the medications, previous days without medications, difficulty to medication accessibility, and the knowledge about the importance of medications.
- To determine the number of pills each patient take, commitment toward compliance, presence of insurance or not, and the family member responsible for bringing the medications.
- To assess the frequency of follow up visits, obstacles in follow up, no of times the medication changed, satisfaction with the doctor patient relationship.
- To determine the degree of impact of hypertension on the patients life and its complications and rising daily complains.
- To assess whether the participants have controlled blood pressure or not at the time of study.

Study design

Descriptive case series hospital based study conducted in the period from November to December 2018.

Study settings

Hospital based in Khartoum teaching hospitals.

There are 23 public hospitals in Khartoum state, 16 in Khartoum locality, 7 in Bahri and 9 in Omdurman locality.

The number of private sector hospitals in Khartoum state are 50 hospitals.

3 hospitals are selected randomly, 2 public and I from the private sector.

Al shaab teaching hospital, Ahmed Gasim teaching hospital and Sudan center for heart diseases.

Alshaab teaching hospital

Located in khartoum altabia street near the dentistry teaching hospital, founded in the year, with total number of patients = 1461, 74 beds making the average hospital admission of 9.1 days.

Regarding out patients clinic, 4 days in a week (two on Monday, two on Tuesday, two on Wednesday and one clinic on Thursday) with an overall total of 6 units for the cardiac diseases.

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Ahmed Gasim hospital for cardiac surgery and renal transplantation

It is specialized hospital in heart and pediatric surgery.

Founded in 1997 in Bahri locality, currently contains the following units: cardiac intensive care unit<cardio surgery unit, cardio pediatric unit, blood bank<excellence unit, pharmacia, and medical logistic units.

They types of heart surgeries performed in the center includes: arterial graft, valve replacement, vascular surgery, and pediatric operations for various congenital diseases.

Study population

The study conducted in the outpatient clinics of the 3 mentioned hospitals.

Inclusion criteria

Any hypertensive patient above 40 years old who have been diagnosed with hypertension for at least one year and on treatment.

Exclusion criteria

Those who recently diagnosed with the disease.

Or their age is younger than 40 years.

Medical staff at the hospital.

Any acutely ill patient who is not able to complete the interview.

Sampling

Sample size

All cases in the period from November 2018 to December 2018 are involved in the study.

Sample selection

Simple random sampling technique. The data collection was piloted to assess the questionnaire acceptance, clarity and completion time and no modification were made.

Tools

- Questionnaire.
- Mercury sphygmomanometer.
- Standardized meter.

Study variables

Dependent variables

- Compliance.
- Commitment toward the compliance.

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- Follow up behavior of the patients.

- Knowledge and perception about the disease state.

- Blood pressure control.

Independent variables

- Socio-demographic data such as age, gender, smoking status, educational level.

- No of years with hypertension.

- No of antihypertensive pills.

- Presence of health insurance.

- Accessibility of treatment.

- Other long term medications.

- BMI.

- Cholesterol presence in the blood.

- Medication self purchasing.

Data collection

The data collected directly from the patient in a form of 10 minutes interview, self conducted. The questionnaire containing socio-demographic characteristics, duration of hypertension, duration of delay in taking the antihypertensive medications.

7 items morisky scale 8 with the exception of the question related to the patient feeling hassled about taking the medications.

It contains both close and open ended questions.

With some questions in the form of Likert scale.

The data collection was piloted to assess the questionnaire acceptance, clarity and completion time and no modification were made.

4 questions we're used to assess the knowledge and perception of disease treatment importance and the last blood pressure readings.

3 questions addressed the commitment of patients to their medication compliance.

3 questions for the follow up behavior of the patients.

One question addressed the complications of the disease.

One question for the presence of health insurance.

One question about the impact of the disease on patient life.

Blood pressure measurement was done at the end of each interview.

With 2 consecutive readings separated by 10 minutes interval, taking into account the standardized criteria for blood pressure measurements.

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The measured systolic and diastolic BP was also transformed into a dichotomous variable, with systolic BP < 140 mmHg and diastolic BP < 90 mmHg (systolic BP < 130 mmHg and diastolic BP < 80 mmHg for patients with diabetes mellitus) regarded as "optimal BP control".

BMI was measured from its 2 components.

Mid upper circumference for the weight.

Demi span for the height.

And the corresponding variables we're measured from the corresponding equations.

General principles of scoring

The Morisky Medication Adherence Scale is a validated assessment tool used to measure non-adherence in a variety of patient populations with good reliability (α = 0.83).

