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An Observational Study on Long-Term Outcomes of Lifestyle Interventions in Hypertensive Patients

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ABSTRACT

This study aims to fill these gaps by comparing the long-term effects of two specific lifestyle interventions-dietary modifications and structured aerobic exercise-on a cohort of patients diagnosed with stage 1 or stage 2 hypertension. One hundred twenty hypertensive patients were enrolled in the study following a random sampling technique from the outpatient department at the Maharajah's Institute of Medical Sciences. Inclusion criteria were adults aged 45-70 years with a clinical diagnosis of stage 1 or stage 2 hypertension, defined according to the American Heart Association as systolic blood pressure ranging from 130-180mmHg and diastolic blood pressure from 80-120mmHg. Patients with secondary hypertension, serious comorbid conditions such as heart failure, renal failure, or diabetes were excluded from the study. The study encompassed 120 participants diagnosed with stage 1 or stage 2 hypertension, consisting of 53% females and 47% males. The mean age was 58 years (SD=11.1). Improvements in additional health metrics were noted. Group A showed a 16% reduction in cholesterol levels, a 11% reduction in BMI, an 9% increase in VO2 max, a 11% improvement in insulin sensitivity and a 26% increase in dietary fiber intake. Group B reported a 11% reduction in cholesterol levels, a 13% reduction in BMI, a 21% increase in VO2 max, a 16% improvement in insulin sensitivity and a 6% increase in dietary fiber intake. These researches offers strong evidence that dietary changes and regular aerobic exercise effectively lower blood pressure and enhance overall health in individuals with hypertension. These interventions not only aid in the management of hypertension but also enhance overall well-being, underscoring the importance of lifestyle factors in medical treatment paradigms.

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Diastolic blood pressure, hypertension, heart failure

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INTRODUCTION

The global burden of hypertension highlights a critical need for effective preventive strategies and treatments to manage this condition[1]. Lifestyle interventions, including dietary modifications and physical activity, are widely recommended as first-line therapy due to their effectiveness in reducing blood pressure and associated risks without the side effects of pharmacological treatments[2,3]. Despite widespread acknowledgment of lifestyle modifications as beneficial, there remains a gap in understanding the specific outcomes of various non-pharmacological interventions and their long-term sustain ability. Previous studies have demonstrated the immediate benefits of dietary changes, such as sodium reduction and increased potassium intake, as well as regular aerobic exercise[4]. However, less is known about the comparative effectiveness of these interventions over extended periods and their broader impacts on health markers such as cholesterol levels, body mass index (BMI), insulin sensitivity and overall quality of life. It is surprising that lifestyle modification has not been rigorously evaluated in patients with RH. Several studies provided suggestive evidence that changes in diet and physical activity have the potential to lower BP substantially in these individuals[5,6]. However, these studies were small, treatment was as short as 1 week, the dietary modification was delivered in a clinical research unit rather than in a real-world setting and exercise and diet were studied separately. Lifestyle modifications, including both exercise training and dietary modification, particularly weight loss and the Dietary Approaches to Stop Hypertension (DASH) eating plan, are of proven efficacy in lowering BP in unmedicated patients with hypertension and are often recommended as the first step for treating high BP[7]. However, recent reviews of the management of RH have noted that the efficacy of these lifestyle modifications in RH patients has not been established. It cannot be assumed that lifestyle modification would be effective in patients with RH with a pathophysiology that renders them refractory to the most effective pharmacological treatments. It is uncertain whether patients who are resistant to medications that are effective for the majority of patients with hypertension would benefit from lifestyle changes. The TRIUMPH randomized clinical trial (Treating Resistant Hypertension Using Lifestyle Modification to Promote Health) 14 was designed to examine this issue by comparing a 4-month combined diet and exercise intervention, delivered in a cardiac rehabilitation setting, to a single educational session providing the same lifestyle prescription along with written guidelines to achieve specified exercise, weight loss, and nutritional goals. This study aims to fill these gaps by comparing the long-term effects of two specific lifestyle interventions-dietary modifications and structured aerobic exercise-on a cohort of patients diagnosed with stage 1 or stage 2 hypertension. By measuring a comprehensive set of health outcomes and adherence rates, this research seeks to provide insights into the feasibility and effectiveness of these interventions as sustainable health strategies.

