UNIVERSITY OF THE WITWATERSRAND, JOHANNESBURG

PHYSICAL ACTIVITY INTERVENTION PLAN FOR HYPERTENSIVE PATIENTS OF UMLAZI TOWNSHIP, KWAZULU-NATAL

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A Thesis submitted to the Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, in fulfillment of the requirements of the degree of Doctor of Philosophy.

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CONTENTS

DECLARATION

I, **Mandisa Jewel Simamane,** declare that this thesis is my own work. It is being submitted for the Degree of **Doctor of Philosophy, Biokinetics** at the University of the Witwatersrand, Johannesburg. It has not been submitted before for any degree or examination at any other University.

_____

(Signature of candidate)

_____July_____ day of_____2024_____ in Johannesburg_____

DEDICATIONS

In the pursuit of academic excellence, I express my gratitude to my Creator (uMkhulu woMkhulu), my Ancestors, and the Universe for aligning themselves perfectly on my academic path. Their generous influence has been instrumental in shaping my journey, and for this, I am sincerely grateful. Addressing my Simamane family, I find myself at a loss for words to adequately convey my appreciation. I extend my heartfelt thanks for your unwavering support, particularly in assuming the responsibility of caring for Awande during my necessitated relocation and travel for academic pursuits. Your invaluable assistance has significantly impacted my academic trajectory, and I am convinced that reaching the culmination of my doctoral thesis submission would not have been feasible without the support I received. As the saying goes, it indeed takes a village to raise a child, and my family has been that village. I am keenly aware of and deeply appreciate every contribution, and I trust that my expressions of gratitude were duly acknowledged with affection. Once again, I extend my sincere appreciation.

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PRESENTATIONS ARISING FROM THIS RESEARCH PROJECT

1. **University of the Witwatersrand Faculty of Health Sciences Research Day**

Date:15 September 2022

Poster Presentation: A Scoping Review examining Physical Activity Intervention for the Management of Hypertension.

Author/s: Mandisa Simamane*; Demitri Constantinou; Estelle Watson; Philippe Gradidge
Department of Exercise Science and Sports Medicine, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

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2. **Carnegie Corporation of New York (CCNY)/ African Studies Association (ASA)**

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Virtual Presentation: Exercise is Medicine - Women's Voices and Experiences of Health, Healing, & Disability due to Chronic Diseases

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Poster Presentation: The Family Involvement Role in Assisting with Hypertension Management: A Qualitative Study.

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Poster Presentation: The Effect of Exercise Intervention in Managing Hypertension

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ABSTRACT

Background

The global increase in hypertension, fueled by aging populations, sedentary lifestyles, and obesity, presents serious health challenges, including elevated risks of cardiovascular diseases and early mortality. Addressing this issue effectively necessitates a holistic healthcare approach that combines medication with lifestyle changes like physical activity, while also incorporating family support and exercise professionals into primary care for personalised treatment plans and improved adherence.

Aim

The principal aim of this study was to ascertain whether the implementation of a physical activity intervention plan, coupled with family member involvement within the primary healthcare sector, would contribute to the effective management of hypertension among hypertensive patients residing in the community of Umlazi Township, KwaZulu-Natal.

Methods

This study adopted a multifaceted methodology to enhance evidence-based hypertension management practices through physical activity. Initiating with a scoping review, it identified and organised relevant literature to establish a solid evidence foundation for a randomised controlled trial. The research included 12 weeks randomised controlled trial into intervention, and the control group assessing the impact of physical activity on hypertension management and secondary outcomes, thus providing a thorough evaluation of the intervention's effectiveness. Moreover, a qualitative inquiry further explored the comprehension and involvement of family members in managing hypertension.

Results

The review identified nine effective physical activity-based interventions out of 31 studies, indicating their success in reducing blood pressure and strengthening cardiovascular health. Notably, aerobic and interval training emerged as especially beneficial. The trial demonstrated significant progress in the Intervention Group (n = 36) compared to the

Control Group (n = 37), particularly in 6-minute walk test results, without major changes in cardiovascular and anthropometric metrics over 12 weeks, underscoring the benefits on physical performance and potential heart health advantages. The qualitative analysis (n = 9) exposed a general lack of hypertension awareness among family members and a gap in their support levels.

Discussion and Conclusion

Conclusively, the study underscored the critical role of augmenting physical activity in managing hypertension, evidenced by its 12-week investigation at the Umlazi Township AA clinic. Though, it reaffirmed the synergy of pharmacological and lifestyle interventions, affirmed by physical activity and familial engagement, in enhancing hypertension care. Despite certain constraints like small sample size and brief intervention span, the findings advocate for an expanded clinical utilisation of physical activity in hypertension treatment, promoting prolonged and consistent exercise routines as integral to a comprehensive management strategy.

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NOMENCLATURE, DEFINITIONS OF TERMS AND ABBREVIATIONS

6MWT	Six Minute Walk Test
ACSM's	American College of Sports Medicine
AIT	Aerobic Interval Training
ABP/M	Ambulatory Blood Pressure/ Monitoring
ATS	American Thoracic Society
BP	Blood Pressure
Bpm	Beats per Minute
BMI	Body Mass Index
CG	Control Group
CV	Cardiovascular
CVD	Cardiovascular Diseases
Cm	Centimeters
Days/ wk	Days per week
DBP	Diastolic Blood Pressure
DoH	Department of Health
ESC	European Society of Cardiology
ESH	European Society of Hypertension
g	Gram
g/ day	Gram per day
HC	Healthcare
HICs	High-Income Countries
IG	Intervention Group
HTN	Hypertension
kg	Kilogram
$kg \cdot m^2$	Kilogram-meter squared
KZN	KwaZulu-Natal
LICs	Low Income Countries
LMICs	Low- and Middle-Income Countries
m	Meter

m^2	Meter Squared
MET·h/day	Metabolic Equivalents hours per day
MICs	Middle Income Countries
Mins	Minutes
Min(s)/ day	Minute(s) per day
Min(s)/ wk	Minute(s) per week
MIT	Moderate Intensity Continuous Training
mm	Millimeter
mmHg	Millimeter of mercury
mmol	Millimole
N	Number of total sample size (participants)
n	Number of sample size (participants)
NCDs	Non-Communicable Diseases
p	Probability Value
PA	Physical Activity
PHC	Primary Healthcare
RCT	Randomised Controlled Trial
SA/n	South Africa/n
SBP	Systolic Blood Pressure
SD (±)	Standard Deviation
t	*t* test
VO_{2max}	Maximum Rate of Oxygen Consumption
WHO	World Health Organisations
WHR	Waist-to-Hip Ratio
%	Percentage
≥	Greater-Than or Equals To
>	Greater-Than
≤	Less-Than or Equals To
<	Less-Than
/	Or

CHAPTER 1 – INTRODUCTION

1.1 INTRODUCTION

As demographic shifts contribute to an aging population, a concurrent trend towards sedentary lifestyles, increased body weight, and a rising global prevalence of hypertension (HTN) is evident (Williams, et al. 2018). Hypertensive adults commonly exhibit modifiable cardiovascular (CV) risk factors, including obesity, hypercholesterolaemia, diabetes mellitus, smoking, physical inactivity, and an unhealthy diet (Whelton and Carey, 2017). Elevated blood pressure (BP) has emerged as a leading contributor to premature mortality, accounting for nearly 10 million deaths and over 200 million disability-adjusted life years globally (Forouzanfar, et al. 2017). Hypertension is a major global medical and societal challenge (Glodzik, et al. 2018). It is the leading risk factor for global mortality and morbidity, significantly contributing to cardiovascular diseases (Song, et al. 2020). In 2010, approximately 1.39 billion people were affected by hypertension (Mills, et al. 2016). The prevalence continues to rise, now exceeding 1 billion affected individuals (Gupta, et al. 2019), according to the World Health Organisation (WHO, 2014), the Global Burden of Disease study (Farouzanfar, et al. 2017), and the NCD Risk Factor Collaboration (2017).

In South Africa (SA), approximately 35% of the population is affected by HTN (Pillay, 2022), and hypertensive diseases were reported as the sixth leading cause of death in 2017, constituting 4.5% of total deaths (Statistics SA, 2017). Subsequently, the prevalence has surged from 25% to exceeding 40% (Ware, et al. 2019). Systolic blood pressure (SBP) levels of ≥140 mmHg contribute significantly to the majority of mortality and disability, with the highest number of SBP-related deaths attributed to ischaemic heart disease (4.9 million), haemorrhagic stroke (2.0 million), and ischaemic stroke (1.5 million) (Forouzanfar, et al. 2017). Hypertension, a multifactorial disorder, is defined in SA as office SBP values ≥140 mmHg and/or diastolic BP (DBP) values ≥90 mmHg (Williams, et al. 2018), with this classification applicable across age groups.

Two well-established strategies for BP reduction include lifestyle interventions and drug treatment (Williams, et al. 2018). Despite widespread prescription of antihypertensive drugs, global HTN control remains a challenge (Arija, et al. 2018). Targeting treated BP

values to 130/80 mmHg or lower is recommended for most patients (Williams, et al. 2018). Some exceptions, and older patients (>65 years) been advised to maintain SBP between 130 and 140 mmHg and DBP below 80 mmHg (Williams, et al. 2018). Importantly, treated SBP should not be lowered below 120 mmHg (Williams, et al. 2018), and high DBP is more prevalent in younger (<50 years) than older patients and is associated with increased CV risk (Williams, et al. 2018).

Promotion of healthy lifestyle behaviors at the individual level, targeting factors such as poor-quality diet, physical inactivity, and smoking, is essential in the general population (Piepoli, et al. 2016). Physical activity (PA) stands out as a key non-pharmacological strategy for the prevention, control, and treatment of HTN and its complications (Cornelissen, et al. 2013; Malachias, et al. 2016). Regular PA at moderate intensity has demonstrated efficacy in lowering BP and reducing stroke risk (American Heart Association, 2018), contributing to a reduction in cardiovascular disease (CVD) mortality (Eijsvogels, et al. 2016). The promotion of PA serves as a modifiable risk factor with a beneficial impact on CVD risk (Arija, et al. 2018), as evidenced by randomised clinical trials reporting a reduction in CVD risk in adult populations (Arija, et al. 2018).

While acute rises in BP, especially SBP, are observed during PA, epidemiological studies suggest the overall benefits of regular aerobic PA for HTN prevention and treatment, as well as lowering CV risk and mortality (Williams, et al. 2018). Recommendations by the American College of Sports Medicine (ACSM) advocate both aerobic and strength exercise for hypertensive patients, with combined exercise showing greater improvements in BP than individual forms (Dos Santos, et al. 2014; Son, et al. 2017). Although aerobic continuous training is well-documented for its antihypertensive effects, reductions in BP have also been noted with strength training (Casonatto, et al. 2016) and interval training (Caminiti, et al. 2019). Prescribing a strength training programme necessitates consideration of demographic and health-related variables (Ruangthai and Phoemsapthawee, 2019).

1.2 STATEMENT OF THE PROBLEM

In order to enhance the management of HTN to optimal levels, there is a pressing need for expanded information dissemination and diversified strategies (Carey, et al. 2018).

Consequently, similar to the prescription of oral medication, the prescription of exercise should be administered at primary healthcare (PHC) facilities by qualified professionals. These professionals, specifically exercise professionals like Biokineticists, are well-equipped to assess patients and tailor exercise programmes accordingly. Recognising the extent of family involvement in supporting HTN management is crucial, given its role as a facilitative factor in treatment adherence (Barreto and Marcon, 2014). It is imperative to comprehend the specific elements constituting family support, acknowledging their varying significance across individuals (Li, et al. 2013). To optimise this approach, a broader integration of healthcare (HC) professionals beyond medical doctors and nurses into HTN management plans in PHC settings is recommended. This includes the active involvement of exercise professionals such as Biokineticists.

1.3 AIM OF THE STUDY

The principal aim of this study was to ascertain whether the implementation of a PA intervention plan, coupled with family member involvement within the PHC sector, would contribute to the effective management of HTN among hypertensive patients residing in the community of Umlazi Township, KwaZulu-Natal (KZN).

1.4 OBJECTIVES OF THE STUDY

1.4.1 Objective 1: A Scoping Review of Physical Activity Interventions for The Management of Hypertension.

A Scoping Review served as a methodological approach to map and summarise evidence-based practices, employing a technique to systematically map relevant literature and portray the types of evidence relevant to the management of HTN through PA.

1.4.1.1 Research Question

What constitutes the evidence concerning exercise intervention and the application of the Frequency, Intensity, Time, and Type (FITT) principles in the management of HTN?

1.4.1.2 Study Design

A Scoping Review was executed following the methodologically approach outlined by Levac et al. (2010) and Arksey and O'Malley (2005). This systematic search was undertaken to comprehensively explore the intersection of HTN and PA.

1.4.2 Objective 2: The effect of an Exercise Intervention in Managing Hypertension

The objective of this study was to determine whether the implementation of a PA intervention plan, developed through a Scoping Review with particular attention to the characteristics of FITT, could contribute to the management of HTN among hypertensive patients in the community of Umlazi Township, KZN.

1.4.2.1 Research Question

Can a PA intervention contribute to the management of HTN among hypertensive patients in the PHC sector within the community of Umlazi Township, KZN?

1.4.2.2 Hypothesis - Null (N_0)

The implementation of a PA intervention was anticipated to lack efficacy in supporting the management of HTN among hypertensive patients in the PHC sector of Umlazi Township, KZN. The reduction of BP, BMI, and WHR is not expected to yield a positive impact on HTN management in this context.

1.4.2.3 Study Design

The study employed a randomised controlled trial design to recognise the effects of PA on the management of HTN and other secondary outcomes associated with HTN management.

1.4.3 Objective 3: The Role of Family Involvement in Assisting with Hypertension Management.

To anaylse the extent which families play a role or become involved in assisting with the management of HTN.

Family support significantly enhances self-care behaviours and mental health in managing chronic diseases like HTN. Integrating family social support is increasingly endorsed by researchers (Rosland and Piette, 2010; Cornwell and Waite, 2012), as it promotes acceptance of crucial self-care practices such as maintaining a proper diet, adhering to medication regimens, and engaging in PA (Maslakpak et al., 2018). This support is also

important for medication adherence, potentially slowing HTN progression and optimising therapeutic outcomes (Susanto, 2015). The family structure: The determinants of family structure remain relatively understudied (Blau and Van Der Klaau, 2013), with a prevailing viewpoint among family researchers and policymakers that married two biological-parent families represent the gold standard (Brown, 2010). Family functioning, as conceptualised, pertains to emotional cohesion, effective communication of emotions and information, and cooperative and flexible problem-solving within the family unit (Epstein, et al. 1978; Olson and Gorall, 2003). Intra-family social capital encompasses the integration of various family types into the community through informal networks involving families, relatives, friends, and, in certain instances, neighbors, as well as networks facilitated by organisations and institutions (Ravanera and Rajulton, 2010).

To clarify the composition of households and their familial structures, this study employed data from the South African General Household Survey of 2019 (Statistics SA, 2021). Nationally, approximately 39.9% of households were categorised as nuclear, defined by couples or one or more parent(s) with children, while 34.2% were broadly classified as extended households, involving a nuclear core combined with other family members such as parents or siblings (Statistics SA, 2021). A mere 2.4% of households were designated as complex, indicating the presence of non-related persons (Statistics SA, 2021). Nuclear households predominated among those with one or two children (55.0% and 51.3%, respectively) (Statistics SA, 2021). In contrast, extended households were more prevalent in households with a larger number of children, namely, those with three children (57.9%), four children (74.7%), and more than four children (84.5%) (Statistics SA, 2021).

1.4.3.1 Research Question

To what extent do families play a role or become involved in assisting with the management of HTN?

1.4.3.2 Study Design

A qualitative research approach has been used for this study, as it aims to gather theoretical insights and clarify the family members' comprehension of HTN and the impact of their involvement in assisting with HTN management.

1.5 STUDY LOCATION AND POPULATION

The sample population comprised individuals from the black ethnic community residing in Umlazi Township, KZN. Participants meeting the inclusion criteria, as detailed in Chapter 4, Objective 2, were systematically recruited from the identified PHC sector. Umlazi Township, situated in southwestern Durban, is recognised as one of the largest townships in SA, second only to Soweto (Mullick, et al. 2005; Ngubane, 2014). Falling under the eThekwini Metropolitan Municipalities (Statistics SA, 2016), Umlazi Township formed part of an urban area with a total population of 3,661,911 in 2016. Among this population, 913,395 resided in formal main dwellings, 48,601 in traditional main dwellings, 149,634 in informal main dwellings, and 7,760 fell under the 'other' main dwelling category (Statistics SA, 2016).

According to KA Economic Development Consulting CC (2013), estimates placed Umlazi's population between 550,000 and over 1 million. The housing settlements exhibited a blend of formal and informal structures (Nsibande, et al. 2013), with approximately 30% to 60% of the population residing in informal housing, notably in the Zakheleni area (KA Economic Development Consulting CC, 2013; Ngubane, 2014). Approximately 46% of the population fell within the age range of 15 to 34 years, with 40% experiencing unemployment and 33% categorised as not economically active (Ngubane, 2014). In 2013, Umlazi Township was served by a district hospital and 10 PHC facilities (Nsibande et al., 2013), a number that increased to 17 PHC clinics by 2016 (Hill, et al. 2016).

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CHAPTER 2 - LITERATURE REVIEW

2.1 HYPERTENSION

2.1.1 Blood Pressure and High Blood Pressure

The variability in blood pressure (BP) has gained increasing attention as a potential adjunctive therapeutic target for mitigating cardiovascular (CV) risk associated with hypertension (HTN) (Caminiti, et al. 2019). Moreover, there is limited evidence concerning adverse events linked to lower BP targets (Wajngarten and Silva, 2019). Hypertension persists as the leading global cause of mortality, responsible for 10.4 million deaths annually (Global Burden of Disease (GBD) Risk Factor Collaborators, 2018). According to the Global Burden of Diseases report 2018, high systolic BP (SBP) emerged as the primary global risk factor in 2017, accounting for 10.2 million [95% uncertainty intervals (UI) 9.16–11.3 million] deaths and 208 million (UI 188–227 million) disability-adjusted life years (Gupta, et al. 2019).

A study by the Non-Communicable Disease (NCD) Risk Factor Collaboration (2017) revealed a notable increase in the number of adults with high BP, surging from 594 million in 1975 to 1.13 billion in 2015, with the majority of this rise occurring in low-income and middle-income countries (LMIC). Overall, 8.61% (UI 7.66–9.56) of total disability-adjusted life years were attributed to high SBP (Gupta, et al. 2019). The escalating prevalence of NCDs in South Africa (SA) has been linked to poor diet, physical inactivity, tobacco use, and inappropriate alcohol consumption as the primary lifestyle risk factors (Puoane, et al. 2008; Ajaero, et al. 2020; Ajaero, et al. 2021). Non-communicable diseases accounted for 43% of total deaths in all ages and sexes in SA in 2012, with a 27% probability of dying between the ages of 30–70 due to NCDs (World Health Organisation, 2014; Ajaero, et al. 2021). Evidence suggests a continued increase in the burden of NCDs over the past 15 years, contributing to an estimated 37% of all-cause mortality and 16% of disability-adjusted life years (Maimela, et al. 2016; Ajaero, et al. 2021).

In response to a global lack of awareness regarding HTN (estimated at 67% in High-Income Countries (HIC) and 38% in LMIC, educational efforts to inform the public about the risks and management of HTN become imperative (Mills, et al. 2016). Despite various initiatives, the prevalence of elevated BP and its adverse impact on CV morbidity and

mortality are on the rise globally, regardless of income (Mills, et al. 2016; NCD Risk Factor Collaboration, 2017). Blood pressure trends exhibit a noticeable shift of the highest BPs from HIC to LMICs, with an estimated 349 million individuals with HTN in HIC and 1.04 billion in LMICs (Mills, et al. 2016). Individuals fall into categories such as 'Normal,' 'Prehypertensive,' 'Hypertensive stage 1,' 'Hypertensive stage 2,' and 'Hypotensive,' with high-normal BP designated to identify those who could benefit from lifestyle interventions and would undergo pharmacological treatment if compelling indications were present (Unger, et al. 2020). People with high-normal BP are particularly susceptible to the development of HTN (Glodzik, et al. 2018).

2.1.2 Diagnosed Hypertension

Hypertension is characterised by a BP level at which the benefits of treatment— The benefits of lifestyle interventions or medications for HTN management clearly outweigh the associated risks (Williams, et al. 2018). This conclusion is substantiated by clinical trials (Williams, et al. 2018). Consistent with major guidelines, HTN is typically diagnosed when a person's systolic BP (SBP) in the office or clinic persists at ≥140 mmHg and/or their diastolic BP (DBP) is ≥90 mmHg upon repeated examination (Unger, et al. 2020). Standard criteria define HTN as an SBP of 140 mmHg or higher and/or a DBP of 90 mmHg or higher (Gupta, et al. 2019). In contrast, the 2017 American College of Cardiology sets a hypertensive threshold at ≥130/80 mmHg, while the International Society of HTN and South African (SAn) HTN Society maintain a reading of ≥140/90 mmHg as indicative of HTN (Williams, et al. 2018; Whelton, et al. 2018; Unger, et al. 2020).

In SA, HTN stands out as a pressing public health concern demanding immediate attention to avert adverse outcomes (Peer, et al. 2021). Nearly one in two SAn adults experienced HTN in 2016, reflecting a high prevalence of 46% in Sub-Saharan Africa—the highest globally reported rate (WHO, 2013). Limited population-based studies exploring changes in HTN prevalence have primarily been regional and concentrated in the Western Cape Province (Peer, et al. 2013; Davids, et al. 2019). Notably, these studies revealed escalating HTN rates in urban residents of Cape Town (Peer, et al. 2021). The prevalence of HTN increased from 22% to 36% among 25–64-year-old men and women in the black population between 1990 and 2008/09 (CRIBSA Study) (Peer, et al. 2013). In the mixed-ancestry population, HTN rose from 31% to 45% between 2008/09 and 2014/16

(Davids, et al. 2019). However, these findings are not representative of rural residents or the remaining SAn provinces, hindering generalisation to the national population (Peer, et al. 2021). Furthermore, there is limited research on changing patterns of HTN management, encompassing awareness, treatment, and control in SA (Peer, et al. 2021).

Often labeled the "silent killer," HTN serves as a major risk factor for coronary artery disease and stroke, significantly contributing to CV and renal morbidity and mortality across genders (Song, et al. 2020). As the most prevalent risk factor for stroke, it is reported in about 64% of stroke patients based on data from 30 studies between 1990 and 2013 (Feigin, et al. 2017). Despite this, evidence regarding serious adverse events or total CV events for individuals with HTN remains limited (Wajngarten and Silva, 2019). A study by Gao, et al. (2020) revealed a twofold higher risk of mortality in patients with HTN, even after adjusting for confounders. Notably, metabolic abnormalities are more frequent in patients with masked HTN, and organ damage progresses irrespective of treatment presence or absence (Whelton and Carey, 2017). As the most prevalent lifestyle-related disease, HTN poses a challenge for specialists in the field (Umemura, et al. 2019).

Substantial disparities in the regional burden of HTN accompany low levels of awareness, treatment, and control rates in LMIC, compared to HIC (Unger, et al. 2020). While genetic differences contribute to these variations, lifestyle and socioeconomic status likely impact health behaviors such as diet, smoking, and physical inactivity—emerging as major contributors (Unger, et al. 2020). The prevalence of HTN rises with age, reaching approximately 60% in those over 60 years and 75% in those over 75 years (Williams, et al. 2018). Despite being a modifiable disease, HTN incidence is highest among older adults (Buford, 2016). The National Health and Nutrition Examination Survey suggests greater improvements in awareness and treatment of HTN in younger adults, with lower BP control rates among young men (Zhang and Moran, 2017). Gender differences in risk factors, awareness, treatment, and control of HTN are well-established (Song, et al. 2020), and prevalence, treatment, and control rates also vary significantly by ethnicity (Unger, et al. 2020), with black populations experiencing a higher prevalence (Modesti, et al. 2016).

The management of HTN involves a multitude of clinicians and practitioners (Umemura, et al. 2019). In response to this, numerous HTN guidelines have been established, primarily for use by clinicians and practitioners, including pharmacists engaged in treatment collaboration with physicians (Umemura, et al. 2019). The recommended treatment strategy advocates for incorporating appropriate lifestyle measures alongside optimal or best-tolerated doses of three or more drugs (Williams, et al. 2018). The 2017 American College of Cardiology/American Heart Association guidelines suggest targeting a BP <130/80 mmHg after the age of 65 years (Whelton, et al. 2018). Treatment resistance is defined when the recommended strategy fails to lower office SBP and DBP values to <140 mmHg and/or <90 mmHg, respectively. The confirmation of inadequate BP control is established through ambulatory BP monitoring or home BP monitoring in patients whose adherence to therapy has been verified (Williams, et al. 2018).

2.2 RISK FACTORS

Efforts to manage HTN encompass regular monitoring of BP, participation in healthy living programmes that emphasise tobacco cessation, increased physical activity (PA), and adherence to a healthy diet promoting caloric balance through the consumption of high-fiber, low-fat, and low-salt foods. This multifaceted approach involves independent initiatives by individuals or communities, complemented by existing healthcare (HC) programmes, and is most effective when initiated early (Irani, 2019). The Global Burden of Diseases (GBDs) study underscores the significance of high SBP, suboptimal dietary intake, and tobacco use as pivotal risk factors for morbidity and mortality (GBDs 2016 Risk Factors Collaborators, 2017). Lifestyle modifications, such as dietary adjustments to limit salt, fat, and alcohol intake, smoking cessation, and weight control, are essential components of HTN management and play a foundational role in the treatment of cardiovascular diseases (CVDs) and chronic kidney disease (Umemura, et al. 2019; Sianipar, et al. 2020).

A distinctive aspect of CV risk estimation in hypertensive patients is the consideration of the impact of HTN itself (Williams, et al. 2018). Social determinants also contribute significantly, with countries experiencing greater human and social development and urbanisation reporting higher incidences of HTN (Gupta, et al. 2019). This trend contrasts with developed countries like the USA, where HTN rates are higher than in less developed

states (Whelton, et al. 2017). Extensive research over decades has revealed that both genetic factors and environmental exposures contribute to BP regulation (Carey, et al. 2018). Approximately 20%–50% of HTN is estimated to be heritable, with environmental exposures accounting for the remaining variance (Carey, et al. 2018).

Individuals with HTN often present with additional modifiable cardiovascular (CV) risk factors, including obesity, hypercholesterolemia, diabetes mellitus, smoking, physical inactivity, and unhealthy diet (Whelton and Carey, 2017). Targeting unhealthy lifestyles, such as poor-quality diet, physical inactivity, and smoking, is paramount in promoting healthy lifestyle behaviors within the general population (Piepoli, et al. 2016). Non-pharmaceutical interventions are considered cost-effective alternatives to control HTN and should address correcting dietary habits, promoting regular PA, and limiting alcohol consumption (Gupta and Guptha, 2010; Akonobi and Khan, 2019; Fu, et al. 2020). Therefore, a comprehensive approach involving non-pharmacological interventions alone or in combination with pharmacological therapy is fundamental for effective HTN management (Whelton and Carey, 2017).

2.2.1 Age

The prevalence of HTN escalates with advancing age (Williams, et al. 2018). As our population ages rapidly, it is inevitable that the prevalence of HTN will continue to surge (Oliveros, et al. 2020). The incidence of HTN is notably high among young adults, with one study estimating that over 20% of individuals develop HTN before reaching the age of 40 (Thomas, et al. 2018). Nevertheless, the incidence of HTN is three times higher among individuals aged over 65 than in those aged 35–44 (National Center for Health Statistics, 2016). In SA, an estimated 8.22 million adults aged ≥20 years without private health insurance are living with HTN, accounting for 30.8% (95% CI 29.5% to 32.1%) of this demographic. This proportion increases to 53.1% (95% CI 50.7% to 55.7%) for adults aged ≥40 years (Kohli-Lynch, et al. 2022). The confluence of a less healthy lifestyle and the rapid aging of society contributes to the growing number of patients with chronic kidney disease (Umemura, et al. 2019). As age advances, the prevalence of HTN and other diseases rises, highlighting the strong influence of age on CV risk, with older individuals consistently exhibiting high absolute CV risk (Williams, et al. 2018).

Older adults constitute a diverse population in terms of functional status, comorbidities, personal experiences, and living environments (Muntner, 2021). Aging induces structural and functional alterations in the arterial vasculature (Oliveros, et al. 2020). Over time, arteries undergo stiffening, featuring fracturing of the elastic lamellae and intimal hyperplasia observed in the aorta (Oliveros, et al. 2020). Stiffened arteries exhibit reduced capacitance and limited recoil, posing challenges in accommodating volume changes throughout the cardiac cycle (Oliveros, et al. 2020). This alteration in arterial structure leads to an increase in reflected pressure waves added to the forward pressure waves in the ascending aorta, further amplifying central SBP (Oliveros, et al. 2020). Recognising and appropriately treating HTN in older adults should be a top priority for physicians (Oliveros, et al. 2020).

2.2.2 Gender Differences

Clinicians, researchers, and policymakers are increasingly acknowledging the profound influence of sex and gender on health (Mauvais-Jarvis, et al. 2020). Biological and environmental factors intricately shape daily life and work roles in both males and females, ultimately impacting their Quality of Life (Badr, et al. 2021). Within the realm of non-modifiable risk factors, gender disparities emerge in the prevalence, awareness, therapy, and prognosis of HTN (Song, et al. 2020). The mechanisms underlying and controlling HTN differ significantly between men and women (Song, et al. 2020). Haemodynamic mechanisms of BP disparities in women and men clarify gender differences in the clinical characteristics of HTN (Song, et al. 2020). Substantial variations exist in the epidemiology and clinical features of HTN between genders (Song, et al. 2020). About two thirds of participants showed undiagnosed hypertension that deserved further investigations, and mere 5% of males were with normal BP, compared to almost 42% of females (Badr, et al. 2021). While around 45% of men and 48% of women older than 15 years in SA have HTN, only about 19% of men and 29% of women with HTN are aware of their condition (Peer, et al. 2021).

While aging is associated with weight gain for both men and women (Mauvais-Jarvis, et al. 2020), women are particularly susceptible to weight gain during the peri- and post-menopausal period due to changes in estrogen levels (Porter, et al., 2020). Mechanisms explaining why obesity has a more significant adverse effect on BP in women are yet to

be fully elucidated (Cooper, et al. 2021). Gender differences may be associated with specific types of HTN, including postmenopausal HTN, white coat HTN, masked HTN, and hypertensive disorders of pregnancy (Song, et al. 2020). Although gender differences play a role in the prevalence and determinants of HTN and pre-HTN, the control rate is similar between men and women taking antihypertensive medication (Song, et al. 2020).

Despite the substantial efforts to comprehend potential mechanisms responsible for HTN in both genders, current HTN guidelines seldom address gender differences in HTN management (Song, et al. 2020). There is evidence suggesting that HTN is less well controlled in aging women than in aging men, although the reasons for this gender difference remain unclear (Song, et al. 2020). Conversely, men exhibit lower levels of HTN awareness and a higher incidence of HTN compared with age-matched women before the sixth decade of life (Zhang and Moran, 2017). A comprehensive understanding of gender differences in HTN could inform optimal therapeutic interventions (Song, et al. 2020). Initial manifestations of HTN in women often include a high percentage of therapy resistant HTN, possibly due to enhanced sensitivity to dietary salt and stimulation of sympathetic nerve activity (Umemura, et al. 2019). Women are more likely to maintain regular visits with HC providers, providing clinicians with more opportunities and greater comfort in discussing sensitive matters (Cooper, et al. 2021). Given that the incidence of CVDs tends to be higher in women of the same generation compared to men, women are more inclined to seek medical attention, increasing the likelihood of early detection (Umemura, et al. 2019). Additional studies are imperative to clarify the extent to which mechanisms related to sex, gender, and their intersection underlie these discrepancies (Cooper, et al. 2021).

2.2.3 Salt

In the realm of dietary interventions for BP reduction, the Dietary Approaches to Stop Hypertension (DASH) diet emerges as a commendable recommendation (Rust and Ekmekcioglu, 2016). Adhering to WHO guidelines, salt intake should not surpass 5 g/day (<2 g sodium/day), and for specific demographics, such as blacks, middle- and older-aged individuals, and those with HTN, sodium intake should be capped at no more than 1.5 g/day (Rust and Ekmekcioglu, 2016). Concurrently, there is a call to elevate potassium intake to around 4.7 g/day (Rust and Ekmekcioglu, 2016). Notably, numerous trials have

demonstrated the BP-lowering efficacy of sodium restriction (Williams, et al., 2018). However, achieving effective salt reduction poses challenges, with a prevalent lack of awareness regarding high-salt foods. Guidance should emphasise the avoidance of added salt and foods with elevated salt content (Williams, et al. 2018). Addressing the broader issue of population salt intake necessitates collaborative efforts involving the food industry, governments, and the public at large, given that 80% of salt consumption involves concealed salt in processed foods (Williams, et al. 2018).

2.2.4 Smoking and Alcohol consumption

The validation of passive smoking's role in HTN awaits confirmation through prospective cohort studies (Umemura, et al. 2019). The influence of electronic tobacco on BP remains an enigma, marked by a paucity of substantial reports (Umemura, et al. 2019). Nevertheless, it is imperative to meticulously record tobacco use history during each patient visit, and hypertensive smokers needs dedicated counseling to stop smoking (Williams, et al. 2018). Comprehensive guidance and treatment for smoking cessation should be provided, complemented by a concerted effort to circumvent passive smoking (Umemura, et al. 2019). The judicious consideration of smoking cessation aids may be warranted as needed (Umemura, et al. 2019).

In the realm of HTN management, due attention must be given to alcohol consumption, with recommended ethanol intake capped at 20–30 mL or less for men and 10–20 mL per day or less for women (Umemura, et al. 2019). Hypertensive men who consume alcohol should be counseled to limit their intake to 14 units per week, while women should adhere to 8 units per week (1 unit equivalent to 125 mL of wine or 250 mL of beer) (Williams, et al. 2018). Encouraging alcohol-free days in a week (Piepoli, et al. 2016) and discouraging binge drinking are additional prudent recommendations (Williams, et al. 2018).