It has been verified and substantiated by numerous studies on a global scale with over 110 versions and over 80 translations [1]. The tool uses a series of short behavioral questions geared in such a way to avoid "yes-saying" bias commonly seen with chronic care patients. More specifically, the wording of the questions is rearranged to prevent answers that tend to follow certain behavioral patterns. It measures both intentional and unintentional adherence based on forgetfulness, carelessness, stopping medication when feeling better, and stopping medication when feeling worse. This allows the patient to respond to questions about non-adherence in a spirit of full disclosure for the clinician.

The Morisky Medication Adherence Scale, otherwise known as the Morisky Scale (MMAS-8), has proved to be a valuable resource to address adherence concerns, such as forgetting to take medications or discontinuing medications without guidance. If a patient scores higher on the scale, they are evaluated as more adherent. If they score lower on the scale, they are presumed to be struggling with no adherence.

The highest score in the scale is 8 and represents those with good compliance.

The lowest score is Zero representing those who are not compliant.

For 7 items score, the highest score will be 7.

Those who score less than 5 are considered to be of poor compliance.

Those who scores from 5 - 6.9 will have medium compliance.

And those scores 7 will have the good compliance score.

The values adjusted to match the modified scale used here.

After calculation of the MMA score, every case has been categorized into good medium or poor complaints.

8 items Morisky scale for medication adherence

Item number 7 has been omitted in this study to accommodate the study backgrounds.

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The items are in the form of yes or No questions.

If a positive response is got, the question will be given score of 1.

In item8 of the original scale, those who never forget to take the medications will get score 1.

Then if they forget once awhile they will get 0.75.

Sometimes will get 0.5.

Usually will get 0.25.

An all the times will get 0.

Other score being used is follow up score containing 2 questions, with those scoring 2 have good follow up behavior and those scoring less have bad score.

Regarding commitment score, 4 questions have been included with those scoring 2 or above are considered committed while those scoring less than 2 are classified as non committed.

Regarding knowledge about current health status score, 6 questions have been included with those scoring 3 or above are considered to have good knowledge and those scoring less than 3 are considered to have bad knowledge about the current health status.

Data analysis

The data analysis was made by using SPSS version 25. the raw score was measured firstly then transformed these measure into percentile scales that allowed doing a complicated statistical analysis. The age described as mean and standard deviation and the other socio demographic as frequency. Then t tests and tests of association have been performed for the data, beside the tests of regression.

Missing values were treated based on scoring manual that allows up to 50% missing item per score. That means the patient must at least answer half of the items on the scale. Also the single-item measures were transformed into the same percentile scale.

Ethical consideration

The community medicine department approval was taken.

Ministry of health approval and the hospital permission are also taken.

The information collected after taking verbal consent from the patient.

And reassured that every information taken will be confidential and used only for purpose of this research.

But the findings will be published in local or international journals and presentations at scientific conferences.

Limitations

This study done as case series so it lacks the capability of assessing causal effect relationships. And it does not allow us to calculate the prevalence of the disease.

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Some localities have not been covered in the sample size that may affect the results of the study.

We a advice for another local study that cover larger population in the country, including those population younger than 40 years of age.

Results

The results of the research are based on 212 participants, with an overall response rate of 100%.

Socio-demographic characteristics

33% the participants are in the age group of (50 - 60 years).

		Frequency	Percentage
Age group	(40-50) years	47	22.2%
	(50-60) years	70	33%
	(60-70) years	61	28.8%
	(70-80) years	27	12.7%
	Above 80 years	7	3.3%
Total		212	100%

Table 1: Represents the age group distribution among the participants in heart centers in Khartoum state 2018.

(Mean age of the participants = 60.320 ± 12.106).

With the mean age of female participants is (58.4 ± 12.8) and that of the males is (63.3 ± 11.36). The sex distribution in the study is 131 (61.8%) for the females.

The participants educational level varies, 62 (29%) are illiterate, while 66 (31.1%) have completed their primary school education, and 50 (23.6%) have successfully attended their secondary school education and only 16 (7.5%) have completed their university educational level.

According to the residency

135 (63.7%) the participants live in Khartoum state.

According to the smoking state, 40 participants (18.9%) are smokers and exclusively from the male gender, while172 (81.1%) have denied smoking. The mean of years of smoking among smoker participants (12.83 years ± SD = 11.87).

The mean BMI of the participants is (mean = 26.86 ± SD = 16.72) with most of the participants 72 (34%) lies in the normal BMI value.

The mean BMI among the females group is slightly higher (28.6 ± 17.98) than the males (24.0 ± 14.09) group.

One sample independent t test have shown statistical significant difference between the BMI of females and males.

