LGJDX ISSN No: 1008-0562 Journal Of Liaoning Technical University Natural Science Edition

HYPERTENSION AND POLYPHARMACY: IDENTIFYING AND MITIGATING DRUG-DRUG INTERACTION RISKS

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Abstract

Background: Hypertension management often involves polypharmacy, which can increase the risk of drug-drug interactions (DDIs) and subsequent adverse drug reactions (ADRs). This study aims to evaluate the prevalence, risk factors, and management of DDIs among hypertensive patients attending primary healthcare centers in Pakistan.

Methods: A cross-sectional study was conducted with 405 hypertensive patients recruited from primary healthcare centers. Data on patient demographics, comorbidities, and prescribed medications were collected. Potential DDIs were identified using a standardized drug interaction database, and their clinical significance was assessed. Statistical analysis was performed to identify risk factors associated with significant DDIs.

Results: The prevalence of potential DDIs among hypertensive patients was found to be 34.6%. Major risk factors for significant DDIs included advanced age, presence of multiple comorbidities, and the use of five or more medications. The most common interactions involved antihypertensive agents, antiplatelets, and statins. Notably, 22.3% of identified DDIs had the potential to cause clinically significant ADRs. Patient education and regular monitoring were highlighted as crucial strategies in mitigating the risks associated with DDIs.

Conclusion: This study underscores the high prevalence of DDIs in hypertensive patients, particularly those with multiple comorbidities and on polypharmacy regimens. Effective management strategies, including patient education and routine monitoring, are essential to minimize the risk of ADRs and optimize hypertension treatment outcomes. The findings

advocate for enhanced pharmacovigilance and tailored interventions to improve patient safety in hypertension management.

Keywords: Hypertension, drug-drug interactions, polypharmacy, primary healthcare, pharmacovigilance, adverse drug reactions, Drug-drug interactions (DDIs), Polypharmacy, Chronic polypharmacy, Elderly population, Hypertension (HTN), Blood pressure classification, Pharmacologic therapy, Combination therapy, Drug-food interactions, Drug-condition interactions, Pharmacovigilance, Drug interaction examples, Anti-hypertensive drugs interactions, Antimicrobials interactions, hypoglycemic drugs interactions, Drug therapy for concomitant diseases, Clinical trials Phase IV, Risk factors evaluation, Therapeutic effects, Side effect profiles.

1. Introduction

Drug-drug interactions crop up when the effects of one drug are altered by the accessary use of a second drug. Currently, demographic and epidemiological shifts have resulted in an increasing percentage of the population reaching older ages and experiencing chronic health conditions concurrently (Reddy 2016). This elderly population is anticipated to induce in an important use of drugs, and a significant prevalence of polypharmacy and chronic polypharmacy (Al Sahli and AlHarbi 2022).

Polypharmacy is interpreted by the World Health Organization as “the administration of various drugs simultaneously or the administration of an excessive number of drugs” and Continuous polypharmacy is restricted to medications that are used over extended and consistent durations. Diverse factors subsidize to the manifestation of DDIs in populations, such as age, comorbidities, polypharmacy, nutritional status, and genetic constitution of an individual. Therefore, DDIs are of concern specifically in elderly patients with comorbidities. Reports indicate that the likelihood of adverse drug reactions from drug-drug interactions rose by 50% among individuals using five medications and doubled among those using eight medications (Guillot, Maumus-Robert et al. 2020).

Mass of the hypertensive patients requires medication to maintain the target blood pressure, and among those, about 70% of them requires the use of two or more antihypertensive drugs. Hypertensive patients are Peculiarly vulnerable to DDIs due to age, comorbid conditions and polypharmacy etc. Besides this, drug therapy for other comorbid conditions which may coexist or emerge as a complication of long-term hypertension, such as diabetes mellitus,

congestive cardiac failure, coronary artery disease (CAD), and chronic kidney disease (CKD) also contribute for increasing risk of DDI (Subramanian, Adhimoolam et al. 2018) (Létinier, Cossin et al. 2019, Ren, Liu et al. 2020).

1.1. Definition of HTN

Hypertension (HTN), in accordance with American Heart Association (AHA), is illustrated based on blood pressure measurements. The AHA classifies blood pressure levels as follows: (Normal) Systolic < 120 mm Hg and diastolic < 80 mm Hg. (Elevated) Systolic between 120-129 mm Hg and diastolic < 80 mm Hg. (Hypertension Stage 1) Systolic between 130-139 mm Hg or diastolic between 80-89 mm Hg. (Hypertension Stage 2) Systolic ≥ 140 mm Hg or diastolic ≥ 90 mm Hg. (Hypertensive Crisis) Systolic > 180 mm Hg and/or diastolic > 120 mm Hg, necessitating immediate medical attention (Finkel, Clark et al. 2009, Ihm, Bakris et al. 2019).

1.2. Pharmacologic therapy (Whalen 2018) (Cuspidi, Tadic et al. 2018)

The HTN is treated using different drug classes like Thiazide-like or thiazide-type diuretics, Long-acting calcium channel blockers, β -adrenoceptor–blocking agents, α-adrenoceptor–blocking agents, Angiotensin-converting enzyme (ACE) inhibitors, Angiotensin II receptor blockers (ARBs), Renin inhibitor.

1.3. Multiple treatments (Smith, Lennon et al. 2020)

Due to coexisting conditions and inadequate control with monotherapy, the most evident reason for adding another medication is clear, which can be done either before or after optimizing the first drug to its highest dosage. If a patient does not achieve sufficient control with a lower starting dose of a single medication, it is reasonable to adjust that medication or to introduce a second one. Starting a second agent before optimizing the first may result in a more significant reduction in blood pressure compared to increasing the dose of the initial medication (Wald, Law et al. 2009).

Response to initial monotherapy varies greatly with individual plasma renin levels, so a different mechanism of action may better address the patient's unique physiology rather than increasing the dosage of a relatively ineffective initial medication (Williams, MacDonald et al. 2018).

1.4. Multiple treatments for HTN

The prevailing recommendation for first-line hypertension therapy remains a beta blocker or diuretic administered at a low dose. A target blood pressure of below 140/90 mm Hg is attained in roughly 50 percent of patients on monotherapy; frequently, two or more agents from distinct pharmacological classes are required to achieve optimal blood pressure regulation (De Caterina and Leone 2011).

Single-dose combination antihypertensive therapy represents a significant option, merging the effectiveness of blood pressure reduction with a favorable side effect profile and the convenience of once-daily dosing to improve adherence (Destro, Cagnoni et al. 2010) (Nedogoda and Stojanov 2017).

Combination antihypertensive medications encompass agents from various pharmacological classes, including diuretics and potassium-sparing diuretics, beta blockers and diuretics, angiotensin-converting enzyme (ACE) inhibitors and diuretics, angiotensin II antagonists and diuretics, as well as calcium channel blockers and ACE inhibitors (Skolnik, Beck et al. 2000).

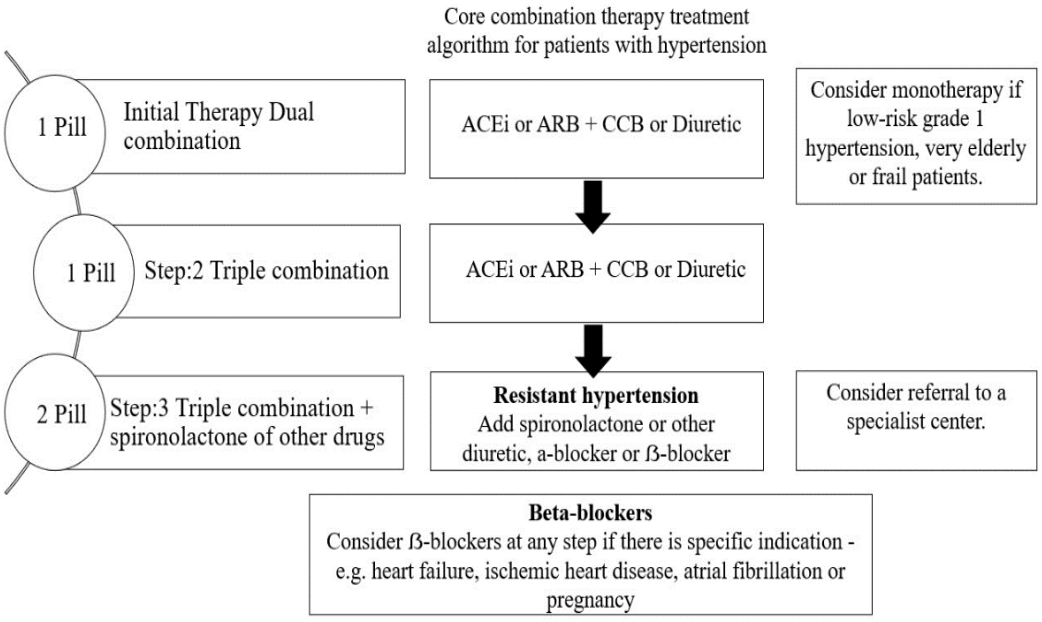

Figure.1: Multiple treatment for HTN (Combination therapy)

1.5. HTN medicine used in concomitant disease:

Hypertension has a direct relationship with many diseases and can cause damage to the heart, kidneys, brain, lungs, and is associated with end organ failure. To treat concomitant disease the different combination of drugs are used (Whalen 2018).