2.2.5 Diet and Weight

Regular consumption of sugar-sweetened soft drinks has been linked to overweight, metabolic syndrome, type 2 diabetes, and an elevated CV risk (Williams, et al. 2018), warranting discouragement of their intake (Piepoli, et al. 2016). Both overweight and obesity are correlated with an increased risk of CV death and all-cause mortality (Williams, et al. 2018). While weight reduction is recommended for overweight and obese

hypertensive patients to manage metabolic risk factors, achieving weight stabilisation may be a reasonable goal for many (Williams, et al. 2018). Obesity and excessive salt intake accelerate kidney damage through mechanisms dependent on and independent of BP (Umemura, et al. 2019). Inactivity and obesity may contribute to diastolic dysfunction and left atrial enlargement, elevating the risk of atrial fibrillation, whereas exercise training can enhance diastolic function and reduce left atrial volume (Kiuchi, et al. 2017). The optimal BMI remains unclear, but the maintenance of a healthy body weight (BMI of approximately 20-25 kg/m² in individuals <60 years of age; higher in older patients) and waist circumference (<102 cm for men and <88 cm for women) is recommended for non-hypertensive individuals to prevent HTN and for hypertensive patients to reduce BP (Piepoli, et al. 2016). Additionally, weight loss has the potential to improve the effectiveness of antihypertensive medications and the cardiovascular risk profile (Williams, et al. 2018).

2.2.6 Physical Inactivity

Another contributing factor to HTN is insufficient PA, and the ready availability of high-calorie foods can contribute to the development of pathological conditions like obesity and CVD (Mahiroh, et al. 2019). Acknowledged as one of the most significant public health challenges of the 21st century (Blair, 2009), physical inactivity is on the rise globally, transcending socioeconomic conditions (WHO, 2016), thereby necessitating urgent attention as a public health priority (Sallis, et al. 2016; Warburton and Bredin, 2017). Moon, et al. (2017) proposed that individuals with lower PA and increased sedentary behavior might exhibit greater susceptibility to genetic influences on adiposity. Furthermore, physical inactivity induces metabolic and structural changes, even in young and healthy individuals, including muscle atrophy, heightened insulin resistance, inflammation, hypertension, and unfavorable alterations in plasma lipid profiles (Mazzucco, et al. 2010). Engaging in at least 75 minutes of vigorous-intensity PA, or 150 minutes per week of moderate-intensity PA, or a combination of both, is recommended to mitigate the risk of chronic diseases, including HTN (WHO, 2016; Warburton and Bredin, 2017).

2.3 DIAGNOSIS AND MANAGEMENT

2.3.1 Diagnosis

Preventing HTN and its related adverse outcomes, including CVDs, necessitates interventions spanning the entire lifespan, from childhood and adolescence to older age (Muntner, 2021). In resource constrained LMIC, the adoption of guidelines from HIC can be challenging, given limited resources and health system capacities (Unger, et al. 2020). In Africa, where only 25% of countries have HTN guidelines, the adoption of guidelines from wealthier countries can be impractical due to various obstacles, such as a severe shortage of trained HC professionals, unreliable electricity, limited access to basic BP devices, and constrained diagnostic capabilities (Dzudie, et al. 2017; Unger, et al. 2020). The global call for harmonisation stems from the ambiguities in the latest guidelines causing confusion among HC providers and anxiety among patients (Rehan, et al. 2017; Messerli and Bangalore, 2018). Consequently, guidelines from HIC may not perfectly align with the global HC agenda (Poulter, et al. 2018).

To mitigate the impact of HTN in elderly patients, key strategies involve screening for BP elevation, improving access to care, and adopting guideline-driven management approaches (Oliveros, et al. 2020). The diagnostic threshold for HTN remains at 140/90 mmHg in clinic BP, prompting the prompt initiation of antihypertensive drug therapy for patients with a BP of ≥140/90 mmHg (Umemura, et al. 2019; Jones, et al. 2020). Diagnosis based on out-of-office measurements is recommended to avoid the risks associated with white-coat HTN (a difference of >20/10 mmHg between clinic readings and average daytime home or ambulatory measurements) (Jones, et al. 2020). Lifestyle modifications should be attempted promptly for those with a BP of 130–139/80–89 mmHg, and if lifestyle changes do not achieve the desired BP reduction, drug therapy should be considered (Bakris and Sorrentino, 2018; Umemura, et al. 2019).

If a target BP of <130/80 mmHg is established, even in patients aged ≥75 years, it should be individually targeted if tolerable (Umemura, et al. 2019). Meta-analyses of randomised controlled trials (RCTs) have demonstrated that a 10-mmHg reduction in SBP or a 5-mmHg reduction in DBP is associated with significant reductions in major CV events, all-cause mortality, stroke, coronary events, and heart failure (Ettehad, et al. 2016). These reductions are consistent across various patient characteristics and comorbidities,

emphasising the importance of BP control (Ettehad, et al. 2016; Brunstrom and Carlberg, 2018).

Annual screening for HTN is advised for adults aged 18 years and older (Unger, et al. 2020). For the diagnosis and treatment of hypertensive patients, evaluating the severity of HTN, differentiating between essential and secondary HTN, assessing CV risk factors, clarifying underlying lifestyle factors, evaluating concurrent CVDs and organ damage, and considering home BP are all essential steps (Umemura, et al. 2019). New approaches, including technologies, are needed to improve screening, detection, and control of elevated BP in the community, especially as healthcare moves towards greater patient involvement in self-monitoring and self-screening of HTN (Kitt, et al. 2019).

Physicians are advised to critically assess the evidence regarding BP targets in older adults, considering factors such as comorbidity burden, life expectancy, clinical judgment, and patient preference (Oliveros, et al. 2020). When medications are needed for uncontrolled HTN in older adults, factors such as comorbidities, frailty, ability to follow instructions, complexity of the current regimen, support system, and electrolytes and renal function should be considered (Whelton, et al. 2018; Zanchetti, et al. 2018). For younger patients, prevention of HTN through lifestyle modification is emphasised to reduce the risk of cognitive impairment, stroke, myocardial infarction, heart failure, renal failure, and other complications (Oliveros, et al. 2020).

2.3.2 Management

Lifestyle modifications stand out as a crucial treatment method, offering a cost-effective means to simultaneously address multiple risk factors (Umemura, et al. 2019). Opting for healthy lifestyle choices not only holds the potential to prevent or delay the onset of HTN but can also significantly reduce CV risk (Piepoli, et al. 2016). In cases of grade 1 HTN, effective lifestyle changes might even suffice to delay or entirely obviate the need for drug therapy (Williams, et al. 2018). Recognising the efficacy of lifestyle modifications in preventing and curbing the progression of HTN, they are also incorporated as a population strategy in health promotion programmes targeting specific populations or the entire society (Umemura, et al. 2019). Distinctions are made in the guidelines between lifestyle improvement promotion through information delivery and lifestyle modifications/non-

pharmacological therapy, which involves planned interventions into lifestyles facilitated by communication with HC professionals (Umemura, et al. 2019).

Individuals diagnosed with confirmed HTN (grade 1 and grade 2) should receive appropriate pharmacological treatment, with antihypertensive drug therapy recommended when office BP exceeds 140/90 mmHg (Williams, et al. 2018; Unger, et al. 2020). Combining lifestyle interventions with drug therapy typically involves initiating treatment with a two-drug combination (Williams, et al. 2018). Post-initiation, regular reviews within the first 2 months are crucial to assess BP effects and potential side effects until optimal control is achieved, with the frequency contingent upon factors such as HTN severity, urgency for control, and patient comorbidities (Williams, et al. 2018).

While lifestyle modification alone may not achieve BP control targets for many hypertensive patients, enhancing the effects of these modifications can potentially reduce the number and doses of antihypertensive drugs (Umemura, et al. 2019). Emphasising health promotion strategies for positive CV health, in addition to treating established CVD, is crucial. Population-based initiatives, including salt reduction, improved fruit and vegetable availability, weight management, and reduced alcohol intake, play a vital role in reducing the global burden of elevated BP (Unger, et al. 2020). Education and awareness programmes in community centers, places of worship, and businesses contribute significantly to these efforts. Healthcare professionals, including nurses, biokineticists, and physiotherapists, should take a leading role in encouraging patients to engage in regular exercise programmes, playing a pivotal role in their development, implementation, and evaluation (Reamico, 2017).

For optimal BP control, most patients will likely require drug therapy in addition to lifestyle measures (Williams, et al. 2018). Previous European Society of Cardiology and European Society of Hypertension (ESC/ESH) guidelines recommended five major drug classes for HTN treatment, based on their proven ability to reduce BP and evidence from placebo-controlled studies demonstrating a reduction in CV events (Williams, et al. 2018). However, it's important to note that commonly used drugs, such as angiotensin-converting enzyme inhibitors and statins, can increase the risk of hyperkalemia. Nevertheless, studies have shown that PA in these patients can be safely implemented, causing only a

short-term, within-normal-range increase in potassium that returns to baseline after rest (Glodzik, et al. 2018; Deska and Nowicki, 2017).

2.3.3 Family Support

Family members of individuals facing chronic illnesses are well-positioned to offer sustained and impactful self-management support (Rosland and Piette, 2010). Their role extends beyond practical assistance, encompassing crucial emotional support that aids patients in coping with the stress associated with their illnesses (Osamor, 2015). Effective medical control and adherence to medication regimens are pivotal aspects of HTN management (Win, et al. 2021). In this context, family support emerges as a linchpin for BP control, augmenting adherence to self-care practices and contributing to enhanced HTN management. Thus, interventions targeting the improvement of family support and the promotion of self-care practices wield significant potential to optimise BP control and prevent CV complications (Osamor, 2015; Chacko and Jeemon, 2020).

The nature of tasks undertaken by family members is diverse, contingent upon individual needs, cultural nuances, and the age of the affected patient (Luttik, et al. 2016). However, critical research gaps persist regarding the specific impact of family involvement on patient outcomes, its cost-effectiveness for the HC system and society, and its effects on the psychological and physical health of family members (Goldfarb, et al. 2022). Experimental evidence suggests that family support contributes significantly to patients' correct adherence to anti-hypertensive medications, resulting in a notable decrease in SBP or DBP after a 6-month intervention (Shen, et al. 2017). The positive correlation between BP control and perceived family support underscores the importance of HC providers assessing available family support when managing individuals with HTN (Chacko and Jeemon, 2020).

Despite evident challenges in family engagement, numerous opportunities exist to shape strategies for improving HTN management (Fort, et al. 2020). Assessing the support received by HTN patients, including family involvement in medication oversight and routine treatment control, is crucial (Tarigan and Syarifah, 2021). Family members may express a desire to actively contribute to the daily care of their loved ones, potentially leading to increased involvement in the patient’s clinical care and enhanced trust from

both the patient and healthcare providers (Rosland and Piette, 2010). Integrating families into the management of hypertensive patients is essential for improving patient function and treatment outcomes (Ojo, et al. 2016). Conducting comprehensive interviews with family members and HC providers contributes to a more thorough understanding of family engagement in disease management (Fort, et al. 2020).

2.4 POOR MANAGEMENT OUTCOMES OF HYPERTENSION

2.4.1 Poor Adherence

Global BP control rates persist at unsatisfactory levels, reflecting a concerning reality (Song, et al. 2020). A study by Xiong, et al. (2020) revealed that nearly 40% of individuals diagnosed with HTN did not receive any antihypertensive medication. Surprisingly, evidence suggests that the occurrence of adverse events did not significantly differ between patients who were previously treated with antihypertensive medications and those who did not receive any therapy despite their HTN (Tadic, et al. 2021). Poor adherence to antihypertensive treatment aligns with elevated BP levels and serves as a significant predictor of an unfavorable prognosis in hypertensive patients (Gupta, et al. 2016; Abegaz, et al. 2017; Gupta, et al. 2017; Wei, et al. 2018).

Hypertensive patients often contend with various comorbidities that impact CV risk and necessitate tailored treatment approaches (Unger, et al. 2020). Comorbidities associated with HTN encompass CVD, obesity, diabetes mellitus, chronic kidney disease, congestive heart failure, and metabolic syndrome, among others (Pescatello, et al. 2019). Hypertension itself stands as a prominent risk factor contributing to global mortality and morbidity, forming a broad association with CVDs such as atherosclerosis, acute myocardial infarction, and cardiomyopathy (Mozaffarian, et al. 2016). Cardiovascular diseases, as NCDs, represent a primary cause of disability and death globally (GBD 2015 Mortality and Causes of Death Collaborators, 2016; Piepoli, et al. 2016). In both the United States and worldwide, CVD stands as the leading cause of death, accounting for a significant proportion of mortality (Benjamin, et al. 2017; WHO, 2018).

Consequently, HTN persists as the major preventable cause of CVD and all-cause mortality on a global scale (Song, et al. 2020). Alarmingly, a substantial number of individuals, including young adults, fall short of achieving optimal CV health (Wajngarten

and Silva, 2019). With the prevalence of HTN increasing significantly in older adults, CVDs become highly prevalent in this demographic (Muntner, et al. 2018; Benjamin, et al. 2019). Hypertension emerges as a pivotal factor contributing to the occurrence of strokes, heart diseases, kidney diseases, and macrovascular diseases, highlighting its multifaceted impact on health (Umemura, et al. 2019). Armed with this knowledge, it becomes imperative for patients to prioritise adherence to medical treatments and adopt a healthy lifestyle (Wajngarten and Silva, 2019).

2.4.2 Adverse Effects

Studies consistently indicate that HTN stands as an autonomous predictor for hospitalisation, advanced pneumonia stages, admission to the intensive care unit, and mortality among affected individuals (de Almeida-Pititto, et al. 2020; Giannouchos, et al. 2020; Wang, et al. 2020). In LICs, the reported prevalence of risk factors in stroke patients is comparatively lower. However, these patients exhibit the highest in-hospital mortality, potentially stemming from delays in seeking acute stroke care, variations in health system response, and acute stroke management practices (Al-Khatib, et al. 2018). Notably, men demonstrate a higher incidence of stroke than women at younger ages, with the trend reversing by the age of 75. Nevertheless, recent data challenges this pattern for black individuals, indicating a similar stroke risk between black women aged 65 to 74 and black men (Benjamin, et al. 2018; Howard, et al. 2019). These disparities seem to be driven by differences in stroke risk factors, particularly HTN (Howard, et al. 2019).

While there has been a global inclination toward reducing stroke incidence, prevalence, and mortality since the 1990s, the absolute number of people affected by stroke continues to rise (Feigin, et al. 2017). Approximately 90% of the stroke burden is attributed to modifiable risk factors, with behavioral elements like smoking, poor diet, and low PA accounting for about 75% of this burden (Wajngarten and Silva, 2019). Smoking, with its acute and prolonged pressor effect on ambulatory BP, is a notable contributor, but its cessation, along with other lifestyle modifications, holds significance beyond BP control, extending to CVD and cancer prevention (Piepoli, et al. 2016). Recognised as a major independent risk factor for CVD, cancer, and respiratory disease, smoking not only induces HTN but also directly elevates the risk for CVD, making smoking cessation a pivotal measure (Williams, et al. 2018; Umemura, et al. 2019). Prioritising smoking

cessation, therefore, remains crucial in comprehensive preventive strategies (Umemura, et al. 2019).

2.5 PHYSICAL ACTIVITY AS A STRATEGY TO MANAGE HYPERTENSION

2.5.1 Physical Activity and Benefits

In the realm of PA, it becomes essential to disentangle terms often used interchangeably, such as PA and exercise (Utami and Kusumaningrum, 2021). Physical activity is characterised as any bodily movement facilitated by skeletal muscles, necessitating energy expenditure (WHO, 2018). This encompasses daily actions like walking, taking the stairs, sweeping, and traveling (Utami and Kusumaningrum, 2021). On the flip side, exercise is deliberate, structured, repetitive, and intentional movement aimed at enhancing or sustaining one or more components of physical fitness (Utami and Kusumaningrum, 2021). It involves organised activities or sports, such as swimming, running, bicycling, or walking, entailing continuous, rhythmic movements of large muscle groups for at least 10 minutes at a time, making exercise a subcategory of PA (Utami and Kusumaningrum, 2021).

Emphasising the importance of exercise therapy, it is strongly recommended as a key component of lifestyle modification for hypertensive patients (Umemura, et al. 2019). Regular participation in exercise is recognised as a non-pharmacologic strategy to reduce BP and counteract HTN (Pescatello, et al. 2004; Pescatello, et al. 2015). The components of PA encompass work, sports, and leisure activities (Utami and Kusumaningrum, 2021). Leisure-time PA, involving sports, fitness, and recreational activities, is influenced by various factors in individuals' daily lives (Utami and Kusumaningrum, 2021). Investigative teams found that the most significant BP reductions were observed in individuals with HTN (5 mmHg to 8 mmHg, 4% to 6% of resting BP level), followed by those with pre-HTN (2 to 4 mmHg, 2% to 4% of resting BP level), and normal BP (1 to 2 mmHg, 1% to 2% of resting BP level) (Pescatello, et al. 2019). The BP reductions ranged from 5 to 17 mm Hg for SBP and 2 to 10 mm Hg for DBP (Pescatello, et al. 2019).

Physical activity is beneficial for CV health (PA Guidelines Advisory Committee, 2018). However, there is an increase in SBP during exercise related to pre-exercise resting BP, age, arterial stiffness, and abdominal obesity, with slightly greater effects in women and

unfit individuals (Williams, et al. 2018). Seeking guidance from experienced fitness trainers may be particularly beneficial to optimise the frequency, intensity, and duration of each exercise type (Oliveros, et al. 2020). The European 2016 guidelines recommend lifestyle interventions, including regular PA, for individuals undergoing treatment for HTN and those with high-normal BP or Grade 1 HTN, emphasising the potential to reduce CV risk without additional antihypertensive medication (Piepoli, et al. 2016). The initiation of lifestyle changes as the primary step is recommended for Grade I HTN, with anti-hypertensive medications added if target BP of <140/90 mmHg is not achieved after a specified period (Hanssen, et al. 2022).

2.5.2 Mechanisms of Physical Activity

Caminiti, et al. (2019) uncovered significant variations in the impact of different exercise modalities on BP variability, even as they induce comparable reductions in BP values. Recent findings further indicate that the antihypertensive benefits of exercise may stem from successive decreases following acute exercise sessions (Da Nobrega and Claudio, 2005). To date, a singular meta-analysis (Corso, et al. 2016) examined the moderating effect of resting BP on tensional responses to concurrent exercise, revealing that SBP saw more pronounced reductions in middle-aged individuals with HTN (25.3 mmHg) compared to those with pre-HTN (22.9 mmHg) or individuals with normal BP (0.9 mmHg) (Cordeiro, et al. 2018). Exercises are associated with unequivocal health benefits, resulting in numerous structural and functional changes to the myocardium that enhance performance and prevent heart failure (La Gerche, et al. 2017). While the impact of regular PA on CV risk is well-established, it may be linked to various mechanisms contributing to the normalisation of BP (Glodzik, et al. 2018). Regular PA, encompassing aerobic and strength training, has demonstrated the ability to increase heart rate variability, likely by enhancing the vagal influence relative to sympathetic influence on the heart (Bhati, et al. 2018).

Exercise and regular PA play a crucial role in averting the detrimental effects of aging, not only by mitigating oxidative stress and inflammation but also by exerting additional antioxidant and anti-inflammatory actions (Sallam and Laher, 2016). Consequently, it remains uncertain whether concurrent exercise would prove efficacious as antihypertensive therapy in older patients (Cordeiro, et al. 2018). The global growth of the

Exercise is Medicine™ initiative has been substantial, being proposed and applied clinically (Umemura, et al. 2019). This initiative extends beyond mere exercise therapy, advocating for the safety management of PA and exercise, considering exercise therapy and exercise programmes as integral components of healthcare. The overarching goal is to achieve and enhance health management through collaborative efforts among HC staff members, including physicians, affiliated HC professionals, and exercise leaders (Umemura, et al. 2019). Recognising the imperative to introduce the concept of exercise as medicine to SA, there is a concerted effort to actively promote exercise as a healthcare programme (Umemura, et al. 2019).

2.5.3 Types of Physical Activity

Reflecting on the collected evidence of the past decade, it becomes evident that there is moderate evidence suggesting the similarity in the relationship between BP response to PA across various exercise modalities. This similarity holds true for aerobic, dynamic strength, and combined aerobic and dynamic strength exercises among adults with normal BP, pre-HTN, and HTN (Pescatello, et al. 2019). Evaluating studies within this context, it was observed that moderate-intensity aerobic, isometric, and dynamic strength exercise training, whether administered alone or in combination, proved equally effective in lowering both SBP and DBP among adults with normal BP, pre-HTN, and HTN (Okechukwu, 2020). Furthermore, engaging in moderate amounts of leisure-time PA was associated with an 11% decreased risk of HTN compared to the reference group engaging in low amounts of leisure-time PA (RR, 0.89; 95% CI, 0.85–0.94) (Pescatello, et al. 2019). Despite the well-established role of combined aerobic and strength training in enhancing cardiac health, its impact on cardiac autonomic control, a crucial component of cardiac health and a key link in the pathophysiology of HTN, remains unknown (Masroor, et al. 2018).

Pescatello, et al. (2019) found moderate evidence supporting the effectiveness of aerobic and dynamic strength exercise training, either alone or in combination, in lowering BP across individuals with normal BP, pre-HTN, and HTN. However, significant knowledge gaps persist, particularly in understanding various effect modifiers of the relationship between PA and BP, notably race/ethnicity (Pescatello, et al. 2019). Noteworthy reductions in SBP were observed in stroke patients following aerobic exercises compared

to the Control Group (CG) (Wang, et al. 2019). Previous research also indicates that aerobic high-intensity interval training led to substantial improvements in BP and cardiorespiratory fitness compared with moderate-intensity continuous training (Boutcher and Boutcher, 2017; Karlsen, et al. 2017).

2.5.4 Safety

Engaging in PA carries profound benefits, significantly lowering CV morbidity and mortality, while physical inactivity stands as a major risk factor for CVD (Kiuchi, et al. 2017). Exercise therapy is recommended for patients with grade II or less severe HTN without existing CVDs, with a precaution for those with grade III or more severe HTN to initiate exercise therapy after achieving a lower BP (Umemura, et al. 2019). High-risk patients, especially those with CVD complications, should undergo a prior medical check to determine an appropriate exercise load level and take necessary actions such as exercise restriction or prohibition as needed (Umemura, et al. 2019). Older adults may perceive exercise as tiring and raise concerns about health and safety (Poon, et al. 2018). They often prefer exercise sessions with moderate intensity and shorter durations, finding them more enjoyable than prolonged approaches (Bartlett, et al. 2011; Poon, et al. 2018).

Safety considerations are paramount for hypertensive patients, necessitating that exercise intensity be set at moderate or lower levels (Umemura, et al. 2019). Exercise intensity is defined as the rate of metabolic energy demand during exercise, expressible in absolute terms (e.g., oxygen uptake, power output, heart rate, speed of locomotion) (MacIntosh, et al. 2021). It can also be expressed in relative terms, considering factors such as body weight, maximal oxygen uptake, maximal heart rate, or heart rate reserve (Anselmi, et al. 2021; MacIntosh, et al. 2021). Low-intensity PA falls within specific parameters, including VO2max <40%, HR max <55%, HR reserve <40%, and within an aerobic training zone (Hansen, et al. 2021). Moderate and vigorous PA are quantified in multiples of resting metabolic equivalent (MET) (MacIntosh, et al. 2021). Considering the variability in VO2max based on age, sex, genetic predisposition, and individual fitness level, a MET-based recommendation covers a wide range of disturbances to homeostasis (Iannetta, et al. 2021).

Moderate-intensity exercises, such as brisk walking, dancing, and gardening, are often prescribed. For vigorous intensity, activities like jogging, running, fast cycling, swimming, and brisk hill walking are recommended (MacIntosh, et al. 2021). Evidence from Kiuchi, et al. (2017) suggests that moderate PA is associated with improved CV health, reduced mortality, and a decreased risk of atrial fibrillation. Walking, the most common form of exercise, is particularly beneficial (Chan, et al. 2018). Further evidence indicates that antihypertensive effects of exercise remain potent after strength or concurrent exercise (aerobic and strength performed in proximity), emphasising the interconnectedness of aerobic and strength exercises (Corso, et al. 2016; MacDonald, et al. 2016; Cordeiro, et al. 2018).

2.6 CONCEPTUAL FRAMEWORK

The conceptual framework guiding our understanding of HTN, and its optimal management is a comprehensive model, encompassing various factors that influence the prevalent CVD. Illustrated in Figure 2.6.1, this framework serves as a roadmap for analysing and addressing the complexity of HTN, aiming for effective prevention and treatment. Acknowledging HTN as a multifaceted issue with both modifiable and non-modifiable risk factors, this framework offers an overall perspective on the condition. It emphasises the necessity for a multifaceted approach that not only addresses medical aspects but also considers social, environmental, and lifestyle factors. Such an approach is crucial for effectively preventing, diagnosing, and managing HTN to enhance overall health.

Individuals engaged in more PA are less likely to be obese and develop HTN (Dun, et al. 2021). The Body Mass Index shows a significant association with the incidence rate of HTN, indicating that a higher BMI corresponds to an increased risk for HTN (Mahiroh, et al. 2019). Obesity, acting as both a complication and a health outcome of numerous diseases, may act as an influencing factor between HTN and PA (Dun, et al. 2021). Lifestyle modifications play a pivotal role in HTN management, both before and after the initiation of antihypertensive drug therapy (Umemura, et al. 2019). Changes in lifestyle, such as incorporating regular PA and adopting healthy dietary habits, are considered the standard and primary treatment for controlling HTN (Yang, et al. 2017; Pescatello, et al. 2019). Encouragingly, there is promising evidence indicating that complementary and

alternative forms of PA are effective in lowering BP among adults with HTN (Pescatello, et al. 2019). When individuals with HTN engage in moderate-intensity PA of the aerobic type, it leads to a significant reduction in BP levels (Sigal, et al. 2018).

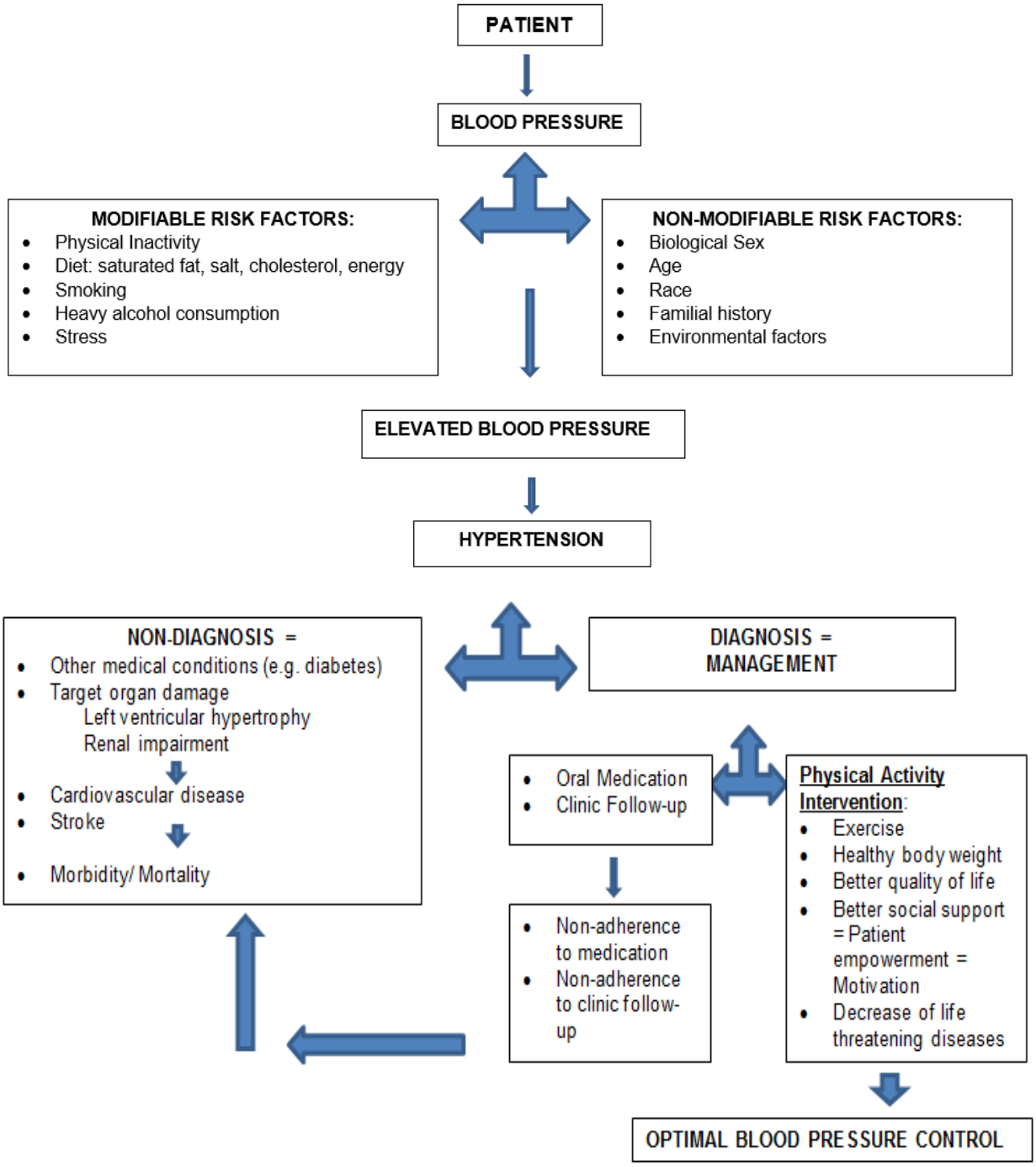

Figure 2.6.1 Conceptual Framework of factors relating to understanding hypertension and optimal management.

The lifelong management of HTN not only diminishes self-motivation but can also contribute to heightened feelings of depression and non-compliance (Indarti, et al. 2020). Notably, a significant correlation exists between self-efficacy and the lifestyle choices of individuals with HTN. Enhanced self-efficacy plays a pivotal role in fostering support and self-motivation toward adopting healthy lifestyles, consequently reducing the occurrence of complications (Amila, 2018). Consequently, individuals with HTN are not only encouraged to lead a healthy lifestyle but are also urged to cultivate self-efficacy and garner support from their families. Additionally, collaborative efforts with health services and other stakeholders, encompassing various elements such as family and society, are crucial in this pursuit (Indarti, et al. 2020).

While high self-efficacy is beneficial, it still necessitates family support to facilitate the seamless execution of daily activities related to self-care, ultimately enhancing the quality of life for individuals dealing with HTN (Indarti, et al. 2020). The adherence to HTN treatment emerges as another vital factor in ensuring the ongoing health and well-being of hypertensive patients (Sianipar, et al. 2020). Adherence serves as a fundamental prerequisite for the effectiveness of HTN therapy, with the most significant potential for improved HTN control lying in the modification of patient behavior (Sianipar, et al. 2020). Complying with a healthy lifestyle not only minimises complications but also significantly enhances the overall quality of life for individuals managing HTN (Indarti, et al. 2020).

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CHAPTER 3 - A SCOPING REVIEW OF PHYSICAL ACTIVITY INTERVENTIONS FOR THE MANAGEMENT OF HYPERTENSION

3.1 INTRODUCTION

Hypertension (HTN) stands as a significant public health epidemic, affecting approximately 4 in 10 adults aged 25 and older, with an additional 1 in 5 grappling with prehypertension. It is projected that a staggering 9 out of 10 individuals reaching the age of 80 will develop HTN (World Health Organisation, 2013). Despite its widespread prevalence, only about 50% of adults with HTN are cognisant of their condition (Campbell, et al. 2014). Shockingly, even with extensive knowledge on prevention and treatment, HTN has maintained its status as the world's leading cause of death for over a decade (Olsen and Spencer, 2015).

For those dealing with HTN, the potential benefits of maintaining a healthy diet, controlling weight, and engaging in regular exercise cannot be overstated (James, et al. 2014). Consequently, individuals with HTN should be encouraged to embark on a light-to-moderate intensity exercise programme without necessarily consulting their doctor (Pescatello, 2014). Physical activity (PA) emerges as a key player in mitigating the risk of mortality, especially for those with HTN who may not be undergoing pharmacotherapy or achieving blood pressure (BP) control. Exercise, as a fundamental lifestyle modification, not only significantly reduces BP but also triggers a countless of additional cardiovascular (CV) benefits (Pagonas, et al. 2014). Moreover, it is advised that training methods serve as an adjunct therapy for maintaining a favorable lipid profile and effectively managing HTN (Lamina, et al. 2012).

Epidemiological studies suggest that regular aerobic PA holds promise for both preventing and treating HTN, as well as lowering CV risk and mortality (Williams, et al. 2018). However, clinicians must carefully consider the intensity-related dose response of aerobic exercise for BP-lowering effects, balancing it against the potentially adverse effects of vigorous exercise when prescribing it for BP reduction (Eicher, et al. 2010). A more individualised approach to exercise intensity prescription may be warranted for those with pre- to stage 1 HTN to optimise the magnitude of BP lowering effects and associated cardiovascular disease (CVD) health benefits (Eicher, et al. 2010). Boutcher and Boutcher

(2017) have reported a greater antihypertensive effect in response to high-intensity exercise compared to lower exercise intensities. For every 10% increase in relative VO2peak, systolic blood pressure (SBP) decreased by 1.5 mmHg, and diastolic blood pressure (DBP) by 0.6 mmHg (Eicher, et al. 2010).