The mean of MAP among the participants is (102.12 ± SD = 16.895), similar to the global population MAP value determined.

The mean arterial pressure haven't shown statistical significant difference between the males and females.

89 (42%) of the participants have been prescribed cholesterol lowering drugs, with 93 (43.9%) have decreased level of daily activities after the diagnosis with hypertension.

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This reduced level of activity have been found statistically associated with the presence of co morbid complications, with those presenting with complications tending to have reduced level of daily activities.

		Reduced Level of Activity	Reduced Level of Activity	Total
Presence of the complications	Yes	73	73	146
	No	20	46	66
Total		93	112	212
		X^2 = 7.161 p = 0.007		

Table 2: *Represents the association between the reduction in activity level and the presence of complications among the participants in heart center in Khartoum state 2018.*

Regarding health insurance and treatment provider, 147 (69.7%) of the participants have health insurance while 30.2% don't have.

About the medications provider, 107 (50.5%) buy the medications by themselves while 105 (49.5%) have another family member to buy the medications for.

Hypertension related factors

64 (30.3%) of the participants have been diagnosed with hypertension in the recent 5 years, 90 (42.5%) for more than ten years and 58 (27.4%) in a period of (5 - 10) years.

166 (78.3%) of the participants haven't experienced any delay in starting their antihypertensive treatment, 21 (9.9%) have one year delay, 3 (1.4%) have 10years delay or more, and about 22 (10.4%) have experienced more than 1 year delay but less than 10 yes delay.

According to the number of antihypertensive pills prescribed, 85.4% have received mono-therapy regimen, with 14.6% have combinational therapy of two, three, or four pills, and 86% of the combinational therapies are in the form of 2 pills per day.

109 (51.4%) of the participants have their drug being changed since the first prescription with 48.6% haven't received any modifications in their treatment course since the diagnosis.

Compliance scale

107 (50.5%) of the participants forget to take their medications.

137 (64.6%) have skipped one dose in the past 2 weeks.

132 (62.3%) of the participants take their medication with them when they leave home. 176 (83%) take medications in the same time each day with only around 10 (4.7%) record the time of the medications in order not to forget.

135 (63.7%) buy new box of medications before the current box runs out.

The majority of the participant about 104 (49.3%) have poor compliance., followed by 65 (30.7%) having medium compliance.

Those having good compliance are about 42 (19.9%) of the participants, 29 (69%) of them are females.

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The ratio of good compliant females is 22.1% in comparison to 16.3% of the corresponding males. In comparing compliance between male and female groups, one sample t test does not show any statistical significant difference between the compliance in the 2 groups (p > 0.05).

14 (33.3%) of the good complaints lie in the age group of (60 - 70) years. The age group of (50 - 60) represents about 27 (41.5%) of the medium complaints, while 25% of the poor complaints lie in the age group of (40 - 50) years.

Compliance			40-50 yrs.	50-60 yrs.	60-70 yrs.	70-80 yrs.	Above80 yrs.	Total
	Good	Count (%)	9 (21.4%)	13 (31%)	14 (33.3%)	16 (14.3%)	0 (0%)	42 (100%)
	Medium	Count (%)	11 (16.9%)	27 (41.5%)	14 (21.5%)	19 (13.8%)	4 (6.2%)	65 (100%)
	Poor	Count (%)	26 (25%)	30 (28.8%)	33 (31.7%)	12 (11.5%)	3 (2.9%)	104 (100%)
	Total	Count (%)	46 (21.8%)	70 (33.2%)	61 (28.9%)	27 (12.8%)	7 (3.3%)	211 (100%)
					(X^2 = 8.299; P = 0.405)			

Table 3: *Represents different age groups compliances among participants in heart centers in 2018.*

Regarding compliance and the educational level, around 38.1% of the good complaints are illiterates in comparison to 26.2% who have completed their secondary education while 33.7% of the poor complaints have been shown to be of primary educational level.

There is no significant statistical association been found between compliance and educational levels (p>0.05)

Regarding compliance and place of residence, about 24 (57.1% of the good complaints) live in Khartoum state.

According to the duration of hypertension, 19 (45.2%) of the good complaints have been diagnosed with hypertension for more than 10 yrs duration, while most of the poor compliant patients 37 (35.7%) are those who have been diagnosed with hypertension in less than 5 years duration.

Compliance does not show any significant association with the duration of hypertension (p > 0.05).

Compliance isn't found to have any statistical significant association with the health insurance, medication self purchasing behavior, number of antihypertensive pills (p > 0.05).