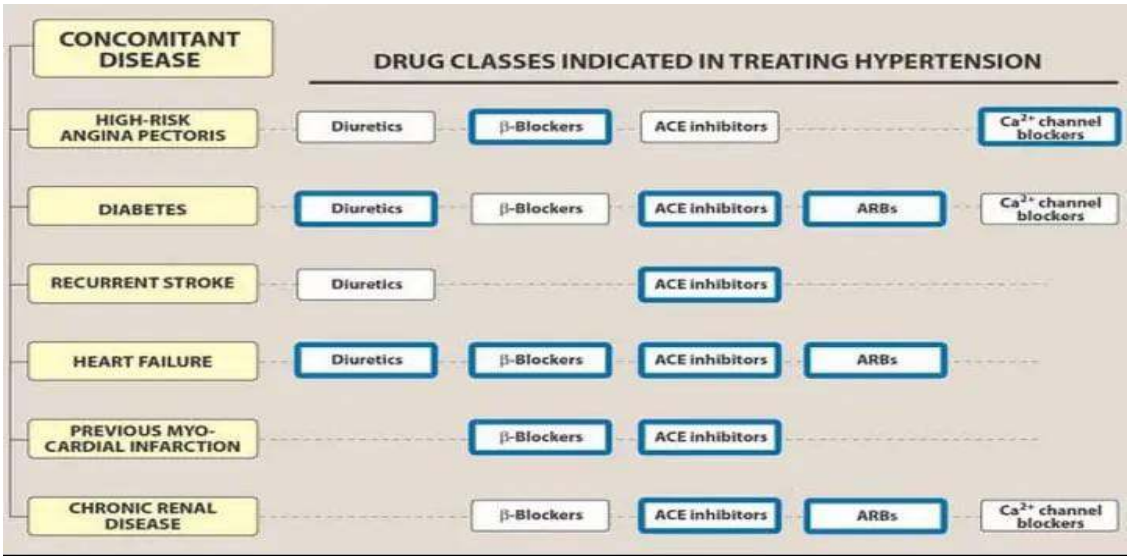

Figure.2: Drug classes used in HTN with concomitant diseases.

1.6. **Types of Interactions** (Bushra, Aslam et al. 2011)

An interaction occurs when a substance affects the activity of a drug, either amplifying or diminishing its effects, or generating a new effect that neither would produce independently. Typically, drug-drug interactions (DDIs) are considered. However, interactions can also occur between drugs and foods (drug-food interactions), as well as drugs and medical conditions (drug-condition interactions).

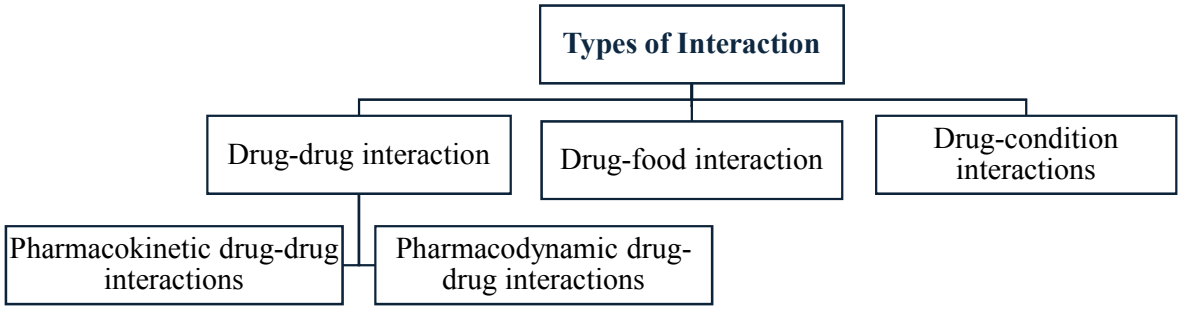

Figure.3: Types of interactions.

1.6.1. Drug-drug interaction: An interaction between two or more medications. For instance, combining atenolol with amlodipine can increase the risk of hypertension.

1.6.2. Drug-food interaction: Most clinically significant food-drug interactions result from alterations in drug bioavailability induced by food. This occurs when a drug interacts with a specific food or beverage. For instance, the absorption of celiprolol, a beta-blocker, is hindered when consumed with orange juice. Hesperidin, found in orange juice, is responsible for reducing the absorption of celiprolol (Ismail and Yaheya 2009).

1.6.3. Drug-condition interactions: An interaction that arises from using a medication while having a particular medical condition. For example, using a nasal decongestant when you have high blood pressure may result in adverse effects (Empey and Medder 1981).

1.7. Drug–drug interactions (Fernandez, Lenoir et al. 2020)

Drug–drug interactions (DDIs) are the matter of great concern among the patients acquiring multidrug therapy. The World Health Organization accentuates that adverse drug reactions and their influence can be significantly reduced by inaugurating careful attention to the population at risk of DDIs. A drug interaction is defined as the qualitative or quantitative alteration of the effect of a drug by the concurrent or sequential administration of a different one. This may lead to the alteration of therapeutic effect and safety of either or both drugs.

1.7.1. Potential DDIs: These are speculative or estimated interactions between drugs based on known pharmacological principles, such as their mechanisms of action, metabolic pathways, or chemical structures.

1.7.2. Confirmed DDIs: These are interactions between drugs that have been directly observed and documented through clinical studies, case reports, or substantial pharmacovigilance data.

1.8. Types of Drug-drug interactions (Sun, Mi et al. 2023)

DDIs (drug-drug interactions) are classified into two types: pharmacokinetic and pharmacodynamic. Pharmacokinetic interactions occur when the delivery of a drug to its site of action is altered. Pharmacodynamic interactions happen when the response of the drug target is modified.

In **pharmacokinetic drug-drug interactions (DDIs),** the plasma concentration of the drugs involved can either increase or decrease based on the interaction type. These interactions affect

absorption, distribution, metabolism, and excretion of the drugs. As a result, they can lead to treatment failure or toxicity (Palleria, Di Paolo et al. 2013).

For example, the gastro-intestinal tract is complex. Various drugs affect the digestive system. These factors can create conditions that lead to drug-drug interactions (DDI), which may change how drugs are absorbed in the body (Mantia and Provenzano 2008).

Pharmacodynamic drug-drug interactions (DDIs) occur when drugs interact to produce either stronger (synergistic) or weaker (antagonistic) effects. A significant interaction happens when a combination of drugs causes an unexpected change in the patient's condition. Pharmacodynamic interactions can be divided into three subgroups:

1. Direct effects at receptor function
2. Interference with biological or physiological control processes
3. Additive or opposing pharmacological effects

For example, Serotonin syndrome can occur when tramadol is added to a selective serotonin reuptake inhibitor (SSRI) (Snyder, Polasek et al. 2012).

1.9. Distribution of potential drug interactions (Subramanian, Adhimoolam et al. 2018)

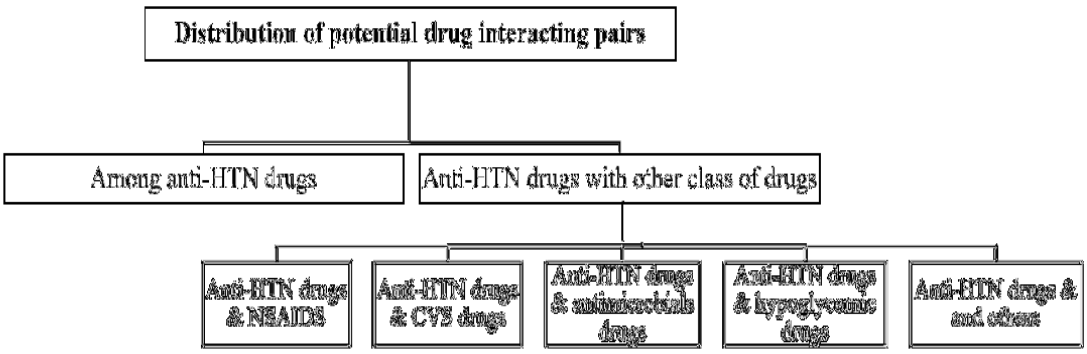

Figure.4: Distribution of potential drug interactions

1.9.1. Distribution of potential drug interacting pairs among anti-hypertensive drugs group

Table 1: DDIs among anti-hypertensive drugs group

DDI Pairs	Possible adverse outcomes
Atenolol + Amlodipine	Accelerates the chances of low blood pressure

Atenolol + Telmisartan	Potassium overload
Atenolol + Nicardipine	Accelerates the chances of low blood pressure
Furosemide + Enalapril	Sudden low blood pressure, greater likelihood of kidney failure
Furosemide + Telmistran	Telmistran rise and Furosemide drop blood K+ level
Furosemide + Spironolactone	Spironolactone rise and Furosemide drop blood K+ level
Furosemide + Carvedilo	Alters the blood K+ level
Furosemide + Atenolol	Affects the blood K+ level
Furosemide + Metoprolol	Affects the blood K+ level
Spironolactone + Enalapril	Potassium overload
Spironolactone + Telmistran	Potassium overload
Spironolactone + Carvedilol	Potassium overload
Amlodipine + Metoprolol	Accelerates the chances of low blood pressure
Telmistran + Metoprolol	Potassium overload
Carvedilol + Nicardipine	Accelerates the chances of low blood pressure

1.9.2. Distribution of potential drug interacting pairs among anti-hypertensive drugs group with other class of drugs

Table 2: Drug interaction between anti-hypertensive drugs and CVS drugs

DDI pairs	**Possible adverse outcomes**
Enalapril + Asprin	Kidney impairment, reduced effectiveness
Enalapril + Digoxin	Excess digoxin levels
Atenolol + Asprin	Diminished effectiveness of atenolol and potassium overload
Furosemide + Asprin	Diminished effectiveness of diuretics and Potassium depletion
Furosemide + Digoxin	Excess digoxin levels
Furosemide + Potassium	Potassium fluctuation
Telmistran + Atorvastatin	Greater likelihood of muscle impairment
Spironolactone + Atorvastatin	Greater likelihood of muscle impairment

Spironolactone + Digoxin	Excess digoxin levels
Spironolactone + Asprin	Potassium overload
Cravidalol + Asprin	Reduced potency of carvedilol and Hyperpotassemia
Metoprolol + Asprin	Reduced potency of Metoprolol and Hyperpotassemia
Nicardipine + Atorvastatin	Greater likelihood of muscle impairment

Table 3: Drug interaction between anti-hypertensive drugs and NSAIDS

DDI Pairs	**Possible adverse outcomes**
Enalapril + Diclofenac	Kidney impairment
Furosemide + Diclofenac	Reduced potency of Furosemide
Spironolactone + Diclofenac	Hyperpotassemia
Telmisatran + Diclofenac	Reduced potency of Telmisatran
Telmisatran + Aceclofenac	Hyperpotassemia
Losatran + Aceclofenac	Hyperpotassemia
Atenolol + Diclofenac	Reduced potency of Atenolol and Hyperpotassemia
Atenolol + Ibuprofen	Reduced potency of Atenolol and Hyperpotassemia

Table 4: Drug interaction between anti-hypertensive drugs and antimicrobials

DDI Pairs	**Possible adverse outcomes**
Amlodipine + Metronidazole	Accelerates the chances of low blood pressure
Amlodipine + Fluconazole	Accelerates the chances of low blood pressure
Furosemide + Ceftriaxone	Renal damage

Table 5: Drug interaction between anti-hypertensive drugs and hypoglycemic drugs

DDI pairs	**Possible adverse outcomes**
Enalapril + Glyburide	Higher chance of low blood sugar
Furosemide + Metformin	Higher chance of low blood sugar

Table 6: Drug interaction between anti-hypertensive drugs and others

DDI pairs	**Possible adverse outcomes**
Furosemide + Folic Acid	Lowered folic acid uptake

Amlodipine + Methyl Prednisolone	Accelerates the chances of low blood pressure
Cravedilol + Sodium bicarbonate	Reduced potency of Cravedilol

1.10. Pharmacovigilance

Pharmacovigilance is the study of adverse drug reactions (ADRs). The term comes from Greek and Latin. The Greek word "Pharmakon" means drug, and the Latin word "vigilance" means to stay alert or keep watch on drugs/medicines. Caring for patients is the most important part of therapy. Health Care Professionals (HCPs) are responsible for providing effective therapy. Pharmacovigilance is integral to all phases of clinical trials, particularly in Phase IV, also known as the post-marketing phase. During this phase, risk factors are evaluated as quickly as possible to inform the development of future guidelines regarding medications. Numerous examples of drug-specific adverse drug reactions (ADRs) have been reported in patients undergoing monotherapy, dual therapy, and triple therapy (Arain, Ghoto et al. 2016) (Fournier, Sommet et al. 2014).