Regarding strength training, a study by Trevizani, et al. (2018) demonstrated that a strength training programme was effective for muscular aerobics and strength gain. It also promoted an acute BP response, with a noticeable decrease in SBP after exercise sessions compared with rest (postexercise hypotension). This provides evidence supporting the use of strength exercise for hypertensive individuals, offering known benefits such as increased quality of life, greater independence, autonomy, lower risk of falls, and improved agility (Cunha and Jardim, 2012). From a CV perspective, it appears safe for pharmacologically treated hypertensives to engage in strength exercises, as there is no immediate increase in BP following strength exercise (Cunha and Jardim, 2012).

When looking at the concurrent PA programme incorporating both aerobic and strength training has been shown to yield significant improvements in anthropometric, hemodynamic, metabolic, and functional parameters, contributing to enhanced overall health in participants (Filho, et al. 2013). The combination of aerobic and strength exercise has been associated with a similar or slightly greater decrease in BP compared to aerobic exercise alone (Sousa, et al. 2013). Ferraria, et al. (2017) demonstrated that concurrent strength and aerobic exercise resulted in significant decreases in both diastolic and mean BP in the first hour following exercise in older patients with essential HTN. Previous research also found that high-intensity interval training three times a week led to greater significant decreases in BP than moderate-intensity continuous training and a control group following a 12-week intervention (Molmen-Hansen, et al. 2011).

3.1.1 Research Question

What are the optimal exercise parameters—type, frequency, duration, intensity, and daily time commitment—for effective hypertension management, based on a broad examination of diverse interventions?

To gain comprehensive insights into specific interventions that have demonstrated efficacy in managing HTN, this research seeks to identify the optimal parameters of exercise, including type, frequency, duration, intensity, and daily time commitment, that contribute to effective HTN management (according to the PICO outcome defined in Table 3.1.1.1). It is essential to note that, unlike a systematic review, a scoping review does not delve into the in-depth critique of research quality typically conducted in systematic reviews (Wright, et al. 2007). Instead, it proves valuable in scrutinising a diverse and heterogeneous literature base, as emphasised by Krekeler, et al. (2021).

Distinguishing itself from a systematic review, a scoping review offers a more encompassing reference guide to the available research evidence concerning exercise interventions and the FITT (Frequency, Intensity, Time, and Type) principles important in HTN management (Krekeler, et al. 2021). Thus, the primary objective of this scoping review is twofold: (a) to systematically map relevant literature, capturing reports on exercise interventions in HTN management, and (b) to identify key characteristics of the FITT principles crucial for designing effective exercise programmes for individuals with HTN.

The study employed the PICO framework to systematically address a well-defined and focused clinical question, as outlined in Table 3.1.1.1. PICO, a structured framework for crafting precise clinical queries, encompasses the following components: Patient or problem; Intervention or exposure; Comparison or control; and Outcome(s) (Huang, et al. 2006; BMJ Best Practice, 2021; Centre for Evidence-Based Medicine, 2021). This framework guided the determination of inclusion criteria, development of the search strategy, data collection, and presentation of findings (Huang, et al. 2006; BMJ Best Practice, 2021; Centre for Evidence-Based Medicine, 2021).

The search strategy employed specific keywords aligned with our predefined inclusion criteria, which encompassed (1) hypertension/ high blood pressure, (2) exercise/ physical activity, (3) intervention/training intervals, (4) Frequency Intensity Time Type, and (5) spanned the period from 2009 to 2020. This systematic approach facilitated a comprehensive exploration of the relevant literature to inform the research objectives.

Table 3.1.1.1 PICO used to clarify and focus research question and outcomes.

P	I	C	O
Population/ Patient/ Problem	**Intervention**	**Comparison or Control**	**Outcome**
• Diagnosed, hypertensives. • Any race • Both men & women. • Adults.	• PA intervention. • Exercise Duration, Frequency, Intensity, Time & Type, to decrease HTN.	• Individual interventions. • Intervention comparing intervention groups with Control groups.	• Primary: decrease in systolic & diastolic BP. • Secondary: decrease in weight loss leading to body mass index (BMI) decrease, decrease in waist-to-hip ratio (WHR), and HR.

3.2 METHOD

3.2.1 Protocol

This study employed a methodologically careful approach to scoping review, following the established guidelines proposed by Levac, et al. (2010) and Arksey and O'Malley, (2005). The aim was to systematically explore the intersection of HTN and PA. The review comprehensively addressed the existing literature pertaining to effective exercise interventions for individuals with HTN. The framework encompassed a meticulous five-step synthesis process: (1) formulating a precise research question, (2) conducting a comprehensive and systematic search to identify relevant studies across a broad comprehensive of potential effectiveness, (3) impartial and objective screening and selection of studies for inclusion, (4) extraction and charting of data based on identified key characteristics, and (5) summarising the findings with a focus on clinical relevance, accompanied by recommendations for future research. All study designs, including qualitative, quantitative, and mixed methods, were considered in this scoping review.

3.2.2 Information Source

A systematic computer-based search was conducted using various reputable databases accessible through the University of the Witwatersrand's LibGuides Electronic Resources, including COCHRANE, EBSCOHost (CINAHL Complete, Global Health, and MEDLINE Complete), ProQuest Health & Medical Complete, PubMed, SA ePublications, ScienceDirect, and SCOPUS. To ensure comprehensive coverage, additional sources (textbooks) were explored to uncover potentially relevant studies related to HTN and PA interventions that might not have been captured in electronic database searches.

Hand-searching involved examining the reference lists of (1) all relevant articles on HTN and PA interventions, (2) all identified 'review' articles, and (3) grey literature (found in the reference lists of approved articles and through Google Scholar). As outlined in the PICO framework, the search terms employed were: (1) hypertension; (2) high blood pressure; (3) exercise; (4) physical activity; (5) intervention; and (6) training intervals, covering the period from January 2009 to August 2020. For reviews addressing exercise interventions for HTN management, restrictions were placed on English language publications only. Global reviews were also examined to identify potential variations in interventions between developed and low- to middle-income countries. Exclusion criteria were applied to papers that did not specifically report HTN intervention outcomes or if the reported outcomes were deemed ineffective for participants. The determination of successful intervention was based on a documented decrease in primary and/or secondary outcomes, with statistical significance further supporting the efficacy of the interventions.

3.3 ETHICAL CONSIDERATIONS

The research design and procedures for this study received approval from the Human Research Ethics Committee (Medical) at the University of the Witwatersrand, with an assigned ethics certificate number (M190442). This approval is integral to the broader Doctor of Philosophy project within the Faculty of Health Sciences.

3.4 DATA EXTRACTION AND ANALYSIS

The search yielded a total of 974 articles, with contributions from various databases: 150 from COCHRANE, 100 from EBSCO (CINAHL Complete, Global Health, and MEDLINE Complete), 145 from ProQuest Health & Medical Complete, 41 from PubMed, 31 from SA

ePublications, 147 from Science Direct, and 17 from SCOPUS. Additionally, 344 articles were handpicked from references. Within this pool of references, a careful screening process excluded 744 articles based on title and abstract criteria that did not align with the inclusion criteria related to HTN and PA. Out of the 121 full-text articles deemed eligible for inclusion, 91 were subsequently excluded due to the absence of five or more criteria (as outlined in the PICO framework and Table 3.1.1.1) necessary for the data extraction of study results. Additionally, some studies were found to be irrelevant to the specific study setting, as illustrated in The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) diagram (Figure 3.4.1). The rigorous screening process involved title and abstract evaluation by two authors (MS and PG), with subsequent independent review of full texts by the same authors, resulting in a consensus without any conflicts.

3.5 DATA CHARTING PROCESS

A sole author (MS) conducted the data charting process using a carefully crafted extraction form, with a subsequent verification of extraction performed by another author (PG). Data exclusively originated from published articles, and efforts were made to ensure accuracy and completeness. In instances where the descriptions of exercise interventions were inadequately detailed, a change was made, whenever feasible, to estimate exercise intensity. This estimation was based on the compendium of exercise energy expenditure (Ainsworth, et al. 2000). It is noteworthy that no attempts were made to contact authors when the published articles did not furnish sufficient information, maintaining a reliance solely on the available published content.

3.5.1 Data Items

The extracted data encompassed a comprehensive set of parameters, including study location, sample size, demographics (sex, race/ethnicity, age group), BP inclusion criteria, HTN medication details, intervention duration, frequency, time, type, and a detailed account of outcomes (refer to Table 3.6.1).

3.5.2 Synthesis of Results

The research employed a 'descriptive-analytical' methodology, utilising a consistent analytical framework as proposed by Arksey and O'Malley, (2005). Physical activity

interventions inherently exhibit variation in dosage, with the combination of intensity (categorised as light, moderate, or vigorous) and duration (expressed in minutes per week) influencing both individual sessions and the overall intervention dosage. Given the inherent heterogeneity in the durations of interventions and the significant impact of PA intensity on effectiveness and sustainability, our emphasis was directed towards interventions that demonstrated successful outcomes.

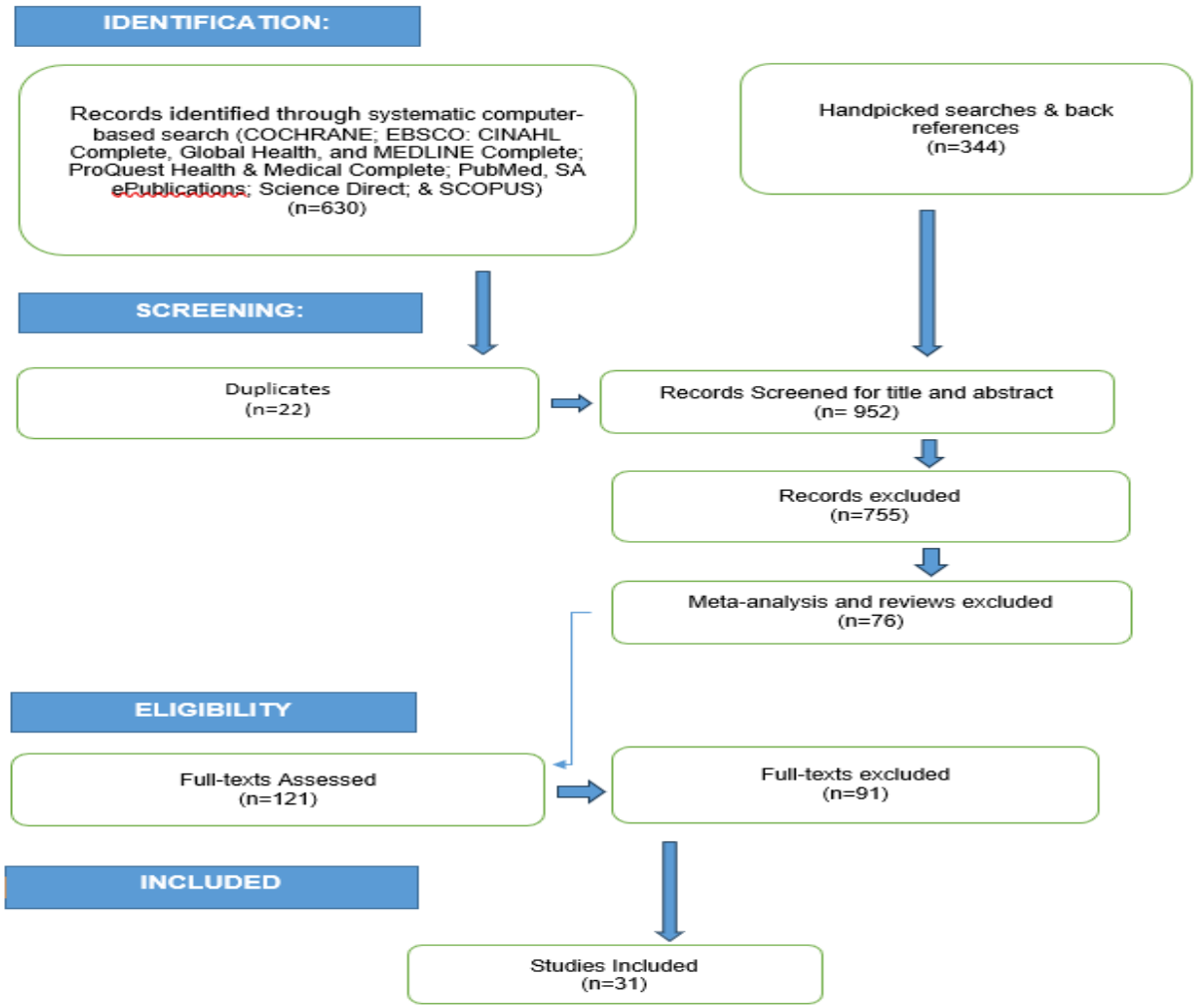

Figure 3.4.1 PRISMA Flow Diagram

3.6 RESULTS

The outcomes of our systematic exploration yielded 31 randomised controlled/experimental studies meeting the meticulous inclusion criteria, which encompassed study design, location, sample size, demographic factors (sex and

race/ethnicity), BP inclusion, consideration of BP medication, intervention characteristics (duration, frequency, intensity, time, and type), as detailed in Table 3.6.1. These studies are organised chronologically, from the earliest to the most recent exercise interventions.

Further refinement led to the exclusion of 22 studies that did not present one or more outcome inclusions. Subsequently, we switch our focus to clarify successful interventions, totaling nine, outlined in Table 3.6.2. These successful interventions encompassed both primary and at least one of the secondary outcomes. Additionally, we categorised and summarised these successful interventions based on the type of exercise, as demonstrated in Table 3.6.3. These discernments form the foundation of our conclusions regarding the efficacy of various PA interventions in managing HTN. Comparative analyses between aerobic interventions (Table 3.6.4) and anaerobic interventions (Table 3.6.5) are further explained in Appendix T, providing a comprehensive overview of our research findings.

3.6.1 Type of Exercise Intervention

3.6.1.1 Aerobic Training

In the study by Knoepfli-Lenzin, et al. (2010), the investigation sought to discern the effects of football versus running training in individuals with mild HTN, considering metabolic risk factors such as elevated BMI (>25 kg/m2) and high blood lipid concentrations. The study involved two groups: one trained outdoors under natural weather conditions, and the other trained with running speed corresponding to 80% of HRmax (±4bpm). A third control group (CG) maintained a sedentary lifestyle. The 12-week football training programme demonstrated positive effects on the health profile in habitually active men with mild HTN. Notably, DBP in the football group decreased compared to the CG. Both intervention and CG exhibited reductions in SBP and DBP after the intervention period. However, the football group showed a significant decrease in DBP compared to the CG. Heart rate and mean arterial pressure also demonstrated favorable changes in the football group.

In the randomised control trial conducted by Aminuddin, et al. (2011), aimed at determining the effects of moderate aerobic exercise training on submaximal and maximal exercise BP and 24-hour Ambulatory Blood Pressure Monitoring (ABPM) in women with elevated BP not on medication, improvements were observed as early as four weeks.

Both intervention group (IG) and CG exhibited overall significant changes in resting SBP at 8 weeks. However, pair-wise comparisons revealed that the significant changes occurred between 0 and 4 weeks. Submaximal exercise SBP at 4 weeks showed a significant decrease in the IG compared to an increment in the CG. Maximal exercise SBP exhibited significant decreases at 8 weeks in both groups. Heart rate peak and total exercise time also showed significant improvements in both groups.

Gorostegi-Anduaga, et al. (2018) implemented a lifestyle intervention involving caloric restriction and exercise to assess changes in BP, body composition, cardiorespiratory fitness, and pharmacological treatment across three different exercise interventions (high volume moderate-intensity continuous training, high-volume high-intensity interval training, low-volume high-intensity interval training), combined with a hypocaloric diet. The 16-week intervention resulted in significant improvements in CV risk factors for all groups, leading to a substantial decrease or complete removal of pharmacological therapy. The high-volume high-intensity interval training group demonstrated greater reductions in body mass and BMI compared to the low-volume high-intensity interval training group. However, there were no significant between-group differences observed for WHR. These findings suggest that supervised aerobic exercise and non-supervised PA recommendations can serve as effective nonpharmacological tools in HTN management.

3.6.1.2 Interval Training

In the study by Molmen-Hansen, et al. (2011), the objective was to assess the impact of Aerobic Interval Training (AIT) (exceeding 90% of HRmax) in comparison to isocaloric Moderate Intensity Training (MIT) (approximately 70% of HRmax) on BP reduction and myocardial function in patients with mild to moderate essential HTN. The CG received standard recommendations for essential HTN patients, involving regular light-moderate intensity exercise (Graham, et al. 2007) without supervision. The 12-week intervention revealed that both AIT and MIT groups exhibited a significant decrease in systolic 24-hour ABP during the daytime. Notably, AIT demonstrated a more substantial reduction in systolic ABP at night compared to MIT and the CG. Diastolic ABP also decreased significantly in both AIT and MIT groups, with AIT showing a more pronounced effect. Body mass index decreased in both AIT and MIT groups, whereas no significant changes were observed in the CG. In the AIT group, 28% of subjects experienced a decrease in

systolic ABP greater than 15 mmHg, while 36% exhibited a decrease between 5–15 mmHg. Approximately 24% of subjects in the AIT group achieved normotensive values. However, only one person in the MIT group and one in the CG attained normotensive values after the study period. Aerobic Interval Training also resulted in a decrease in mean HR, with significant reductions in HR mean during day- and night-time.

Conversely, a study by Dimeo, et al. (2012) explored the hypothesis that an aerobic exercise programme could reduce BP in resistant HTN. The training programme involved walking on a treadmill with an interval-training pattern, targeting a lactate concentration slightly above the aerobic threshold. This exercise programme significantly lowered both SBP and DBP at rest. Daytime systolic and diastolic ABPs exhibited significant decreases, as did 24-hour systolic and diastolic ABPs. The exercise programme also led to a significant increase in the mean maximal workload level, indicating improved CV fitness. These findings suggest that specific aerobic training interventions, tailored to intensity and duration, can effectively impact BP in individuals with HTN.

3.6.1.3 Strength and Concurrent Training

The study conducted by Barone, et al. (2009) sought to elucidate the impact of a 6-month aerobic and strength training intervention on exercise BP. Subsequent to the intervention, participants exhibited a noteworthy reduction in resting diastolic BP compared to the CG. Moreover, those engaged in the exercise programme demonstrated significant enhancements in maximum exercise SBP, VO2peak, and stages completed in the graded exercise test (GXT) in comparison to the CG. The reduction in weight, BMI, and waist circumference within the IG was significantly associated with lower SBP. The graded exercise test stages 1–5, corresponding to approximately 4, 4.5, 5, 6, and 7 METS respectively, showcased significant decreases in SBP at stages 2, 3, 4, and 5 for IG as opposed to CG, where the decrease was observed only at stage 2. Notably, the 6-month change in exercise systolic BP exhibited significant differences between IG and CG, particularly at stages 3 ($p = 0.03$) and 4 ($p = 0.03$). While DBP decreased significantly among exercisers at stages 1–5, no significant differences were noted between the groups.

In the investigation by Filho, et al. (2013), the unique population examined participated in a combined stretching, balance, and aerobic and strength prescription of exercise programme. This comprehensive exercise programme resulted in notable improvements in various health markers and functional autonomy among elderly women. The IG exhibited significant reductions in both SBP and DBP, while the CG experienced a reduction only in SBP. The training intervention not only decreased SBP by 6% but also led to improvements in cardiorespiratory fitness (+42%), flexibility (+11%), and a reduction in plasma glucose (-4%). The study demonstrated substantial enhancements in blood lipids, blood glucose, BP, BMI, and functional autonomy after a 16-week combined exercise programme. Remarkably, the BMI in the IG decreased from 29.0 ± 5.2 to 28.4 ± 5.1 kg/m2, while the BMI in the CG remained unchanged (29.3 ± 4.2 to 29.3 ± 4.3 kg/m2) over the 16 weeks.

Masroor, et al. (2018) explored the combined effects of aerobic and strength training on cardiac autonomic control in middle-aged, sedentary, hypertensive women. The study employed a 2x2 mixed model ANOVA, revealing significant interaction effects for weight, BMI, resting HR, and DBP. These findings underscored greater improvements in the combined aerobic and strength training group relative to the CG. Subsequent analysis using ANCOVA, with the pre-training value as a covariate, identified significant differences in SBP between the two groups at baseline, emphasising the main effects for both group and interaction ($p < 0.001$).

Caminiti, et al. (2019) undertook a comparative assessment of the acute effects of a single bout of three different exercise modalities on short-term BP variability. The study's primary endpoint was the comparative changes in 24-hour SBP variability, with secondary endpoints including alterations in daytime and nighttime SBP variability and 24-hour DBP variability. Notably, the 24-hour SBP variability increased in the IG, remained unchanged in the aerobic continuous training group, and decreased in the CG (intergroup $p = 0.03$). Furthermore, the 24-hour DBP variability decreased in the aerobic continuous training and combined training groups, while increasing in the IG (intergroup $p = 0.002$). Daytime SBP variability increased in the interval training and aerobic continuous training groups but decreased in the combined training group (intergroup $p = 0.0006$). Conversely, nighttime SBP variability exhibited a slight decrease in the aerobic continuous training and

combined training groups, while increasing in the interval training group. These findings shed light on the diverse acute effects of different exercise modalities on short-term BPvariability.

3.6.2 Dose of Exercise

The exercise dose components are systematically presented and discussed herein, organised by exercise type, with detailed information available in Table 3.6.3 and Appendices T (Tables 3.6.4 and 3.6.5). Duration, a key parameter mandated by the inclusion criteria, exhibited noteworthy variations across the diverse exercise programmes looked at in this review. Combination exercise programmes, for instance, extended up to a substantial 24 weeks (Barone, et al. 2009). Aerobic interventions manifested durations ranging from a minimum of 8 weeks (Aminuddin, et al. 2011; Dimeo, et al. 2012) to 16 weeks as observed in studies by Knoepfli-Lenzin, et al. (2010), Molmen-Hansen, et al. (2011), and Gorostegi-Anduaga, et al. (2018). Concurrent exercise interventions exhibited a variable duration, spanning from 1 to 24 weeks (Barone, et al. 2009; Filho, et al. 2013; Masroor, et al. 2018; Caminiti, et al. 2019). Notably, unsuccessful interventions predominantly featured programmes lasting less than 4 weeks, as elucidated in Table 3.6.1.

Frequency, a fundamental aspect detailed in all examined exercise programmes, exhibited considerable diversity, ranging from 5 days/week to 2 days/week. Aerobic exercise interventions consistently featured frequencies of 2–3 days/week, with a preference for 3 days/week (refer to Table 3.6.4). Concurrent and strength interventions, conversely, embraced frequencies of 3 days/week up to 5 days/week (refer to Table 3.6.5). Unsuccessful interventions displayed substantial variability, spanning from 1 day/week to 7 days/week, contingent upon the specific program (refer to Table 3.6.1).

Intensity, predominantly expressed in percentages relative to metrics such as HRM, HRR, VO2max, and 1RM, exhibited notable variability (refer to Table 3.6.1). Unsuccessful interventions mirrored the trends observed in successful interventions, yet some delineated intensity in terms of METs. Successful interventions documented intensity levels ranging from 50% to 90% in aerobic interventions (Table 3.6.4), while concurrent and strength interventions exhibited analogous trends, reaching up to 95% (Table 3.6.5).

Time, another integral component detailed in all exercise intervention programmes, showcased variability across aerobic interventions, spanning from 20 to 60 minutes per session (refer to Table 3.6.4). Concurrent and strength exercise interventions mirrored these patterns, with durations ranging from 20 minutes to 70 minutes in certain concurrent interventions (refer to Table 3.6.5). Conversely, unsuccessful interventions featured exercise durations of up to 80 minutes per day, with the majority falling below the 30-minute threshold per session (refer to Table 3.6.1).

Table 3.6.1 Summary of articles included in the scoping review (n=31)

Author & Year	Study Design	Study Location	Sample Size (n)	Sex	Race/ Ethnicity	Age Group	BP Inclusion	HTN Medication	Duration	Frequency	Intensity	Time	Type	Outcomes
Barone, et al. 2009	Randomised controlled trial	United States	115	Men & Women	Not specified	55–75 years	130–159/ 80–99 mmHg	Yes	24 weeks	Not specified	Aerobic: 60–90% HR max; Strength: 50% 1RM	60 Min	Concurrent: Aerobic/ Strength	Decrease in SBP, DBP, HR, BMI & WHR
Mota, et al. 2009	Randomised controlled trial	Brazil	15	Men & Women	Not specified	42.9±1.6 years	140-159/ 90-99 mmHg	Yes	1 week	1 day	40% of 1RM/ 70 –80% HRR	20/ 20 Min	Concurrent: submaximal strength/ Aerobic	Decrease in SBP & DBP
Saptharishi, et al. 2009	Randomised controlled trial	India	113	Men & Women	Not specified	20-25 years	120-139/ 80-89 mmHg	Not specified	8 weeks	4-5 days/ week	Not specified	30-60 min	Aerobic: Aerobic & Flexibility	Physical activity was more effective in reducing SBP & DBP.
Eicher, et al. 2010	Experiemental	Not specified	45	Men	White	18-55 years	≥160/ 100mmHg	Discontinued	1 week	1 day	40%/ 60%/ 100% VO^2max	40 Min	Aerobic	Decrease in SBP & DBP
Guimarães, et al. 2010	Randomised controlled trial	Not specified	65	Men & Women	Not specified	45-50 years	<140/ 90 mmHg	Yes	16 weeks	3 days/ week	50-80% HRR	80 Min	Continuous; Interval	No change in SBP, DBP, HR, BMI & WHR
Knoepfli-Lenzin, et al. 2010	Randomised control trial	Switzerland	32	Men	Not specified	20-45 years	120–150/ 80-95 mmHg	No	12 weeks	2.5 days/ week	80% HRM	60 min	Aerobic	Decrease in SBP, DBP & HR
Aminuddin, et al. 2011	Randomised control trial	Malaysia	6	Women	Not specified	35-60 years	SBP 130-160 mmHg	No	8 weeks	3 days/ week	50-70% HRR	30-45 min	Aerobic	Decrease in resting SBP in both groups & HR changes in intervention

														group. No changes in DBP
Molmen-Hanse, et al. 2011	Randomised trial	Norway	88	Men & Women	Not specified	<65 years	140-179/ 90-109 mmHg	No	12 weeks	3 days/ week	60-90% / 60-70% VO^2max	38/ 47 Min	AIT/ MIT	Decrease in SBP, DBP, HR & BMI
Park, et al. 2011	Randomised controlled trial	Ireland	45	Women	White	≥65 years	≥130/ 85 mmHg	Yes	12 weeks	2 day/ week	Thera-bands (red)	50 Min	Strength	Decrease in SBP & DBP
Subramanian, et al. 2011	Cross-over randomised controlled trial	India	98	Men & Women	Not specified	21-25 years	126-132/ 78-81 mmHg	Not specified	8 weeks	3-5 days/ week	Not specified	30-60 min	Aerobic and flexibility	Significant decrease in SBP & DBP in all 3 groups
Scher, et al. 2011	Experiemental	Brazil	16	Men & Women	Not specified	≥60 years	130±15/ 76±8mmHg	Yes	1 week	7 days	40% 1RM	60 Min	Strength	No significant change to SBP & DBP
Cunha, et al. 2012	Controlled crossover clinical trial	Brazil	16	Women	Not specified	60-70 years	≤160/ 100mmHg	Yes	1 week	1 day	Water sessions	40 Min	Aerobic	Decrease in SBP & DBP
Cunha & Jardim, 2012	Controlled clinical trial	Brazil	30	Women	Not specified	60-80 years	≤160/ 100mmHg	Yes	1 week	3 days	10RM	45 Min	Strength	No significant change to SBP & DBP
Dimeo, et al. 2012	Randomised controlled trial	Not specified	50	Men & Women	White	42-78 years	≥180mm Hg (SBP)	Yes	8-12 weeks	3 days/ week	15-point Borg scale ranging from 6 to 20: with "6" corresponding with a "very, very light effort" and "20"	20-30 Min	Aerobic/ Interval-training	Decrease in daytime, 24h and BP on exertion in both SBP & DBP. HR only AIT & both AIT & MIT: decrease in BMI. No change in BMI & WHR.

											corresponding with "exhaustion. A target lactate concentration of 2.0±0.5 mmol/L in capillary blood slightly above the aerobic threshold.			
Lamina & Okoye, 2012	Randomised controlled trial	Nigeria	245	Men	Not specified	50-70 years	140-180/90-109 mmHg	Yes	8 weeks	3 days/ week	60–79% HRM	60 min	Interval	Significant decrease in SBP & DBP
Filho, et al. 2013	Experiemental	Brazil	54	Women	Not specified	68.9±6.8 years	145.3±14.3/ 95.8±8.6 mmHg	Not specified	16 weeks	3 days/ week	3-5 OMNI-RES Scale (goal of 3-5 intensity level)	60-70 Min	Concurrent training	Decrease in SBP, DBP & BMI
Arca, et al. 2014	Interventional randomised controlled trial	Brazil	52	Women	Not specified	64 ± 7.0 years	140-179/ 90-109 mmHg	Yes	12 weeks	3 days/ week	Minus 17 heart beats for aquatic exercise to obtain VO^2max as dry land/ 50-	50 Min	Water aerobics/ dry land aerobic	Decrease in SBP and no changes to DBP

Mohr, et al.2014	Randomised controlled trial	United Kingdom	62	Women	Not specified	35-48 years	Not specified	Yes	15 weeks	2.5–3.3 days/ week	60% HRR High intensity	15-25 min	Aerobic	HIT & MOD SBP decreased, DBP remained similar for both HIT & MOD
Pagonas, et al. 2014	Parallel group randomised controlled trial	Germany	72	Men & Women	Not specified	42-79 years	≥140/ 90mmHg	Yes	8-12 weeks	3 days/ week	Not specified	15-36 Min	Aerobic	Significant decrease of daytime SBP & DBP
Bashiri, 2015	Semi-experimental study	Iran	36	Men	Not specified	20-30 years	Not specified	Yes	4 weeks	4 days/ week	60-75% HRM	30-45 min	Aerobic	Intragroup analysis showed that SBP and DBP significantly decreased in both Training placebo and garlic group
Ferrari, et al. 2017	Randomised crossover trial	Brazil	20	Men	Not specified	60-70 years	Increase from test <60/ 110mmHg	Not specified	1 week	2 days	65–70% VO^2max/ 30-40% 1RM & 65–70% VO^2max	45/ 20 & 25 Min	Aerobic exercise/ Concurrent strength & aerobic exercise	Decrease in SBP & DBP
Arija, et al. 2018	Randomised clinical trial	Spain	207	Men & Women	Not specified	67.4 (6.6)-70.1 (9.3)	Not specified	Yes	36 weeks	2 days/ week	396 METs/min/week	60 Min	Aerobic	Decrease in SBP. No decrease in BMI & WHI
Cordeiro, et al. 2018	Controlled trial	Brazil	16	Men & Women	Not specified	64.9±1.4-70.8±2.7	116.3±1.2-139.9±3.5/ 69.3±2.6-	Yes	1 week, 3 days	10 days	60–70% HRR	50 min	Concurrent Exercise	Decrease in SBP & MAP, but not DBP

Gorostegi-Anduaga, et al. 2018	Multi-arm parallel randomised, single-blind controlled experimental trial	Spain	167	Men & Women	White	53.7±7.8 years	81.9±3.2 mmHg ≥140/90 mmHg	Not specified	16 weeks	2 days/ week	Moderate to High	20-45 min	Aerobic	SBP was significantly improved
Gorostegi-Anduag, et al. 2018	Multi-arm parallel randomised, single-blind controlled experimental trial	Spain	175	Men & Women	White	54±8.2 years	140–179/ 90–109 mmHg	Yes	16 weeks	2 days/ week	High volume moderate intensity continuous training: 65% VO2max; High volume HIIT: 90% VO2max; low volume: <65 VO2max	55 min	Aerobic	Decrease in resting and mean on both SBP & DBP. Decrease in HR, only high-volume HITT group decrease in BMI
Masroor, et al. 2018	Randomiased control trial	India	28	Women	Indian	30-50 years	Not specified	Yes	4 weeks	5 days/ week	50–80% Hrmax & 50-80% 1RM	20 Min	Concurrent: aerobic and strength training	Decrease in SBP, DBP, HR, BMI & WHR
Rasmussen, et al. 2018	Randomised cross-over trial	Denmark	22	Women	Not specified	18-65 years	≤160/100 mmHg	Not specified	1 week	1 day	81.4% HRM	30 min	Aerobic	Significant decrease in SBP & DBP
Trevizani, et al. 2018	Experiemental	Brazil	31	Men	Not specified	≥50 years	Not specified	Yes	4 weeks	3 days/ week	50-55% 1RM	Not specified	Strength	Significant differences in SBP in groups, no

														changes in DBP between groups
Vale, et al. 2018	Randomised crossover design clinical trial	Brazil	15	Women	Not specified	45–69 years	Not specified	Yes	Not specified	Not specified	6 & 15RM	12-15 Reps	Strength	Increase in SBP. DBP, & HR immediately following exercise
Caminiti, et al. 2019	Randomised controlled trial	Not specified	21	Men	Not specified	63±7.2 years	<160/ 100 mmHg	Yes	1 week	3 days/ week	ACT: 55-7% VO2; IT: 80-95% VO2; Combined Training: 55-70%	ACT: 60 Min; IT: 3: 15 mins; CT: treadmill @ 30 mins & 10 reps @ 30 mins	Aerobic Continuous / Interval/ Concurrent	Twenty-four-hour systolic BP variability decreased in the CT group. Daytime systolic BP variability decreased in the CT group. Twenty-four-hour diastolic BP variability decreased in the ACT and CT groups while it increased in the IT group.
Ruangthai & Phoemsapthawee, 2019	Randomised controlled trial	Thailand	54	Men & Women	Not specified	≥60 years	≥130/ 80 mmHg	Yes	12 weeks	3 days/ week	50-70% HR max/ 50-80% 1RM/ 50-70 HR max & 50-80 1RM	60 Min	Aerobic/ strength/ concurrent aerobic and strength	Decrease in SBP & DBP. No change in HR, BMI, WHR

Table 3.6.2 Summary of successful Interventions Demographics (n=9)

Author & Year	Study Design	Study Location	Sample Size (n)	Sex	Race/ Ethnicity	Age Group	BP Inclusion	HTN Medication	Control Group included?
Barone, et al. 2009	Randomised controlled trial	United States	115	Men & Women	Not specified	55–75 years	130–159/ 80–99 mmHg	Yes	Yes (only given written exercise guidelines from the National Institute of Aging)
Knoepfli-Lenzin, et al. 2010	Randomised control trial	Switzerland	32	Men	Not specified	20-45 years	120–150/ 80-95 mmHg	No	Yes (No Exercise)
Aminuddin, et al. 2011	Randomised control trial	Malaysia	6	Women	Not specified	35-60 years	SBP 130-160 mmHg	No	Yes (No Exercise)
Molmen-Hanse, et al. 2011	Randomised trial	Norway	88	Men & Women	Not specified	<65 years	140-179/ 90-109 mmHg	No	Yes (Standard recommendation for patients with essential HTN)
Dimeo, et al. 2012	Randomised controlled trial	Not specified	50	Men & Women	White	42-78 years	≥180mm Hg (SBP)	Yes	No
Filho, et al. 2013	Experiemental	Brazil	54	Women	Not specified	68.9±6.8 years	145.3±14.3/ 95.8±8.6 mmHg	Not specified	Yes (No Exercise)
Gorostegi-Anduag, et al. 2018	Multi-arm parallel randomised, single-blind controlled experimental trial	Spain	175	Men & Women	White	54±8.2 years	140–179/ 90–109 mmHg	Yes	Yes (The only group that received the standard guidelines for PA)
Masroor, et al. 2018	Randomised control trial	India	28	Women	Indian	30-50 years	Not specified	Yes	Yes (No Exercise)
Caminiti, et al. 2019	Randomised controlled trial	Not specified	21	Men	Not specified	63±7.2 years	<160/ 100 mmHg	Yes	No (No exercise)

Table 3.6.3 Summary of successful Interventions outcomes primary and secondary outcomes (n=9)

Author & Year	Duration	Frequency	Intensity	Time	Type	Exercise	Statistically Significance	Primary Outcomes	Secondary Outcomes
Barone, et al. 2009	24 weeks	Not specified	Aerobic: 60–90% HR max; Strength: 50% 1RM	60 Mins	Concurrent: Aerobic/ Strength	Aerobic: not specified (but at a target HR); Strength: 7 weight training (latisissimus dorsi pull down, leg extension, leg curl, bench press, leg press, shoulder press and seated mid-rowing)	Yes (p = 0.03)	Decrease in SBP & DBP.	Decrease in HR, BMI & WHR
Knoepfli-Lenzin, et al. 2010	12 weeks	2.5 days/ week	80% HRM	60 min	Aerobic	Either outdoor on a natural or an artificial grass field or indoor in a gym, depending on the weather conditions.	Yes (p = 0.001)	Decrease in SBP & DBP.	Decrease in HR
Aminuddin, et al. 2011	8 weeks	3 days/ week	50-70% HRR	30-45 min	Aerobic	Treadmill	Yes (p <0.01)	Significant changes in resting SBP in both groups & no significant changes in DBP	Decrease in HR in intervention group.
Molmen-Hanse, et al. 2011	12 weeks	3 days/ week	AIM: 85-90% VO2max; MIT: 60-70% VO2max	38/ 47 Min	AIM: 38 Mins; MIT 47 Mins	AIM & MIT: walking/ running uphill on a treadmill	Yes (p <0.001)	decrease AIT & MIT in both SBP & DBP.	HR only AIT & both AIT & MIT: decrease in BMI
Dimeo, et al. 2012	8-12 weeks	3 days/ week	15-point Borg scale ranging from 6 to 20: with “6” corresponding with a “very, very light effort” and “20” corresponding with “exhaustion. A target lactate concentration of	20-30 Min	Aerobic/ Interval-training	The training programme, consisting of walking on a treadmill according to an interval-training pattern, was carried out 3 times weekly for 8 to 12 weeks.	Yes (p <0.01)	Decrease in daytime, 24h and BP on exertion in both SBP & DBP.	No change in BMI & WHR.