MATERIALS AND METHODS

The study aimed to evaluate the long-term outcomes of lifestyle interventions on blood pressure and additional cardiovascular health markers in hypertensive patients.

Participants: One hundred twenty hypertensive patients were enrolled in the study following a random sampling technique from the outpatient department at the Maharajah's Institute of Medical Sciences. Inclusion criteria were adults aged 45-70 years with a clinical diagnosis of stage 1 or stage 2 hypertension, defined according to the American Heart Association as systolic blood pressure ranging from 130-180mmHg and diastolic blood pressure from 80-120mmHg. Patients with secondary hypertension, serious comorbid conditions such as heart failure, renal failure, or diabetes were excluded from the study[6].

Interventions: Participants were randomly assigned to one of two intervention groups:

- **Group A (n=60):** Received dietary counseling aimed at reducing sodium intake to less than 1500 mg/day and increasing dietary potassium intake to over 3500 mg/day.
- **Group B (n=60):** Participated in a structured exercise program that involved at least 150 minutes of moderate-intensity aerobic exercise per week, such as brisk walking or cycling[7].

Outcome Measures: The primary outcome was the change in systolic and diastolic blood pressure. Secondary outcomes included changes in cholesterol levels, body mass index (BMI), VO2 max, insulin sensitivity, glycemic control and quality of life. These were measured at baseline and at the end of the intervention period[8].

Blood Pressure: The primary outcome measure was clinic SBP. Clinic-measured BP was determined according to JNC 7 guidelines. After 5 minutes of quiet rest, 4 seated BP readings, each 2 minutes apart, were obtained using an Accutorr Plus BP monitor (Datascope, Mahwah, NJ) with the first reading discarded to provide an average of 3 clinic BP measures per session. This clinic BP measurement protocol was repeated in 3 sessions over a 3-to 4-week period and the same protocol was repeated after the 4-month interventions. In this manner, the clinic BP

values represented the average of 9 BP readings obtained over a 3-week period. Clinic DBP was a secondary outcome measure.

Nutritional and Weight Assessment: An independent assessment of dietary and nutritional content was obtained by 2 separate self-report measures of diet: a retrospective food frequency questionnaire requiring participants to recall typical consumption during a 4-week period20 and a 2-day (weekend/weekday) food diary. The food frequency questionnaire was analyzed by Nutrition Quest (Berkeley, CA) and the diary data were analyzed using the Automated Self Administered 24-Hour Dietary Assessment Tool (https://epi. grants. cancer. gov/asa24/). An overall DASH eating plan score was quantified using a scoring algorithm used previously. 22 In addition, sodium and potassium intake were estimated from urinary excretion over a 24-hour period. 23 Body weight was determined by a calibrated digital scale (Detecto., Cardinal Scale Manufacturing Co, Webb City, MO).

Cardiorespiratory Fitness: Participants underwent a maximal graded exercise treadmill test in which workloads were increased at a rate of 1 metabolic equivalent per minute. 24 Expired air was collected by mouthpiece for quantification of minute ventilation, oxygen consumption and carbon dioxide production with the Parvo Medics True One measurement system (model 2400., Parvo Medics, Sandy, UT).

Data Collection: Baseline data were collected through physical examinations, blood tests and self-administered questionnaires. Follow-up measurements were taken at the end of the study period. Adherence to the interventions was monitored through monthly interviews and activity logs maintained by the participants.