Pharmacovigilance of antihypertensive drugs in Pakistan is progressing, albeit with several obstructions. The Drug Regulatory Authority of Pakistan (DRAP) superintend pharmacovigilance via the National Pharmacovigilance Centre (NPC), which congregates and evaluates adverse drug reactions (ADRs) from diverse sources, such as healthcare providers, patients, and regional centers. DRAP also hook up with international organizations like the WHO Uppsala Monitoring Centre to maintain global standards. Research from a teaching hospital in Hyderabad, Sindh, reveals critical data on the side effects of antihypertensive medications, identifying the combination of telmisartan and hydrochlorothiazide as particularly precarious. This reinforces the necessity for an active pharmacovigilance system to adequately monitor and address these issues. Nevertheless, challenges such as logistical, financial, and legal barriers impede the robust implementation of pharmacovigilance practices. Enhanced communication between healthcare professionals and the pharmacovigilance center, along with extensive training and awareness initiatives, are crucial. Ongoing efforts to refine the pharmacovigilance system, including standardizing reporting protocols and bolstering stakeholder engagement, are vital to improving medication safety and public health outcomes (Arain, Ghoto et al. 2016).

2.Literature Review

Hypertensive patients are at high risk for Drug Therapy Problems (DTPs), but there is a scarcity of research on DTP patterns and their impact on blood pressure control. This study aimed to identify DTPs and their association with blood pressure control among hypertensive patients in Indonesian PHCs. Findings revealed that most patients were female (76%) and aged 50-65 (54.7%), with half having controlled blood pressure (52.7%). Most patients were on three to four medications simultaneously (57.3%). A total of 563 DTPs were identified, including unnecessary drug use (15.6%), need for additional drug therapy (11.4%), low dosage (21.5%), nonadherence (19.2%), and adverse drug reactions (26%). A significant association was found between the number of DTPs and blood pressure control ($P<0.05$).This study highlights the high prevalence of DTPs among hypertensive patients and their significant impact on blood pressure control, emphasizing the need for enhanced pharmaceutical care in Indonesian PHCs (Snyder, Polasek et al. 2012).

Drug interactions can cause adverse drug events, but not all interactions are harmful. Their impact depends on the patient's genetic profile. Adding inhibitors or inducers of drug-metabolizing enzymes like CYP and UGT can cause phenoconversion, leading to a mismatch between genetic and observable phenotypes. Drug-drug-gene and drug-gene-gene interactions influence drug toxicity and effectiveness. This review highlights the limited research on genetic variations' impact on drug interactions, explains phenoconversion, and offers clinical recommendations for integrating pharmacogenomics (PGx) into assessing drug interactions (Hahn and Roll 2021).

Drug-drug interactions (DDIs) are a significant concern in pharmaceutical research. While traditional machine learning methods predict if two drugs will interact, it is more beneficial to predict specific DDI events to understand the mechanisms and adverse reactions involved. This study uses data from the Drug Bank database to identify 65 categories of DDI events. It introduces a deep learning framework called DDIMDL, which combines various drug features to predict these events. DDIMDL uses deep neural network (DNN) sub-models for four drug features: chemical substructures, targets, enzymes, and pathways. These sub-models are combined to predict DDI events. The results show that DDIMDL is highly accurate and efficient, outperforming existing methods (Deng, Xu et al. 2020).

The study provides a systematic review of rural-urban differences in hypertension rates in West Africa. By analyzing comprehensive database searches from 2000 to 2021, it includes 22 studies with a total of over 62,000 participants. The findings indicate high rates of

hypertension in both rural and urban areas, but with slightly lower odds in rural regions. Data broken down by sex show similar hypertension prevalence between women and men. The study emphasizes the importance of comprehensive hypertension management strategies that address both rural and urban populations in West Africa, regardless of gender (Burnier and Damianaki 2023).

This study highlights the significant prevalence of potential drug–drug interactions (pDDIs) in outpatient settings, stressing their role in adverse drug reactions and therapeutic failures. A retrospective analysis of 16,120 prescriptions from a university hospital in Shanghai identified 6,667 pDDIs, predominantly in risk category C, with male gender, older age, and polypharmacy as key risk factors. The study advocates for computerized surveillance systems and clinical guidelines to manage pDDIs, emphasizing the need for heightened awareness and proactive measures in prescribing practices to enhance patient safety (Ren, Liu et al. 2020).

Stroke raises the risk of severe infections and death, and there's growing evidence linking it to COVID-19. This review looks at the major neurologic side effects and drug interactions of medications used for COVID-19 and stroke. It's important to monitor patients on chloroquine, hydroxychloroquine, antiviral drugs, and corticosteroids for heart issues, delirium, seizures, muscle problems, and nerve damage. Key drug interactions include those between COVID-19 drugs and stroke medications like tissue plasminogen activator (tPA), blood thinners, and blood pressure drugs, especially interactions involving lopinavir/ritonavir or atazanavir with clopidogrel, prasugrel, and new oral anticoagulants (NOACs) (Ghasemiyeh, Borhani-Haghighi et al. 2020).

3. Materials and Methodology

3.1. Study Design

This research utilized a cross-sectional survey approach to evaluate the prevalence of hypertension in adults. A structured questionnaire administered via Google Forms was used as the primary tool for data collection.

3.2. Participants

The study targeted adults aged 18 and above up to 65. A sample size of 300 participants was determined to provide a representative overview.

3.3. Questionnaire Design

The questionnaire was designed to capture demographic information, lifestyle factors, and specific indicators related to the condition being studied. The questionnaire comprised various sections:

3.4. Demographic Information: Age, gender, occupation, education level, etc.

3.5. Lifestyle Factors: Questions about diet, physical activity, smoking status, and alcohol consumption.

3.6. Condition-Specific Indicators: Questions tailored to identify symptoms, duration, and severity related to the condition. etc.

3.7. Data Collection

Data collection was conducted over a one-month period using Google Forms. The survey link was distributed through email, social media platforms, and community networks to reach a broad audience. Participation was voluntary, and informed consent was obtained digitally before respondents could proceed with the survey. Measures were taken to ensure anonymity and confidentiality.

3.8. Data Analysis

Quantitative data from the questionnaire were analyzed using Excel. Percentages were used to summarize the data and to evaluate the DDIs in treatment of HTN.

3.8.1. Table: Questionnaire

(Questionnaire)
We are doing PHARM-D at the University of Chenab. We are conducting research on the topic HTN in adults. Please express your views freely. All the information you provide will be confidential and will use only for research purpose. Thanks in advance for your participation
Date_____
Section – A
Prevalence of Hypertension in Adults

Hypertension is a disease without noticeable symptoms, which is why it's called a **'silent killer'**. According to a 2002 WHO report, it caused 7.1 million deaths globally, accounting for 13% of all deaths that year. HTN is closely connected to various diseases and can harm important organs like the heart, kidneys, brain, and lungs, often resulting in organ failure.

Our aim is to check the different aspects in Hypertension:

- Hypertension related different concomitant diseases
- Effect of noncompliance in Hypertension
- Presence of drug interactions in already prescribing patients

Consent Form:

We are conducting this research in hypertensive patients All information gathered during this study will remain confidential. Your responses will be used exclusively for research purposes. Your participation will enhance our understanding and is greatly appreciated.

Section – B

Demographic Information

This data pertains to statistical information about the population, including attributes such as age, gender, education level, marital status, occupation, and geographic location.

Sr.	Question	Option-A	Option-B	Option-C	Option-D	Option-E
1.	**Age**	18 to 24	25 to 34	35 to 44	45 to 54	55 and above
2.	**Gender**	Male	Female	Other		
3.	**Weight**	Below 40	40-50	50-60	60-70	Above 70
4.	**Education Level**	Primary	Secondary	Bachelor's degree	Master's degree	Un educated
5.	**Marital Status**	Married	Un married	Divorced	Widow	
6.	**Area of residence**	Rural	Urban	Town		
7.	**Family System**	Joint Separate	Joint Separate			
8.	**Job**	Governme nt	Private	Own Business	Housewife	Student

9.	**Standard**	Lower class	Middle class	Upper class	Business class	

Section – C

Monitoring

How often do you monitor your blood pressure at home?

Daily	Weekly	Monthly	Rarely	Never

How you monitor your B.P?

A	By Sphygmomanometer
B	By automatic machine
C	Minimally affects hypertension control
D	Pulse seeking
E	By symptoms

Have you experienced any symptoms associated with hypertension (e.g., headaches, dizziness, chest pain)?

Yes	No	Not sure

Range of Systolic blood pressure?

120 - 129 mmHg	130 - 139 mmHg	140 - 159 mmHg	160 mmHg or higher

Range of Diastolic blood pressure?

80 - 89 mmHg	90 - 99 mmHg	100 - 109 mmHg	Above 110 mmHg

Section – D

Treatment, patient compliance and lifestyle modification

What do you think about compliance with prescribed medicine?

A	Level 1 (completely compliance)

B	Level 2 (partially compliance)
C	Level 3 (no compliance)

How consistently do you follow prescribed schedule for taking medicine?