			2.0±0.5 mmol/L in capillary bloodslightly above the aerobic threshold.						
Filho, et al. 2013	16 weeks	3 days/ week	3-5 OMNI-RES Scale (goal of 3-5 intensity level)	60-70 Min	Concurrent training	Walking, strength, stretching and balance	Yes (p = <0.05)	Decrease in SBP & DBP.	Decrease in BMI
Gorostegi-Anduag, et al. 2018	16 weeks	2 days/ week	High volume moderate intensity continous training: 65% VO2max; High volume HIIT: 90% VO2max; low volume: <65 VO2max	55 min	Aerobic	All groups Treadmill and Bike	Yes (p = 0.011)	Decrease in resting and mean on both SBP & DBP.	Decrease in HR, only high-volume HITT group decrease in BMI
Masroor, et al. 2018	4 weeks	5 days/ week	50–80% Hrmax & 50-80% 1RM	20 Min	Concurrent: aerobic and strength training	Aerobic: Treadmill; Strength sets of 10 repetitions of 5 exercises: bicep curls, triceps extensions, abdominal crunches, leg curls, and knee extensions	Yes (p = <0.001)	Decrease in SBP & DBP.	Decrease in HR, BMI & WHR
Caminiti, et al. 2019	1 week	3 days/ week	ACT: 55-7% VO2; IT: 80-95% VO2; Combined Training: 55-70%	ACT: 60 Min; IT: 3: 15 mins; CT: treadmill @ 30 mins & 10 reps @ 30 mins	Aerobic Continuous/ Interval/ Concurrent	Aerobic Continous: Walk on treadmill; Interval: 3 peaks of high-intensity exercise, each one lasting 5 minutes at 80–95% of VO2 spaced by three intervals of low-intensity exercise each; Combined: treadmill & strength exercises (arms & legs; 10 reps @ 30% of maximal muscle strength)	Yes (p = 0.002)	Twenty-four-hour systolic BP variability decreased in the CT group. Daytime systolic BP variability decreased in the CT group. Twenty-four-hour diastolic BP variability decreased in the ACT and CT groups while it	None

increased in the IT group.

3.7 DISCUSSION

This scoping review examined the specific PA interventions tailored to manage HTN in hypertensive patients. The exploration encompasses the diverse effects of PA interventions, considering exercise modalities, intensity, and frequency, with a goal to bridge the gap between research findings and clinical implementation. A comprehensive search identified and scrutinised 31 articles, yielding 9 notably successful interventions based on the PICO outcomes outlined in Table 3.1.1.1, further categorised into 5 successful aerobic interventions and 4 successful concurrent interventions (comprising combined aerobic and strength training).

To fulfill the objectives of this review, we provided a comprehensive overview of articles incorporating two or more components of the FITT principle, including exercise duration. The findings explain that distinct exercise modalities induce varying changes in BP variability, while concurrently resulting in similar BP value reductions (Caminiti, et al. 2019). Successful interventions typically employed an average frequency of 3 days/week for 8 to 12 weeks, both in aerobic (Aminuddin, et al. 2011; Molmen-Hanse, et al. 2011; Dimeo, et al. 2012) and concurrent interventions (Caminiti, et al. 2019; Filho, et al. 2013). Conversely, unsuccessful interventions exhibited considerable variability, ranging from 1 day/week for a one-week duration (Mota, et al. 2009; Eicher, et al. 2010; Cunha, et al. 2012; Rasmussen, et al. 2018) to 3 to 7 days/week, lasting 1 to 8 weeks (Saptharishi, et al. 2009; Scher, et al. 2011; Subramanian, et al. 2011; Lamina and Okoye, 2012).

In terms of intensity, exercising caution is paramount when prescribing for individuals with high BP (Eicher, et al. 2010). A personalised approach to exercise intensity is warranted for those with pre- to stage 1 HTN, considering clinical characteristics and intensity dose (Ma, et al. 2018). The intensity-dependent impact on BP was emphasised by Molmen-Hansen, et al. (2011), while Gorostegi-Anduaga, et al. (2018) demonstrated varied effects based on exercise interventions. Notably, an intensity of >50% in both aerobic and strength exercises yielded positive outcomes in all successful interventions (refer to Appendix T).

The review identified a dose–response curve regarding volume and intensity, indicating that high-volume high-intensity interval training provides greater reductions in body mass compared with low-volume high-intensity interval training (Gorostegi-Anduaga, et al. 2018). Furthermore, high-intensity aerobic training significantly reduced systolic and diastolic ABP compared with moderate continuous training (Molmen-Hansen, et al. 2011). The collective findings suggest that an intensity of >50% (VO2, HRmax & 1RM) induces positive physiological changes, resulting in decreased SBP and DBP through vasodilation, thereby aiding in managing HTN.

The duration of each exercise session followed a consistent trend of >30 minutes for both aerobic and concurrent exercises in successful interventions, aligning with recommendations in the ESC/ESH Guidelines for HTN management (Williams, et al. 2018). However, the review underscores the need to consider frequency and duration in tandem to achieve positive and significant effects on hypertensive patients.

Aerobic exercise emerges as a gold standard for reducing BP, even in patients with well-controlled BP, emphasising its effectiveness in post-exercise BP reduction (Ferraria, et al. 2017). The benefits extend beyond BP reduction, encompassing a spectrum of cardiovascular risk factors (Dimeo, et al. 2012). In contrast, unsuccessful strength and concurrent exercises underscore the importance of considering antihypertensive treatment in mitigating acute hypertensive responses during strength exercises (Cunha, et al. 2012). The residual fatigue from high-intensity strength exercises may impact post-exercise hypotension, potentially diminishing the benefits of continuous aerobic exercise (Ferraria, et al. 2017).

Combining exercises emerges as a favorable nonpharmacological treatment for HTN, offering an economically viable solution (Mota, et al. 2009). The study by Jones, et al. (2010) introduces a novel approach, combining deep, slow breathing with inspiratory load during exercise, demonstrating its efficacy in reducing BP. Controlled slow breathing, when incorporated with exercise, resulted in significant decreases in SBP, DBP, pulse pressure, and HR (Jones, et al. 2010).

3.8 STRENGTHS AND LIMITATIONS

While this scoping review carefully examined a substantial and promising body of research on PA interventions for HTN, it is essential to acknowledge potential limitations. Despite the comprehensive inclusion of studies, the review might have overlooked certain interventions, such as those absent in the grey literature search or those lacking sufficient details regarding exercise methodologies. The focus of this review was primarily on specific outcomes, characterise primary and secondary outcomes, rather than offering a holistic perspective on the comprehensive management of HTN. Additionally, the review did not consider studies that might have restricted participants with a higher prevalence of HTN diagnosis from engaging in PA interventions.

It is noteworthy that the design and reporting of human participant research adhered to established standards, ensuring the provision of ample details for result replication. Key aspects, including study selection, intervention protocols, outcome assessments, rationale for their selection, sample size, statistical methods, and, when applicable, the use of blinding and randomisation, were clarified following the guidelines set forth by Schulz, et al. (2010). These guidelines are elaborately described in PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analysis.

Furthermore, this review not only elucidated the circumstances under which PA programmes can be prescribed across diverse settings but also underscored their potential positive impact on HTN management. By navigating through these clarifications, this review contributes to a refined understanding of the complicated relationship between prescribed PA and its favorable effects on HTN management.

3.9 CONCLUSION

This scoping review not only reaffirms the important role of PA in assisting hypertensive patients in managing their HTN but also outlines valuable insights. The findings suggest that an aerobic exercise programme in isolation can yield comparable results to a combined exercise programme, fostering an overall positive impact with a concurrent

reduction in both SBP and DBP. Additionally, these interventions manifest physiological enhancements, including a reduction in BMI, and WHR.

In line with established recommendations and consistent with the observations in this review, successful HTN management is associated with engaging in PA for a minimum of 2 or more days per week, spanning a duration exceeding 4 weeks, at an intensity surpassing 50% of various parameters such as VO2, HRmax, and 1RM. The review underscores the significance of PA sessions lasting longer than 20 minutes to achieve optimal benefits. Consequently, it is advised that a concurrent exercise programme, incorporating both aerobic and strength training components, be adopted as a strategy for effective HTN management.

Aerobic exercise is highlighted for its positive impact on cardiovascular physiology and efficiency, while strength exercises contribute to overall fitness by enhancing muscle strength and metabolism. This dual approach aids in improving the patient's ability to perform daily activities, enhances calorie expenditure, and ultimately elevates the overall quality of life for individuals managing HTN.

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CHAPTER 4 - THE EFFECT OF AN EXERCISE INTERVENTION IN MANAGING HYPERTENSION

4.1 INTRODUCTION

Hypertension (HTN) stands as the most prevalent outpatient medical condition, yet its treatment remains suboptimal (Gil-Guillén, et al. 2010; Huebschmann, et al. 2012). Recognised as a potentially preventable threat to well-being of an individual (Campbell, et al. 2014), HTN is among the five leading risk factors for cardiovascular disease (CVD), along with tobacco use, high blood glucose, physical inactivity, and overweight/obesity (World Health Organisation (WHO), 2011). Hypertension emerges as a substantial risk factor for both haemorrhagic and ischaemic strokes, as well as recurrent strokes (Williams, et al. 2018). Elevated systolic blood pressure (SBP) primarily contributes to HTN across the age span, with diastolic blood pressure (DBP) elevations and isolated diastolic HTN also observed (Sundstrom, et al. 2015). The prevalence of isolated systolic HTN in the elderly is explained by progressive arterial stiffening, leading to a continuous increase in SBP throughout adult life, while DBP plateaus in the sixth decade and decreases thereafter (Fagard and Cornelissen, 2007).

A direct and linear correlation exists between weight loss and reductions in blood pressure (BP), tied to the decrease in visceral fat mass (Sayarliogl, 2013). Conversely, an increase in visceral adipose tissue correlates with elevated BP due to heightened protein, calorie, and carbohydrate intake, along with increased plasma catecholamines, sympathetic nervous system activity, and insulin secretion (Sayarliogl, 2013). Weight reduction is recommended in overweight and obese hypertensive patients to control metabolic risk factors, potentially enhancing the efficacy of antihypertensive medications, and improving the cardiovascular (CV) risk profile (Williams, et al. 2018).

While the optimal body mass index (BMI) is unclear, maintaining a healthy body weight (BMI of approximately 20 - 25 kg/m2 in people <60 years of age; higher in older patients) and waist circumference (<102 cm for men and <88 cm for women) is recommended for preventing HTN in non-hypertensive individuals and reducing BP in hypertensive patients

(Piepoli, et al. 2016). Body mass index strongly predicts HTN and is associated with urbanisation, potentially resulting from dietary changes, reduced physical activity (PA), increased psychological stress, and disrupted traditional family links (BeLue, et al. 2009; Forman, et al. 2009; Ibrahim and Damasceno, 2012). Additionally, high BMI and low aerobic capacity in late adolescence independently associate with a higher risk of HTN in adulthood (Crump, et al. 2016).

Regular PA is crucial for reducing CVD risk factors (Chan, et al. 2018). In hypertensive adults, PA is linked to reduced mortality risk, even in the absence of pharmacotherapy or BP control compared to physically inactive adults (Brown, et al. 2013). However, only 53% of hypertensive adults engage in PA (Brown, et al. 2013); In South Africa (SA) 39.1% were highly physical active, 32.4% were moderately physical active and 28.4% had low physical activity (Mbambo, et al. 2019). Exercise prescription for hypertensive individuals broadly follows guidelines promoting and maintaining health in the general adult population (Sharman and Stowasser, 2009).

In clinical populations, the average duration of previous studies has been approximately 4 months of PA at a moderate strength, thrice a week. In contrast, training in healthy populations has been considerably shorter in duration (Carter and Ray, 2015). Recommended PAs include aerobic exercise (90-150 minutes per week with achievement of 65% to 75% of heart rate reserve), dynamic strength (90-150 minutes per week), or isometric strength (3 sessions per week for 8 to 10 weeks of 4 ×2 minutes of hand grip, 1-minute rest, 30% to 40% of maximum voluntary contraction) (Whelton, et al. 2018). Extended interventions (≥4 months) have proven more effective in reducing sympathetic activity in other populations. Therefore, Howden, et al. (2017) suggest adopting a similar approach in patients with chronic kidney disease, emphasising the potential benefits of intense aerobic training on autonomic balance, particularly for individuals with high sympathetic tone (Kiuchi, et al. 2017).

Findings from our recent scoping review (Chapter 3) suggest that various exercise modalities induce different changes in BP variability, emphasising the need for more

individualised exercise intensity prescriptions to optimise BP-lowering effects and associated CV health benefits (Eicher et al., 2010). Although there is currently no consensus on normal BP response during PA (Williams, et al. 2018), studies document a consistent 10-20 mmHg reduction in systolic BP within 1 to 3 hours following moderate-intensity dynamic exercise in individuals with HTN (American College of Sports Medicine (ACSM's)-Exercise Management for Persons with Chronic Diseases and Disabilities, 2016). This training-induced BP reduction may persist for up to 9 hours and is mediated by a transient decrease in stroke volume rather than peripheral vasodilation (ACSM's-Exercise Management for Persons with Chronic Diseases and Disabilities, 2016). Gradual progression of exercise intensity, frequency, and duration with a "start low, go slow" approach is recommended (Sharman, et al. 2015). A complete exercise session, including warm-up and cool down, can be accomplished in approximately 40 minutes (Sharman, et al. 2015).

4.1.1 Research Aim

The aim of this study was to investigate the impact of exercise on reducing BP and other related outcomes. The intervention was carefully designed following a comprehensive Scoping Review (Chapter 3), with special attention given to the key characteristics of Frequency, Intensity, Time, and Type (FITT). The study aimed to assess how these FITT parameters could contribute to the effective management of HTN among patients residing in the community of Umlazi Township, KwaZulu-Natal (KZN).

The following were the objectives:

a. *Primary outcome:* To determine if the exercise programme would decrease systolic and diastolic BP after 6 weeks and 12 weeks intervention.
b. *Secondary outcome:* To determine if the exercise programme would decrease BMI and waist-to-hip ratio (WHR); and increase in six minutes-walk test (6MWT) after 6 weeks and 12 weeks intervention.

∴ Hypothesising

Physical Activity intervention will be able to assist the PHC hypertensive patients of Umlazi Township, KZN in managing HTN, by decreasing BP and decreasing resting HR, BMI and WHR.

∴ Alternative Hypothesising

Physical Activity intervention will significantly assist the PHC hypertensive patients of Umlazi Township, KZN in managing HTN, by significantly decreasing BP and reducing resting HR, BMI, and WHR, when compared to a control group.

∴ Null Hypothesising

Physical Activity intervention will not assist the PHC hypertensive patients of Umlazi Township, KZN in managing HTN, leading to no significant difference in BP, resting HR, BMI, and WHR, when compared to a control group.

4.2 METHOD

An application seeking approval to conduct the study at the eThekwini Municipality Primary Healthcare (PHC) clinic (Umlazi AA) was formally submitted via email (refer to Appendix B) and granted. Subsequently, the researcher extended invitations to potential participants via and at the PHC clinic in Umlazi townships, KZN. In parallel, a written request (refer to Appendix C) was submitted to the eThekwini Municipality, seeking permission to utilise their community hall or suitable venues for the screening days, contingent upon venue availability. Due to logistical constraints, including the need for intervention days and adherence to COVID-19 regulations (resulting in the full booking of the nearby community hall for weekends of the intervention), an adjacent unused land area near the clinic was utilised. This ensured compliance with social distancing measures and facilitated proper airflow during the screening sessions. Frequent visits to the clinic were undertaken to facilitate the recruitment process, with the researcher providing detailed information through an information document (refer to Appendix D). Interested individuals were briefed on the research study's purpose, aims, objectives, as well as the inclusion and exclusion criteria. Additionally, they were informed about the specific day, time, and venue for the initial health screening. To confirm participants'

hypertensive diagnosis and prevent misallocation, those expressing interest from the identified clinic were requested to provide proof of hypertensive diagnosis.

4.2.1 Study Design and Data Gathering Procedure

4.2.1.1 Trial design and Participants

The study employed a randomised control trial design to identify the effects of PA on reducing HTN and other secondary outcomes. The data collection spanned a 12-week period, occurring on Saturdays and Sundays, aligning with the findings from the scoping review (Objective 1, Chapter 3). This review provided evidence for the application of the FITT principle and specific exercise durations aimed at managing HTN. The primary outcomes looked at including any reduction in SBP and DBP, while secondary outcomes encompassed potential weight loss leading to a decrease in BMI, and a reduction in WHR.

All participants were systematically recruited from the same clinic. Those meeting the predefined inclusion criteria and demonstrating a clear understanding of the study's purpose, aims, and objectives were invited to participate. They were duly informed about the testing and intervention days, ensuring a comprehensive understanding of the research process.

4.2.1.2 Inclusion Criteria

a. Individuals who were diagnosed with any type of HTN by a medical doctor, nurse and/ or qualified healthcare (HC) professional prior to baseline testing.
b. Individuals who were taking antihypertensive medication prescribed by a medical doctor prior to baseline testing.
c. Individuals who utilised strictly primary HC sector to manage HTN.
d. Individuals living in the areas of Umlazi Townships, KZN.
e. Individuals who had HTN classifications ≥100-179 mmHg for systolic and ≥70-129 mmHg for diastolic resting BP (inclusion of controlled and uncontrolled BP patients).
f. Participants had to comply and attend 70-80% of the PA intervention classes.
g. Males and females.
h. Ages 18 years old and above.

4.2.1.3 Exclusion Criteria

a. Individuals who utilised both PHC sector and private HC sectors to manage HTN.
b. Individuals who presented with pre-HTN but had not yet been diagnosed.
c. Individuals diagnosed with HTN, who presented with physical disability or were suffering and/ or recovering from stroke or any other co-morbidity that may had affect their physical abilities.
d. Individuals with mental or physical disabilities that would have prevent them from answering the questions effectively and participating in PA to their full potential.
e. Individuals who were already taking part in any form of regular PA programme.
f. Individuals who were pregnant.

4.2.2 Interventions

During the baseline week, participants were warmly greeted as the researcher introduced herself and conveyed the research's purpose and the data collection procedures in IsiZulu, ensuring clear communication. Participants were encouraged to ask questions, which were addressed comprehensively, and their verbal confirmation of understanding marked their participation's formal commencement. Subsequently, participants were presented with various forms: Participant Letter of Information (refer to Appendix D); Participant Informed Consent Form (refer to Appendix E); and Indemnity (refer to Appendix F) to read and sign. Simultaneously, the researcher administered questionnaires: Health Screening Indemnity (refer to Appendix G); Group Class Indemnity (refer to Appendix H); and Medical History Form (refer to Appendix I) by engaging participants directly, explaining queries in IsiZulu where necessary. Personal details were recorded in the research register (refer to Appendix J) during the form-signing process.

Strict adherence to the return of signed forms was maintained as a prerequisite for participation, encompassing Letter of Information (refer to Appendix D), Informed Consent Form (refer to Appendix E), general Indemnity (refer to Appendix F), Health Screening Indemnity (refer to Appendix G), Group Class Indemnity (refer to Appendix H), the Medical History Form and PAR-Q Form (refer to Appendices I), and registration for the

programme (refer to Appendices J). All health screening days were meticulously documented during the baseline, sixth (midpoint), and twelfth (end of intervention) weeks on the weekly attendance registration form. Initial screenings were summarised in report cards (refer to Appendix K), with participants receiving one copy for their records, and the other retained by the researcher for data analysis. Subsequent re-screenings were documented in the re-screening form (refer to Appendix L). Attendance registers were consistently maintained, noting participant availability, resting BP, and resting HR during the first session of each week. Participants with resting BP ≥180-200/110 mmHg were prohibited from exercising on that day, aligning with ACSM's guidelines (2017).

Lastly, participants were familiarised with the measurement testing procedures, where the researcher conducted assessments, including BP, HR, weight and stature (for BMI calculation), waist and hip circumference (for WHR calculation), and the 6MWT. Measurements were taken at the baseline, sixth (midpoint), and twelfth (end of intervention) weeks, with the intervention group (IG) assessed in the mornings and the control group (CG) in the afternoons. The IG engaged in a tailored exercise intervention involving warm-up, stretching, aerobic training, and strength training with resistance bands (refer to Appendix M). Breathing patterns were emphasised, and sessions were held every weekend. The CG participated in low-intensity Pilates and stretching sessions to maintain engagement without influencing IG results. Access to participants' identifying documents was restricted to the researcher and stored separately from data collection sheets in a secure location. Participants in both the IG and CG were instructed to refrain from engaging in any other physical activity throughout the 12-week study period.

4.2.3 Measuring Tools and Instruments

All the information on the measuring tools that were used are explained below:

4.2.3.1 Health Screening Questionnaires

The Wellness and Lifestyle Questionnaire was meticulously crafted to look into lifestyle factors, such as stress, PA, and diet, offering valuable insights into their potential impact on participants' health (refer to Appendix G-I). Complementing this, the Medical History

Form and PA Readiness-Questionnaires were specifically designed to explore participants' medical histories (refer to Appendix G-I). The questionnaire were traditionally used by the University of the Witwatersrand, Department of Exercise Science and Sports Medicine (Sport Clinic) adapted from the ACSM's guideline (2017). These questionnaires serve as self-screening tools, adept at identifying the small subset of adults for whom PA may be inappropriate or those who would benefit from medical advice regarding the most suitable types of activities for their well-being, aligning with ACSM's guidelines (2017).

To ensure accurate and reliable data, participants were quetioned about smoking or caffeine consumption within the 30 minutes preceding testing. Those affirming either behaviour were required to sit for approximately 30 minutes before testing could proceed, in accordance with ACSM's guidelines (2017). This careful approach underscores the commitment to adhering to established protocols and maintaining the scientific rigor of the study.

4.2.3.2 Resting Automated Blood Pressure

Each participant was directed to assume a calm seated position for a minimum of 5 minutes, seated in a chair providing adequate back support, feet firmly grounded, and arms positioned at heart level. Prior to the commencement of testing, a crucial inquiry was made regarding recent smoking or caffeine consumption within the last 30 minutes. Affirmative responses to either query prompted a mandatory additional 30-minute period of rest before testing could proceed.

The BP assessment was executed using an automatic machine, the Clicks Upper Arm BP Monitor, characterised by its portability and designed to accommodate arm circumferences ranging from 22 cm to 42 cm. Manufactured and marketed by Clicks Retailers (Pty) Ltd., with a GMDN classification of 16157 and ID: 300481. The BP cuff, securely wrapped around the upper arm at heart level (specifically on the left side), was meticulously aligned with the brachial artery. The selection of an appropriately sized cuff was a pivotal consideration, ensuring precision in measurement. The bladder within the cuff was positioned to encircle at least 80% of the upper arm. A series of at least three

measurements were taken, with intervals of 3 to 5 minutes between each reading, and the resulting averages were recorded in millimetres of mercury (mmHg), adhering to the established ACSM guidelines (2017). This approach underscores the commitment to accuracy and reliability in the data collection process.

4.2.3.3 Resting Automated Heart Rate

Concurrently with the automated resting BP measurements, the HR was recorded. Using the Clicks Upper Arm BP Monitor, a minimum of three HR measurements were obtained at intervals of 3 to 5 minutes, adhering to the strict standards outlined in the ACSM guidelines (2017). The resulting average of the overall resting heart rate (HR) was then accurately documented in beats per minute (bpm), ensuring accuracy and reliability in the measurement process.

4.2.3.4 Body Mass

A calibrated electronic scale (Pure Pleasure Digital Glass Scale - Bsg01) was used, ensuring accuracy through calibration using weights validated by a government department of weights and measures. Participants were instructed to remove their shoes and any additional heavy clothing or items contributing to their body mass. Adopting a stance with feet slightly apart and arms by their sides, participants stood with minimal movement. The conclusive weight reading from the scale was recorded in kilograms (kg), aligning with the strict standards outlined in the ACSM guidelines (2017).

4.2.3.5 Stature

A steel weighted tape measure (Topline, quality guarantee – 3M) served as the instrument for height measurement. Positioned vertically against a wall, participants were directed to remove their shoes, stand in a relaxed manner with their back against the tape measure, and place their feet together with arms by their sides. The standing height was meticulously measured in meters (m), capturing the maximum distance from the floor to the highest point on the head while the subject faced directly ahead. This method adhered to the stict standards outlined in the ACSM guidelines (2017).

4.2.3.6 Body Mass Index

A standardised computation was applied to determine the BMI, achieved by dividing the participant's weight in kilograms by the square of their height in meters (m^2). The resulting BMI was documented in kilograms per meter squared ($kg \cdot m^2$). While BMI is a widely used indicator for assessing overweight and obesity, it should be noted that it does not distinguish between body fat, muscle mass, or bone density. Notably, a BMI exceeding 30 $kg \cdot m^2$ is associated with an elevated risk of HTN, total cholesterol issues, coronary disease, and mortality rates (ACSM's guidelines, 2017). According to ACSM's guidelines (2017) and the Expert panel on the Identification Evaluation and Treatment of Overweight and Obesity in Adults (1998), a BMI falling within the range of 25.0-29.9 $kg \cdot m^2$ is considered overweight, while a BMI of 30.0 $kg \cdot m^2$ or higher is classified as obese. It is crucial to recognise that obesity-related health concerns tend to escalate beyond a BMI of 25.0 $kg \cdot m^2$ for most individuals.

4.2.3.7 Circumferences

The WHR was measured using measurements obtained with a flexible yet non-elastic tape measure (Dynatronics). To ensure accuracy, the tape was gently placed on the skin surface without exerting pressure on the subcutaneous adipose tissue. Duplicate measures were taken at each site, and in cases where the duplicates deviated by more than 3 centimeters (cm), the measurement was repeated. The researcher followed a systematic alternation through the measurement sites to allow sufficient time for the skin to regain its normal texture (ACSM guidelines, 2017).

4.2.3.7.1 Waist Circumference

Participants were instructed to eliminate any bulky clothing around the waist and, if necessary, to loosen tight garments. Standing upright with arms at their sides, feet slightly apart, and striving to distribute weight evenly, participants were measured horizontally at the narrowest part of the torso (above the umbilicus and below the xiphoid process). To ensure precision, the researcher positioned themselves on the side of the participant, guaranteeing a level placement of the tape around the waist. Emphasizing the importance of natural breathing, participants were prompted to inhale and exhale, with measurements

taken during the exhale to prevent inaccuracies caused by abdominal muscle contraction or breath-holding. Waist measurements were recorded to the nearest cm (ACSM guidelines, 2017).

4.2.3.7.2 Hips Circumference

The methodology for hip circumference measurement closely mirrored that of waist circumference, with participants following the same preparation and procedure. However, in this instance, participants were instructed to remove any bulky clothing around the hips. The measurement was then taken horizontally at the maximal circumference of the buttocks. All circumference measurements were recorded to the nearest cm, adhering to ACSM guidelines (2017).

4.2.3.8 Six-Minute Walk Test

The 6MWT serves as a widely acknowledged endpoint for assessing aerobic exercise capacity, recognised by regulatory bodies for its clinical significance (McDonald, et al. 2013). Adhering to the guidelines set forth by the American Thoracic Society (ATS) statement (2002), the test commenced following a pre-test resting period of a minimum of 10 minutes. Participants were instructed to walk in a straight 25-meter path marked with lines at every meter, with standardised instructions to walk as far as possible without jogging or running. This process involved turning around a marked cone at the course's end and repeating the loop for a duration of 6 minutes, with no practice test allowed (Young, et al. 2016). Encouragement, delivered with even, neutral tones and scripted text, followed the ATS guidelines (ATS statement, 2002).

Participants were allowed to rest without sitting if necessary, and various metrics were recorded, including the total distance covered, distance for each minute, and the time taken for each 25-meter interval (Young, et al. 2016). Falls, if any, were documented. A detailed administration manual can be found as supplemental material in Montes et al. (2013). The percent of the predicted distance on the 6MWT was computed using recent normative values (Geiger, et al. 2007). Fatigue, expressed as the percent change between the distance walked during the first and last test minute, was determined, with a

positive value representing fatigue (Montes, et al. 2010). The test was administered during health screening days for both the IG and CG in the 1st week (baseline), 6th week (midpoint), and 12th week (end of intervention). In the event of a participant stopping during the test, appropriate measures were taken, and the test was discontinued if clinically warranted reasons, such as chest pain or extreme fatigue, arose.

The moderate correlations between the 6MWT and various functional measures validate its effectiveness in assessing exercise capacity in the studied population (Chan and Pin, 2019). This study reported more precise measurements (SEM: 10.1–17.6m and MDC95: 28.1–48.7m) compared to previous research on individuals with dementia (SEM: 19.6–21.9m; MDC95: 54.2–60.6m) (Ries, et al. 2009), despite similar cognitive function levels (mean MMSE = 13.1). The observed improvement in measurement accuracy could be linked to the demographic and functional profile of the participants, particularly their younger age (mean age = 80.7) and higher independence, as indicated by the larger percentage of community-dwelling participants (76.5%) (Ries, et al. 2009).

4.2.3.9 Reliability and Validity

a) Reliability

The measurements were conducted by the researcher, who had undergone a thorough familiarisation process, ensuring stability and reliability through a test-retest method with consistent results on separate days. This approach aligns with established practices in fitness and motor performance measures (Thomas, et al. 2015).

b) Validity

The measures employed in this study are standard in research of this nature and have been established as valid. The tests and instruments exhibit content validity, ensuring that they adequately cover the expected domains (Thomas, et al. 2015). The 6MWT demonstrates high reliability in measuring exercise capacity in older adults, with excellent test-retest and inter-rater reliability (ICC ranges from 0.83 to 0.92). This supports its effectiveness and consistency in clinical assessments.

4.2.4 Outcomes

a) **Primary:** Reduction in BP.
b) **Secondary:** Decrease in BMI, decrease in WHR, HR and increase in 6MWT.