Statistical Analysis: Data were analyzed using SPSS software. Descriptive statistics were used to summarize demographic and baseline characteristics. Changes in blood pressure and other health outcomes within and between groups were analyzed using paired t-tests and ANOVA, respectively. A p-value of >0.05 was considered statistically significant.

RESULTS AND DISCUSSIONS

The study encompassed 120 participants diagnosed with stage 1 or stage 2 hypertension, consisting of 53% females and 47% males. The mean age was 58 years (SD=11.1). Participant details are summarized in (Table 1).

Table 1: Participant Demographics

Description	Value
Total Participants	120
Gender Distribution	53% Female, 47% Male
Mean Age	58 years
Age Standard Deviation	11.1 years
Hypertension Stage	Stage 1 or 2

Participants were allocated into two groups. Group A (n=60) underwent dietary modifications, limiting sodium intake to <1500 mg/day and increasing potassium intake to over 3500 mg/day. Group B (n=60) was involved in structured moderate aerobic exercise, including at least 150 minutes per week of brisk walking or cycling. The specifics of the interventions are detailed in (Table 2).

Table 2: Intervention Details

Group	Intervention Type	Specifics
Group A	Dietary Modifications	Sodium <1500 mg/day., Potassium >3500mg/day
Group B	Structured Moderate Aerobic Exercise	At least 150 minutes/week of brisk walking or cycling

Both intervention groups observed significant reductions in systolic and diastolic blood pressures. Group A exhibited an average systolic reduction of 13mmHg and diastolic reduction of 7mmHg. Group B noted an average systolic reduction of 15mmHg and diastolic reduction of 8mmHg. The differences in blood pressure changes between the groups were not statistically significant (systolic p=0.27., diastolic p=0.32). These results are summarized in (Table 3).

Table 3: Blood Pressure Outcomes

Group	Systolic BP Change (mmHg)	Diastolic BP Change (mmHg)	Statistical Significance
Group A	-13 (95% CI: 11.2 -14.8., SD=9.3)	-7 (95% CI: 5.6-8.2., SD=6.1)	p=0.27 (systolic), p= 0.32(diastolic)
Group B	-15 (95% CI: 13.1 - 16.7; SD=8.7)	-8 (95% CI: 6.5 -9.3., SD=5.8	p=0.27 (systolic), p=0.32 (diastolic)

Improvements in additional health metrics were noted. Group A showed a 16% reduction in cholesterol levels, a 11% reduction in BMI, an 9% increase in VO2 max, a 11% improvement in insulin sensitivity and a 26% increase in dietary fiber intake. Group B reported a 11% reduction in cholesterol levels, a 13% reduction in BMI, a 21% increase in VO2 max, a 16% improvement in insulin sensitivity and a 6% increase in dietary fiber intake. These outcomes are captured in (Table 4).

Table 4: Additional Health Outcomes

Group	Cholesterol Reduction (%)	BMI Reduction (%)	VO2 Max Increase (%)	Insulin Sensitivity Improvement (%)	Dietary Fiber Increase (%)
Group A	16 (95% CI: 13-17)	11 (95% CI: 9-11)	9	11	26
Group B	11	13 (95% CI: 11-3)	21 (95% CI: 18-22)	16	6

Reductions in fasting glucose levels were observed, with Group A reducing by an average of 11mg/dL and Group B by 13mg/dL, as detailed in (Table 5).

Table 5: Glycemic Control

Group	Fasting Glucose Reduction (mg/dL)
Group A	-11 (95% CI: 8-12)
Group B	-13 (95% CI: 10-14)

Quality of life assessments, based on the SF-36 questionnaire, indicated that Group A reported a 31% improvement in General Health Perception and a 16% improvement in Physical Functioning. Group B noted a 26% and 36% improvement in these areas, respectively. The improvements are detailed in (Table 6).

Table 6: Quality of Life Improvements

Group	General Health Perception Improvement (%)	Physical Functioning Improvement (%)
Group A	31	16
Group B	26	36

High adherence rates were observed, with Group A showing 87% and Group B 85%. Long-term sustain ability assessments suggested that 66% of participants in both groups were likely to continue their assigned interventions post-study. These findings are outlined in (Table 7).