Always	Mostly	Sometimes	Never

Have you missed any dose recently?

Yes	No	Maybe

Did your doctor prescribe you any lifestyle modification?

Yes	No	Maybe

Which lifestyle modification are you following?

A	Reduce sodium intake
B	Increased potassium intake
C	Exercise and walk
D	Losing weight

Section – E

Drug - Drug interactions

Intake of more than two drugs usually increases the risk of interaction between the drugs. The factors which considerably contribute to one or more interactions include:

- Polypharmacy
- Patient`s age more than 60 years and
- Those having cardiovascular diseases and other co-morbids.

Are you having any side effect from your medication?

Yes	No	Not sure

If yes, then please describe below

Are you taking the combination of medicine?

Yes	No	Maybe

If yes, then please describe below

4. Results

4.1 Demographic Data

The survey included 300 participants, with 32.3% male and 67.8% female. Age distribution was as follows: 71.3% were 18-24 years old, 21% were 25-34, 3.9% were 35-44, 2.9% were 45-54, and 0.9% were 55 or older. Regarding weight, 31.3% weighed 40-50 kg, 30% weighed 50-60 kg, 20.5% weighed 60-70 kg, 13.4% weighed over 70 kg, and 4.9% weighed under 40 kg. Most participants were unmarried (81.4%), followed by married (17.3%) and widowed (1%). Residency was distributed as 33.2% rural, 38.1% urban, and 28.7% town. In terms of family system, 55.7% belonged to a joint family, while 44.3% lived separately. Employment status included 18.2% in private jobs, 3.6% in government jobs, 3.6% housewives, 4.6% business owners, and 65.8% students.

LGJDX
ISSN No: 1008-0562
Journal Of Liaoning Technical University
Natural Science Edition

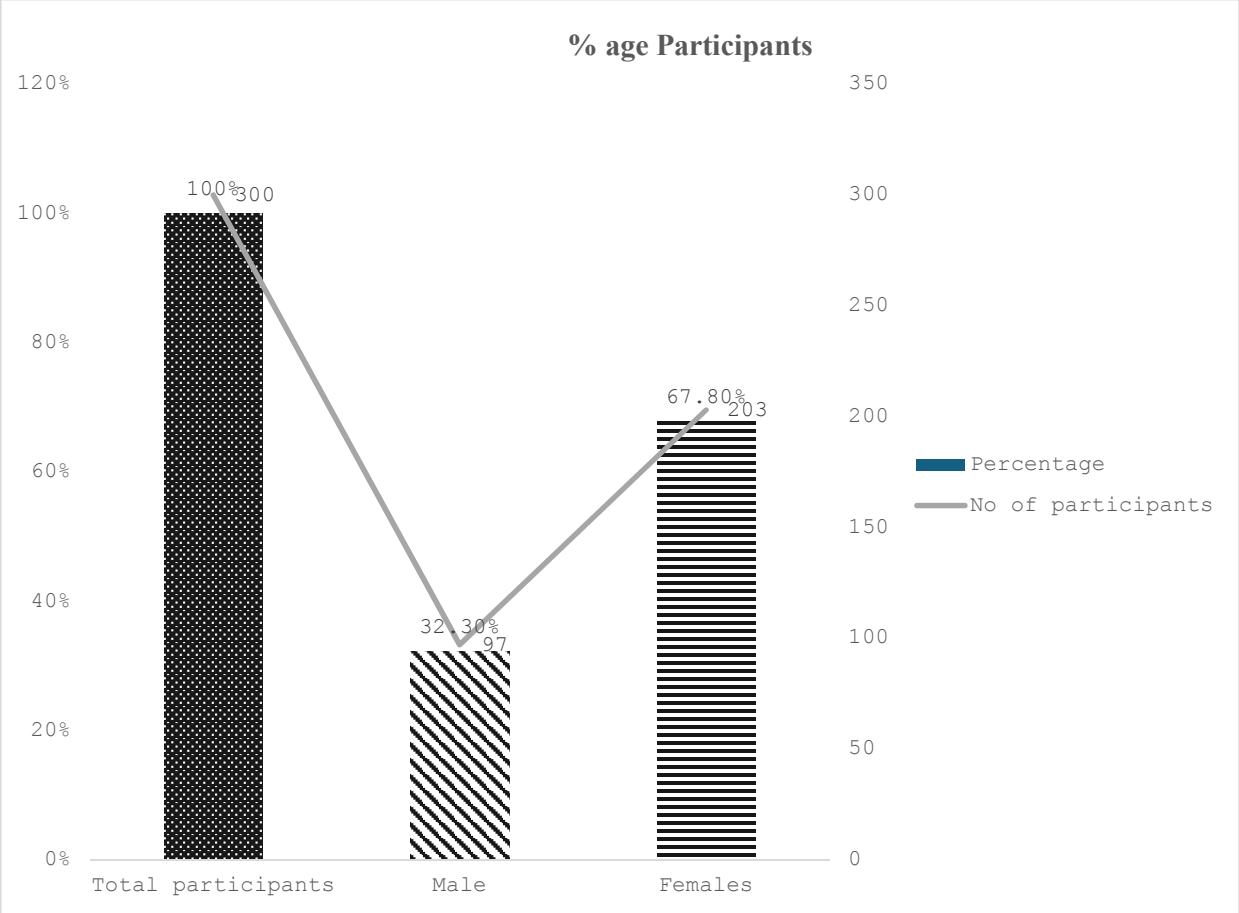

Figure 1: % of Participants

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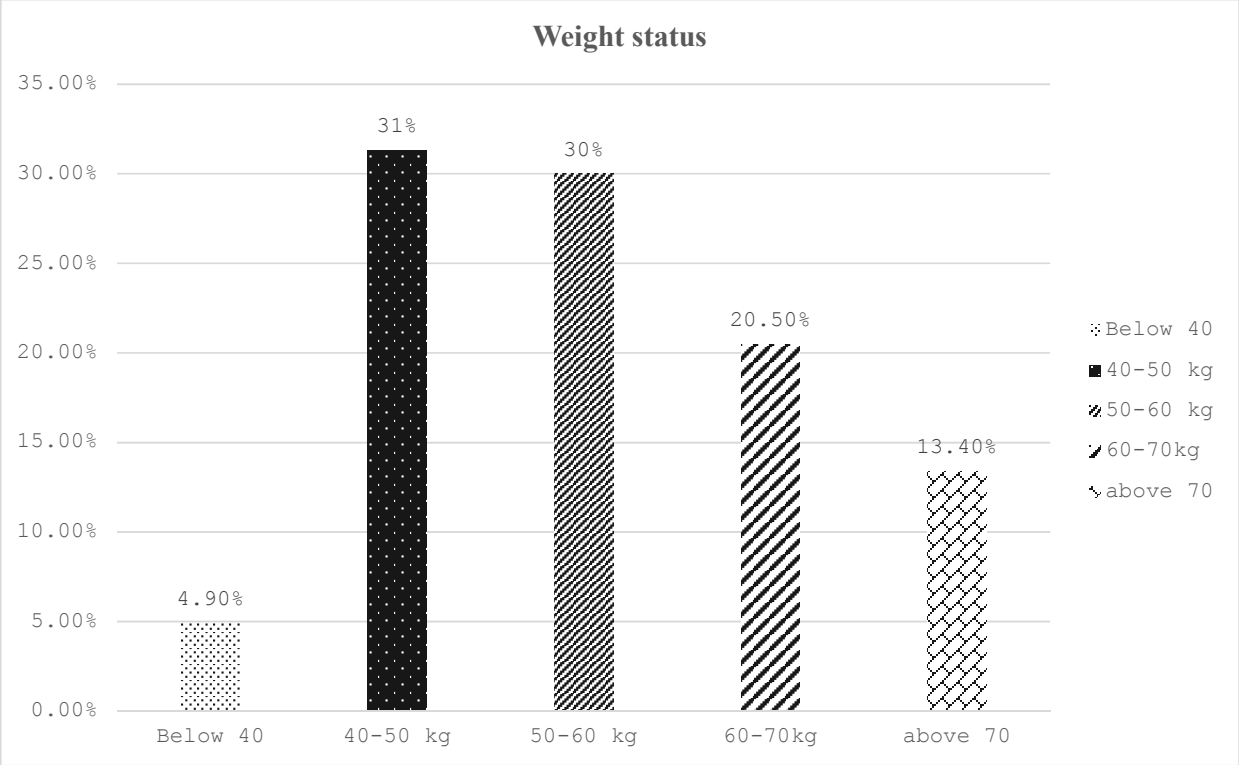