Compliance also isn't found to have any statistical significant association with the duration of delay in taking the antihypertensive pills, symptoms of high blood pressure, hypertension related complications (p > 0.05).

Compliance isn't found to have statistical significant association with the MAP (p > 0.05).

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Compliance isn't found to have statistical significant association with the level of knowledge about the current health status (p > 0.05).

There is a significant association between the compliance status and taking other long-term medications for other conditions, with those taking other long-term medications being more compliant.

Yes		Do You Take Other Long Term Medications?		Total
		No		
Compliance	Good	3 (78.6%)	9 (21.4%)	42 (100%)
	Medium	42 (64.6%)	23 (35.4%)	65 (100%)
	Poor	57 (54.8%)	47 (45.2%)	104 (100%)
Total		131 (62.6%)	79 (37.4%)	211 (100%)
		(X^2 = 3.383; p = 0.025)		

Table 4: *Represents the association between compliance and taking other long term medications among the participants in heart centers in Khartoum state 2018.*

Also, there is significant association between compliance and commitment toward this compliance, with those committed tending to have good compliance (p = 0.000).

			Committed	Not Committed	Total
Compliance	Count (%)	Good	31 (73.8%)	11 (26.2%)	42 (100%)
	Count (%)	Medium	36 (55.4%)	29 (44.6%)	65 (100%)
	Count (%)	Poor	21 (20.2%)	83 (79.8%)	104 (100%)
	Count (%)	Total	88 (41.7%)	123 (58.3%)	211 (100%)
			(X^2 = 42.606; P = 0.000)		

Table 5: *Represents the relation between compliance and commitment status among participants in heart centers in 2018.*

Regarding compliance and follow up behavior, compliance is found to have statistical significant association with follow up behavior of the patients with (p = 0.000).

			Good Follow Up	Bad Follow Up	Total
Compliance	Good	Count (%)	28 (66.7%)	14 (33.3%)	42 (100%)
	Medium	Count (%)	37 (56.9%)	28 (43.1%)	65 (100%)
	Poor	Count (%)	36 (34.6%)	68 (65.4%)	104 (100%)
	Total	Count (%)	101 (47.9%)	100 (42.1%)	211 (100%)
			(X^2 = 15.403; p = 0.000)		

Table 6: *Represents different compliance groups follow up behaviors among participants in heart centers in Khartoum state 2018.*

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Regarding compliance and blood pressure control, about 26 (61.9%) of the good complaints have achieved blood pressure control, while 43 (41.3%) of the poorly compliant patients have uncontrolled blood pressure with no significant association being found (p > 0.05).

The category of participants who have previously stopped their antihypertensive therapy is found to have statistical significant association with those who take other long term treatment, with about 104 (67.1%) of those who have cut back the medications have other long term drugs, and 29 (50.9%) of those who have never stopped their medications aren't taking other long term medications (p = 0.017).

			Taking Other Long Term Medications		
Have you ever cut back your medications because you feel worse?			**Yes**	**No**	**Total**
	Yes	Count (%)	104 (67.1%)	51 (32.9%)	155 (100%)
	No	Count (%)	28 (49.1%)	29 (50.9%)	57 (100%)
Total		Count (%)	132 (62.3%)	80 (37.7%)	212 (100)
		$(X^2 = 5.730; p = 0.017)$			

Table 7: *Represents the association of previous treatment stop and having other long term conditions among participants in heart centers in Khartoum state 2018.*

Previous treatment stop is found to have statistical significant association with the perception about current health status with 62.5% of those who stopped their medications have good perception about the current health condition (p = 0.05).

		Knowledge score		Total
		Good knowledge	**Bad knowledge**	
Medications stop	Yes	101 (65.2%)	54 (34.8%)	155 (100%)
	No	29 (50.9%)	28 (49.1%)	57 (100%)
Total		130 (61.3%)	82 (38.7%)	212 (100%)
		$(X^2 = 3.585; P = 0.058)$		

Table 8: *Represents the association between previous medications stop and the knowledge about the current health status among the participants in health centers in Khartoum state 2018.*

125 (59%) of the participants think that missing pills doesn't affect health too much, with 76% of those who think missing pills will affect health are nonsmokers and only about 24% of them are smokers (p = 0.022).

63.7% of the participants confirm that they take their antihypertensive medications when their blood pressure is controlled.

52% states that high blood pressure doesn't affect the other condition they have.