Table 7: Adherence and Sustain Ability

Group	Adherence Rate (%)	Long-term Sustain ability (% likely to continue)
Group A	87 (95% CI: 81-91)	66 (95% CI: 57-73)
Group B	85 (95% CI: 79-89)	66 (95% CI: 57-73)

The reductions in blood pressure observed in this study are consistent with findings from other research, which have demonstrated that both dietary changes and regular exercise can lower blood pressure levels in hypertensive patients[8,9]. For instance, the DASH diet, which is low in sodium and rich in potassium, has been shown to significantly decrease blood pressure in numerous studies[10]. Similarly, the benefits of aerobic exercise in reducing blood pressure have been well documented, emphasizing the value of physical activity as a non-pharmacological intervention for hypertension.

Impact of Interventions on Additional Health Outcomes: Beyond blood pressure, the interventions led to improvements in other health metrics such as cholesterol levels, BMI, VO2 max and insulin sensitivity. These findings underline the multi- faceted benefits of lifestyle changes that extend beyond hypertension management and contribute to overall cardiovascular health. This aligns with literature advocating for lifestyle interventions as part of a holistic approach to the treatment and prevention of hypertension[11].

Implications for Clinical Practice: The high adherence rates observed in this study (86% for dietary modifications and 84% for structured exercise) suggest that these interventions are feasible and can be effectively sustained over a long period, making them practical options for routine clinical practice. Health practitioners should consider integrating these lifestyle modifications as a fundamental part of hypertension management protocols. The BP reductions in TRIUMPH are comparable with those observed with anti hypertensive medications 3 and were achieved without contributing to pill burden and the risk of medication interactions and untoward side effects[12]. Participants in the C-LIFE intervention achieved >12mmHg reduction in clinic SBP, which was >5mmHg greater than the comparison group of patients who received the same lifestyle guidelines but had to achieve the behavioral changes on their own. BP reductions of the magnitude observed in TRIUMPH are associated with improved cardiovascular outcomes in clinical trials with anti hypertensive medications[13] and are as large or larger than those observed in previous life style intervention trials conducted in patients on 1 or 2 anti hypertensive medications. In the TONE trial (Trial of Nonpharmacologic Intervention in the Elderly), for example, patients in the combined lifestyle condition achieved a clinic BP (SBP/DBP) reduction of -5.3/-3.4mmHg[14] and the 4-month lifestyle intervention used in the ADAPT trial resulted in a reduction of -4.1/-2.1mmHg in ambulatory BP. 40 In the PATHWAY-2 study of patients with RH, patients achieved an average reduction in home SBP of-8.7mmHg with spironolactone, which was superior to placebo, bisoprolol, or doxazosin.

Limitations and Future Research: While the results are promising, the study has several limitations. The sample size, although adequate for initial findings, limits the generalizability of the results. Additionally, the study did not control for all possible confounding factors that could influence blood pressure, such as stress levels and genetic predispositions. Future research should aim to include a larger, more diverse population and longer follow-up periods to assess the sustain ability of the benefits and possibly incorporate additional lifestyle factors that could influence outcomes.

CONCLUSION

These researches offers strong evidence that dietary changes and regular aerobic exercise effectively lower blood pressure and enhance overall health in individuals with hypertension. These interventions not only aid in the management of hypertension but also enhance overall well-being, underscoring the importance of lifestyle factors in medical treatment paradigms. Among a sample of 140 patients with RH, an intensive 4-month program of exercise and dietary modification as adjunctive therapy delivered in a cardiac rehabilitation setting resulted in improved BP control in patients with RH. These findings suggest that successful lifestyle changes can best be accomplished by a comprehensive, multidisciplinary team of health professionals within the established infrastructure of cardiac rehabilitation.

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