Figure 2: Weight Statistics

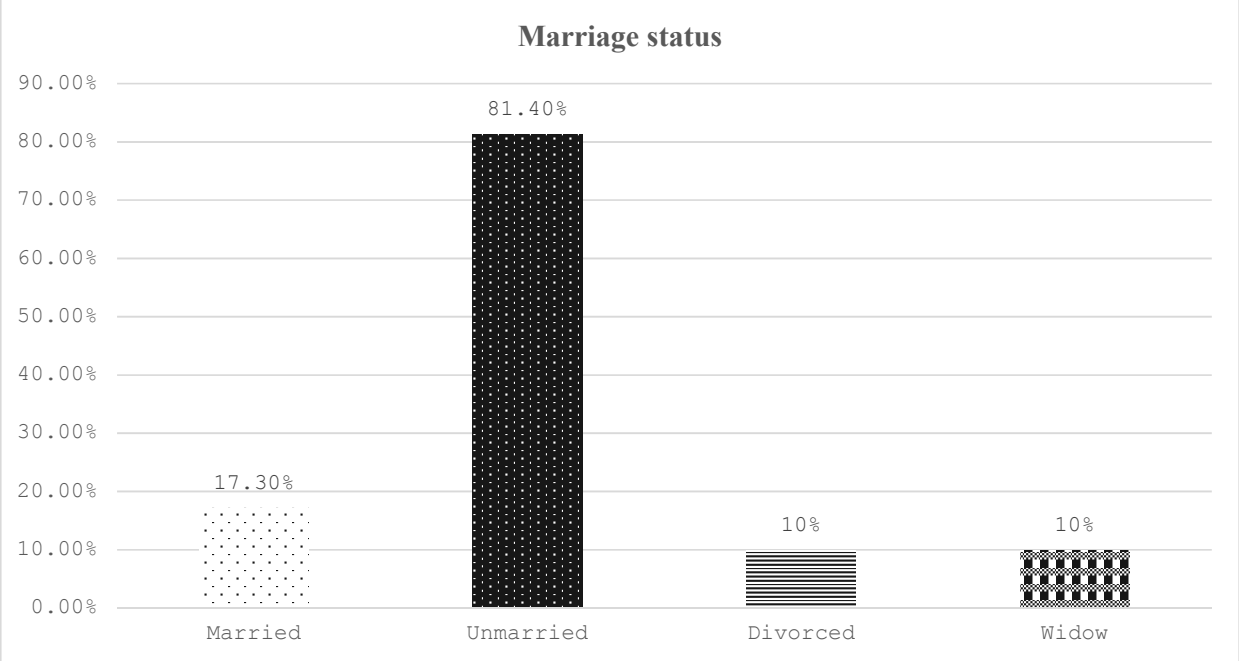

Figure 3: Weight Status

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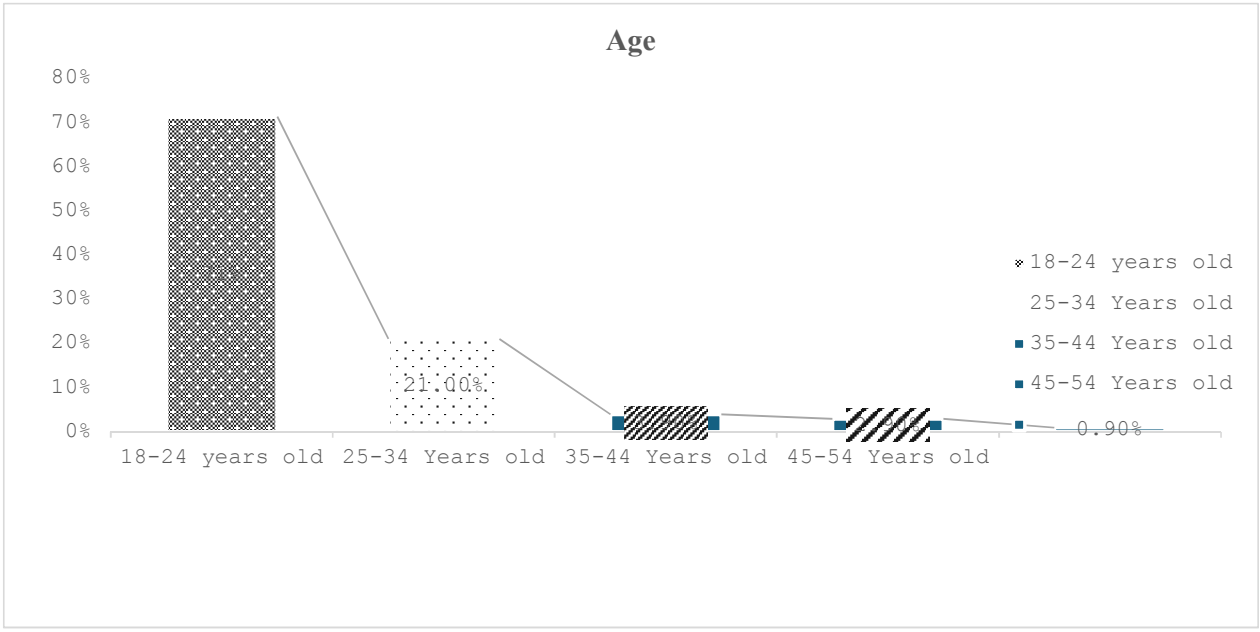

Figure 4: Age Statistics

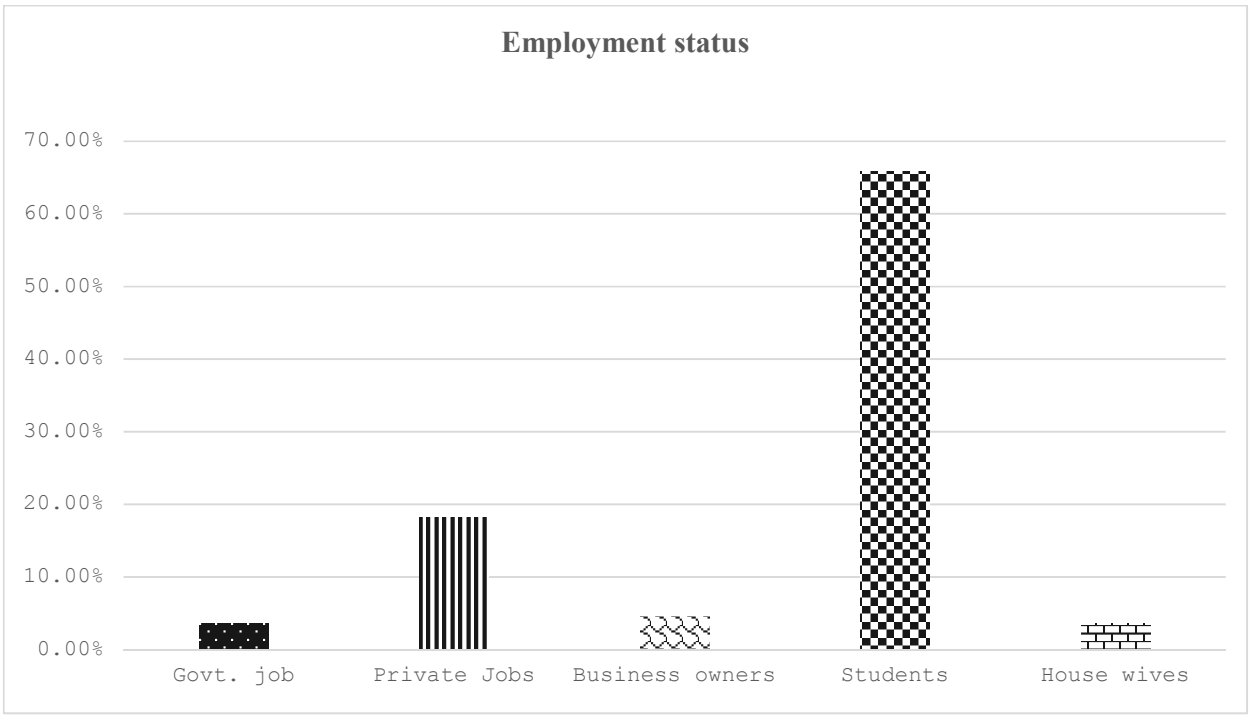

Figure 5: Employment status

4.2. Monitoring

The monitoring habit of BP shows that 28.9% monitors rarely, 28.9% monitors weekly, 21.1% monitors monthly, 13.2% monitors daily and 7.9% never monitors. According to responses 52.6%, 39.5%,5.3% and 2.6% respondents monitor their BP via automatic machine, Sphygmomanometer, symptoms and pulse seeking respectively. 84.2% of respondents experienced symptoms associated with hypertension (e.g., headaches, dizziness, chest pain) while 7.9% were not sure and also 7.9% didn't experienced with these symptoms. The range of Systolic blood pressure of 39.5% respondents is 140 - 159 mmHg, 26.3% respondents is 130 - 139 mmHg, 26.3% respondents is 120 - 129 mmHg, and 7.9% respondents is 160 mmHg or higher. The range of Diastolic blood pressure of 44.7% respondents is 90 - 99 mmHg, 36.8% respondents is 80 - 89 mmHg, 10.5% respondents is 100 - 109 mmHg and 7.9% respondents is Above 110 mmHg.