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		Are you smoker?		Total
		Yes	**No**	
Do you think missing pills will affect your health?	Yes	30 (24%)	95 (76%)	125 (100%)
	No	10 (11.5%)	77 (88.5%)	87 (100%)
Total		40 (18.9%)	172 (81.1%)	212 (100%)
		(X^2 = 5.241; P = 0.022)		

Table 9: *Represents the association between smoking status and the perception about the effect of missing pills on health among the participants in heart centers in Khartoum state 2018.*

Blood pressure control

135 (64%) of the participants have achieved controlled blood pressure reading at the time of the study, while 76 (36%) have uncontrolled blood pressure.

Blood pressure control is found to have statistical significant association with residency, with 57 (41.9%) living outside Khartoum state have achieved blood pressure control.

		Inside Khartoum State	**Outside Khartoum State**	**Total**
Blood pressure control	Controlled	79 (58.1%)	57 (41.9%)	136 (100%)
	Not controlled	56 (73.7%)	20 (26.3%)	76 (100%)
	Total	135 (63.7%)	77 (36.3%)	212 (100%)
		(X^2 = 5.127; P = 0.024)		

Table 10: *Represents relationship between blood pressure control and residency among participants in heart centers in Khartoum state in 2018.*

Regarding the relation of blood pressure control and duration of hypertension, 64 (47.1%) of those diagnosed with hypertension for more than 10 years have achieved blood pressure control.

There is significant association between blood pressure control and the duration of hypertension with (p = 0.054).

			< 5 years	**5 - 10 years**	**> 10 years**	**Total**
Blood pressure control	Controlled	Count (%)	42 (30.9%)	30 (22.1%)	64 (47.1)	136 (100%)
	Uncontrolled	Count (%)	22 (28.9%)	28 (36.8%)	26 (34.3%)	76 (100%)
	Total	Count (%)	64 (30.2%)	58 (27.4%)	90 (42.5%)	212 (100%)
		(X^2 = 5.851; p = 0.054)				

Table 11: *Represents the relationship between blood pressure control and the duration of hypertension among participants in heart centers in Khartoum state 2018.*

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Having monotherapy vs combinational therapy is found to have significant association with blood pressure control (p = 0.009).

With 61.9% of those prescribed monotherapy have achieved blood pressure control, and 85.2% prescribed combinational therapy (2 pills regimens) have achieved blood pressure control.

No of Pills		Controlled	Not Controlled	Total
1 pill	Count (%)	112 (61.9%)	69 (38.1%)	181 (100%)
2 pills	Count (%)	23 (85.2%)	4 (14.8%)	27 (100%)
3 pills	Count (%)	0 (0%)	3 100%	3 (100%)
4 pills	Count (%)	1 (100%)	0 (0%)	1 (100%)
		$(X^2 = 11.528; p = 0.009)$		

Table 12: Represents number of antihypertensive pills and the blood pressure control among participants in heart centers in Khartoum state 2018.

Regarding blood pressure control and follow up behavior of the patients, 73 (72.3%) of those who have good follow up behavior have achieved blood pressure control, while 48.2% of those who have bad follow up behavior have uncontrolled blood pressure with p = 0.01)

		Controlled	Uncontrolled	Total
Good follow up	Count %	73 (72.3%)	28 (27.7%)	101 (100%)
Bad follow up	Count %	63 (56.6%)	48 (43.2%)	111 (100%)
Total	Count %	136 (64.2%)	76 (35.8%)	212 (100%)
		$(X^2 = 5.539; p = 0.019)$		

Table 13: Represents the relationship between follow up behavior and blood pressure control among participants in heart centers in Khartoum state 2018.

Other sociodemographic factors like sex, educational level, and presence of health insurance have no statistical significant association with blood pressure control (p > 0.05).

Smoking status, duration of smoking, the BMI and high cholesterol levels are not found to have statistical significant association with blood pressure control (p > 0.05).

Blood pressure related complications and symptoms of high blood pressure are not found to have statistical significant association with blood pressure control (p > 0.05).

Commitment toward medication compliance, having other co morbid condition are not found to have statistical significant association with blood pressure control (p>0.05).

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And neither of medication self purchasing, number of antihypertensive pills, medication change from the first prescription nor difficulty in taking the medications is found to have significant association with blood pressure control (p > 0.05).

Previous medication stop isn't found to have significant association with blood pressure control (p > 0.05).

Follow up behavior of the participant

111 (52%) of the participants are found to have bad follow up score with 101 (48%) having bad score in follow up.

Commitment toward medication compliance is found to have significant association with follow up behavior of the patients, with 51 (58%) of the committed have good follow up and 74 (59.7%)of the non committed have bad follow up behavior (p = 0.001).