4.2.5 Sample Size and Selection

The choice of the PHC clinic (Umlazi AA) was based on its geographical location, ensuring the practicality of data collection. The determination of the sample size followed established methodologies from prior HTN intervention studies (Knoepfli-Lenzin, et al. 2010; Molmen-Hanse, et al. 2011; Dimeo, et al. 2012), utilising STATA and STATISTICA, and incorporating CGs. Considering the anticipated primary outcome (SBP) with an expected reduction of 6 mmHg for the IG, a standard deviation (SD) of ±10 mmHg, and a power of 80%, the sample size calculation resulted in 64 participants per group (IG and CG), amounting to a total of 128 participants from both groups combined.

4.2.6 Randomisation

In the baseline week, all participants underwent testing, following which they were evenly distributed into two distinct groups: the IG and the CG. This allocation was achieved through a simple randomisation process utilising a Microsoft Excel spreadsheet. The randomisation procedure involved the following steps using the RAND formula: (1) The study numbers assigned to participants were copied and pasted into a new sheet. A new column, next to the study number column (A1), was designated for the RAND formula input (B1) to facilitate randomisation. (2) The "=RAND()" formula was applied in B1 and down the column, generating random numbers next to each study number without duplicates. (3) The B1 column was sorted in ascending order. (4) The randomisation was altered; the column was recalculated twice to generate new numbers. (5) The randomisation was stopped, and the results were saved. In column C1, participants were categorised as either IG (first half column) or CG (second half column). This straightforward randomisation method, based on a single sequence of random assignments, ensures the complete randomness of subject allocation to specific groups (Altman, et al. 1999; Suresh, 2011).

4.2.7 Blinding

Due to the nature of the study the participants and researcher could not be blinded to the intervention.

4.3 STATISTICAL METHODS

Data management, organisation, and analysis were conducted using the latest version of STATA (Statistics and Data Science) software, version 18.0 (2023). This advanced software facilitated a comprehensive and precise examination of the data. To provide a clear understanding of the dataset. An intention-to-treat approach was used and specifically, these statistics were based on the distribution of the data. The normality of the data was determined using the Shapiro-Wilk test and histograms. Data that was normally distributed was presented as mean ± standard deviation, or frequency (percentage), while skewed data was presented as median (interquartile range).

In our analytical approach, we employed a range of statistical tests that were best suited for the data under investigation, which were normally distributed. For normally distributed data the inferential statistics, T-Test was utilised to determine the difference between study groups and an Analysis of Variance (ANOVA) was utilised to compare the data across different time intervals and groups. Comparisons were made between baseline and 6 weeks, between baseline and 12 weeks, and between 6 weeks and 12 weeks. These comparisons were conducted for both the IG and the CG, allowing for a comprehensive understanding of the intervention's impact over time. To establish statistical significance, a 95% confidence level was set, with a probability value (p-value) of less than 0.05 indicating statistical significance. This threshold ensured that the results were both reliable and meaningful, providing a robust foundation for the conclusions drawn from this research.

4.4 GENERAL DATA PROCESSING AND ETHICAL, SAFETY CONSIDERATIONS

The research design and procedures for the study were submitted for ethics approval to the Human Research Ethics Committee (Medical) at the University of the Witwatersrand, the eThekwini Municipalities, Umlazi AA Clinic, and the Faculty of Health Sciences. The

study was approved from all these committees: Human Research Ethics Committee (Medical), University of the Witwatersrand (M190442) (refer to Appendix N), eThekwini Municipalities, Umlazi AA Clinic (refer to Appendix O), and Faculty of Health Sciences (refer to Appendix P).

Subsequently, potential participants were extended invitations to partake in the study and provided with an information sheet outlining study details. Upon expressing their willingness to participate, individuals were requested to complete an informed consent form (refer to Appendix E) before entering the study. This step aimed to ensure the implementation of appropriate safety measures for participants, upholding their rights, including privacy, nonparticipation, anonymity, confidentiality, and the right to withdraw from the study without facing negative consequences.

Data collected during the study were initially coded with respect to participants, assigning everyone a code number on data collection forms to maintain anonymity and confidentiality. This procedure safeguarded against the disclosure of identifying information, upholding the participant's right to privacy. The results of the 12-week intervention were carefully recorded in an Excel spreadsheet under the respective tested variables.

4.5 RESULTS

The study design included intervention and control groups using inclusion and exclusion criteria, using the flow chart as per Figure 4.5.1.1.

The study groups were homogeneous and demonstrated a well-balanced distribution of predictive factors. Notably, no adverse events were detected or documented throughout the entire intervention process. The initial sample consisted of 73 participants, who were subsequently allocated into the IG (n = 36) and the CG (n = 37). By the sixth week, 12 participants were lost to follow-up due to various reasons: three participants faced challenges adhering to the chosen training day, five participants struggled to maintain the prescribed training programme, three participants could not be reached, and one

participant voluntarily opted out of continuing the training. As the study progressed to the twelfth week, an additional eight participants were lost to follow-up: one participant was reported deceased by their family, four participants missed more than four days of training (over two weeks), and three participants could not be reached (refer to Figure 4.5.1.1).

4.5.1 Intervention vs Control Groups Participant Characteristics

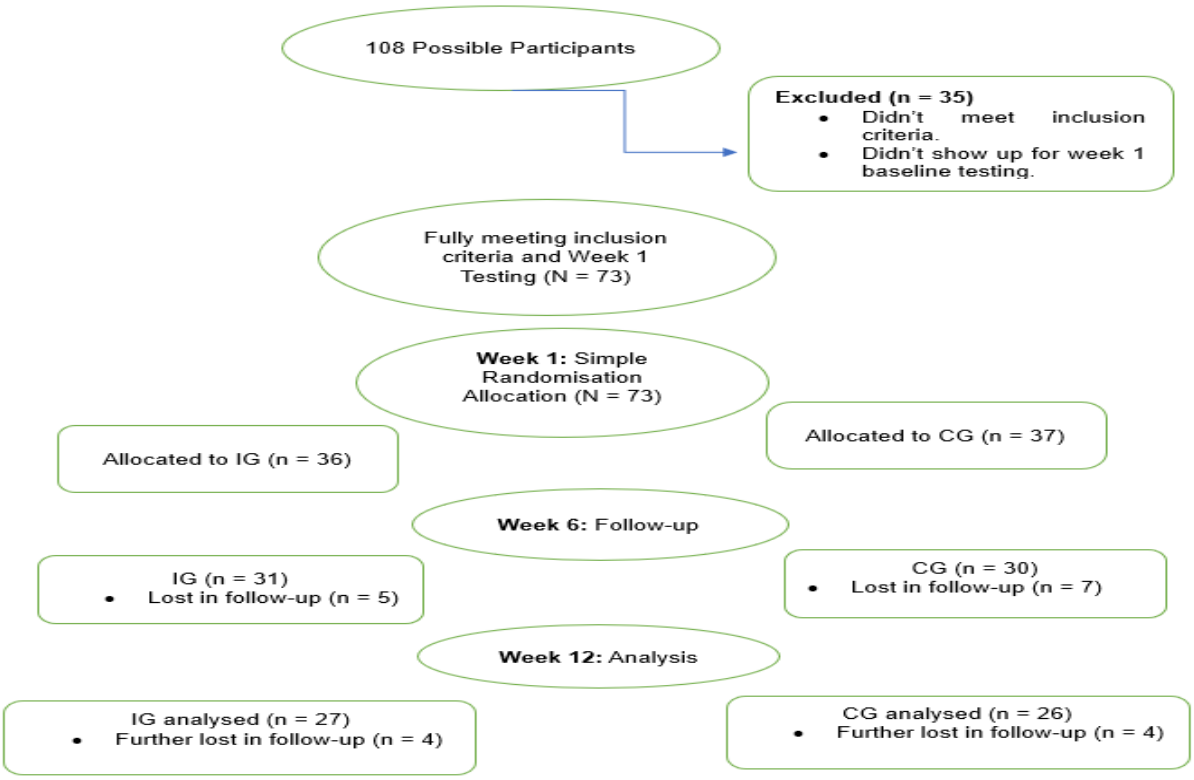

Figure 4.5.1.1 Flow diagram of the participants phase of involvement.

4.5.2 Primary and Secondary Outcomes

The study cohort, with a mean age of 55.2 years (±8.0), observed a significant difference between the mean IG 53.3 years (±8.9) and CG 57.1 years (±6.6) (p =0.04*). The majority of participants were aged 50 years or older, and most were female. With cardiovascular metrics, the mean SBP was 133.1 mmHg (±12.7), and mean DBP was 79.1 mmHg (±9.4), (Table 4.5.2.1).

Table 4.5.2.1 Baseline Key Characteristics of Study Participants

Variables	Intervention (n=36)	Control (n=37)	Total (N=73)	P value
	Mean (±SD)			
Age (years)	53.3 (±8.9)	57.1 (±6.6)	55.2 (±8.0)	0.04*
Systolic BP (mmHg)	131.8 (±11.3)	134.5 (±13.9)	133.1 (±12.7)	0.4
Diastolic BP (mmHg)	79.2 (±11.0)	79.1 (±7.7)	79.1 (±9.4)	1.0
Heart Rate (bpm)	80.3 (±14.8)	82.5 (±15.1)	81.4 (±14.9)	0.5
Body Mass (kg)	68.1 (±9.7)	68.5 (±12.0)	68.3 (±10.9)	0.9
Stature (m)	1.6 (±0.1)	1.6 (±0.1)	1.6 (±0.1)	0.9
BMI (kg·m^2)	26.0 (±4.5)	26.1 (±5.6)	Median 3 (IQR 1-5)	0.9
Waist Circumference (cm)	97.6 (±13.8)	95.9 (±16.7)	96.7 (±15.3)	0.7
Waist-to-Hip Ratio (cm)	1.0 (±0.2) (0.97±0.19)	0.9 (±0.2) (0.96±0.21)	1.0 (±0.2) (0.96±0.20)	0.8
Six-Minute Walk (m)	435.7 (±115.0)	399.2 (±108.9)	417.2 (±112.7)	0.2

N = Total number of participants, n = number of participants; mmHg = Millimetres of mercury; Bpm = Beats per Minute; kg = Kilogram; m = Metre; kg·m^2 = Kilogram-metre squared; cm = Centimetres, * = Significance; Two-sample t test with equal variances.

Turning to anthropometric measurements, the highest recorded BMI was 40.7 kg·m² in the total baseline week. The data were not normally distributed with the interquartile range of 3 (1-5). However, when looking at the BMI in both the IG and CG, it averaged at 26.0 kg·m² (±4.5) and 26.1 kg·m² (±5.6), respectively (Table 4.5.2.1). Waist circumference averaged at 96.7 (±15.3), with classifications including very high (n=14), high (n=29), low (n=27), and very low (n=3). Meanwhile, the mean WHR stood at 0.96 (±0.20), with classifications indicating high risk (obese, n=47), moderate risk (overweight, n=7), and low risk (normal, n=19) (Table 4.5.2.2).

Table 4.5.2.2 Baseline Classifications of Intervention vs. Control Groups

Variables	Intervention		Control		Total		P Values
	n (36)	%	n (37)	%	N (73)	%	
Age (Years)							**0.01**
35-50 years	13	36.1	4	10.8	17	23.3	
>50 years	23	63.9	33	89.2	56	76.7	
Total	36	100	37	100	73	100	
Gender							**0.73**
Female	28	77.8	30	81.1	58	79.5	
Male	8	22.2	7	18.9	15	20.5	
Total	36	100	37	100	73	100	
Blood Pressure Classifications							**0.34**
Hypertensive II	2	5.6	0	0	2	2.7	

Hypertensive I	7	19.4	12	32.4	19	26	
Normal	4	11.1	4	10.8	8	11	
Prehypertensive	23	63.9	21	56.8	44	60.3	
Total	36	100	37	100	73	100	
Waist Circumference Classifications							**0.81**
Very high	6	16.7	8	21.6	14	19.2	
High	16	44.4	13	35.1	29	39.7	
Low	13	36.1	14	37.8	27	37	
Very low	1	2.8	2	5.4	3	4.1	
Total	36	100	37	100	73	100	
Waist-to-Hip-Ratio Classifications							**0.27**
High risk (obese)	24	66.7	23	62.2	47	64.4	
Low risk (normal)	7	19.4	12	32.4	19	26	
Moderate risk (overweight)	5	13.9	2	5.4	7	9.6	
Total	36	100	37	100	73	100	

Two-sample Wilcoxon rank-sum (Mann–Whitney) test

4.5.3 Intervention and Control Group in Week 6 and 12

Interestingly, while the mean SBP did not show statistically significant changes, a consistent trend was noted. The SBP in the IG (130.8±9.4 at week 6 and 132.4±10.8 at week 12) remained consistently lower than in the CG (134.6±11.6 at week 6 and 136.8±12.0 at week 12). The diastolic pressures increased from baseline to week 6 in both groups, but not statistically significant. At baseline, 7 participants were classified as hypertensive I compared to 12 participants in the CG and when comparing at week 12, also 7 participants in the IG were classified as hypertensive I, compared to 10 in the CG. Moreover, a comparison between baseline and week 12 within the IG showed a decrease in the number of participants classified as hypertensive II, from 2 at baseline to none at week 6 and 12, as detailed in Tables 4.5.2.2; Table 4.5.3.2 and Table 4.5.3.3.

Table 4.5.3.1 Outlining Differences of Intervention vs. Control Groups in Weeks: 6 & 12

Variables	**Total (n=73)**	**Intervention (n=31)**	**Control (n=30)**	**P Value**	**Intervention (n=27)**	**Control (n=26)**	**P Value**
	Baseline	**Week 6 Mean (±SD)**			**Week 12 Mean (±SD)**		

Systolic BP (mmHg)	133.1 (±12.7)	130.8 (±9.4)	134.6 (±11.6)	0.1	132.4 (±10.8)	136.8 (±12.0)	0.2
Diastolic BP (mmHg)	79.1 (±9.4)	78.3 (±8.3)	79.4 (±8.2)	0.5	85.9 (±8.9)	83.5 (±7.8)	0.4
Heart Rate (bpm)	81.4 (±14.9)	87.4 (±9.8)	88.3 (±16.2)	0.9	90.1 (±13.1)	84.0 (±14.0)	0.1
Body Mass (kg)	68.3 (±10.9)	68.4 (±10.1)	68.2 (±11.1)	0.9	68.4 (±9.0)	67.7 (±11.1)	0.8
BMI (kg·m^2)	26.1 (±5.0)	26.0 (±4.5)	26.0 (±5.0) (25.94±4.97)	0.9	26.3 (±4.5)	25.9 (±4.8)	0.8
Waist Circumference (cm)	96.7 (±15.3)	96.2 (±13.3)	95.7 (±16.3)	0.9	95.2 (±13.3)	93.4 (±14.6)	0.6
Waist-to-Hip Ratio (cm)	1.0 (±0.2) (0.96±0.20)	1.0. (±0.2) (0.95±0.19)	1.0 (±0.2) (0.96±0.19)	0.9	0.9 (±0.2)	0.9 (±0.2)	0.9
Six-Minute Walk (m)	417.2 (±112.7)	451.0 (±113.5)	400.3 (±98.4)	0.04*	457.7 (118.2)	402.6 (86.1)	0.06

n = number of participants; mmHg = Millimetres of mercury; Bpm = Beats per Minute; kg = Kilogram; m = Metre; kg·m^2 = Kilogram-metre squared; cm = Centimetres; * = Significance; Two-sample t test with equal variances.

Body weight and BMI assessments revealed consistent patterns. In both week 6 and week 12, the average BMI of participants remained stable, categorising them as overweight (BMI > 25.9 kg/m²). This consistency was observed despite the interventions. Additionally, when considering disease risk in relation to weight and waist circumference (>93.4 cm) participants in both groups were classified as high risk at both time points, as shown in Table 4.5.3.1. Body mass index observed similar classifications in both the IG and CG at week 6; n = 1 obese II, n = 5 obese I and n = 2 underweight in both the groups (Table 4.5.3.2). Waist circumference also observed similar classifications in both the IG and CG at week 12; n = 4 very high and n =11 high in both the groups (Table 4.5.3.3).
For the 6MWT at week 6, the IG exhibited a significant improvement with the intervention, covering a mean distance of 451.0 meters (±113.5), compared to the CG, which covered 400.3 meters (±98.4), yielding a statistically significant p = 0.04*, (Table 4.5.3.1).

Table 4.5.3.2 Week 6 Classifications of Intervention vs. Control Groups

Variable	Intervention		Control		Total		P Values
	n (31)	%	n (30)	%	N (61)	%	
Blood Pressure Classifications							0.63
Hypertensive I	6	19.4	9	30	15	24.6	
Normal	5	16.1	4	13.3	9	14.8	
Prehypertensive	20	64.5	17	56.7	37	60.7	
Total	31	100	30	100	61	100	
BMI Classifications ACSM_W6							0.97
Obese II	1	3.2	1	3.3	2	3.3	
Obese I	5	16.1	5	16.7	10	16.4	
Overweight	12	38.7	9	30	21	34.4	
Normal	11	35.5	13	43.3	24	39.3	
Underweight	2	6.5	2	6.7	4	6.6	
Total	31	100	30	100	61	100	
Waist Circumference Classifications							0.79
Very high	4	12.9	6	20	10	16.4	
High	14	45.2	12	40	26	42.6	
Low	12	38.7	10	33.3	22	36.1	
Very low	1	3.2	2	6.7	3	4.9	
Total	31	100	30	100	61	100	
Waist-to-Hip-Ratio Classifications							0.91
High risk (obese)	21	67.7	21	70	42	68.9	
Low risk (normal)	7	22.6	7	23.3	14	23	
Moderate risk (overweight)	3	9.7	2	6.7	5	8.2	
Total	31	100	30	100	61	100	

Two-sample Wilcoxon rank-sum (Mann–Whitney) test.

Table 4.5.3.3 Week 12 Classifications of Intervention vs. Control Groups

Variables	Intervention		Control		Total		P Values
	n (27)	%	n (26)	%	N (53)	%	
Gender							**0.34**
Female	20	74.1	22	84.6	42	79.2	
Male	7	25.9	4	15.4	11	20.8	
Total	27	100	26	100	53	100	
Blood Pressure Classifications							**0.62**
Hypertensive I	7	25.9	10	38.5	17	32.1	
Normal	4	14.8	3	11.5	7	13.2	
Prehypertensive	16	59.3	13	50	29	54.7	
Total	27	100	26	100	53	100	

Waist Circumference Classifications							**0.92**
Very high	4	14.8	4	15.4	8	15.1	
High	11	40.7	11	42.3	22	41.5	
Low	11	40.7	9	34.6	20	37.7	
Very low	1	3.7	2	7.7	3	5.7	
Total	27	100	26	100	53	100	
Waist-to-Hip-Ratio Classifications							**0.39**
High risk (obese)	18	66.7	19	73.1	37	69.8	
Low risk (normal)	5	18.5	6	23.1	11	20.8	
Moderate risk (overweight)	4	14.8	1	3.8	5	9.4	
Total	27	100	26	100	53	100	

Two-sample Wilcoxon rank-sum (Mann–Whitney) test.

4.5.4 Intervention Group

A comprehensive comparison was conducted across the three key time points - baseline, 6 weeks, and 12 weeks - within the IG. This comparison encompassed all variables associated with the primary and secondary outcomes of the study. Notably, significant differences emerged in three critical variables. Firstly, the DBP displayed a notable change. From baseline to week 6, there was a slight decrease of 0.9 mmHg, followed by a more substantial increase of 7.6 mmHg from week 6 to week 12. Secondly, the HR, showed a 7.1 bpm increase in week 6 from baseline and a further increase of 2.7 mmHg in week 12 from week 6. Thirdly, for the 6MWT there was a 15.3 m increase in week 6 from baseline and a further increase of 6.7 m in week 12 from week 6 in the 6MWT, a significant change was observed, as detailed in Table 4.5.4.1.

Table 4.5.4.1 Insights into the Intervention Group Across Weeks: Baseline, 6, & 12

Variables:	Baseline (n=36)	Week 6 (n=31)	Week 12 (n=27)	P Value
	Mean (±SD)			
Systolic BP (mmHg)	131.8 (±11.3)	130.8 (±9.4)	132.4 (±10.8)	0.3
Diastolic BP (mmHg)	79.2 (±11.0)	78.3 (±8.3)	85.9 (±8.9)	0.02*
Heart Rate (bpm)	80.3 (±14.8)	87.4 (±9.8)	90.1 (±13.1)	<0.01*
Body Mass (kg)	68.1 (±9.7)	68.4 (±10.1)	68.4 (±9.0)	0.2
BMI (kg·m^2)	26.0 (±4.5)	26.0 (±4.5)	26.3 (±4.5)	0.1

Waist Circumference (cm)	96.7 (±13.8)	96.2 (±13.3)	95.2 (±13.3)	0.3
Waist-to-Hip Ratio (cm)	1.0 (±0.2) (0.97±0.19)	1.0. (±0.2) (0.95±0.19)	0.9 (±0.2)	0.6
Six-Minute Walk (m)	435.7 (±115.0)	451.0 (±113.5)	457.7 (118.2)	<0.01*

n = number of participants; mmHg = Millimetres of mercury; Bpm = Beats per Minute; kg = Kilogram; m = Metre; $kg \cdot m^2$ = Kilogram-metre squared; cm = Centimetres; * = Significance; Two-sample t test with equal variances.

Further analysis between baseline and week 12 revealed additional significant changes. The HR showed a significant increase from 80.7 bpm (±14.4) to 90.1 bpm (±13.1) ($p < 0.02$*), indicating a rise of 9.4 bpm. Additionally, in the 6MWT, an increase of 22.0 meters was noted, from 435.7 m (±115.0) to 457.7 m (±118.2) ($p = 0.02$*). When comparing week 6 to week 12, significant differences were observed in DBP, which increased from 78.3 mmHg (±8.3 mmHg) to 85.9 mmHg (±8.9 mmHg) ($p = 0.02$*), and in the 6MWT, which increased by 6.7 m, from 451.0 m (±113.5) to 457.7 m (±118.2) ($p < 0.06$*), as shown in Table 4.5.4.2.

4.5.5 Control Group

In the CG of this study, a detailed comparison of primary and secondary outcome variables was also conducted across three key time points: baseline, 6 weeks, and 12 weeks. This analysis revealed significant changes in four distinct variables. The SBP demonstrated an increase of 0.1 mmHg at the 6-week mark from the baseline. However, there was a subsequent increase of 2.2 mmHg from the baseline to week 12. The DBP showed an initial increase of 0.3 mmHg from baseline to week 6, followed by a further increase of 4.1 mmHg from week 6 to week 12, indicating a significant difference- ($p = 0.01$*). Body mass also indicated significant changes, with a decrease of 0.3 kg from baseline to week 6 and an additional decrease of 0.5 kg from week 6 to week 12. In the 6MWT, there was an increase of 1.1 m from baseline to week 6 and a further increase of 2.3 m from week 6 to week 12, as detailed in Table 4.5.5.1.

Table 4.5.5.1 Insights into the Control Group Across Weeks: Baseline, 6 & 12

Variables:	Baseline (n=37)	Week 6 (n=30)	Week 12 (n=26)	P Value
	Mean (±SD)			
Systolic BP (mmHg)	134.5 (±13.9)	134.6 (±11.6)	136.8 (±12.0)	0.3
Diastolic BP (mmHg)	79.1 (±7.7)	79.4 (±8.2)	83.5 (±7.8)	0.01*
Heart Rate (bpm)	82.5 (±15.1)	88.3 (±16.2)	84.0 (±14.0)	0.1
Body Mass (kg)	68.5 (±15.1)	68.2 (±11.1)	67.7 (±11.1)	<0.01*
BMI (kg·m^2)	26.1 (±5.6)	26.0 (±5.0) (25.94±4.97)	25.9 (±4.8)	0.4
Waist Circumference (cm)	95.9 (±16.7)	95.7 (±16.3)	93.4 (±14.6)	0.1
Waist-to-Hip Ratio (cm)	0.9 (±0.2)	1.0 (±0.2) (0.96±0.19)	0.9 (±0.2)	0.7
Six-Minute Walk (m)	399.2 (±108.9)	400.3 (±98.4)	402.6 (86.1)	<0.01*

n = number of participants; mmHg = Millimetres of mercury; Bpm = Beats per Minute; kg = Kilogram; m = Metre; kg·m^2 = Kilogram-metre squared; cm = Centimetres; * = Significance; Two-sample t test with equal variances.

Comparing two specific time points, significant differences in baseline and week 6 were observed in three variables. The HR increase of 5.8 bpm from 82.5 bpm (±15.1) to 88.3 bpm (±16.2) (p = 0.01*) Body Mass decreased of 0.3 kg from 68.5 kg (±15.1) to 68.2 kg (±11.1) (p = 0.02*). The 6MWT showed an increase of 1.1 meters, from 399.2 m (±108.9) to 400.3 m (±98.4) (p = 0.03*). Between baseline and week 12, significant changes were noted in three variables: DBP increased by 4.4 mmHg from 79.1 mmHg (±7.7) to 83.5 mmHg (±7.8) (p = 0.01*), Body Mass decreased by 0.8 kg from 68.0 kg (±15.1) to 67.7 kg (±11.1) (p = 0.01*), and the 6MWT showed an increase of 3.4 m from 399.2 meters (±10.8.9) to 402.6 meters (±86.1) (p < 0.02*). Between week 6 and week 12, significant differences were seen in four variables: SBP increased by 2.2 mmHg from 134.6 mmHg (±11.6) to 136.8 mmHg (±12.0) (p = 0.01*), DBP increased by 4.1 mmHg from 79.4 mmHg (±8.2) to 83.5 mmHg (±7.8) (p = 0.04*). Body Mass decrease by 0.5 kg from 68.2 kg (±11.1) to 67.7 kg (±11.1) (p = 0.03*), and the 6MWT increased by 2.3 m from 400.3 m (±98.4) to 402.6 meters (±86.1) (p < 0.01*), as illustrated in Table 4.5.5.2.

Table 4.5.4.2 Profiling the Intervention Group Across Baseline, Week 6, & 12

Variables:	Baseline (n=36)	Week 6 (n=31)	P Value	Baseline (n=36)	Week 12 (n=27)	P Value	Week 6 (n=31)	Week 12 (n=27)	P Value
	Baseline & Week 6 Mean (±SD)			Baseline & Week 12 Mean (±SD)			Week 6 &12 Mean (±SD)		
Systolic BP (mmHg)	131.8 (±11.3)	130.8 (±9.4)	0.2	131.8 (±11.3)	132.4 (±10.8)	0.2	130.8 (±9.4)	132.4 (±10.8)	0.7
Diastolic BP (mmHg)	79.2 (±11.0)	78.3 (±8.3)	0.6	79.2 (±11.0)	85.9 (±8.9)	0.1	78.3 (±8.3)	85.9 (±8.9)	0.02*
Heart Rate (bpm)	80.3 (±14.8)	87.4 (±9.8)	<0.04*	80.3 (±14.8)	90.1 (±13.1)	<0.02*	87.4 (±9.8)	90.1 (±13.1)	0.7
Body Mass (kg)	68.1 (±9.7)	68.4 (±10.1)	0.7	68.1 (±9.7)	68.4 (±9.0)	1.0	68.4 (±10.1)	68.4 (±9.0)	0.1
BMI (kg·m^2)	26.0 (±4.5)	26.0 (±4.5)	0.1	26.0 (±4.5)	26.3 (±4.5)	1.0	26.0 (±4.5)	26.3 (±4.5)	0.2
Waist Circumference (cm)	96.7 (±13.8)	96.2 (±13.3)	0.2	96.7 (±13.8)	95.2 (±13.3)	0.8	96.2 (±13.3)	95.2 (±13.3)	0.6
Waist-to-Hip Ratio (cm)	1.0 (±0.2) (0.97±0.19)	1.0. (±0.2) (0.95±0.19)	1.0	1.0 (±0.2) (0.97±0.19)	0.9 (±0.2)	0.6	1.0. (±0.2) (0.95±0.19)	0.9 (±0.2)	0.4
Six-Minute Walk (m)	435.7 (±115.0)	451.0 (±113.5)	0.4	435.7 (±115.0)	457.7 (118.2)	0.02*	451.0 (±113.5)	457.7 (118.2)	<0.06*

n = number of participants; mmHg = Millimetres of mercury; Bpm = Beats per Minute; kg = Kilogram; m = Metre; kg·m^2 = Kilogram-metre squared; cm = Centimetres; * = Significance; Two-sample t test with equal variances.

Table 4.5.5.2 Profiling the Control Group Across Baseline, Week 6, & 12

Variables:	Baseline (n=37)	Week 6 (n=30)	P Value	Baseline (n=37)	Week 12 (n=26)	P Value	Week 6 (n=30)	Week 12 (n=26)	P Value
	Baseline & Week 6 Mean (±SD)			Baseline & Week 12 Mean (±SD)			Week 6 & 12 Mean (±SD)		
Systolic BP (mmHg)	134.5 (±13.9)	134.6 (±11.6)	0.6	134.5 (±13.9)	136.8 (±12.0)	0.2	134.6 (±11.6)	136.8 (±12.0)	0.01*
Diastolic BP (mmHg)	79.1 (±7.7)	79.4 (±8.2)	0.6	79.1 (±7.7)	83.5 (±7.8)	0.01*	79.4 (±8.2)	83.5 (±7.8)	0.04*
Heart Rate (bpm)	82.5 (±15.1)	88.3 (±16.2)	0.01*	82.5 (±15.1)	84.0 (±14.0)	0.6	88.3 (±16.2)	84.0 (±14.0)	0.4
Body Mass (kg)	68.5 (±15.1)	68.2 (±11.1)	0.02*	68.5 (±15.1)	67.7 (±11.1)	0.01*	68.2 (±11.1)	67.7 (±11.1)	0.03*
BMI (kg·m^2)	26.1 (±5.6)	26.0 (±5.0) (25.94±4.97)	0.6	26.1 (±5.6)	25.9 (±4.8)	0.2	26.0 (±5.0) (25.94±4.97)	25.9 (±4.8)	0.8
Waist Circumference (cm)	95.9 (±16.7)	95.7 (±16.3)	0.1	95.9 (±16.7)	93.4 (±14.6)	0.1	95.7 (±16.3)	93.4 (±14.6)	0.5
Waist-to-Hip Ratio (cm)	0.9 (±0.2)	1.0 (±0.2) (0.96±0.19)	0.2	0.9 (±0.2)	0.9 (±0.2)	1.0	1.0 (±0.2) (0.96±0.19)	0.9 (±0.2)	0.7
Six-Minute Walk (m)	399.2 (±108.9)	400.3 (±98.4)	0.03*	399.2 (±108.9)	402.6 (86.1)	<0.02*	400.3 (±98.4)	402.6 (86.1)	<0.01*

n = number of participants; mmHg = Millimetres of mercury; Bpm = Beats per Minute; kg = Kilogram; m = Metre; kg·m^2 = Kilogram-metre squared; cm = Centimetres; * = Significance; Two-sample t test with equal variances.

4.6 DISCUSSION

The aim of this study was to identify whether exercise could effectively reduce BP and other targeted outcomes within a community-based intervention in the Umlazi Township, KZN. Guided by a Scoping Review, our intervention was uniquely designed, giving special consideration to the characteristics of FITT, aiming to assist hypertensive patients in managing HTN. Despite approximately 72% of older adults self-reporting the use of antihypertensive medication, only 30% achieve control (Fryar, et al. 2017; Virani, et al. 2020). Several studies, including those by Diaz and Shimbo (2013); Börjesson, et al. (2016); Bakker, et al. (2018); You, et al. (2018); and Dun, et al. (2021), have explored the relationship between PA as a non-pharmaceutical method for HTN management. Engaging in PA was associated with a decreased risk of CV mortality for individuals with high BP, while physically inactive individuals faced a higher risk of mortality (Sihombing, 2017; Okechukwu, 2020). Recognising these findings, it is evident that regular PA stands as an effective means to prevent and control HTN in older adults (Centers for Disease Control and Prevention, 2020).

Aligning with the WHO, 2020 PA guidelines, which recommend various types of PA, including aerobic exercises, muscle strengthening, and multicomponent activities for those with chronic conditions (Bull, et al. 2020; WHO, 2020), this study's intervention sought to implement a comprehensive exercise programme. While the recommended duration of aerobic PA aligns with established HTN guidelines (Pescatello, et al. 2015; Unger, et al. 2020), the specific duration for muscle-strengthening and multicomponent PA remains undefined (Wattanapisit, et al. 2022). In this study, the IG adhered to a programme comprising of 2 days/week of moderate-intensity exercise, spanning 35-45 minutes of warm-up, stretching, aerobic training, and 15-25 minutes of strength training using resistance bands and body weight. The participants were also encouraged to regulate their breathing patterns regularly and include rest sessions during exercise.

The FITT framework, as suggested by Wattanapisit et al. (2022), served as our guide, breaking down guidelines into specific components and emphasising the gradual increase of frequency, intensity, and duration to avoid adverse events. While the WHO, 2020 PA

guidelines offer a generic recommendation to gradually increase these components over time (Bull, et al. 2020; WHO, 2020), a sudden increase, particularly in intensity, should be avoided (Pescatello, et al. 2015), given the potential risks associated with significant increases in these parameters (Yang, 2019; Orchard, 2020; WHO, 2020). Also considering that patients with HTN may not be able to meet recommended PA levels instantly (Wattanapisit, et al. 2022).

More than 60% of adults worldwide do not reach the recommended level of PA (Adi, 2021). It is also worth noting that at certain ages, especially in old age, the organs of the human body experience a decline in functions such as muscle strength, bones, and CV function (Adi, 2021). Considering the significant CV risks associated with HTN, such as CV and cerebrovascular diseases and sudden death (Pedersen and Saltin, 2015), the 10% rule was applied to control the progression of training load in this study. The 10% rule limits the rate of progression to 10% increases per week, commonly used in sports training and adapted here for daily activities (Orchard, 2020). Factors such as BP control, changes in hypertensive medications, medication-related adverse effects due to PA, and the presence of end organ damage were considered in adjusting tailored PA strategies (Pescatello, et al. 2015). In our study, progression to the training programme was implemented after 4 weeks of exercise, deviating from the traditional 10% increment per week, as adaptation to exercise has been demonstrated after 4 weeks of regular activity.