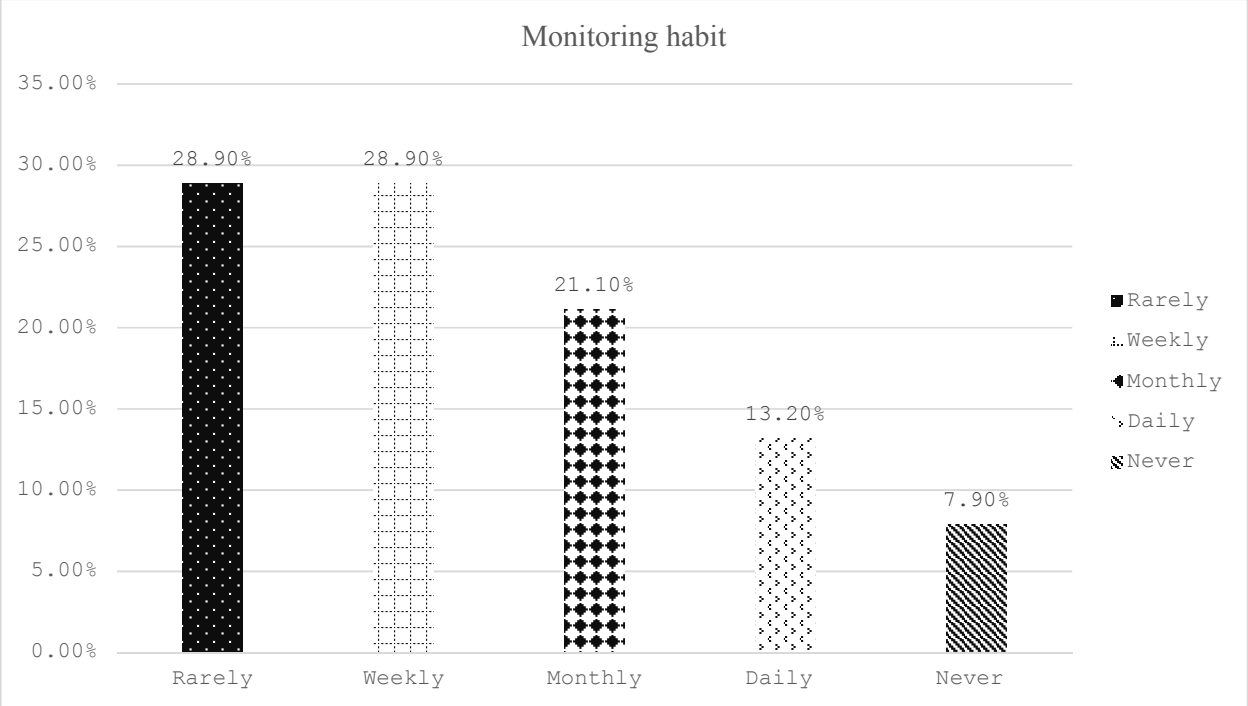

Figure 5: Monitoring habit

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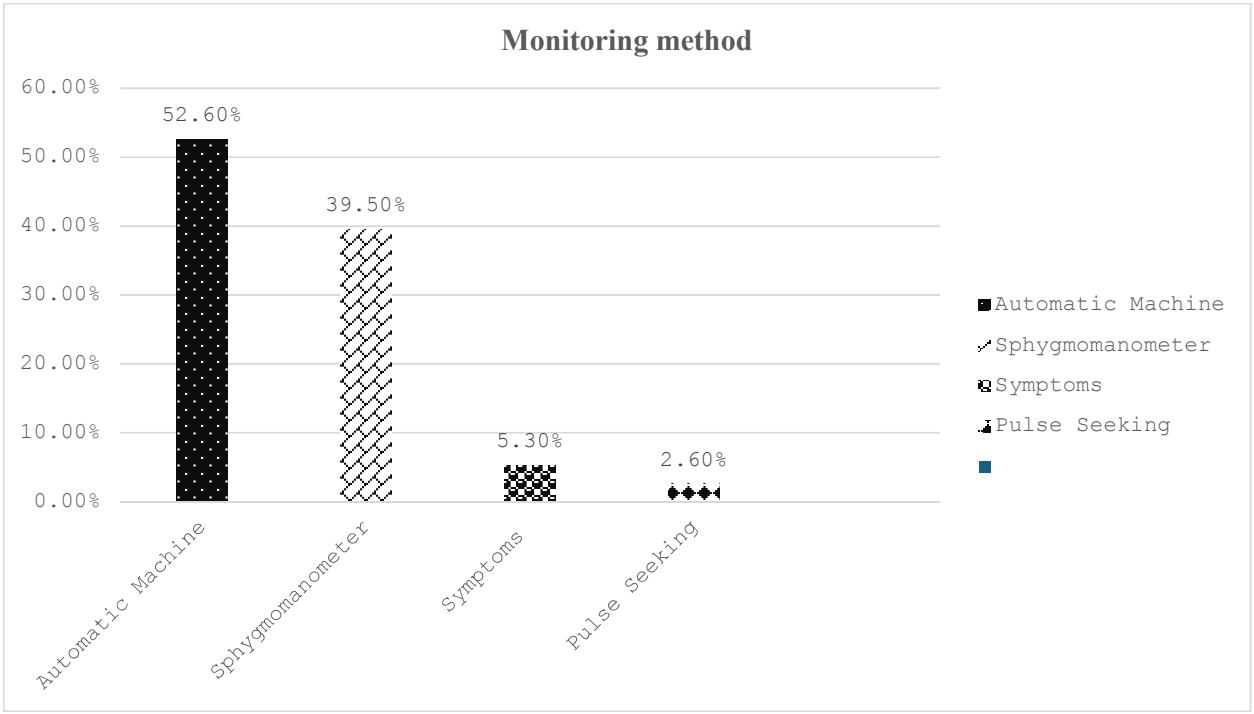