			Good	Bad	Total
	Committed	Count (%)	51(58%)	37(42%)	88(100%)
	Non committed	Count (%)	50(40.3%)	74(59.7%)	124(100%)
Commitment	Total	Count (%)	101 (47.6%)	111(52.4%)	212 (100%)
				(X^2 = 6.415; P = 0.001)	

Table 14: *Represents the relationship between follow up behavior and commitment toward medication compliance among participants in heart centers in Khartoum 2018.*

Follow up behavior is found to have significant association with having other co morbid condition, with 71 (53.8) of those taking other long term medications apart from hypertensive therapy, have good follow up behavior, while 50 (62.5%) of those not having other long term condition having bad follow up behavior (p = 0.021).

		Good Follow Up	Bad Follow Up	Total
Taking other long-term medication	Count (%)	71 (53.8%)	61 (56.2%)	132 (100%)
Not taking other long-term medications	Count (%)	30 (37.5%)	50 (62.5%)	80 (100%)
Total	Count (%)	101 (47.6%)	111(52.4%)	212 (100%)
		(X^2 = 5.298; p = 0.021)		

Table 15: *Represents the relationship between follow up behavior and having other long-term condition among participants in heart centers in Khartoum state 2018.*

Follow up behavior is found to have significant statistical association with difficulty in taking the medications, with 81.3% of those having difficulty in taking the medications all the times have bad follow up behavior in comparison to 60.7% of those who never have difficulty in taking the medications and have good follow up behavior.

Regarding health insurance and follow up behavior, there is significant strong association being demonstrates, with 57.1% of those having health insurance having good follow up, while (73.1%) of those with no health insurance having bad follow up behavior.

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		Good Follow Up	Bad Follow Up	Total
Difficulty in taking the medications	All the times	Count (%)	3(18.8%)	13 (81.3%)	16 (100%)
	Usually	Count (%)	3 (30%)	7 (70%)	10(100%)
	Sometimes	Count (%)	10(32.3%)	21 (67.7%)	31(100%)
	Once a while	Count (%)	20(42.6%)	27 (57.4%)	47(100%)
	Never	Count (%)	65(60.7%)	42 (39.3%)	107(100%)
	Total		101(47.9%)	110 (52.1)	211(100)
			$(X^2 = 17.387; P = 0.002)$		

Table 16: *Represents the relationship between difficulty in taking antihypertensive medications and follow up behavior among participants in heart centers in Khartoum 2018.*

		Good Follow Up	Bad Follow Up	Total
Having health insurance	Count (%)	84 (57.1%)	63 (42.9%)	147 (100%)
Not having health insurance	Count (%)	17 (26.6%)	47 (73.4%)	64 (100%)
Total	Count (%)	101 (47.9%)	110 (52.1%)	211 (100%)
		$(X^2 = 16.709; p = 0.000)$		

Table 17: *Represents the relationship between follow up behavior and health insurance among participants in heart centers in Khartoum state 2018.*

Follow up behavior is found to be statistically associated with previous antihypertensive treatment stop, with 70.2% of those who had stopped their medications having bad follow up score.

		Good Follow Up	Bad Follow Up	Total
Stopped medications	Count (%)	17 (29.8%)	40 (70.2%)	57 (100%)
Never Stopped	Count (%)	84 (54.2%)	71 (45.8%)	155 (100%)
Total	Count (%)	101 (47.6%)	111 (52.4%)	212 (100%)
		$(X^2 = 9.921; P = 0.002)$		

Table 18: *Represents the association between previous antihypertensive medications stoppage and follow up behavior among participants in heart centers in Khartoum state 2018.*

Other factors like: age, residency, level of education, duration of hypertension and the duration of delay in taking antihypertensive medications are not found to have statistical significant association with patients follow up behavior (p > 0.05).

Regarding the association of follow up behavior and sex with percentage of 39.5% of good compliance among males in comparison to 52.7% among females, but this association is not found to be statistically significant (p > 0.05).

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Follow up behavior wasn't found to have statistical significant association with the perception about current health state nor the medication self-purchasing behavior (p > 0.05).

Neither antihypertensive medications change nor the disease related complication is found to have significant association with follow up behavior (p > 0.05).

Regarding the category of patients who never go regular follow up

94.3% of them are not satisfied with the doctor –patient relationship. 41.5% of them dislike to go to doctors and hospitals, while 34.9% of them think that taking the medications only will be sufficient.

1.9% mention that doctor did not requested for further follow up, with 20.8% have other reasons like preoccupation with work.

Other results

Other finding is that high cholesterol levels are found to have significant association with diabetes mellitus (p = 0.000), and angina pectoris as a complication is found to have statistical significant association with DM (P = 0.007).