4.6.1 Dynamics of Hypertension Management incorporating Physical Activity Interventions

Adequate and routine pre-exercise screening and monitoring, well-informed prescription of therapeutic exercise by qualified exercise professionals, and sufficient knowledge about potential interaction between exercise and antihypertensive medications are essential to a successful utilisation or administration of exercise for HTN in all clinical settings (Muhammad, et al. 2020). Recent experimental evidence from interventional studies (Herrod, et al. 2021; Byambasukh, et al. 2020; Arija, et al. 2018; Medina, et al. 2018; Lamina, et al. 2013) underscores the important role of regular PA in controlling HTN. In the study by Chen et al (2020), exercise intervention at baseline the mean SBP

and mean DBP were 141.9 mmHg (±18.7) and 77.1 mmHg (±12.5), respectively, while in this study the CG exhibited mean SBP and mean DBP of 146.6 mmHg (±21.6) and 78.9 mmHg (±11.2), respectively.

Analysing the IG over the entire study duration, our investigation revealed a consistent pattern in SBP, with no noticeable changes from baseline to weeks 6 and 12. However, a noteworthy contrast emerged in DBP ($p = 0.02$*). Specifically, a slight reduction of 0.9 mmHg was observed in week 6 compared to baseline, followed by a subsequent increase of 7.3 mmHg in week 12 when compared to week 6. Conversely, the CG demonstrated a significant alteration in SBP across all weeks ($p = 0.03$*), featuring a 0.1 mmHg increase in week 6 from baseline and a subsequent increase of 2.3 mmHg from week 12 compared to baseline. Additionally, the CG exhibited a noteworthy difference in DBP over the study duration ($p = 0.01$*), manifesting as a 0.3 mmHg increase in week 6 from baseline and a further increase of 4.1 mmHg in week 12 compared to week 6. The comparison between baseline and week 12 within the IG showed a decrease in the number of participants classified as hypertensive II, from 2 at baseline to none at week 12, suggesting lower CV risk; further supported by increase in cardiorespiratory fitness evidenced by the 6MWT. This enhanced aerobic capacity contributing to CV health and predictors of low mortality rates associated with CVD. This improvement reinforces the potential of comprehensive lifestyle intervention, especially in the improvement of PA in the PHC. While the observed changes in this study were modest, they suggest that over the first 6 weeks exercise-based interventions play a role in mitigating HTN. Although the IG did not show a significant reduction in BP over the 12 weeks, the observed implies a potential positive impact over time in managing HTN.

Evidence from previous studies supports the effectiveness of traditional exercise-based lifestyle interventions and PA conducted twice a week may not have been enough to see the type of changes expected. A three-month participation in such a programme produced a decrease in SBP of approximately 5 mmHg and DBP of 3 mmHg in older individuals (Herrod, et al. 2018). Okechukwu (2020) found that various exercise training programmes were equally effective in lowering BP among adults with normal BP, pre-HTN, and HTN.

However, if resistance training increases DBP more than 20 mm Hg over baseline or the DBP rises above 120 mm Hg, the programme should be reviewed (Ghadieh and Saab, 2015). It is therefore very important that exercise healthcare providers closely monitor patients to ensure compliance. The review by Rodrigues, et al. (2022) emphasises that various components of FITT influence BP reduction. Home-based endurance studies conducted for more than 12 weeks have shown significant reductions in BP with different exercise intensities. Mandini, et al. (2018) found that participants with higher resting SBP experienced greater reductions following a walking-based intervention.

Physical activity can change both SBP and DBP, however the patterns of these changes vary based on the FITT applied, as well as the individual's health status and the presence of comorbidities beyond HTN. The mechanisms underlying reduced BP may vary depending on the home-based exercise protocol (i.e., endurance, isometric, and breathing training) (Rodrigues, et al. 2022). These findings collectively contribute to our understanding of the defined relationship between PA interventions and BP regulation in hypertensive individuals. Diastolic BP often remain stable, decrease, or have a slight increase, the increase happens during strength training. The DBP can increase, due to the muscular contraction work against the resistance, increasing the vascular resistance, which may lead to an overall increase in BP. The methodology for this study obtaining BP measurements may not have perfectly captured resting values, as participants were required to walk to the venue where the exercise activities were conducted. This movement could potentially elevate BP readings temporarily, which was not factored, suggesting the need for a protocol that ensures true resting conditions are met before measurements are taken. The usage of ambulatory BP monitoring over a 24-hour period could also be used to obtain a more accurate reading.

On the other hand, PA plays a crucial role in the sympathetic nervous system by slowing down HR, which reduces peripheral resistance and lowers BP (Utami and Kusumaningrum, 2021). In the current study, there were no significant differences in HR between the IG and the CG at any of the testing points: baseline, week 6, and week 12. Within the IG, however, significant differences in HR were observed over the testing

weeks: baseline, week 6, and week 12 (<0.01*). Specifically, there was a significant increase in HR from baseline to week 6 ($p < 0.04$*), with an average increase of 7.1 bpm. Additionally, a significant increase was noted between baseline and week 12 ($p < 0.02$*), with an average increase of 9.8 bpm. These findings contrast with the consensus in the literature, which generally suggests that regular PA chronically reduces pressure levels (Brown, et al. 2013) and improves cardiac autonomic modulation in hypertensive subjects (Cozza, et al. 2012; Trevizani, et al. 2018). In the CG, there were no significant HR differences across all testing weeks. However, when examining the weeks individually, there was a significant increase in HR from baseline to week 6 ($p = 0.01$*), with an average increase of 5.8 bpm. This trend of increasing HR was expected in the CG, as they did not participate in any PA intervention. This observation aligns with Badr, et al. (2021), who reported that physically inactive or relatively active individuals are more likely to exhibit one of the leading risk factors for noncommunicable diseases and mortality.

4.6.2 Interplay of Physical Activity, Body Weight, and Hypertension

Overweight and obesity stand as pivotal risk factors influencing the onset of HTN (Rhee, et al. 2018). Regular PA plays a crucial role in reducing excess weight, enhancing CV efficiency, and fostering overall psychological well-being (Tiziana, et al. 2017). Home-based endurance training, as demonstrated by Farinatti, et al. (2016), has proven effective in reducing weight, WHR, and body fat in hypertensive patients, contributing to the observed reductions in BP. Although our study did not specifically investigate dietary habits, it is important to note that the baseline overweight status, as assessed through both BMI and WHR, persisted uniformly within both the IG and CG, without any statistically significant changes. Even in the presence of small changes in body weight, these findings highlight the importance of considering dietary interventions in combination with exercise for achieving considerable weight loss in individuals with HTN, as emphasised in previous research (Jensen, et al. 2014).

Interestingly, significant within-group differences ($p = 0.01$*) in body mass were exclusively noted in the CG across all testing weeks (baseline, week 6, and week 12). These differences manifested as increases in body mass, indicating a negative trend.

Conversely, the IG did not exhibit significant changes in body weight within the weekly assessments, suggesting that the IG's body weight was better maintained compared to the CG throughout the study. This underscores the importance of PA for overweight and obese individuals in achieving and maintaining ideal weight and reducing the risk of HTN (Díaz-Martínez, et al. 2018). Sousa Junior, et al. (2020) reported no significant improvement in the metabolic profile and body composition of participants following a 12-week PA intervention. The study duration, considered short-term (<12 weeks), may not be sufficient to enhance cardiorespiratory fitness, as observed in other studies (Jurio-Iriarte and Maldonado-Martín, 2019). High-intensity interval training interventions may be more effective in improving aerobic capacity over longer durations (>12 weeks). These findings align with Bravata, et al. (2007), who demonstrated that a pedometer-measured increase in PA did not correlate with improvements in metabolic profiles, emphasising the need for a comprehensive understanding of exercise programmes and their impact.

Despite the modest impact on metabolic profiles, exercise has been recognised for its CV benefits. Jurio-Iriarte, and Maldonado-Martín, (2019) revealed that structured and supervised PA training significantly increased cardiorespiratory fitness, particularly in participants engaging in moderate-intensity continuous training and high-intensity interval training. Notably, home-based exercises may present unique advantages, with Rodrigues, et al. (2022) suggesting greater progress per week for obese adults compared to those attending gym-based exercise groups. While the role of exercise in reducing CV risk is acknowledged, questions persist regarding the optimal duration and intensity required for maximal CV protection. Further research is needed to understand the FITT components of exercise treatment for HTN and overweight/obese individuals, aiming for generalisable results that will inform evidence-based recommendations for exercise training in the hypertensive population (Jurio-Iriarte and Maldonado-Martín, 2019; Rodrigues, et al. 2022).

This study did not account for variations in the participants' diets, which may have undergone significant changes during the COVID-19 pandemic, potentially influencing their response to the exercise intervention. Diet plays a significant role in BP management

and CV health. The lack of control or consideration for dietary differences among participants, especially given the potential changes in eating habits during the COVID-19 pandemic, introduces a confounding variable that may affect the results. This oversight highlights the importance of considering dietary habits, as the pandemic has been shown to impact both PA levels and nutritional choices, affecting overall health outcomes.

4.6.3 Optimising Physical Activity Prescriptions for Hypertension

To achieve recommended moderate to vigorous PA levels, minimising sedentary behavior, particularly sitting time, is important (Sousa Junior, et al. 2020). Physical activity prescriptions should adhere to the FITT principles (Eicher, et al. 2010), emphasising the need for individualised exercise prescriptions for hypertensive patients (Ghadieh and Saab, 2015). It's crucial to recognise that the hypotensive response to exercise is influenced by various factors, including exercise duration and type (but not intensity), as well as individual clinical status, age, ethnicity, and physical fitness (Eicher, et al. 2010). Moreover, genetic variations, hypertensive pathogenesis, and pharmacological factors contribute to the diverse BP responses to exercise in hypertensive patients (Ruivo and Alcântara, 2012), underscoring the potential of PA in reducing the risk of HTN progression and increasing the likelihood of HTN remission in prehypertensive individuals (Cai, et al. 2021).

Building upon the work of Aslan, et al. (2018), our study investigated the association between 6MWT distance, PA levels, and inspiratory muscle strength in hypertensive patients. While no significant differences were observed between the IG and CG at baseline and week 6, a notable difference emerged at baseline and 12 in both the ($p = 0.02^*$). Intra-group analyses revealed significant changes within the IG, with a 22 m increase between week 1 and week 12 and a 6.7 m increase from week 6 to week 12. The CG exhibited similar trends, but with less pronounced increases. A comprehensive evaluation of all three time points (baseline, week 6, and week 12) within the CG revealed significant differences ($p = 0.01^*$), with noteworthy increases between various intervals. These findings highlight the positive impact of PA on functional capacity, particularly in the CG.

Sousa Junior, et al. (2020) expanded on step count as a measure of PA, the IG group demonstrated an increase in steps per day and a trend toward reduced sitting time, indicative of healthier movement behavior. However, Tudor-Locke, et al. (2008) observed that although hypertensive adults increased their daily step count, they did not transition from a sedentary to an active lifestyle. Similarly, as reported by Sousa Junior, et al. (2020), noted a modest increase of ~800 steps per day and a trend toward a ~2-hour decrease in sitting time in the IG group. Interestingly, these changes were not associated with significant reductions in BP or improvements in metabolic profile and body composition, potentially suggesting challenges in maintaining PA goals post-intervention.

Exploring different PA intervention approaches, Kolt, et al. (2012) compared the effectiveness of time-based versus pedometer step-based PA programmes in low-active older adults. While both interventions demonstrated improvements in PA levels, the pedometer step-based approach resulted in increased leisure walking. This aligns with the findings of Jurio-Iriarte and Maldonado-Martín (2019), emphasising that longer and more intense interventions tend to yield greater improvements in physical fitness. The intervention frequency, set at twice weekly, may not have been sufficient to elicit significant changes in BP among participants with HTN. Guidelines from health Organisations often recommend more frequent PA for managing HTN (Williams, et al. 2018). The supervised PA intervention programme of 9-month duration, with a walking group of 120 min / week and with sociocultural activities, increased PA, reduced the CVD risk and SBP, and increased the health-related quality of life scores in the physical component summary and its domains and in the vitality of the mental component (Arija, et al. 2018). Therefore, our study underscores the importance of tailoring PA interventions for hypertensive patients, considering individual characteristics and optimising the FITT principles. Recognising the complexities of maintaining behavioural changes post-intervention, ongoing support, and strategies to sustain PA engagement merit further exploration for long-term HTN management.

The principle of the new normal COVID-19 also affected how people continued to carry out their daily activities like before the pandemic but must adapt to health protocols as an effort to break the chain of spreading COVID-19 (Adi, 2021). These health protocols included the obligation to use a mask when outside the house and maintain a social distance of at least 1 meter when carrying out various activities, to name a few (Adi, 2021). The implementation of COVID-19 lockdown measures in SA between March and May 2021 presented substantial challenges in sustaining regular PA. Movement restrictions significantly limited opportunities for exercise, potentially influencing the outcomes of this study. The enforced home confinement led to increased stress levels and a reduction in leisure activities. Consequently, this heightened stress triggered the release of stress hormones such as adrenaline and cortisol, altered vagal tone, and led to physiological changes including elevated resting HR and BP. Although there was an attempt to increase the volume of exercise through the intervention, it may not have compensated for the overall reduction in daily PA levels caused by lockdowns, and it appears this was insufficient to counteract the broader impact of lockdowns on PA levels. This context underscores the need for innovative strategies to promote PA under such constraints, particularly for individuals with HTN, to achieve meaningful physiological improvements.

4.7 STRENGTHS AND LIMITATIONS

This intervention in Umlazi Township, KZN effectively generated increased PA among hypertensive participants, fostering a lifestyle that promises enduring benefits for their overall well-being. Beyond promoting individual health, the initiative created a sense of community, promoting mutual support in managing HTN. Maintaining this lifestyle within HC facilities holds substantial potential for preventing and minimising complications associated with HTN, such as strokes. The programme, characterised by inclusivity and tailored considerations for factors like age, fitness level, and other health conditions, aimed to enhance the overall participant experience.

The observation highlights a critical limitation in the study's design and methodology, underscoring the importance of considering participants' comprehensive medical history, medication usage, and coexisting health conditions in research. This oversight could

significantly affect the study's findings, as such factors might influence participants' engagement in the intervention and its outcomes. For instance, certain medications or underlying health conditions could either enhance or diminish participants' ability to participate fully in the intervention, potentially skewing the results. Furthermore, without accounting for these variables, it becomes challenging to generalise the findings to broader populations, as the impact of the intervention might vary significantly among individuals with different health backgrounds.

To ensure participant safety and prevent potential harm, a series of careful precautions were implemented: (1) Prior health screenings assessed individual health conditions and identified pre-existing medical concerns. (2) Monitoring vital signs, including HR and BP, before each session, ensured ongoing assessment for prompt identification of adverse reactions or signs of distress during PA sessions. (3) Professional supervision by trained experts oversaw PA sessions, ensuring correct and safe exercise performance, thereby minimising the risk of injuries. (4) Gradual progression to the PA programme incorporated a model that allowed participants to incrementally build up exercise intensity and duration over time, facilitating the body's adaptation to increased PA levels and reducing the risk of overexertion. (5) Open communication channels encouraged participants to express any discomfort, pain, or concerns during PA sessions, fostering a supportive and responsive environment.

It is noteworthy that this study did not delve into the comprehensive medical histories of participants, including details about medications, duration of usage, and other relevant health conditions that could impact their engagement in the intervention. While primary HC facilities commonly prescribe similar medications for comparable conditions, this assumption was not validated. Ideally, a thorough consideration of the participant's medical history, documented through clinical visits and HC records, would have provided a more comprehensive understanding. Examining reasons for participant dropout and considering the impact of COVID-19 on the programme informed adjustments for better engagement and future programme success. Logistical, social, and personal barriers may have contributed to participant dropout, highlighting the importance of enhanced

communication to understand participant expectations, potential challenges, and long-term benefits. Clear communication could have aided participants in better navigating the programme, reducing the likelihood of dropout. Furthermore, it's crucial to acknowledge that the study's findings are specific to the participants involved and may not fully represent the broader hypertensive community in Umlazi Township, KZN.

4.8 CONCLUSION

The 12-week PA exercise programme, implemented twice a week, yielded moderate changes within this hypertensive study population. Nevertheless, there is a theory that extending the PA duration beyond 12 weeks and increasing session frequency to at least three times a week could yield more significant differences, particularly in reducing both SBP and DBP, as well as body weight. It remains imperative for hypertensive individuals to adhere to their prescribed pharmaceutical interventions under HC professionals' guidance. Moreover, the incorporation of a comprehensive, long-term PA programme comprising of aerobic, strength, and flexibility exercises is strongly recommended. Undoubtedly, regular PA not only contributes to weight management but also limits injury risk, enhances flexibility, and elevates the basal metabolic rate. The reduction in body weight achieved through PA can significantly enhance HTN management.

However, acknowledging these limitations and considering their implications for the study's results is Important. They highlight the complexity of conducting research in real-world settings, especially during a global pandemic and in specific populations, where specific contextual interventions may have different outcomes. The COVID-19 pandemic may have influenced leisure time activity, stress, diet, immunity and unknown factors that affected this specific study. Despite the elevated diastolic blood pressure, potential benefits were also realised in cardiorespiratory fitness. Increasing awareness of risk factors and physical activity may have positive long-term benefits. Addressing these issues in future research could lead to more definitive conclusions about the impact of exercise on BP and overall CV health during times of restricted movement and altered lifestyles.

Future research should aim to collect detailed medical history, medication usage, and information on any coexisting health conditions from participants. This approach would enable a more detailed analysis of how these factors might interact with the intervention, leading to more robust, applicable, and generalisable findings. Additionally, understanding these interactions can help in tailoring interventions more effectively to meet the needs of diverse populations, in turn enhancing the efficacy and applicability of health-related interventions. Encouraging the development of more individualised exercise programmes is also important. This approach ensures interventions align with the unique needs of each hypertensive patient, fostering a more personalised and effective strategy. This should differentiate between controlled and non-controlled HTN PA interventions, shedding light on the distinct roles that PA plays in these respective groups.

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CHAPTER 5 - THE ROLE OF FAMILY INVOLVEMENT IN ASSISTING WITH HYPERTENSION MANAGEMENT

5.1 INTRODUCTION

Hypertension (HTN) is a persistent health condition necessitating continuous management (Li, et al. 2013). Despite the availability of effective antihypertensive drugs, low- and middle-income countries (LMICs) exhibit dismal blood pressure (BP) control rates, contributing to a disproportionate number of deaths from elevated BP compared to High-income countries (HICs) (Irazola, et al. 2016; Chacko and Jeemon, 2020). The comprehensive management of HTN demands a combination of pharmacological interventions and lifestyle modifications (Chacko and Jeemon, 2020). Notwithstanding effective therapies, approximately half of adults with HTN still struggle to achieve optimal BP control (Magid and Green, 2013; Mozaffarian, et al. 2016), involving significant daily efforts such as medication adherence, BP monitoring, and lifestyle adjustments (Chobanian, et al. 2003).

Poor medication compliance hinders the realisation of treatment goals, leading to uncontrolled BP, frequent medical visits, diminished quality of life, and increased medical costs (Vervloet, et al. 2011; Maslakpak, et al. 2018). Successful HTN management is crucial for prevent premature deaths and associated disabilities (Chacko and Jeemon, 2020). Achieving long-term BP control requires interventions encompassing training, reminders about medication, medical appointments, and follow-up to bolster adherence and persistence on treatment (Bobrow, et al. 2014). However, the demands of lifestyle changes and coping with HTN management may potentially elevate the risk of developing mental disorders, such as anxiety and depression (Hamer, et al. 2010; Johansen, et al. 2012).

Given the difficulty of HTN management and the potential coexistence of mental disorders, many hypertensive patients may benefit from additional support (Li, et al. 2013). Family support plays a pivotal role in disease control, as patients often require support from family, friends, and professional organisations (Hogan, et al. 2002; Gorman

and Sivaganesan, 2007; Tarigan and Syarifah, 2021). Motivation and positive health-related attitudes thrive when the family, as a social network, encourages behaviours conducive to health (Costa Rdos and Nogueira, 2008), serving as a facilitator of treatment adherence (Barreto and Marcon, 2014).

The components and relative significance of family support may vary across individuals and medical conditions (Li, et al. 2013). The body of literature indicates that higher levels of family support correlate with increased frequency of self-care behaviours in patients (Mollaoglu, 2006; Baumann and Dang, 2012). The positive influence of families on disease control is evident through family relationships, attention to offspring, and active involvement in patient care (Efendi and Larasati, 2017). While some studies narrowly define "family," typically as one other person within the same household, broader consideration of the familial network may yield richer insights (Jiang, et al. 2002; Torenholt, et al. 2014).

Incorporating family members into training programmes can enhance their understanding of hypertensive patients' needs, facilitate adherence to treatment plans, and provide essential care support (Hinkle and Cheever, 2015). Family support embodies intricate social ties that may be challenging to objectively define and measure (Li, et al. 2013). Nevertheless, clinics catering to low-income and underrepresented minorities may find significant value in engaging families in chronic disease management (Fort, et al. 2020). Conversely, self-care, defined as the capacity of individuals, families, and communities to promote health, prevent disease, maintain well-being, and cope with illness and disability, emerges as a crucial determinant for achieving optimal BP control at the individual level (Chacko and Jeemon, 2020; World Health Organisation and Asia RO 2020).

5.1.1 Aims and Objectives

The objective of this study was to investigate the impact of family involvement in supporting HTN management.

The overarching aim of this study was to explore the extent of the role family involvement plays in assisting with HTN management, specifically in enhancing the family's understanding of HTN and its management. Consequently, the study had the following objectives:

a. To assess the level of understanding within families regarding what HTN is.
b. To explore the understanding that families have in the management of HTN.

5.2 METHOD

5.2.1 Study Design and Sample Population

This study explored the role played by family members in managing HTN within the townships of SA is an underexplored area in current research. This study adopted a qualitative research approach to gain a theoretical understanding and describe the comprehension of HTN among family members, as well as their involvement in assisting with HTN management of hypertensive patients. Employing a grounded theory method for qualitative inquiry, the study aimed to understand insights from the experiences and perspectives of participants.

The participants were purposefully selected through in-depth conversations with individuals involved in the intervention study groups (intervention and control). Recruitment efforts were concentrated in Umlazi Township, KwaZulu-Natal (KZN), with active engagement from the study groups. Umlazi Township, situated in the southwestern region of Durban, is recognised as one of the largest townships in SA, following Soweto (Mullick, et al. 2005; Ngubane, 2014). Falling under the eThekwini Metropolitan Municipalities (Statistics SA, 2016), Umlazi Township represents an urban area with distinctive characteristics relevant to the study of family involvement in HTN management.

5.2.2 Inclusion and Exclusion Criteria Included

The selection of participants for this research adhered to specific criteria, ensuring relevance to the study objectives. The inclusion criteria encompassed: a) Identification of the closest family member, emphasising intra-family social capital, as elaborated in

Section 5.1.1 Aim and Objectives; b) Co-residence with the participants within the same household; c) Age requirement of 18 years and above; and d) Inclusion of hypertensive study participants recruited for objective 2 (IG and CG participants). Conversely, participants were excluded based on the following criteria: a) Family members with significant cognitive impairments that prevent meaningful engagement. b) Individuals with severe mental health conditions that interfere with participation. c) Family members who are unwilling or unable to participate in the study activities. d) Individuals who have a conflicting role or relationship with the participant that could bias the study results.

5.2.3 Data Collection Procedure

Twenty potential participants expressed their intention to take part in this segment of the study, encompassing both family members and hypertensive patients. Out of these, 15 participants met the specified inclusion criteria. Participants were provided with an information sheet and requested to review it thoroughly, followed by the signing of the consent form (refer to Appendix A). The consent form outlined the study's purpose, participation requirements, data collection methods, and the participant's agreement to partake in the study.

Nine participants returned the signed consent forms and made themselves available for individual interviews. Six participants were females, and the remaining three participants were male. Out of these, five participants belonged to family units, while the other four were involved in the PA intervention groups (IG and CG). It's noteworthy that all participants from the PA intervention groups had familial connections with other participants. Contact was established with participants to arrange interview sessions, during which the date, time, and location were finalised. In-person interviews, recorded for accuracy, spanned approximately 30 to 60 minutes, contingent upon the depth of discussions with participants. Both participants and their respective family members underwent interviews, though on separate occasions. The interview questions were tailored and guided by responses provided during the interview process.

Conducted within a two-week timeframe from initial contact, the interview sessions included a comprehensive overview of the study to ensure participants' understanding and reasonable expectations. Questions focused on the nature of their involvement in or contributions to HTN management. Additionally, questions were posed in a language comfortable for participants, IsiZulu. Employing open-ended questions, the researcher utilised probing techniques to explore areas deemed beneficial for the study and subsequent analysis. Interviews unfolded organically, with participants informed that the session might extend beyond the initially anticipated 30 to 60 minutes, depending on the need for thorough exploration.

5.3 ETHICAL CONSIDERATIONS

The research design and procedures of this study underwent ethics by the Human Research Ethics Committee (Medical) at the University of the Witwatersrand, receiving approval with the ethics certificate number M190442. Additionally, the study was reviewed by the Faculty of Health Sciences Protocol Review Committee as an structural component of the broader Doctor of Philosophy project. Throughout the confirmation of their participation, participants were explicitly informed on multiple occasions that all interviews would be recorded and that these recordings would be securely stored for future research work. To uphold confidentiality, participants' recorded interviews and corresponding transcripts were carefully maintained in a secure and confidential location. This assurance was specifically outlined in the consent form provided to and acknowledged by the participants.

5.4 DATA ANALYSIS

This study employed Framework Analysis, a method described as an inherently comparative form of thematic analysis, utilising an organised structure of inductively- and deductively-derived themes—a framework. Rooted in cross-sectional analysis, this approach aimed to identify, describe, and interpret key patterns within and across cases, focusing on the family involvement role in assisting with HTN management. The overall objective was to ground the analysis in the data, ensuring a comprehensive interpretation. Framework analysis involves two major components: creating an analytic framework and

applying this framework through five steps: (1) Data Familiarisation; (2) Framework Identification; (3) Indexing the study data against the framework; (4) Charting to summarise the indexed data; and (5) Mapping and interpretation of patterns found with the charts.

The recorded data underwent accurate transcription using the Simon Says A.I transcription/translation site, a versatile transcription software solution compatible with various languages, including IsiZulu and English. The software facilitated the translation of IsiZulu language data into English, resulting in a final transcript and translation stored in a Word Document. To ensure the validity of identified Themes and Codes, a data services librarian at the University of the Witwatersrand, East Campus, Wartenweiler Library reviewed and confirmed the researcher's findings. Discrepancies were addressed through discussion, and revisions were made to achieve consensus. Data generated from interviews were approached interpretively, focusing on patients' and family members' experiences, perceptions, and sense-making related to the discussed topics. Coded words were assigned to every sentence, allowing key and sub-themes to emerge, which were then grouped into broader categories: (i) HTN understanding; (ii) family support; (iii) response to emergencies; and (iv) importance of PA. In instances where participants mentioned names, anonymity was preserved by replacing names with generic pronouns (him/her, he/she).

Step 1: Data Familiarisation

Initially the researcher familiarised with the data to purposefully understand the data collected by transcribing the recordings into written form. When the native language (isiZulu) was used, it was then translated into English by the researcher. Coding was also included in this process and deciding to use deductive coding made sense based on already predetermined themes created from the objective and interview questions.

Step 2: Framework Identification

The researcher used this phase to move from concrete descriptions of themes in the data to the identification of more abstract concepts, to create a framework for the analysis and the resulting interpretation. The researcher then grouped and ordered these themes into

a way that helped address the focus of the objective: family involvement in assisting with HTN management.

Step 3: Indexing the study data against the framework

In this step assumption that a reasonable framework was identified, so the researcher systematically applied the framework to all the transcribed data. This step also provided an important opportunity for the framework revision to all the framework and all the data identified, to assess how well the framework worked with and for the study data.

Step 4: Charting to summarise the indexed data

This step of the analysis the researcher used as a process of abstracting the now indexed data, so that it could be examined systematically and in totality. The researcher had an opportunity to revisit and enhance decisions made in the earlier steps around the appropriate analysis: the appropriate level of data abstracted, and the adequacy of the framework for the data used. The researcher used a pen and paper to chart the objective question and the developing analysis to ensure there is sufficient order on what used for the analysis and framework components on the chart.

Step 5: Mapping and Interpretation

Comparing across and within units of analysis and the framework, the researcher interpreted patterns of interest, providing a holistic understanding across the entire dataset. This final step synthesised the outcomes of the previous steps and offered comprehensive insights into family involvement in HTN management.

5.5 TRUSTWORTHINESS

The researcher adhered to Guba's (1981) trustworthiness model, specifically designed for qualitative studies. Guba (1981) describe four crucial aspects within a realistic model to establish trustworthiness: (1) credibility; (2) transferability; (3) dependability; and (4) conformability.

(1) Credibility: Recognising the diverse and rich nature of each participant's lived experiences, the researcher aimed to preserve the essence of these experiences during data analysis (Guba, 1981). In cases where participants responded in languages other than English, such as IsiZulu, direct translation was conducted to ensure accurate

representation. An additional layer of confirmation involved having someone else review and validate the identified Themes and Codes, addressing any potential oversights. ***(2) Transferability:*** Acknowledging that individual experiences are naturally unique and may not be universally applicable, the researcher considered the limited transferability of findings. Nonetheless, certain aspects could be deemed transferable, especially given the purposeful selection of the participants. ***(3) Dependability:*** While maintaining a consistent basic structure during data collection, the researcher acknowledged potential variations in the interview process and question flow based on dynamic interactions with each participant. This adaptability sought to accommodate the uniqueness of each participant's experience. ***(4) Conformability:*** The data interpretation presented above aimed for clarity, with the researcher acknowledging a level of inherent bias due to prior interactions during the intervention groups period. Despite the impossibility of complete neutrality, the study emphasised transparent and accurate representation of participants' experiences and understanding of HTN throughout the research process.

5.6 RESULTS

The study comprised a total of nine participants, with a majority being female (n = 6), and the remaining three participants being male. Out of these, five participants belonged to family units, while the remaining four were involved in the PA intervention groups (IG and CG). It's noteworthy that all participants from the PA intervention groups had familial connections with other participants. The qualitative findings of the study are systematically categorised into four distinct typologies: (a) Hypertension Understanding; (b) Family Support; (c) Level of Knowledge of HTN Complications; and (d) Knowledge of the Importance of Non-pharmaceutical Management of HTN. The participants' insights and perspectives are presented through direct quotes, each attributed to the participant's number, family member or intervention groups affiliation, and gender. This approach ensures a clear and organised presentation of the qualitative findings.

Theme 1: Hypertension Understanding:

What is your understanding of what HTN is? Why do you think it is so bad for us? Do you know how check your own BP?

The majority of participants indicate a fundamental understanding of HTN, although their comprehension fell short of taking into account of the important details of its physiological impact on the body. While recognising the involvement of BP, their awareness centred on the potential risk primarily to the heart, rather than other organs. In terms of monitoring BP, only two participants, part of the same family, asserted their ability to conduct BP checks, benefitting from the daughter's nursing profession and access to the necessary equipment. On the other hand, the remaining participants relied on Primary Healthcare (PHC) facilities for BP assessments, with each participant routinely having their BP checked during clinic visits.

“Ukucindezela kwegazi, ukuthi lingakwazi ukufika ezindaweni zonke emzimbeni. Nenhliziyo ingcine isinencindezi yokuthi ishaye kakhulu ukuze igazi lisabalale. Angazi noma ngichaze kahle yini.”
“[Hypertension is] Pressure of the blood, that it cannot reach all parts of the body. And the heart finally has the pressure to beat hard to spread the blood. I don't know if I explained it well.” (Participant 5, Intervention Participant, Female)
“Isifo esingenazo izimpawu ezitheni. Kodwa esisondeleni nenhliziyo kakhulu. Isifo esikubulala sithule.”
“Having a problem with blood vessels. It puts the heart at risk, and fatigue.” (Participant 7, Family member (daughter), Female).

Theme 2: Family Support:

How can you help to make managing HTN easier? How has your family done to help make it easier for you?

There exists a range of family support dynamics, ranging from instances where family members lack awareness of their role in assisting the management of HTN to assumptions that attending clinics and adhering to medication demands for effective HTN management. In certain cases, there is a misconception that active involvement is unnecessary.

“Yini kodwa engayishintsha mina? Impilo isaqhubeka ngokujwayekile nje. Umehluko ukuthi usedla imishanguzo yesifo somfutho wegazi eliphezulu.”
“What can I change? Life goes on as usual. The difference is that she [hypertensive family member] is taking medication for high blood pressure.” (Participant 9, Family member (husband), Male)

On the other hand, part of participants experienced substantial support, driven either by family members possessing a heightened understanding of HTN or prompted by health crises, such as hospital admissions resulting from HTN complications and blood clotting. In these instances, family members recognised the important role of support they needed to play, ensuring the hypertensive patient's adherence to medication, to a complete daily meal plan, timely medication intake, and attendance at scheduled clinic appointments.

“Emva kokulaliswa esibhedlela, bayazihlupha ukuthi ngiyaphuza kahle yini amaphilisi. Bangiphekela nephalishi ekuseni, bangikhumbuze ukuthi ngingaphuzi kakhulu. Kahle kahle nje, bangiphathisa okwengane.”
“After being hospitalized, they [family] worry about whether I am taking the pills correctly. They also cooked me porridge in the morning and reminded me not to drink too much. Well, they treated me like a child.” (Participant 4, Intervention Participant, Male)

Theme 3: Level of Knowledge of Hypertension Complications:

What complications do you think that can be caused by HTN? If they were to be in a position to have complications due to BP, would you know which medication to give them from their prescribed medication?

There were differences in the participants' knowledge levels regarding complications associated with HTN. The participants working within the HC system and individuals who had personally experienced HTN-related complications demonstrated a greater understanding. They recognised the potential for stroke caused by blood clotting and the thinning of blood vessels throughout the body. Additionally, a limited number were aware of the impact on vision and the likelihood of headaches. However, some participants,

while making assumptions in the correct direction, expressed uncertainty about the accuracy of their understanding.