Figure 6: Monitoring method

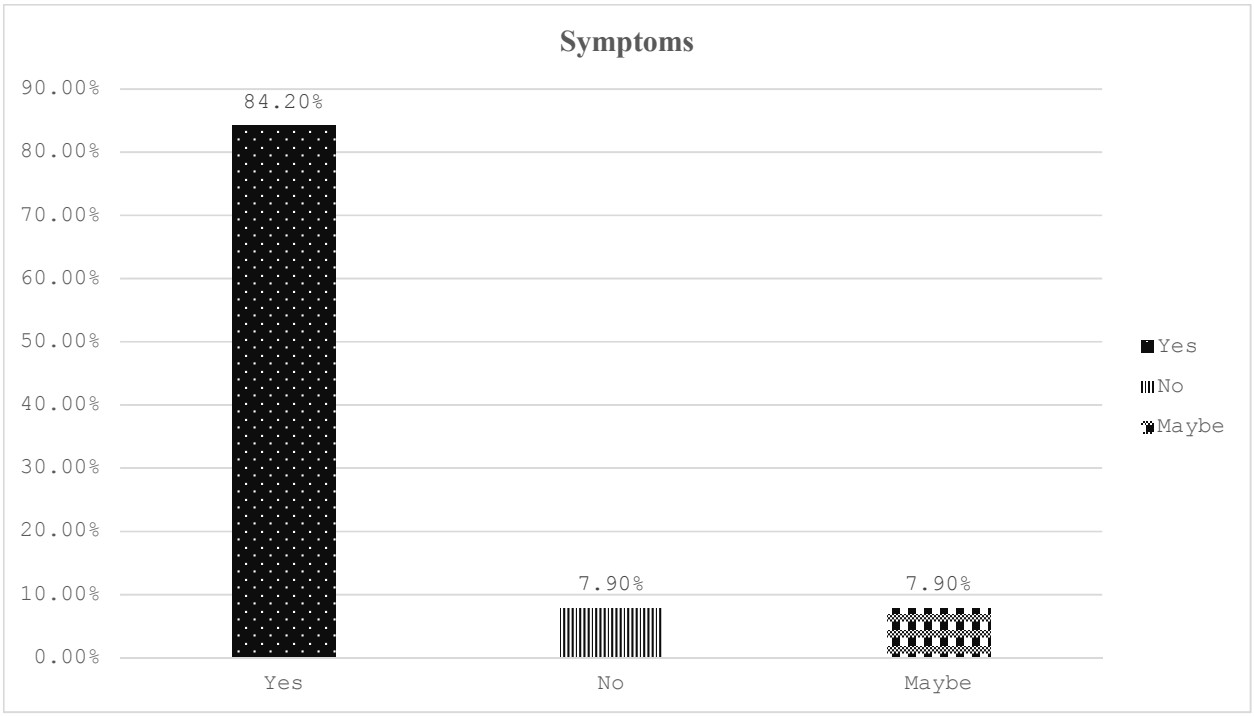

Figure 7: Symptoms

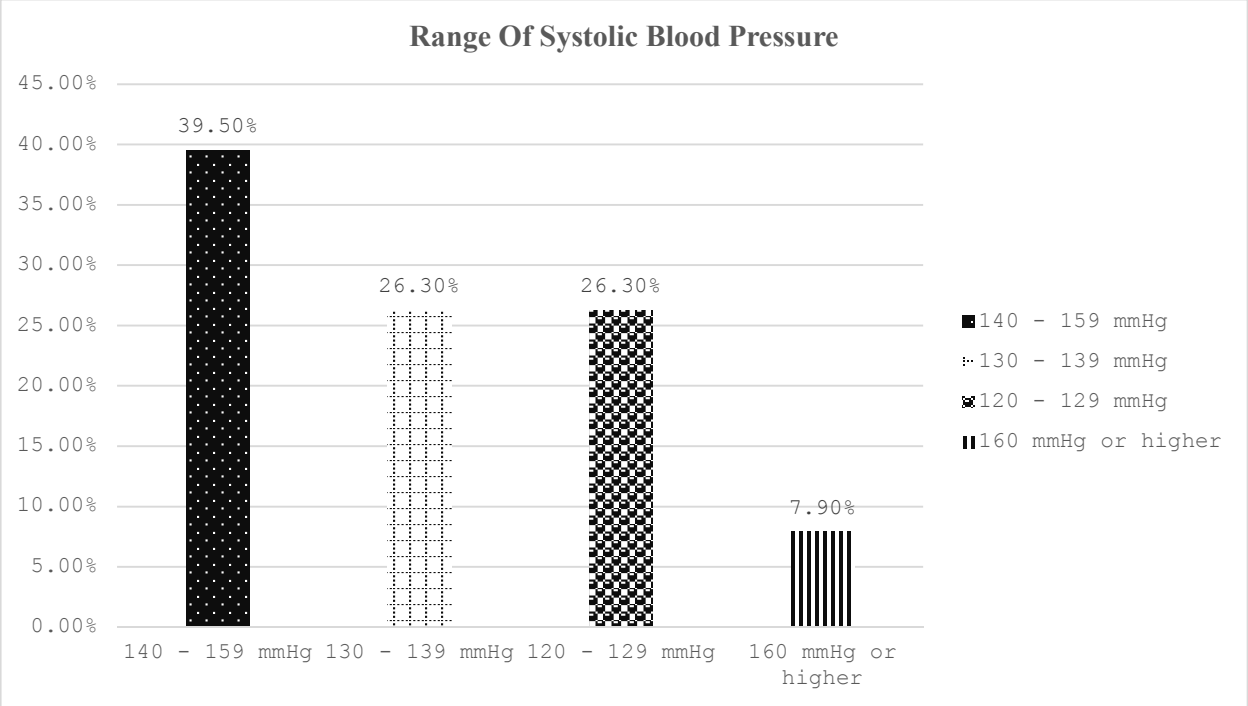

Figure 8: Range Of Systolic Blood Pressure

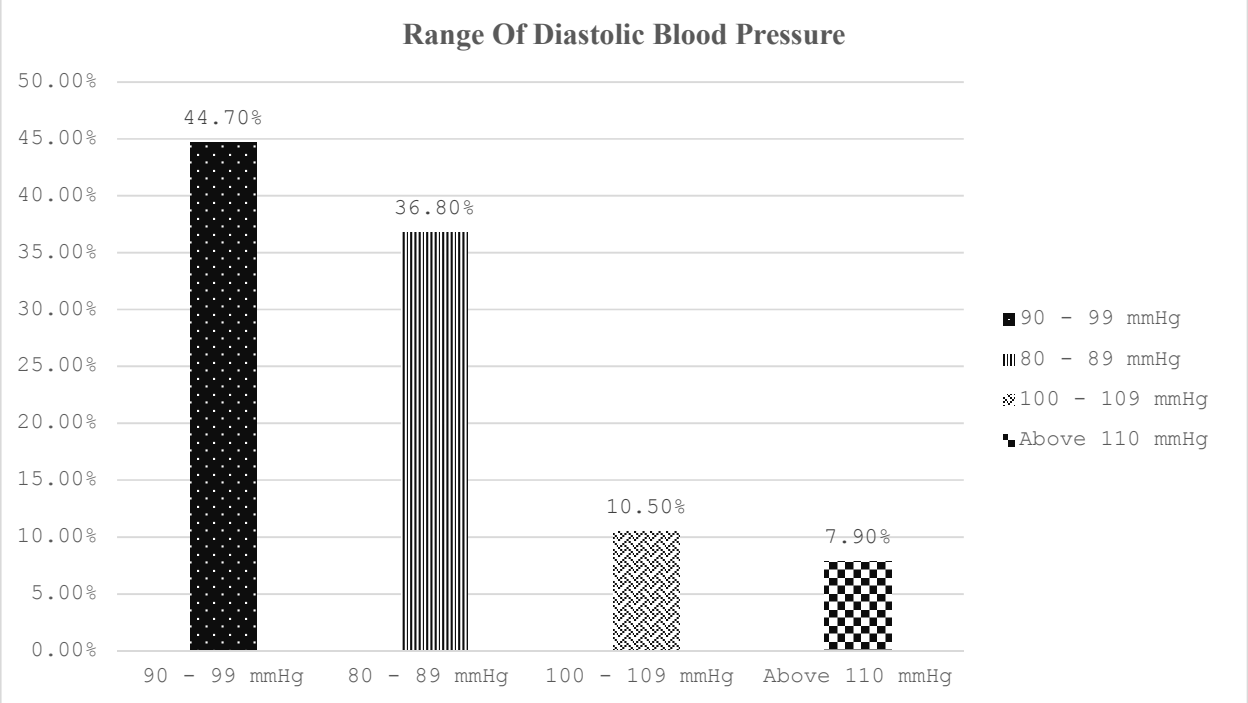

Figure 9: Range Of Diastolic Blood Pressure

4.3. Treatment, Patient Compliance and lifestyle Modification

According to patients review about compliance with prescribed medicine is that 44.7% are completely compliance, 42.1% are partially compliance and 13.2% had no compliance. The data about following prescribed schedule for taking medicine shows that 44.7% sometimes follow prescribed schedule, 28.9% mostly follow prescribed schedule, 23.7% always follow prescribed schedule and 2.6% never follow prescribed schedule. The 34.2% respondents say yes, 34.2% respondents says no while 31.6% of respondents were not sure on missing any dose recently.63.2% were those respondents whom with doctor has prescribed lifestyle modification while 26.3% were not prescribed and 10.5% were not sure about prescribed lifestyle modification. 34.2% do exercise and walk, 34.3% reduce sodium intake, 21.1% started taking potassium and 10.5% lose their weight as the lifestyle modification.

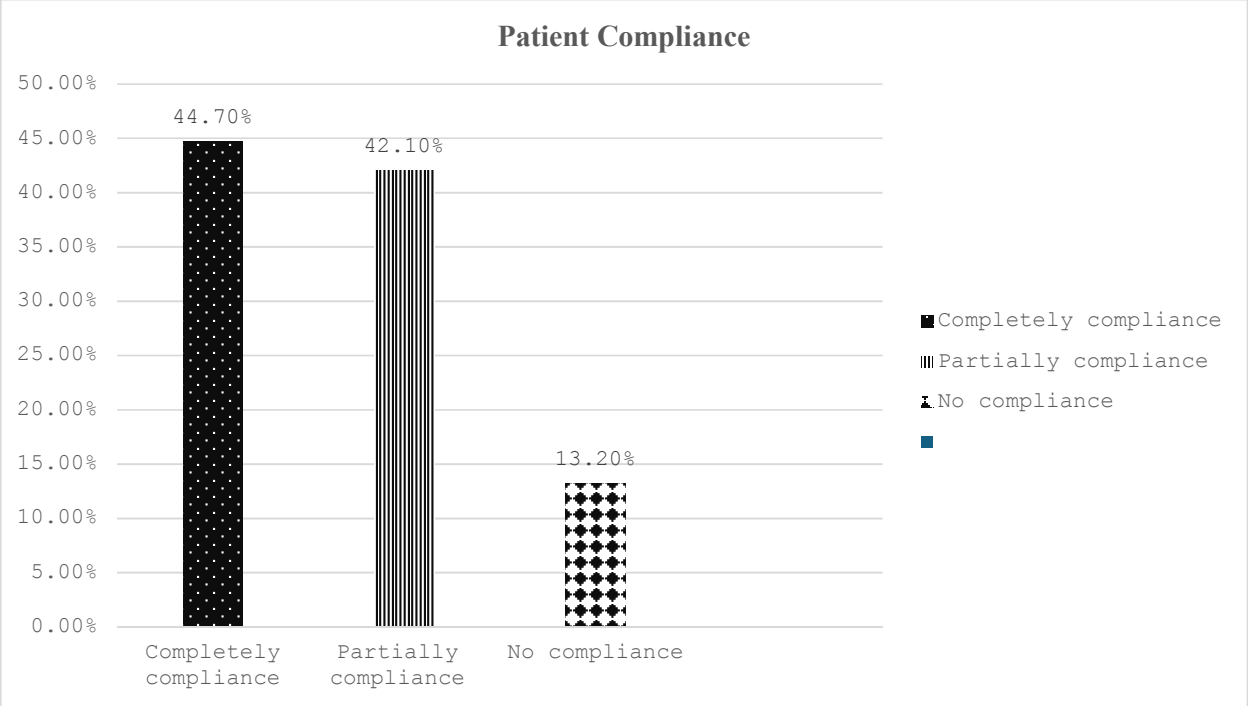

Figure 10: Patient Compliance

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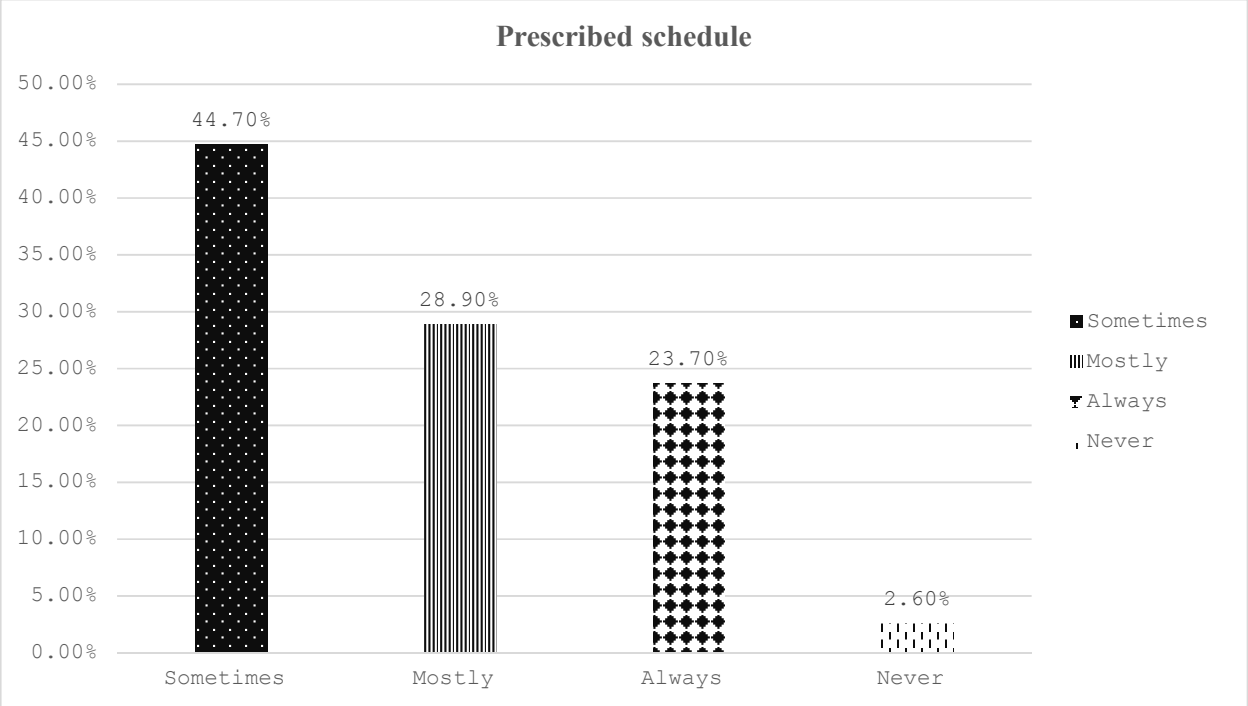