Emergency hypertension as a complication is found to be associated with uncontrolled blood pressure (p = 0.001).

In multivariate logistic regression for compliance and its associated factors

Compliance was divided into two groups (optimal and suboptimal) taking the cut off point 5.5 as a reference point.

Any score above it is considered optimal, any score equals or below than 5.5 is considered suboptimal with following results being demonstrated below.

Age, follow up behavior and presence of other long term treatments have been excluded, with only difficulty in taking the medications (with an odd ratio = 1753.784),commitment toward compliance (0dd ratio = 0.233), yrs with hypertension affecting the patients compliance (Odd ratio = 1.625) multivariate logistic regression for blood pressure control only the following factors have been found to affect the level of blood pressure control:

BMI (odd ratio = 3.818), Level of education (odd = 0.416), follow up behavior (odd = 25.129). multivariate logistic regression for follow up behavior for patients demonstrated the following factors to have an affect on frequency of visits: gender (odd ratio = 0.517), health insurance (odd ratio = 4.176), And commitment toward medications compliance (odd ratio = 1.851).

Discussion

This study about compliance to the antihypertensive therapy in Sudanese population demonstrated the most important factors associated with the level of compliance and highlighted those who have great effect on compliance.

The majority of the Sudanese population is of low socioeconomic class and this class of population is occupied in most of the times with work and money earning, males and females, giving too little weight for health and treatment compliance, so there is no difference in treatment compliance between the males and females, this is found to be consistent with the study of Nigerian population [14] and that of

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African American population [4] which found that sex does not have statistical significant association with medications compliance. This contradicts the results of other studies like non adherence to antihypertensive medications in 2007 [7] and the study about predictors of poor adherence to hypertensive medications in Tunis in 2019 [13], which have concluded that sex has a major significant association with medications adherence.

Younger people usually are preoccupied in most of the time in comparison to older group who have a lot of time to take care of their health and the complications that may arise with aging, so older people tends to report every small health problem to medical advice and they become more adherent to their medications. This is found to be consistent with the study done in Pakistan in 2007 [5], Nigerian study [14] and the African American [4] study which all isolated age as an important factor associated with medications adherence.

Other studies that have consistent results are: Nigerian study [14], African American study [4], both isolated age as an important factor associated with medications adherence.

Regarding educational level, education in the past 40 to 50 years ago is not like today, in the past people tends to leave schools at younger ages to search for money gaining jobs, and for the females sex they leave schools earlier and get marry. In addition to cultural backgrounds and believes that have a great role with these high illiteracy rates in the community.

This why educational level is not found to have statistical significant association with the medications compliance, this finding contradicts the results of the study done in 2005 about barriers to antihypertensive medication adherence [16] that identified educational level as an important factor associated with medication adherence with those less educated being less adherent.

Despite these high ratios of illiterates and primary school educations, most of the participants have good knowledge regarding their health status, this can be due to the high rates of Informal education in African countries, so people tends to learn from their daily activities and this makes them more ready to ask about the disease, their health status and know the disadvantages of not taking the medications.

Although having hypertension for longer durations make the patient more used to his treatment and may enhance his medication compliance, and this is the case in the Nigerian study in 2015 [14] about medications compliance, the results of this study don't not show any statistical significant association between medications compliance and the duration of the disease.

In spite of the associations being isolated between duration of the disease and compliance with those with the disease for 10 years or more being more complaints, but this association isn't significant and this may be due to the sample size, better associations may be demonstrated with larger sample sizes.

Regarding antihypertensive regimen, new regimens are directed toward combinational therapy instead of the old monotherapy regimen, most of the participants here are put on the old monotherapy regimen, with no significant association being found between the level of compliance and the type of regimen being used. This contradicts the Ethiopian study in 2018 [6] and Nigerian one in 2015 [14] where they found an inverse relationship between level of compliance and the number of antihypertensive therapy.

Regarding compliance and level of co-morbidities

In our community greater care is achieved for those who have co morbid conditions, and the patient perception about importance of medication adherence increases as the number of health conditions increases, patients here in the community believes that having more

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than one health condition will have a greater effect on the overall health outcome so they become adherents. these results match the results of the study done in Pakistan [5] that concluded: compliance increases as the number of co morbid conditions increases, while these contradicts the study done in Ethiopia [6], HONG Kong [9], and the that founded an inverse relationship between compliance and presence of co morbidities.

Because of the good family support here in Sudan, family members tend to help in purchasing the medications for the patients, so treatment may be available in most of the times, this is why self purchasing for the medications is not identified as a significant factor associated with drug compliance, and this contradicts the study done in Ethiopia in 2018 [6] that concludes an inverse relationship between self purchasing to medications and compliance.