“Ngazikahle nje, engingakwenza. Kungaya ngokuthi iyiphi inkinga abhekene nayo. Kodwa kona ngoba nguwunesi, nginalo ulwazi.”
“I do have knowledge of what I can do. It depends on what problem she [mother] is faced with. But, because I am a nurse, I have knowledge of what to do. (Participant 7, Family member (daughter), Female)”

Conversely, a significant portion of participants believed that HTN could lead to various complications. However, in the event of complications, they lacked detailed knowledge about the initial steps to take, aside from a general awareness that calling an ambulance or taking the hypertensive patient to the clinic were appropriate responses. Regarding the association between HTN and stroke, many expressed uncertainties and doubted this connection, as the prevailing assumption among them was that strokes were associated with other health issues rather than HTN.

“Angicabangi ukuthi bayatshelwa ukuthi umndeni ungasiza kanjani, mina angazi kodwa kuba ukuthi inkinga ikuphi noma iyiphi emvelele.”
“I don't think they are told how the family can help, I don't know but it is where the problem is and which one is prominent. (Participant 1, Family Member (daughter), Female)”

Theme 4: Knowledge of the Importance of Non-pharmaceutical Management of Hypertension:

What important changes do you think you need to make in order to manage your HTN? Do they follow any specific diet to manage their HTN? Do you know how smoking and drinking too much alcohol can affect their management of HTN?

The majority of participants demonstrated an understanding of the important role played by non-pharmaceutical management in HTN. Specifically, the emphasis was placed on hypertensive patients managing weight through dietary choices and PA. However, the implementation of these measures presented challenges, notably related to issues of

motivation and the practical difficulties of altering dietary habits, especially when economic implications were a concern. Instances were noted where family members were unwilling to change their diets to accommodate the dietary needs of one individual. While some participants mentioned efforts to reduce salt intake during cooking and eating, their knowledge about the role of salt intake in HTN and its potential impact on managing HTN was limited.

“Ngicabanga ukuthi ukuphuza kakhulu utshwala ungadlile, noma ungcine usukholwa ukuphuza amaphilisi kahle… Lapho, ngabe ngiqamba amanga. Angazi bandla ukuthi ukubhema kudlala yiphi indima.”
“I think that drinking too much alcohol without eating, or finally believing that taking pills is good… There, I would be lying. I don't know, dear. I don’t know how smoking play which role.” (Participant 6, Family Member (daughter), Female)

Nevertheless, participants showed a limited understanding of the significance of reducing excessive alcohol intake and stopping smoking habits in the context of HTN. The connection between alcohol consumption, smoking, and their potential impact on HTN management seemed unclear to several participants. Additionally, some individuals expressed a unenthusiastic to make lifestyle changes, doubting the perceived effectiveness of such changes in managing their own HTN or that of their family members.

“Cha bandla, angibulokothi utshwala... Nakho futhi, angibhemi. Inkinga yami enkulu nje ukudla okucebile kanye nokunosawoti.”
“No dear, I never drink alcohol... Also, I don't smoke. My biggest problem is rich and salty foods.” (Participant 3, Intervention Participant 3, Female)

5.7 DISCUSSION

The aim of this study was to investigate the depth of the role played by family involvement in assisting with the management of HTN, specifically in terms of comprehending the nature of HTN and the strategies employed for its management. Pioneering in SA, this study aimed to assess whether families understand the difficulties of HTN and to indicate

the extent of their understanding in effectively managing the condition. Recognising the important role of family support in enhancing adherence to self-care practices, the study aligns with existing literature emphasising the significance of family support in achieving optimal BP control among individuals with HTN (Chacko and Jeemon, 2020; Tarigan and Syarifah, 2021). Despite limited knowledge regarding the determinants of family structure (Blau and Van Der Klaau, 2013), there is a prevailing perspective, especially among family researchers and policymakers, that views the married two biological-parent family as the ideal standard (Brown, 2010). However, family functioning, encompassing emotional bonding, effective communication, and cooperative problem-solving (Epstein, et al. 1978; Olson and Gorall, 2003), is recognised as a more refined aspect of family dynamics.

The South African (SA) General Household Survey of 2019 highlighted that household compositions are influenced by the residential patterns of its members and their relationships (Statistics SA, 2021). Nationally, approximately 39.9% of households were categorised as nuclear (couples or one or more parent(s) with children), while 34.2% were broadly classified as extended households (nuclear core combined with additional family members) (Statistics SA, 2021). Only 2.4% of households fell into the complex category, indicating the presence of non-related persons (Statistics SA, 2021). Notably, nuclear households were prevalent in families with one or two children (55.0% and 51.3%, respectively), while extended households were more common in larger families with three children (57.9%), four children (74.7%), and more than four children (84.5%) (Statistics SA, 2021).

Although the involvement of family members in supporting patients with self-care behaviours is acknowledged, the optimal approach to engage families in this context remains unclear (Fort, et al. 2020). Incorporating family members into patient care has demonstrated improvements in chronic disease self-care and management (McDaniel, et al. 2005; Rosland, 2009). Recognising the positive impact of family support on self-care behaviours and mental health, there is a growing agreement among researchers to integrate family social support into the management of chronic diseases like HTN

(Rosland and Piette, 2010; Cornwell and Waite, 2012). Family involvement plays an important role in HTN treatment, fostering acceptance of self-care practices such as maintaining a proper diet, adhering to medication regimens, and engaging in physical activity (PA) (Maslakpak, et al. 2018). Importantly, family support is linked to medication adherence, indicating its potential to impede the progression of HTN and enhance the success of therapeutic interventions (Susanto, 2015).

The investigation identified four thematic areas encompassing overall perceptions of family support in HTN management and how hypertensive patients perceive the support they receive. These themes centre around understanding HTN, assessing both positive and negative dimensions of family support, evaluating the level of knowledge regarding HTN complications, and assess the understanding of the importance of non-pharmaceutical management in the context of HTN.

5.7.1 Hypertension Understanding

The hypertensive patient's level of awareness regarding the physiological complexity of their condition appears to correlate positively with their ability to effectively manage it. Consistent with findings from other studies, it is imperative to acknowledge potential confounding variables, including uncontrollable factors such as the cultural background of patients and their families, as well as their motivation to comprehend HTN (Maslakpak, et al. 2018). Echoing this sentiment, the study conducted by Tarigan and Syarifah, (2021) insist that knowledge encompasses the information or understanding possessed by respondents, encompassing aspects like the HTN diet and dietary habits of hypertensive patients in adhering to HTN dietary recommendations. As elaborated, heightened knowledge levels among hypertensive patients contribute to an increased awareness of lifestyle modifications, facilitating optimal adherence to self-care strategies. This heightened awareness is recognised as important in enhancing BP management rates among individuals with HTN (Chacko and Jeemon, 2020).

5.7.2 Family Support

This study observed that heightened family involvement empowers HTN patients to actively participate in their health management, fostering a comprehensive understanding of their condition and the necessary lifestyle enhancements. *“Nginendodakazi ewunesi, ingisiza kakhulu nokubheka, ingichazela izinto, ingilethele ulwazi futhi ifundise nabanye emndenini. Ingikhumbuze mekufaneke ngiye emtholampilo ngiyolanda amaphilisi, noma kufaneke ngiye esibhedlela ngiyobonana nodokotela.” “I have a daughter who is a nurse. It reminded me that I should go to the clinic to get pills, or I should go to the hospital to see a doctor.” (Participant 8, Intervention Participant, Female).* The significance of strong perceived family support in enhancing self-worth, motivation, and effective HTN management (Ojo, et al. 2016). In resource-constrained environments, family engagement emerges as a valuable avenue for supporting HTN management (Fort, et al. 2020).

Conversely, a perceived lack of support from family members not only demotivates hypertensive patients from implementing lifestyle changes but also diminishes their inclination to seek additional knowledge about HTN. *“Emva kokulaliswa esibhedlela, bayazihlupha ukuthi ngiyaphuza kahle yini amaphilisi. Bangiphekela nephalishi ekuseni, bangikhumbuze ukuthi ngingaphuzi kakhulu. Kahle kahle nje, bangiphathisa okwengane.” “After being hospitalised, they worry about whether I am taking the pills correctly. They also cooked me porridge in the morning and reminded me not to drink too much. Well, they treated me like a child.” (Participant 4, Intervention Participant, Male).* A study by Chandola, et al. (2004) align with this perspective, highlighting that reduced family support may contribute to the adoption of fewer habits associated with a healthy lifestyle.

Moreover, when contemplating the absence of family support, it is crucial to consider the inherent challenges, such as economic hardships, housing instability, and traumatic events, which can adversely impact HTN management (Fort, et al. 2020). Recognising both the strengths and weaknesses within patients' families enables HC professionals to construct personalised strategies for therapeutic care (Barreto and Marcon, 2014).

Significantly, a family-oriented approach to patient education has the potential to enhance BP control, resulting in reduced systolic and diastolic BP levels among individuals with HTN (Maslakpak, et al. 2018).

5.7.3 The level of knowledge of hypertension complications

The in-depth understanding and knowledge about potential complications arising from HTN is important, as it can be lifesaving in situations where immediate medical assistance is unavailable. This knowledge can also serve as a preventative measure, limiting the risk factors associated with HTN that could otherwise adversely impact an individual's quality of life. In instances where family members lack awareness of HTN complications, the insights from Bisnu, et al. (2017) underscore the importance of family support for hypertensive patients. Such support is instrumental in preventing the worsen of their condition and avoid complications associated with HTN.

Understanding the significance of non-pharmaceutical approaches to HTN management, including diet, PA, reduced alcohol intake, and smoking cessation, is important. A more informed understanding at an accessible level enhances the ability of hypertensive patients and their families to actively contribute to controlling and maintaining medically acceptable BP levels. This not only helps individuals in their efforts to manage HTN but could also potentially reduce the burden on HC facilities by reducing the prevalence of uncontrollable HTN. Aligning with findings from Shen et al. (2017), this study acknowledges that family-based educational interventions positively impact patients' adherence to BP monitoring and hypertensive medications.

In the context of Umlazi Township, research focused on interventions to educate and involve family members in supporting hypertensive patients' management is crucial. Tailoring these interventions to accommodate patient preferences, independence levels desired by patients, and their confidence in the support provided by family members is essential. Developing a tool that HC clinics can utilise to understand the roles and requirements of family members in HTN management would be important. This tool serves a dual purpose by educating and empowering family members about HTN, its

risks, potential complications, and the most effective ways they can support hypertensive patients.

5.8 STRENGTHS AND LIMITATIONS

This study investigates family engagement in hypertension management within the unique context of Umlazi Township, KZN. By shedding light on the support levels received by hypertensive patients, it offers valuable insights for HC providers. The study not only brings attention to the challenges faced by families and patients, serving as a lens into potential barriers to the effective management of HTN, but also provides foundational information. This foundational knowledge can be leveraged to develop enhanced resources for engaging families in meaningful efforts, conversations, and interventions aimed at strengthening HTN management in Umlazi Township, KZN.

Despite these contributions, the study is not without limitations. The sample size is one such constraint, impacting the generalisability of findings. Additionally, the study lacks details explaining the reasons for non-participation, introducing a gap in understanding participant perspectives. Although careful measures were implemented to ensure confidentiality, participants expressed reservations, fearing potential personal relationships with clinic staff might compromise the anonymity of their shared information. This concern led some participants to withhold certain details, assuming familiarity between the researcher and clinic staff, and raising questions about the impact of disclosed information on their hypertensive family members during clinical visits. These limitations, while acknowledged, underscore the need for ongoing research to look deeper into these complexities and refine future study designs.

5.9 CONCLUSION

The participants in this study have given insight of the complex dynamics surrounding the involvement of family members in the management of HTN among patients. Their insights, coupled with the experiences and perceptions of hypertensive individuals, underscore a compelling narrative advocating for an intensified focus on family engagement in HTN management. A pressing need is evident for the development of a

comprehensive plan that caters to the distinctive needs of patients and acknowledges potential resource constraints faced by family members.

It is crucial to address this imperative by providing enhanced resources and information to family members, empowering them to actively support and encourage HTN management in hypertensive patients. Interventions geared toward fostering stronger connections between family members and HC facilities responsible for hypertensive patients appear to be a very important in facilitating family engagement. Such initiatives hold the promise of not only improving the support system for hypertensive individuals but also revealing broader challenges in HTN management. Through this holistic approach, valuable insights can be understood of the reasons underlying inadequate HTN management in certain cases.

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CHAPTER 6 - OVERALL CONCLUSION WITH RECOMMENDATIONS

6.1 OVERALL CONCLUSIONS AND RECOMMENDATIONS

In summary, the widespread health burden of hypertension (HTN) demands ongoing attention. It is imperative, during each clinic appointment, to reinforce the significance of lifestyle modifications alongside pharmacological therapy for maintaining optimal blood pressure (BP) levels. Encouraging and incorporating physical activity (PA) into patient care at primary healthcare (PHC) facilities is equally crucial. Introducing a group-based programme can serve as a gradual introduction to the value of engaging in PA, motivating patients to proactively work toward meeting the recommended minimum PA requirements. Notably, the South African HTN Guideline briefly mentions PA within a table as a component of lifestyle changes. A more prominent emphasis on PA, especially at the community level, should be considered, along with an awareness of the risks associated with not maintaining optimal HTN levels. Physical activity has the potential to play an important role in improving HTN management across various regions of the country, offering a cost-effective means to support individuals at different socioeconomic levels and educational backgrounds.

This scoping review examined the degree in which PA interventions tailored for managing HTN in hypertensive patients, highlighting the important role of exercise modality, intensity, and frequency in bridging the gap between research and clinical practice. The analysed articles yield 9 successful interventions—5 aerobic and 4 concurrent (aerobic plus strength training)—emphasising the importance of incorporating multiple components of the FITT principle, particularly exercise duration. The findings revealed that while different exercise modalities induce varying changes in BP variability, they commonly result in similar reductions in BP values, with successful interventions typically featuring an average frequency of 3 days/week over 8 to 12 weeks. The review underscored the necessity of a personalised approach to exercise intensity for individuals with high BP, noting that an intensity of >50% is effective across all successful interventions. It also points out the significance of considering frequency and duration together for impactful outcomes on hypertensive patients. The review elaborated on the

broader benefits of aerobic exercise for BP reduction and cardiovascular risk decrease, while also cautioning against the acute hypertensive responses associated with strength training without concurrent antihypertensive treatment.

It emphasised the crucial role of family involvement in aiding individuals in managing HTN. Participants were educated on the advantages of their family members being informed about optimal BP readings, prescribed medications, and the family's role in providing encouragement for medication adherence. The significance of follow-up clinic appointments, potential complications resulting from non-adherence to pharmacological programmes, and the necessary steps to address such complications were also stressed to participants. Incorporating family members into lifestyle interventions for individuals diagnosed with HTN is paramount. This involves equipping them with a comprehensive understanding of the condition, enabling them to provide essential support, respond effectively in emergencies, and promote healthy living practices. It is vital for family members to be well-informed about prescribed medications and their proper usage, even in urgent situations. They can be readily trained in tasks such as monitoring vital signs, including BP, and knowing when to take action or seek immediate medical assistance when BP reaches a critical point. This holistic approach ensures that the support network of individuals with HTN is well-prepared and actively engaged in their care and well-being.

Furthermore, this study introduced a noteworthy lifestyle modification, namely increased PA, to hypertensive patients attending the Umlazi Township AA clinic. This intervention played an important role in instilling proactive health management among patients, emphasising the importance of supplementing pharmacological therapy with lifestyle changes. The study underscored the remarkable benefits of regular PA, shedding light on its positive impact on participants over the 12-week intervention period. It is worth acknowledging and commending the initiative that has led to the establishment of public outdoor gym spaces in township communities under the eThekwini Municipality's ruling government. These park-like facilities are thoughtfully designed to encourage and enhance PA within the community, provided at no cost to users. While presently utilised by various age groups, there is hopeful anticipation that, in the long term, even the older

generation will recognise the important value and significance of these outdoor fitness spaces. Primary healthcare facilities can actively promote their utilisation among patients undergoing HTN treatment, encouraging individuals to improve and sustain their physical fitness and contributing significantly to HTN and other chronic disease management. Additionally, it fosters social interaction, providing further holistic benefits to the community.

6.2 OVERALL STRENGTHS AND LIMITATIONS

This study was conducted within a community setting, emphasizing practical and translational applications aimed at directly benefiting hypertensive patients. The selection of the Umlazi AA PHC clinic as the research site was strategically based on its geographic proximity and suitability for effective data collection. It is crucial to highlight a deviation in the sample size of participants from the initially calculated number, which was determined based on insights from previous HTN intervention studies utilising both STATA and STATISTICA effectively. The systolic blood pressure (SBP) within the IG, with the aim of achieving a 5 mmHg reduction and accounting for a standard deviation (SD) of ±10 mmHg, while aiming for a statistical power of 80%. This calculation initially indicated a need for 100 participants per group (IG and control group (CG)), totaling 200 participants. However, upon recalculating the sample size for an anticipated SBP reduction of 6 mmHg in the IG, maintaining the same SD of ±10 mmHg and 80% power, a revised estimate of 64 participants per group emerged.

The initial calculation was grounded in an application submitted to the University of the Witwatersrand Human Research Ethics Committee and the Faculty of Health Sciences. This application proposed the use of two separate clinics, one for the IG and another for the CG. Yet, following recommendations from the Faculty of Health Sciences, a decision was made to consolidate all participants within a single clinic, encompassing both the IG and CG. This adjustment aimed to ensure consistent participant characteristics and minimise potential biases affecting the study. Consequently, the sample size per group was ultimately smaller than initially anticipated due to the use of a single clinic. This reduction may have introduced some bias into the study, influencing the expected

outcomes and the ability to detect significant differences and relationships within the research.

The intervention spanned a 12-week period, involving less than three days of activity per week. This relatively limited timeframe and frequency of intervention might have constrained the scope for expected results. Notably, extended interventions lasting beyond 12 weeks, with a minimum of three days a week, or even spanning six months or more, as demonstrated in other studies, have yielded more pronounced and significant differences.

6.3 OVERALL CLINICAL APPLICATIONS

Participation in regular PA not only serves as an effective measure against overweight issues but also brings about significant enhancements in various physiological aspects of the body. These improvements encompass a decreased risk of injury, heightened flexibility, and an elevated basal metabolic rate. Hence, for individuals dealing with HTN, it becomes important to adhere to prescribed pharmaceutical interventions as recommended by HC professionals, all the while seamlessly integrating a consistent, long-term PA programme that encompasses aerobic, strength, and flexibility exercises.

This exercise programme should extend beyond 12 weeks, transforming into a lifelong commitment seamlessly invent into one's lifestyle, featuring a frequency of at least three days a week, with each session lasting more than 30 minutes. Within the community context explored in this study, the accessibility of increasing PA is facilitated through activities such as walking and utilising readily available outdoor gyms, thereby eliminating the need for additional facilities or expenses. Moreover, recognising the specialised knowledge of Biokineticists in aiding HTN management through PA, their involvement alongside other HC professionals is instrumental in providing the accurate guidance, motivation, and monitoring necessary for patients on this health transformative journey.

APPENDIX A - FAMILY MEMBER INFORMATION, INFORMED CONSENT AND QUESTIONNAIRE

INFORMATION;

Dear Sir/Madam

Good day, my name is Miss Mandisa Jewel Simamane, I am a student at the University of the Witwatersrand. I am currently doing my PhD, Biokinetics. This letter intends to invites you to participate in a study aimed at identifying if a plan for healthy lifestyle intervention (inclusion of physical activity intervention and family member involvement) will assist hypertensive patients in managing hypertension in the community of Umlazi Township, KwaZulu-Natal utilising the primary health care sector. The aim of this study has been separated into 3 testable objectives: (1) Physical activity interventions for the management of hypertension: a scoping review; (2) to assess the effect of the exercise intervention plan would have in managing hypertension, and (3) to assess the extent the role of family involvement has in assisting with hypertension management. Participation is entirely voluntary and not accepting the invitation to participate will in no way have any negative consequences on you. The nature and the purpose of the research study and of this informed consent declaration will be explained to you in a language that you understand. Your participation will be greatly appreciated. Please ask as many questions as you like regarding the study before giving consent.

Where will the study take place? The interview will take place in an area specified by you as a participant.

What the study involves? The purpose of the research study involves (2) the relationship between family members involvement and hypertension management, (3) the relationship between recommended minimum physical activity and hypertension management, (4) the relationship between blood pressure and heart rate in managing hypertension. The University of Witwatersrand will give ethical clearance to this research project and you may request to see it. You as participants will participate in this study by being interviewed orally and the interviewed recorded with your consent.

You can participate if you are: (1) closest family member, (2) living with the participants in the same household, (4) above the age of 18 years, and (4) any gender.

***You cannot participate if you*:** (1) family member is not living with the participant in the same household, and (2) person's younger than 18 years.

Freedom of consent: Your participation is entirely voluntary, should you at any stage wish to withdraw from participating further and you may do so without any negative consequences. You may be asked to withdraw from the study before it has finished if the researcher or any other appropriate person feels it is in your best interest to do so or if the given instructions are not followed accordingly.

Risks: No risks involved to you as the interviewee.

Benefits: No direct benefits to you as the interviewee.

What is your responsibility? You are responsible for fully disclosing information to the researcher that might be of importance to the study, and answer all questions with honesty and understanding, ask for clarification if there is something you do not understand.

Conclusion: The researcher intends to publish the research results in the form of an article. However, confidentiality and anonymity of records will be maintained and that your name and identity will not be revealed to anyone who has not been involved in the conduct of the research. You will receive written feedback regarding the results obtained during the study. Any further questions that you might have concerning the study or your participation will be answered by Miss Mandisa Jewel Simamane at 073 726 4219, and email at simamanemandisa@gmail.com

Your participation would be greatly appreciated.

Kind Regards,
Miss Mandisa Jewel Simamane
Biokineticist| Candidate, Ph.D (Biokinetics) | MSc Medicine, Biokinetics (Wits) | BSc Honours, Biokinetics (UniZulu) | BTech, Sport and Exercise Technology (TUT) | NDip, Sport and Exercise Technology (UniZulu)
Tel: 073 726 4219 Email: simamanemandisa@gmail.com

INFORMED CONSENT;

I, ……., give consent to partake in the study of **"HEALTHY LIFESTYLE AND PHYSICAL ACTIVITY INTERVENTION PLAN FOR HYPERTENSIVE PATIENTS OF UMLAZI TOWNSHIP, KWAZULU-NATAL",** alongside my family member that is part of the study.

- I hereby confirm that I have been informed by the researcher, Mandisa Simamane about the nature, conduct, benefits and risks of the above mentioned clinical study called.
- I have also received, read and understood the above written information (Participant Information Leaflet and Informed Consent) regarding the clinical study.
- I am aware that the results of the study, including personal details regarding the information about my understanding of hypertension and how my family member manages hypertension will be anonymously processed into a study report.
- In view of the requirements of research, I agree that the data collected during this study can be processed in a computerised system by Mandisa Simamane or on their behalf.
- I may, at any stage, without prejudice, withdraw my consent and participation in the study.
- I have had sufficient opportunity to ask questions and (of my own free will) declare myself prepared to participate in the study.

…… ……
Participants Signature Date

…… ……
Witness's Signature Date

CONSENT TO RECORD IN-DEPTH INTERVIEWS;

- I have read or understood the project information sheet, and I understand that it is up to me whether or not the interview is audio or video recorded. It will not affect in any way how the interviewer treats me if I do not want the interview to be recorded.
- I understand that if the interview is recoded that the tape will be destroyed six years after the interview.
- I understand that I can ask the person interviewing me to stop recording, and to stop the interview altogether, at anytime.
- I understand that the information that I give will be treated in the strictest confidence and that my name will not be used when the interviews are typed up.

◯ **Yes, I give my permission for the interview to be recorded**
◯ **No, I do not give my permission for the interview to be recorded**

…… ……
Participants Signature Date

…… ……
Witness's Signature Date

QUESTIONS;

Question 1: What is your understanding of what hypertension is?
Why is it so bad for us?
Question 2: What are the complications that can be caused by hypertension?
Name some of them.
Question 3: Explain to me how blood pressure is checked? How regularly do you check your blood pressure?
Question 4: Tell me a bit about how and when your family was diagnosed with hypertension?
What did this mean for you?
Question 5: How you participate in your family member routine check-up?
Provide some examples
Question 6: What important changes do you think your family member needs to make in order to manage their hypertension?
Question 7: What changes did you make if any, as family when you found out about your family member's diagnosis?
Question 8: How important do you think diet is in managing hypertension?
Question 9: How important do you think physical activity is in managing hypertension?
Question 10: What role do you play in making these changes?
Question 11: What makes it hard for them to change these behaviors?
Question 12: How can you help to make it easier?
Question 13: What could make it easier for them to change? How can you assist?

APPENDIX B – CLINICS APPLICATION LETTER

Dear Sir/ Madam

The University of Witwatersrand, Centre for Exercise Science and Sports Medicine in collaboration with their registered student in PhD, Biokinetics, Mandisa Jewel Simamane would like to request permission from the clinic and invite the clinic to participate in a research study for **individuals with specifications listed below**. The research study is intended for research purposes of people who reside in Umlazi Township, aimed at identifying if a plan for healthy lifestyle intervention (inclusion of physical activity intervention and family member involvement) will assist hypertensive patients in managing hypertension in the community of Umlazi Township, KwaZulu-Natal utilizing the primary health care sector. The aim of this study has been separated into 3 testable objectives: (1) Physical activity interventions for the management of hypertension: a scoping review; (2) to assess the effect of the exercise intervention plan would have in managing hypertension, and (3) to assess the extent the role of family involvement has in assisting with hypertension management. Participation is entirely voluntary **(NO FEES or EQUIPMENT REQUIRED FROM THE CLINIC)** and not accepting the invitation to participate will in no way have any negative consequences on the clinic. Your participation will be greatly appreciated. Please ask as many questions as you like regarding the study before giving consent.

Where will the study take place? The health screenings and physical training will take place in one clinic, for two different groups. The study will take place at a community hall near Umlazi AA primary health care clinic and/ or the Umlazi U Clinic, the study will also take place at a community hall near.

What the study involves? The purpose of the research study involves (1) the relationship between family members involvement and hypertension management, (2) the relationship between recommended minimum physical activity and hypertension management, (3) the relationship between blood pressure and heart rate in managing hypertension. The University of Witwatersrand will give ethical clearance to this research project and you may request to see it. You as participants will participate in this study by being assessed on a series of tests such physiological health screening beginning of each month, wellness and lifestyle questions, medical history and Physical Activity Readiness-Questionnaires and intervention in group exercise programs and general healthy lifestyle.

Who can participate? Patients who are; (1) diagnosed with any type of hypertension by a medical doctor, nurse and/or qualified healthcare professional, (2) taking antihypertensive medication prescribed by a medical doctor, (3) utilizing strictly PHC sector to manage hypertension, (4) living in the areas of Umlazi Townships, KwaZulu-Natal, (5) with hypertension classifications 140-179 mmHg for systolic and 90-129 mmHg for diastolic resting blood pressure (confirmed during baseline tests), (6) compliance and attendance of 70-80%, and (7) both males and females, no age restrictions.

Who cannot participate? Patients who are; (1) utilizing both PHC sector and private health care sectors to manage hypertension, (2) present with pre-hypertension but not yet diagnosed, (3) diagnosed with hypertension, who present with physical disability or suffering and/or recovering from stroke or any other co-morbidity that may affect their physical abilities, (4) diagnosed with hypertension, but are not currently taking hypertensive medication, (5) hypertensive but do not reside in Umlazi Township, KwaZulu-Natal, (6) with mental or physical disabilities that would prevent them from answering the questions effectively and participating in PA to their full potential,

(7) already taking part in any form of PA routine, (8) pregnant, and (9) with hypertension classifications between ≥180 mmHg systolic and ≥130 mmHg for diastolic resting blood pressure (confirmed during baseline tests).

Freedom of consent: The clinics participation is entirely voluntary, should it at any stage wish to withdraw from participating further and it may do so without any negative consequences, it may be asked to withdraw from the study before it has finished if the researcher or any other appropriate person feels it is in their best interest to do so or if the mutual instructions are not followed accordingly.

Risks: There may be risks associated with the study to the participants: this may include minor injuries to the participants, but there will be a first aid kit present during exercise training sessions and the researcher is trained with first response to the injuries. There can be also abnormal increased heart rate and blood pressure levels during the physical training sessions. No risks to the clinic

Benefits: There will be direct physiological changes to the participant's body, e.g. lowered blood pressure, improved activities of daily living, etc. This will differ per individual. There will be no direct benefits to the clinic, expect information in concluding with the objectives of the study.

What is the participant's responsibility? The participants are responsible for fully disclosing information to the researcher that might be of importance to the study, and if they encounter difficulties of any sort during the physical training sessions. The clinic might also be requested to confirm that the participants are diagnosed with hypertension.

What is the primary health care providers' responsibility? To sign the 'Group Classes Indemnity Form' for the participants medical clearance in order for the participants to partake in group exercises.

Conclusion: The researcher intends to publish the research results in the form of an article. However, confidentiality and anonymity of records will be maintained and that the participants name and identity will not be revealed to anyone who has not been involved in the conduct of the research. The clinic will receive written feedback regarding the results obtained during the study. Any further questions that the clinic might have concerning the study or their participation will be answered by Miss Mandisa Jewel Simamane at 073 726 4219, and email at simamanemandisa@gmail.com

Your consent and participation would be greatly appreciated.

Kind Regards,

Miss Mandisa Jewel Simamane
Biokineticist| Candidate, Ph.D (Biokinetics) | MSc Medicine, Biokinetics (Wits) | BSc Honours, Biokinetics (UniZulu) | BTech, Sport and Exercise Technology (TUT) | NDip, Sport and Exercise Technology (UniZulu)
Tel: 073 726 4219
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APPENDIX C – MUNICIPALITY COMMUNITY HALL APPLICATION LETTER

Dear Sir/ Madam

The University of Witwatersrand, Centre for Exercise Science and Sport Medicine in collaboration with their registered student in PhD, Biokinetics, Mandisa Jewel Simamane would like to request permission from the municipality to use its facilities, community halls, at Umlazi AA hall and/or Umlazi U. The research study is intended for research purposes of people who reside in Umlazi Township, aimed at identifying if a plan for healthy lifestyle intervention (inclusion of physical activity intervention and family member involvement) will assist hypertensive patients in managing hypertension in the community of Umlazi Township, KwaZulu-Natal utilizing the primary health care sector. Participation is entirely voluntary **(NO FEES or EQUIPMENT REQUIRED FROM THE MUNICIPALITY with exception to the main hall, parking and/or bathrooms)** and not accepting the invitation to participate will in no way have any negative consequences on the municipality. Your participation will be greatly appreciated. Please ask as many questions as you like regarding the study before giving consent.

Risks: No risks to the municipality or hall management team.
Benefits: No direct benefits to the municipality or hall management team.

Any further questions that you might have concerning the study or your participation will be answered by Miss Mandisa Jewel Simamane at 073 726 4219, and email at simamanemandisa@gmail.com

Your consent and participation would be greatly appreciated.

Kind Regards,
Miss Mandisa Jewel Simamane
Biokineticist| Candidate, Ph.D (Biokinetics) | MSc Medicine, Biokinetics (Wits) | BSc Honours, Biokinetics (UniZulu) | BTech, Sport and Exercise Technology (TUT) | NDip, Sport and Exercise Technology (UniZulu)
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APPENDIX D - PARTICIPANT LETTER OF INFORMATION

Dear Sir/ Madam

Good day, my name is Miss Mandisa Jewel Simamane, I am a student at the University of the Witwatersrand. I am currently doing my PhD, Biokinetics. This letter intends to invites you to participate in a study aimed at identifying if a plan for physical activity intervention and family member involvement assist hypertensive patients in managing hypertension in the community of Umlazi Township, KwaZulu-Natal utilizing the primary health care sector. The aim of this study has been separated into 3 objectives: (1) A scoping review examining physical activity interventions for the management of hypertension; and (2) to assess the effect of the exercise intervention plan would have in managing hypertension, and (3) to assess the extent the role of family involvement has in assisting with hypertension management. Participation is completely voluntary and not accepting the invitation to participate will in no way have any negative consequences on you. The research study will be explained to you in a language that you understand by the researcher. Your participation will be greatly appreciated. Please ask as many questions as you like regarding the study before giving consent.

Where will the study take place? The health screenings and physical training will take place in one venue, you will be allocated into either the; control (playing board games) or intervention (exercise) groups. The intervention group, the study will take place at a community hall near Umlazi AA primary health care clinic or at a community hall near Umlazi U Clinic.

What the study involves? The purpose of the research study involves (1) the relationship between family members involvement and hypertension management, and (2) the relationship between recommended minimum physical activity and hypertension management. The University of Witwatersrand will give ethical clearance to this research study and you can request to see it. You as participants will participate in this study by being assessed on a series of tests such physiological health screening beginning of each month, and will be asked questions on your medical history and Physical Activity Readiness-Questionnaires.

Who can participate? You can participate if: (1) diagnosed with any type of hypertension by a medical doctor, nurse and/or qualified healthcare professional, (2) taking antihypertensive medication prescribed by a medical doctor, (3) utilizing strictly PHC sector to manage hypertension, (4) living in the areas of Umlazi Townships, KwaZulu-Natal, (5) with hypertension classifications 140-179 mmHg for systolic and 90-129 mmHg for diastolic resting blood pressure (confirmed during baseline tests), (6) compliance and attendance of 70-80%, and (7) both males and females, no age restrictions.