Figure 11: Prescribed schedule

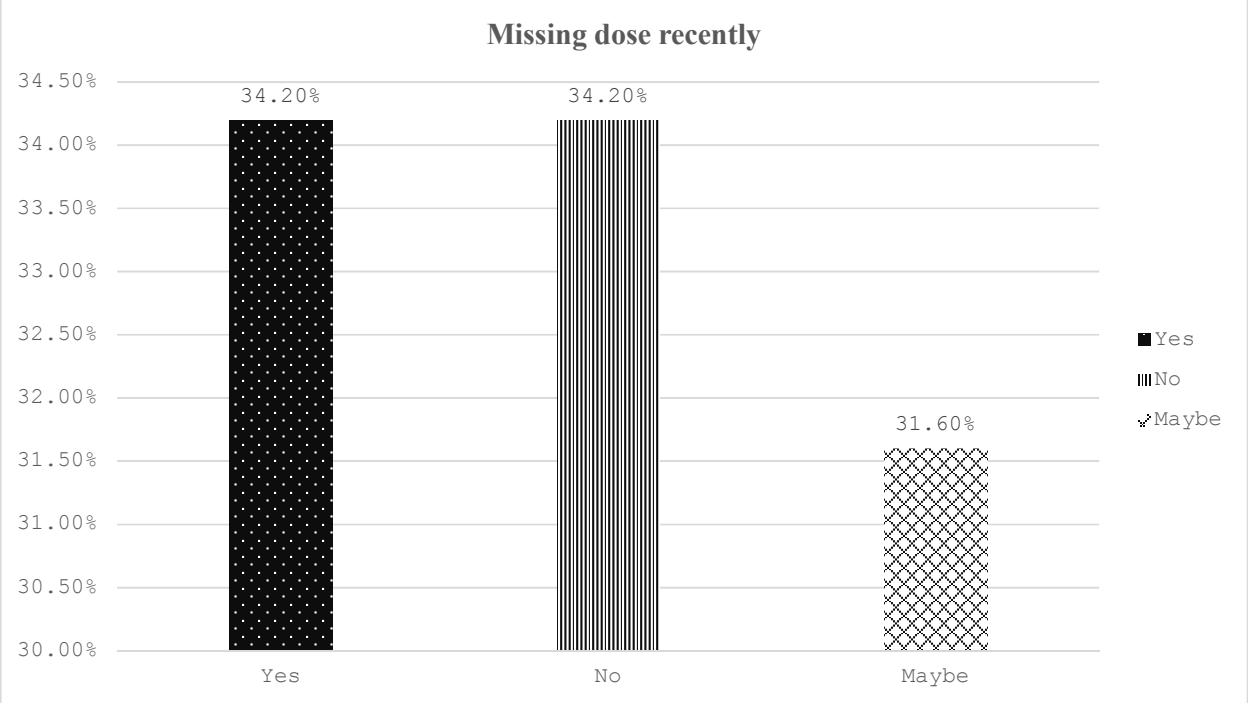

Figure 12: Missing dose recently

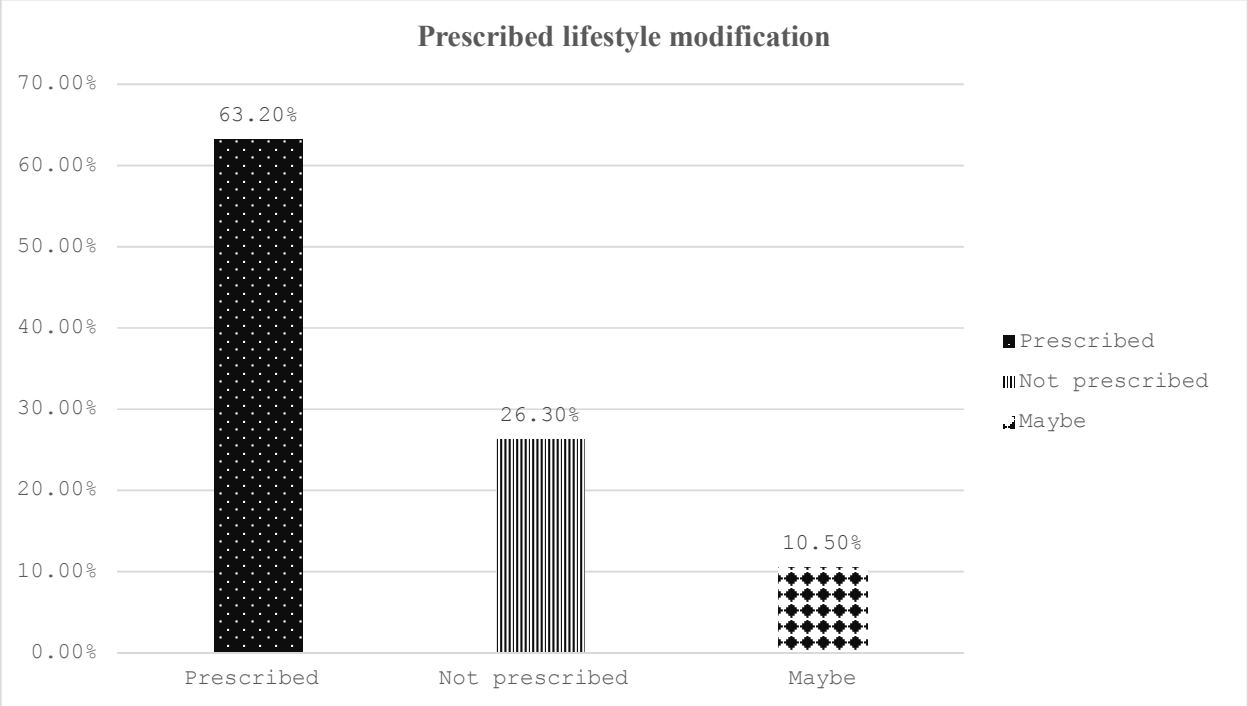

Figure 13: Prescribed lifestyle modification

Figure 14: Lifestyle modification

4.4. Drug-drug interactions

64.9% of respondents don't have side effects from their medication. While 27% respondents have side effects from their medication while 8.1% were not sure. 58.3% don't use any combinations of medicines, 33.3% of respondents are using the medicine in combinations while 8.3% were not sure.

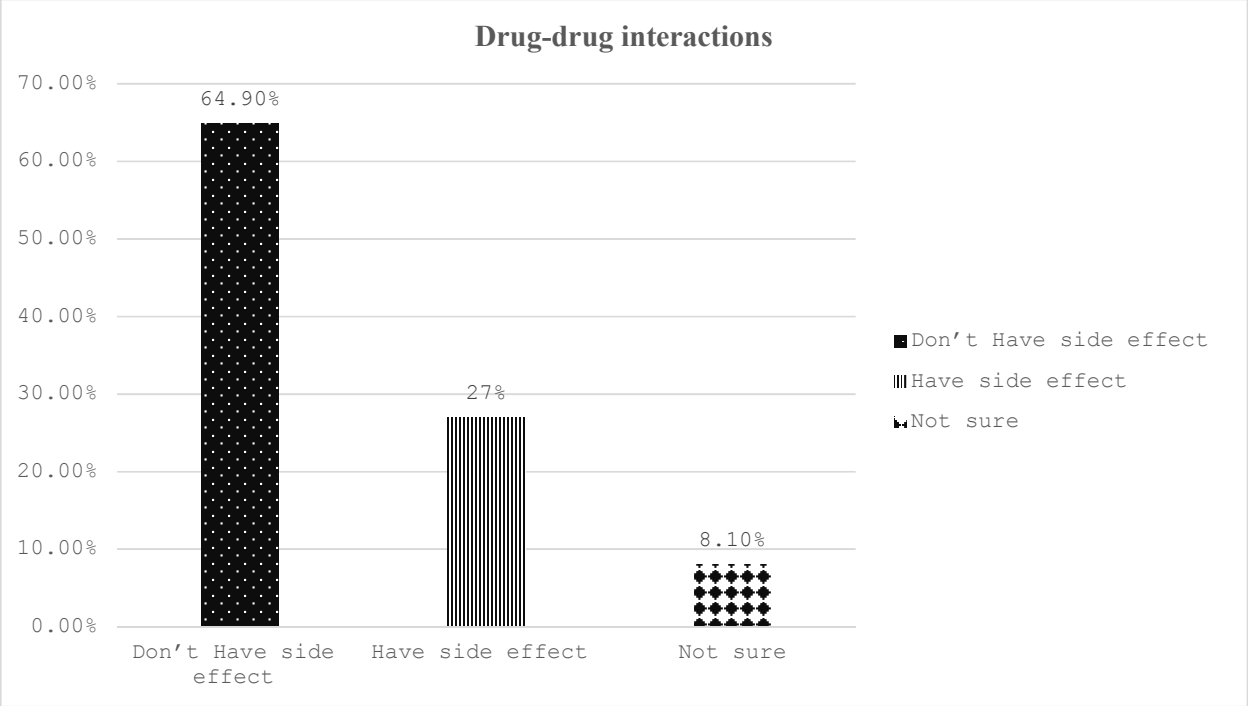

Figure 15: Drug-drug interactions

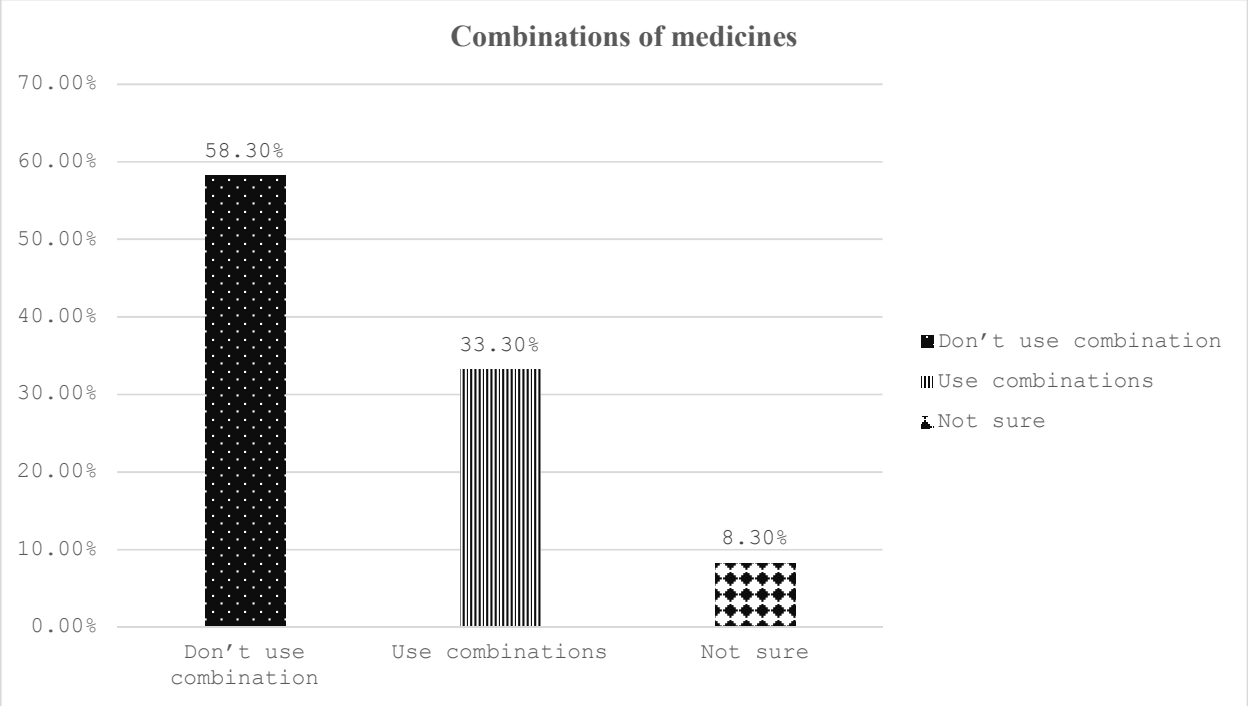

Figure 16: Combinations of medicines

5. Recommendations (Ren, Liu et al. 2020)

Drug–drug interactions are frequent in outpatients. Health professionals including physicians and pharmacists should raise awareness of the potential impact of drug–drug interactions. It is important to incorporate the clinical pharmacists into the healthcare team to routinely screen the potential drug–drug interactions. A computerized warning system with smarter screening software may be beneficial in reducing the potential risk of drug–drug interactions. Further research is needed to develop clinical guidelines regarding the widespread potential drug–drug interactions along with their potential adverse outcomes and management strategies.

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