Most of the participants in this study have health insurance so it isn't identified as a significant factor affecting the medications adherence, this result has been demonstrated in the study done about adherence to antihypertensive medications among family practice patients in patients with diabetes mellitus and hypertension in 2013 [15] which found 88% of the participants have health insurance, and that health insurance isn't as a barrier in medications adherence. This contradicts the study done in 2005 in united state [16] that founded a direct relationship between presence of health insurance and medications compliance.

About the hypertension related complications and compliance state

Because there are many factors apart from treatment compliance lag behind the scene and play a major role in the complications presence, the study does not identified a significant association between the complications and compliance, this lines with the study made in Pakistan in 2007 [5] which found that greater proportions of patients suffering from hypertension related complications are adherent toward their antihypertensive therapy and contradicts study done in 2015in HONG KONG [9] about the effects of medication adherence in blood pressure control, and the study in 2002 in Sweden [18] which found a great reduction in cardiovascular risks achieved through good medication adherence.

Other factors apart from knowledge about the current health status, mainly the psychological factors and how the patient reacts toward his health condition, affect treatment compliance, so knowledge about current health illness isn't identified as a significant factor affecting medications compliance. this contradicts the study done in 2015 in the people of HONG KONG [9] and the other one done in 2004 in Korean patients [8], which concluded that the level of knowledge about the disease status has significant effect on the medications compliance.

Regarding blood pressure control

Living in areas far from the capital city, with lower access to the health services tends to make the patients more committed toward their compliance and to attain their blood pressure controlled, in order not to have complication s in addition to the fact that people of rural areas have less preoccupation with plenty of time to rest. life style also has a great effect on blood pressure control, that's why the people living outside the Khartoum state in this study has more controlled blood pressure in comparison to those who live in the capital city.

As the duration of hypertension increases, the patients get more used to their treatment, so they easily become more adherent and achieve more blood pressure control in the other side many people who have been recently diagnosed with hypertension have their denial

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mechanisms active about having the disease and this plays as an obstacle toward medication compliance and blood pressure control, that is why the duration of hypertension have been identified as a significant factor affecting blood pressure control.

Regular home blood pressure measurements helps in identifying the days with high blood pressure, making the patient more attached to his medications which aids in achieving controlled blood pressure, this finding has been demonstrated by the study done in Spain in 2017 [19], which contradicts our study that hasn't demonstrated any association between regular blood pressure measurement and blood pressure control.

As the patient become more committed toward his treatment, he tends to care more about health and health seeking behavior and this this will improve the follow up score, that is why commitment toward the medications compliance is isolated as an important factor affecting the patients follow up behavior.

The presence of other long term medical condition tend to affect the follow up visits of the patients, with those having more than one condition tends to show good follow up behavior. and this can be due to the increased patients awareness toward the importance of regular check ups with the increased conditions they have.

The overall effect is improved health seeking behavior, making those patients more attached to the clinics for regular follow ups and reassurance.

Most of the Sudanese people are of low socioeconomic classes and about 75% of the health expenditure is out of pockets, many patients don't afford this and because of these expenses most of the people in Sudan only go for doctors when they are ill, so health insurance lies as an important link between the patients, health service and regular check up visits. That is why health insurance is found to have significant association with the follow up visits, with those lacking health insurance having bad follow up behavior, this matches the results of united states study done in 2015 [16] about the barriers to medications compliance, that mentioned, health insurance and lack of infrequent regular visits and difficulty in taking medications are the most common barriers in the achievement of good compliance and blood pressure control.

Because of the high representations of the poor complaints in this study, and the different associated co morbidities that may affect blood pressure control, blood pressure control isn't found to have statistical significant association with the compliance and this contradicts the 2 studies, one in HONG KONG [9] and the other one in Nigerian [14], that have concluded the association between medications compliance and blood pressure control.

Conclusion

So, in conclusion Sudanese hypertensive patients have overall suboptimal compliance to their antihypertensive therapy, major hypertension related complications, with moderate blood pressure control.

Other co morbidities play a major role in hypertension related complications.

The overall patient's perception about their current illnesses is adequate, with good commitment toward medications compliance.

The overall follow up behavior is average, but needs to encouraged.

A lot of patients have stopped their medications because they feel worse, this problem has to be addressed.

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Health insurance works as a major barrier toward the achievement of regular follow up visits, beside the educational level of the patients.

So, more work has to be done in this area so as to increase the patients compliance and toward achievement of controlled blood pressure with less hypertension related complications.

Acknowledgement

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