Who cannot participate? You cannot participate if: (1) utilizing both PHC sector and private health care sectors to manage hypertension, (2) present with pre-hypertension but not yet diagnosed, (3) diagnosed with hypertension, who present with physical disability or suffering and/or recovering from stroke or any other co-morbidity that may affect their physical abilities, (4) diagnosed with hypertension, but are not currently taking hypertensive medication, (5) hypertensive but do not reside in Umlazi Township, KwaZulu-Natal, (6) with mental or physical disabilities that would prevent them from answering the questions effectively and participating in PA to their full potential, (7) already taking part in any form of PA routine, (8) pregnant, and (9) with hypertension classifications between ≥180 mmHg systolic and ≥130 mmHg for diastolic resting blood pressure (confirmed during baseline tests).

Freedom of consent: Your participation is completely voluntary, should you at any stage wish to stop from participating further and you may do so without any negative consequences. You may be asked to stop from the study before it has finished if the researcher feels it is in your best interest to do so or if the given instructions are not followed accordingly.

Risks: There may be risks associated with the study to the participants: this may include minor injuries to the participants, but there will be a first aid kit present during exercise training sessions and the researcher is trained with first response to the injuries. There can be also abnormal increases in your heart rate and/or blood pressure levels during the exercise.
Benefits: There will be direct physiological changes to your body, e.g. lowered blood pressure, improved activities you can do daily, etc. This may differ per individual.
What is your responsibility? You are fully responsible for make known to the researcher any information that might be of importance to the study or affects your participation to the exercises, and if you encounter difficulties of any sort during the exercises. (E.g. being sick, injuries, etc.)

Conclusion: The researcher will publish the research results in the form of an article. However, your name and identity will not be revealed to anyone who has not been involved in the conduct of the research. You will receive written feedback regarding the results obtained during the study. Any further questions that you might have concerning the study or your participation will be answered by Miss Mandisa Jewel Simamane at 073 726 4219, and email at simamanemandisa@gmail.com

Your participation would be greatly appreciated.

Kind Regards,

Miss Mandisa Jewel Simamane
Biokineticist| Candidate, Ph.D (Biokinetics) | MSc Medicine, Biokinetics (Wits) | BSc Honours, Biokinetics (UniZulu) | BTech, Sport and Exercise Technology (TUT) | NDip, Sport and Exercise Technology (UniZulu)
Tel: 073 726 4219
Email: simamanemandisa@gmail.com

APPENDIX E - PARTICIPANT INFORMED CONSENT FORM

Study Number: ……..

I, ……., do hereby give consent to participate in the study entitled: **Physical activity intervention plan for hypertension in Umlazi Township, KwaZulu-Natal**. I have read the letter of information and confirm that the information has been explained to me in a language that I understand and I am aware of this document's contents. I have asked all questions that I wished to ask and these have been answered to my satisfaction. I fully understand what is expected of me during the study.

By signing this informed consent declaration I am not waiving any legal claims rights or remedies that I may have.
An original copy of this informed consent declaration will be kept on record by the researcher.

I have not been pressurised in any way to participate in the study. By signing below, I voluntarily agree to participate in the above mentioned study.

……	……
Participants Signature	Date
……	……
Witness's Signature	Date

APPENDIX F - INDEMNITY

Study Number: ……..

This section of the form is to be completed by the participant and given to the researcher / Biokineticist prior to screening.

I, ……, Do hereby declare that, to the best of my knowledge, I am currently free from any medical conditions or other complaints that would preclude me from undertaking any of the physiological and/or anthropometric tests. I understand that the test protocol and subsequent result of any test(s) will be explained to me by the researcher and all test results are strictly confidential. The results will be published by the researcher in the form of an article(s). However, confidentiality and anonymity of records will be maintained and that my name and identity will not be revealed to anyone who has not been involved in the conduct of the research.

I, the undersigned, on my own behalf and on behalf of my heirs, executors, administrators, successors and assigns and on behalf of my dependents and next of kin, do hereby –

I) Waive and release any and all claims whatsoever that I or they may have against the University of the Witwatersrand and its officers and staff, including, but without in any way limiting the generality of the foregoing, its professors, lecturers, laboratory assistants and technicians whether full-time or part-time and whether in permanent or temporary employment, paid or voluntary their heirs, executors, administrators, successors, the researchers, participating health care clinics, eThekwini municipalities, it employees and assigns for any loss or damage whatsoever, including gross negligence, of any or all of them whilst I am participating in the health screening tests and any activities related thereto or connected or associated therewith from the exercise training centre, and including but not limited to any and all medical and legal costs, fees and expenses relating to resulting from any claim in respect of any such act or omission, whether reasonably incurred or not.

II) Indemnity and hold harmless the University of the Witwatersrand and its officers and staff as aforesaid against any such claim that I or heirs, executors, administrators, successors and assigns, my dependents or next of kin may institute or assert against them and any claim in respect of any costs including legal costs, fees and expenses necessary or incidental thereto.

I have read this form carefully and fully understand the test procedures. I consent to participate in these tests, voluntarily.

……	……
Participants Signature	Date
……	…….
Witness's Signature	Date

APPENDIX G - HEALTH SCREENING INDEMNITY

Study Number: ……..

This section of the form is to be completed by the participants and given to the health care researcher / Biokineticist prior to screening.

I, ……, agree to participate in the HEALTH SCREENING at my own risk and will not hold the University of the Witwatersrand, the researchers, participating health care clinics, eThekwini municipalities, or employees responsible for any injury that may occur as a result of the HEALTH SCREENING. I have disclosed all known medical conditions to the Researcher/ Health Care Provider prior to participating in the HEALTH SCREENING.

I accept full responsibility for participating in the HEALTH SCREENING and declare that I do so voluntarily.

I have been advised that my information will be used for research purposes, published by the researcher in the form of an article(s). However, confidentiality and anonymity of records will be maintained and that my name and identity will not be revealed to anyone who has not been involved in the conduct of the research.

……	……
Participants Signature	Date
……	…….
Witness's Signature	Date

APPENDIX H - GROUP CLASS INDEMNITY

Study Number: ……..

This section of the form is to be completed by the participant, the health care provider and given to the Researcher prior to starting the group exercise class.

I, ……, agree to participate in the EXERCISE CLASSES at my own risk and will do so at a level appropriate to my abilities. I hereby declare that I have discussed my plans to participate in physical activity with my health care provider and I have obtained his/her approval to begin participation. I have disclosed all known medical conditions to the researcher's and have received medical clearance from my doctor to participate in an exercise programme.
I accept full responsibility for participating in the EXERCISE CLASSES and declare that I do so voluntarily.

……	……
Participants Signature	Date
……	……..…
Witness's Signature	Date

Name of health care provider	Health care providers comments (if any)
Address	
Telephone number	
	Signature of health care provider

APPENDIX I - MEDICAL HISTORY FORM

Participant Record (confidential information)

Regular physical activity is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, in order to ensure that it is safe for you to begin an exercise programme, we need to ask you a few questions

Please Read carefully before signing.
You must complete this medical form, which includes a medical questionnaire section and a PAR-Q section to enrol in the physical activity classes.

MEDICAL QUESTIONAIRE
The purpose of this medical Questionnaire is to find out if you should be examined by your doctor before participating in a group exercise class. A positive response to a question does not necessarily disqualify you from participating. A positive response may mean that there is a pre-existing condition that may affect your safety in the group classes and you must seek the advice of your physician prior to engaging in physical activity.

Have you ever had or do you currently have… (Please Tick Correct Answer Yes/No)

	Yes	No
1. History of heart problems, chest pain or stroke		
2. Any chronic illness or condition		
3. Difficulty with physical exercise		
4. Advice form physician not to exercise		
5. Recent surgery (last 12 months)		
6. Pregnancy (now or within last 3 months)		
7. History of breathing or lung problems		
8. Muscle, joint or back disorder, or any previous injury still affecting you		
9. Diabetes or thyroid condition		
10. Cigarette smoking habit		
11. Increased blood cholesterol		
12. History of heart problems in immediate family		

13. Hernia, or any condition that may be aggravated by lifting weights		

Please explain any **"yes"** answers below:

_____
_____
_____
_____

Are you currently taking any medication?

_____
_____
_____
_____

MEDICAL PAR-Q

If you are planning to become much more physically active than you are now, start by answering the seven questions below. The Physical Active Readiness Questionnaire (PAR-Q) is a self-screening tool designed to identify the small number of adults for whom physical activity may be inappropriate or those who should have medical advice concerning the type of activity most suitable for them.

If you are between the ages of 15 and 69, The PAR-Q will tell you if you should check with your doctor before you start. Please read the questions carefully and answer each one honestly.

Please circle your answer:

1. Has your doctor ever said that you have a heart condition and that you should only do physical activity recommended by a doctor? **(Y / N)**
2. Do you feel pain in your chest when you do physical activity? **(Y / N)**
3. In the past month, have you had chest pain when you were not doing physical activity? **(Y / N)**
4. Do you lose your balance because of dizziness or do you ever lose consciousness? **(Y / N)**
5. Do you have a bone or joint problem that could be made worse by a change in your physical activity? **(Y / N)**
6. Is your doctor currently prescribing drugs (eg: water pills) for your blood pressure or heart condition? **(Y / N)**
7. Do you know of any other reason why you should not do physical activity? **(Y / N)**

If you answered yes to any of the above questions, we must request that you consult with your physician prior to participating in the group exercise classes.

Talk to your doctor by phone or in person **BEFORE** you start becoming much more physically active or **BEFORE** you have a fitness appraisal. Tell your doctor about the PAR-Q and which questions you answered YES.

You may be able to do an activity you want – as long as you start slowly and build up gradually. Or, you may need to restrict your activities to those which are safe for you.

Please note:
If your health changes so that you then answer YES to any of the above questions, tell your health professional immediately.

When to delay becoming more active
If you are not feeling well because of a temporary illness such as a cold or fever – wait until you feel better.

The information I have provided about my medical history is accurate to the best of my knowledge. I agree to accept responsibility for omissions regarding my failure to disclose any existing or past health condition.

……
Study Number

……	……
Participants Signature	Date
……	……
Witness's Signature	Date

CONFIDENTIAL
(Information to be used by health professionals only and kept in a confidential file)

APPENDIX J - WEEKLY ATTENDANCE REGISTER

Group 1: Control **(Date_____ Week_____)**

Initials and Surname	Study Number	Present (1) Not Present (0)	Resting BP	Resting HR

Group 2: Intervention **(Date_____ Week_____)**

Initials and Surname	Study Number	Present (1) Not Present (0)	Resting BP	Resting HR

APPENDIX K - HEALTH SCREENING REPORT CARD (FOR RESEARCHER)

Study Number: ……. **DOB:** ……..……...
Researcher: …… **Date of screening:** ……..…….

Body Profile

	Your score	Goal	Comment
Body Mass			
Stature			
Body Mass Index Measures body fat or shape based on height and weight		**18.5 – 24.9 Normal weight**	
Waist Circumference			
Hip Circumference			
Waist to Hip Ratio Helps to determine your overall health risk, by measuring your fat distribution. More weight around the waist increases your risk for heart disease compared to more weight around hips.		**<0.90 – Males** **<0.85 – Females**	

Healthy Heart Screening

	Your score	Goal	Comment
Blood pressure Measure of the pressure when the heart is pumping and when it is relaxing.		**120/80 mmHg**	
Resting HR		**60 – 80 beats per min**	

Comments

……
……
……
……

Health Screening Report Card (For Participants)

Study Number: ……. **DOB:** ……..……

Researcher: ……... **Date of screening:** ……..…….

Body Profile

	Your score	Goal	Comment
Body Mass			
Stature			
Body Mass Index Measures body fat or shape based on height and weight		**18.5 – 24.9 Normal weight**	
Waist Circumference			
Hip Circumference			
Waist to Hip Ratio Helps to determine your overall health risk, by measuring your fat distribution. More weight around the waist increases your risk for heart disease compared to more weight around hips.		**<0.90 – Males** **<0.85 – Females**	

Healthy Heart Screening

	Your score	Goal	Comment
Blood pressure Measure of the pressure when the heart is pumping and when it is relaxing.		**120/80 mmHg**	
Resting HR		**60 – 80 beats per min**	

Comments

……
……
……
……

Thank you for participating in the health screening! If your scores are above the goal in any of the categories, please contact your doctor or health care provider.

APPENDIX L - RE-SCREENING QUESTIONNAIRE

Study Number			
Date			
When was your last visit to the clinic?	**DD/MM/YY**		
Reason for clinic visit			
Have you had any of the following SINCE the last screening?			
Pain in your chest with physical activity		**Y**	**N**
Pain in your chest without physical activity		**Y**	**N**
Loss of balance, dizziness, loss of consciousness		**Y**	**N**
Have you been diagnosed with any of the following SINCE the last screening?			
Heart condition		**Y**	**N**
Bone or joint condition		**Y**	**N**
High blood pressure		**Y**	**N**
Surgery		**Y**	**N**
Diabetes		**Y**	**N**
Breathing or lung problems		**Y**	**N**
Has your medication CHANGED since the last screening?		**Y**	**N**
If yes, please provide details			
Have you started taking any NEW medication since the last screening?			
If yes, please provide details			
Any other comments			

APPENDIX M – EXERCISE PROGRAMME

Intervention Group:

Week 1-4 (Full body workout)

Warm-up: Slow jogging on the spot/ Shuffling/ Knee highs/ Butt touches – 60 seconds each – x1 sets each – 8 repetitions

Stretching: Full body dynamic and static stretching – 60 seconds per stretch – x1 set of each large muscle groups body site

Aerobic exercise: Aerobic dance exercise/ step routine with music (Zumba) – 25 minutes – x1 full dance routine

Strength exercises: Squats**/** Static split Lunges**/** Mountain climbers**/** Plank – x2 sets & 8 repetitions

Cool down: Breathing patterns – 30 seconds – x1 sets

Week 5-8 (Full body workout)

Warm-up: Slow jogging on the spot/ Shuffling/ Knee highs/ Butt touches – 60 seconds each – x2 sets each – 10 repetitions

Stretching: Full body dynamic and static stretching – 60 seconds per stretch – x2 sets of each large muscle groups body site

Aerobic exercise: Aerobic dance exercise/ step routine with music (Zumba) – 30 minutes – x1 full dance routine

Strength exercises: Squats**/** Static split Lunges**/** Mountain climbers**/** Plank – x2 sets & 12 repetitions

Cool down: Breathing patterns – 30 seconds – x2 sets

Week 9-12 (Full body workout)

Warm-up: Slow jogging on the spot/ Shuffling/ Knee highs/ Butt touches – 60 seconds each – x3 sets each – 12 repetitions

Stretching: Full body dynamic and static stretching – 60 seconds per stretch – x1 set of each large muscle groups body site

Aerobic exercise: Aerobic dance exercise/ step routine with music (Zumba) – 40 minutes – x1 full dance routine

Strength exercises: Squats**/** Static split Lunges**/** Mountain climbers**/** Plank – x2 sets & 8 repetitions

Cool down: Breathing patterns – 45 seconds – x3 sets

APPENDIX N - WITS HREC APPROVAL LETTER

UNIVERSITY OF THE WITWATERSRAND JOHANNESBURG

R14/49 Ms MJ Simamane

HUMAN RESEARCH ETHICS COMMITTEE (MEDICAL)
CLEARANCE CERTIFICATE NO. M190442

NAME: (Principal Investigator)	Ms MJ Simamane
DEPARTMENT:	School of Therapeutic Sciences Centre of Exercise Science and Sports Medicine Medical School University
PROJECT TITLE:	Physical activity intervention plan for hypertensive patients of Umlazi Township, Kwazulu-Natal
DATE CONSIDERED:	2019/04/26
DECISION:	Approved unconditionally
CONDITIONS:	
SUPERVISOR:	Professor D Constantinou and Dr E Watson
APPROVED BY:	Dr CB Penny, Chairperson, HREC (Medical)
DATE OF APPROVAL:	2020/09/11

This clearance certificate is valid for 5 years from the date of approval. Extension may be applied for.

DECLARATION OF INVESTIGATORS

To be completed in duplicate and **ONE COPY** returned to the Research Office Secretary on the 3rd Floor, Phillip Tobias Building, Parktown, University of the Witwatersrand, Johannesburg.
I/we fully understand the conditions under which I am/we are authorized to carry out the above-mentioned research and I/we undertake to ensure compliance with these conditions. Should any departure be contemplated, from the research protocol as approved, I/we undertake to submit details to the Committee. **I agree to submit a yearly progress report**. When a funder requires annual re-certification, the application date will be one year after the date when the study was initially reviewed. In this case, the study was initially reviewed in **April** and will therefore reports and re-certification will be due early in the month of **April** each year. Unreported changes to the application may invalidate the clearance given by the HREC (Medical).

Principal Investigator Signature

19/11/2020
Date

APPENDIX O - ETHEKWINI MUNICIPALITY AA CLINIC APPROVAL LETTER

Part 1

ETHEKWINI MUNICIPALITY
Community & Emergency Services Cluster
Health Unit

9 Archie Gumede Place
Durban 4001
P O Box 2443
Durban 4000
Tel: (031) 311 3505
Fax: (031) 311 3710
Website: http://www.durban.org.za

20 August 2019

Dear Ms. M.J Simamane

Subject: Approval of a Research Proposal

The Research Proposal Titled: **Physical activity interventions plan for Hypertensive patients of Umlazi Township, KZN.** The study is hereby **approved to be conducted at Umlazi AA primary health care clinic and is valid for one year as from 31 May 2019.**

The following conditions need to be noted:

- Submission of the indemnity form obtainable from the eThekwini Municipality Health Unit before commencement of the study.
- Prior arrangements to be made with the facility and an assurance that clinic services will not be disrupted.
- No staff member should be used for collecting data for the researchers.
- **Progress reports to be provided and the final report of the study to the eThekwini Municipality Health Unit or emailed to:** Bongi.Ntombela@durban.gov.za
- Obtain permission from the eThekwini municipality health department for press releases and release of results to communities/stakeholders.
- The department has to receive recognition for the assistance given.
- Any amendment to the study must be communicated with the eThekwini Municipality Health Unit and the relevant amendment form obtainable from the unit to be submitted.
- Withdrawal of permission to conduct research will be left to the discretion of the eThekwini Municipality Health Unit.
- **Please take note of the duration of the study approval.**
- **An extension may be applied for if required. The Committee will review such a request and provide feedback accordingly.**

Yours sincerely

Dr N.I Gxagxisa: Head of Health

Part 2

ETHEKWINI MUNICIPALITY
Community & Emergency Services Cluster
Health Unit

9 Archie Gumede Place
Durban 4001
P O Box 2443
Durban 4000
Tel: (031) 311 3505
Fax: (031) 311 3710
Website:
http://www.durban.org.za

15 October 2020

Dear Researcher

Subject: Approval of a Research Proposal

The Research Proposal Titled: "**Physical Activity Intervention Plan For Hypertensive Patients Of Umlazi Township, Kwazulu-Natal.**" was reviewed by the eThekwini Municipal Health Department Research Committee. The study is hereby **approved to be conducted at Umlazi AA Primary Health Care Clinic and is Valid for 5 years as from 15 October 2020**

The following conditions need to be noted:

- Submission of the indemnity form obtainable from the eThekwini Municipality Health Unit before commencement of the study.
- Prior arrangements to be made with the facility and an assurance that clinic services will not be disrupted.
- No staff member should be used for collecting data for the researchers.
- **Progress reports to be provided and the final report of the study to the eThekwini Municipality Health Unit or emailed to: Bongi.Ntombela@durban.gov.za**
- Obtain permission from the eThekwini municipality health department for press releases and release of results to communities/stakeholders.
- The department has to receive recognition for the assistance given.
- Any amendment to the study must be communicated with the eThekwini Municipality Health Unit and the relevant amendment form obtainable from the unit to be submitted.
- Withdrawal of permission to conduct research will be left to the discretion of the eThekwini Municipality Health Unit.
- **Please take note of the duration of the study approval.**
- **An extension may be applied for if required. The Committee will review such a request and provide feedback accordingly.**

Yours sincerely

Dr N.I Gxagxisa: Head of Health

APPENDIX P - FACULTY OF HEALTH SCIENCES STUDY APPROVAL

UNIVERSITY OF THE
WITWATERSRAND,
JOHANNESBURG

Private Bag 3 Wits, 2050
Fax: 027117172119
Tel: 02711 7172076

Reference: Mrs Sandra Benn
E-mail: sandra.benn@wits.ac.za

24 January 2020
Person No: 1497887
PAG

Ms MJ Simamane
Bb1001 Umlazi
Dinizulu Road
4066
South Africa

Dear Ms Mandisa Simamane

Doctor of Philosophy: Approval of Title

We have pleasure in advising that your proposal entitled *Physical activity intervention plan for hypertensive patients of Umlazi township, KwaZulu-Natal* has been approved. Please note that any amendments to this title have to be endorsed by the Faculty's higher degrees committee and formally approved.

Yours sincerely

Mrs Sandra Benn
Faculty Registrar
Faculty of Health Sciences

APPENDIX Q - FUNDING

Reference: SFH170605236921
UID: 113876
14 February 2018

Ms MJ Simamane
Department/School of Therapeutic Sciences, Centre for Exercise Scien
University of the Witwatersrand
simamanemandisa@gmail.com

Dear Ms Simamane

SCHOLARSHIP FOR 2018: DST-NRF INNOVATION DOCTORAL SCHOLARSHIP

It is my pleasure to inform you that the DST-NRF innovation Doctoral Scholarship has provisionally been reserved for you. Congratulations on this outstanding achievement. The scholarship consists of the following:

Grant Amount	:	R120 000 p.a. (one hundred and twenty thousand rand per annum)
Period of Support	:	Three (3) years, depending on initial date of commencement of doctoral study and meeting NRF eligibility criteria
Institution	:	University of the Witwatersrand
Department	:	Department/School of Therapeutic Sciences, Centre for Exercise Scien
Degree to be funded	:	Doctoral degree
Contractual date of completion of scholarship:		1 (one) year after NRF funding has ceased. (Please refer to the NRF Conditions of Grant for more information

Please note that this scholarship will only be authorised for payment to you subject to you meeting the NRF's minimum requirements. Refer to the Scholarship Conditions and Regulatory Clauses in the Conditions of Grant for a list of these requirements.

Should you wish to accept the above scholarship, the following documents must be returned to the NRF via the appropriate bursary/research/financial aid office of your institution soon after registering for this degree

1. Signed copy of the **NRF Conditions of Grant**: Applicable to Masters and Doctoral Scholarships
2. **Proof of Registration**, the original proof of registration received from the institution
3. Latest copy of your **Academic Transcript**
4. Copy of your **Identity Document**.

If these documents are not received by the NRF, via your institution, by 30 April of the year of award, the scholarship will be cancelled automatically. Payment of the first instalment of the scholarship will only be made after receipt of the above documents. It will then take a further few weeks for your institution to make the funds available to you.

As the scholarship will be administered by the institution you have selected, it is important that all correspondence and queries concerning the award are directed to the bursary office of your university or university of technology for onward transmission to the NRF.

Yours sincerely

Mrs. Thashni Pillay
Director: Emerging Researchers

Grants Management & Systems Administration (GMSA)

Annexure:

i) NRF Conditions of Grant

APPENDIX R - FUNDING (EXTENSION)

Date: 30 January 2021
Reference: MND200411512485
UID: 131079

Ms MJ Simamane
Centre for Exercise Science and Sports Medicine
University of the Witwatersrand
simamanemandisa@gmail.com

Dear Ms Simamane

SCHOLARSHIP FOR 2021 : EXTENSION SUPPORT DOCTORAL SCHOLARSHIP

It is my pleasure to inform you that the Extension Support Doctoral Scholarship has been provisionally reserved for you. Congratulations on this outstanding achievement.

SCHOLARSHIP DETAILS	
Level of the Degree	Doctoral degree
Scholarship Value	R120 000,00
Period of Support	Six (6) or Twelve (12) months, depending on the months remaining and approved to complete the degree, not renewable
Contractual date of completion of degree	At the end of the extended funding year

Please note that this scholarship will be authorised subject to you meeting the NRF's minimum requirements. Refer to the NRF Postgraduate Scholarships Call for 2020 Framework document and the Conditions of Grant for a list of these requirements. The NRF reserves the right to withdraw the scholarship should it come to the NRF's attention that you do not meet the necessary requirements.

Should you wish to accept the above scholarship, the following documents must be returned to the NRF via the appropriate bursary/research/financial aid office of your institution soon after registering for this degree.

1. Signed NRF Conditions of Grant: Applicable to NRF Postgraduate Scholarships;
2. Official institutional **Proof of registration**; and
3. Copy of **Ethical Clearance Certificate** (if applicable)

If these documents are not received by the NRF, via the institution, by 30 April of the year of award, the scholarship will be cancelled. Once all the above correct documents are submitted to the NRF, funds will be released. Payment of the first instalment of the scholarship will be made to the institution. It will then take a further few weeks for your institution to make the funds available to you.

Yours sincerely

Electronic Signature
Mrs. Thashni Pillay
Director: Emerging Researchers

Grants Management & Systems Administration (GMSA)

Annexures
Conditions of Grant for 2021

APPENDIX S - TRAINING CERTIFICATES

Module 1 – Introduction to Research Ethics

TRREE

Zertifikat
Certificat
Certificado
Certificate

Promouvoir les plus hauts standards éthiques dans la protection des participants à la recherche biomédicale
Promoting the highest ethical standards in the protection of biomedical research participants

Clinical Trials Centre
The University of Hong Kong

Certificat de formation - Training Certificate

Ce document atteste que - this document certifies that

Mandisa Simamane

a complété avec succès - has successfully completed

Introduction to Research Ethics

du programme de formation TRREE en évaluation éthique de la recherche
of the TRREE training programme in research ethics evaluation

Release Date: 2020/04/02
CID : I2cKe2ADZT

Professeur Dominique Sprumont
Coordinateur TRREE Coordinator

FMH Continuing Education Program (5 Credits)
Programme de Formation continue (5 Crédits)

Foederatio Pharmaceutica Helvetiae FPH Programmes de formation continue Continuing Education Programms
Programmes de formation continue

Ce programme est soutenu par - This program is supported by :
European and Developing Countries Clinical Trials Partnership (EDCTP) (www.edctp.org) - Swiss National Science Foundation (www.snf.ch) - Canadian Institutes of Health Research (http://www.cihr-irsc.gc.ca/e/2891.html) - Swiss Academy of Medical Science (SAMS/ASSM/SAMW) (www.samw.ch) - Commission for Research Partnerships with Developing Countries (www.kfpe.ch)

[REV : 20170310]

Module 2 – Research Ethics Evaluation

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du programme de formation TRREE en évaluation éthique de la recherche
of the TRREE training programme in research ethics evaluation

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APPENDIX T - SCOPING REVIEW OF SUCCESSFUL INTERVENTIONS

Table 3.6.4 Summary of successful Aerobic Interventions of primary and secondary outcomes (n= 5)

Author & Year	Duration	Frequency	Intensity	Time	Type	Exercise Intervention	Statistically Significance	Primary Outcomes	Secondary Outcomes	Control Group included?
Knoepfli-Lenzin, et al. 2010	12 weeks	2.5 days/ week	80% HRM	60 min	Aerobic	Either outdoor on a natural or an artificial grass field or indoor in a gym, depending on the weather conditions.	Yes (p = 0.001)	Decrease in SBP & DBP.	Decrease in HR	Yes (No Exercise)
Aminuddin, et al. 2011	8 weeks	3 days/ week	50-70% HRR	30-45 min	Aerobic	Treadmill	Yes (p = <0.01)	Decrease resting SBP in both groups & no changes in DBP	Decrease in HR in intervention group.	Yes (No Exercise)
Molmen-Hanse, et al. 2011	12 weeks	3 days/ week	AIM: 85-90% VO2max; MIT: 60-70% VO2max	38/ 47 Min	AIM: 38 Mins; MIT 47 Mins	AIM & MIT: walking/ running uphill on a treadmill	Yes (p = <0.001)	decrease AIT & MIT in both SBP & DBP.	HR only AIT & both AIT & MIT: decrease in BMI	Yes (Standard recommendation for patients with essential HTN)
Dimeo, et al. 2012	8-12 weeks	3 days/ week	15-point Borg scale ranging from 6 to 20: with "6" corresponding with a "very, very light effort" and "20" corresponding with "exhaustion. A target lactate	20-30 Min	Aerobic/ Interval-training	The training program, consisting of walking on a treadmill according to an interval-training pattern.	Yes (p = <0.01)	Decrease in daytime, 24h and BP on exertion in both SBP & DBP.	No change in BMI & WHR.	No

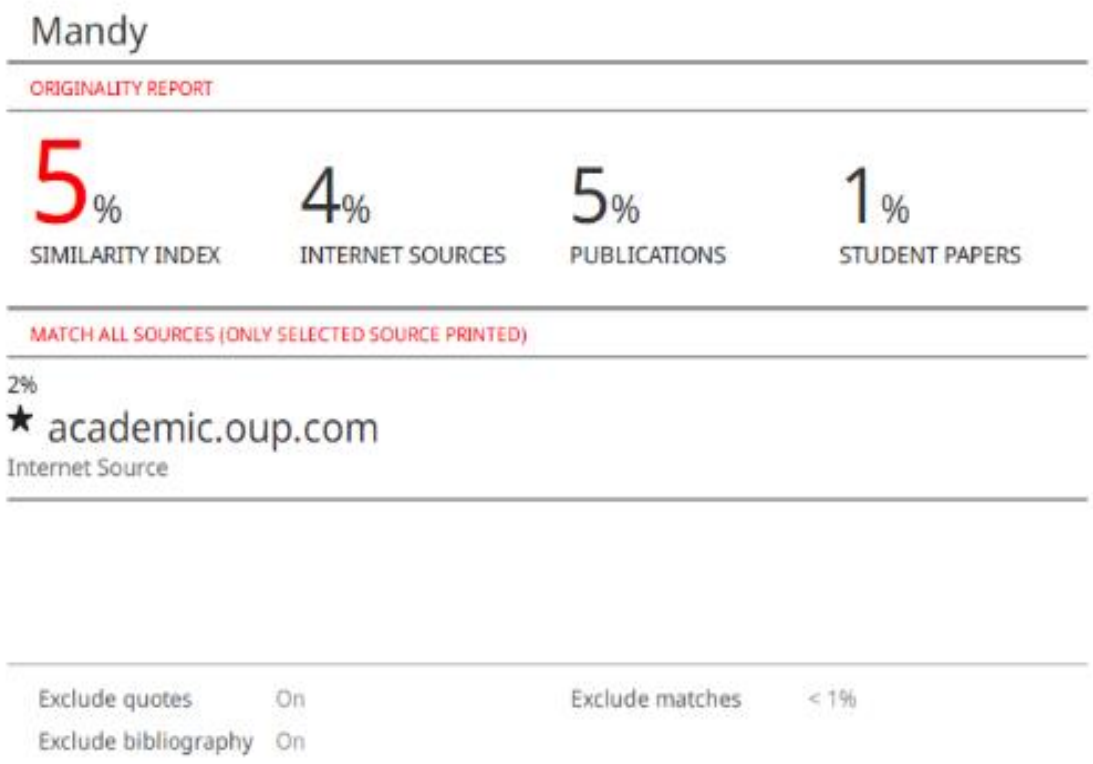
			concentration of 2.0±0.5 mmol/L in capillary blood slightly above the aerobic threshold.							
Gorostegi-Anduag, et al. 2018	16 weeks	2 days/ week	High volume moderate intensity continuous training: 65% VO2max; High volume HIIT: 90% VO2max; low volume: <65 VO2max	55 min	Aerobic	All groups Treadmill and Bike	Yes (p = 0.011)	Decrease in resting and mean on both SBP & DBP.	Decrease in HR, only high-volume HITT group decrease in BMI	Yes (The only group that received the standard guidelines for PA)

Table 3.6.5 Summary of successful Concurrent Interventions of primary and secondary outcomes (n= 4)

Author & Year	Duration	Frequency	Intensity	Time	Type	Exercise	Statistically Significance	Primary Outcomes	Secondary Outcomes	Control Group included?
Barone, et al. 2009	24 weeks	Not specified	Aerobic: 60–90% HR max; Strength: 50% 1RM	60 Mins	Concurrent: Aerobic/ Strength	Aerobic: not specified (but at a target HR); Strength: 7 weight training (latisissimus dorsi pull down, leg extension, leg curl, bench press, leg press, shoulder press and seated mid-rowing)	Yes (p = 0.03)	Decrease in SBP (p = 0.04) & DBP (p = 0.06).	Decrease in HR, BMI & Waist Circumference (<0.001)	Yes (only given written exercise guidelines from the National Institute of Aging)
Filho, et al. 2013	16 weeks	3 days/ week	3-5 OMNI-RES Scale (goal of 3-5 intensity level)	60-70 Min	Concurrent training	Walking, strength, stretching and balance	Yes (p = <0.05)	Decrease in SBP & DBP.	Decrease in BMI	Yes (No Exercise)
Masroor, et al. 2018	4 weeks	5 days/ week	50–80% Hrmax & 50-80% 1RM	20 Min	Concurrent: aerobic and strength training	Aerobic: Treadmill; Strength sets of 10 repetitions of 5 exercises: bicep curls, triceps extensions, abdominal crunches, leg curls, and knee extensions	Yes (p = <0.001)	Decrease in SBP & DBP.	Decrease in HR, BMI & WHR	Yes (No Exercise)
Caminiti, et al. 2019	1 week	3 days/ week	ACT: 55-7% VO2; IT: 80-95% VO2; Combined Training: 55-70%	ACT: 60 Min; IT: 3: 15 mins; CT: treadmill @ 30 mins &	Aerobic Continuous/ Interval/ Concurrent	Aerobic Continuous: Walk on treadmill; Interval: 3 peaks of high-intensity	Yes (p = 0.002)	Twenty-four-hour systolic BP variability decreased in the CT group.	None	No

		10 reps @ 30 mins	exercise, each one lasting 5 minutes at 80–95% of VO2 spaced by three intervals of low-intensity exercise each; Combined: treadmill & strength exercises (arms & legs; 10 reps @ 30% of maximal muscle strength)	Daytime systolic BP variability decreased in the CT group. Twenty-four-hour diastolic BP variability decreased in the ACT and CT groups while it increased in the IT group.

APPENDIX U – TURNITIN REPORT



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