Received: 8 January 2025/ Revised: 17 January 2025/ Accepted: 27 January 2025

CASE REPORT

Journal of Hacettepe University
Physical Therapy and Rehabilitation

Effect of Telerehabilitation on Exercise Capacity, Cardiac Function and Physical Activity in a Patient with Systemic Arterial Hypertension: A Case Report

Beyza Nur DURUKAN[1*], Farzın JAM[2], Yasemin Buran CIRAK[3], Zeynep Tuğba OZAN[4], Yusuf Ziya SENER[5], Naciye VARDAR-YAGLI[6]

[1] Yozgat Bozok University, School of Sarikaya Physiotherapy and Rehabilitation, Yozgat, Türkiye
[2] Sorgun State Hospital, Department of Cardiology, Yozgat, Türkiye
[3] Istinye University, Faculty of Health Sciences, Department of Physiotherapy and Rehabilitation, Istanbul, Türkiye
[4] Yozgat Bozok University, Faculty of Medicine, Department of Internal Medicine, Yozgat, Türkiye
[5] Erasmus MC, Rotterdam, Netherlands
[6] Hacettepe University, Faculty of Physical Therapy and Rehabilitation, Department of Cardiorespiratory Physiotherapy and Rehabilitation, Ankara, Türkiye
*Corresponding author e-mail: beyzakrdz@gmail.com

ABSTRACT

Purpose: The aim of this study was to investigate the effects of aerobic exercise training applied via telerehabilitation on cardiac functions, exercise capacity, physical activity, and body composition in a systemic hypertensive individual.

Method: A 48-year-old female case is presented in this study. The hypertensive individual who applied to the Sorgun State Hospital Department of Cardiology was consulted for cardiac rehabilitation (CR). Since the patient could not access outpatient CR, the physical therapist decided to perform synchronous telerehabilitation. Before and at the end of the exercise training, exercise capacity was assessed with 6-minute stepper test and maximal stress test, physical activity level with the International Physical Activity Scale and smartwatch, body composition with bioelectrical impedance analysis, and systolic and diastolic functions with echocardiography. The patient underwent submaximal exercise training via video conference for 24 sessions and real-time heart rate monitoring was performed during the exercise.

Results: The patient (height: 155 cm, body mass index: 31.61 kg/m²) completed all 24 sessions (100%). No adverse events were observed. At the end of the exercise training, there were improvements in the patient's cardiac functions as well as in blood pressure. Moreover, there was a significant increase in oxygen consumption and exercise capacity levels. In addition, positive changes were observed in the patient's physical activity level and body composition.

Discussion: Hypertension can benefit from aerobic exercise training delivered via telerehabilitation, Given the high adherence rate, cost-effectiveness, and feasibility, cardiac telerehabilitation appears to be a promising intervention for managing hypertension.

Key Words: Hypertension, Exercise, Telerehabilitation.

INTRODUCTION

Arterial hypertension (HTN) is characterized by elevated blood pressure and a modifiable cardiovascular risk factor for cardiovascular morbidity and mortality. The pathophysiology of HTN could be explained with several mechanisms. Some physiologic mechanisms underlying HTN development are increased cardiac output and peripheral vascular resistance of arterioles (1). Risk factors of HTN could be categorized as modifiable and non-modifiable risk factors. Age, gender, ethnicity, and family history are some of non-modifiable and obesity, smoking, physical inactivity, excess salt, fat, and alcohol consumption are some of the modifiable risk factors (2). Physical activity (PA) is a cornerstone of HTN management. PA and exercise have been suggested with 1A evidence level in up-to-date HTN guidelines (3, 4). In addition to the development of HTN, PA also delays or prevents the occurrence of HTN-related complications (e.g; cerebrovascular accident, cardiovascular disease-CVD). Some benefits of PA and exercise are improved endothelial functions, angiogenesis, increased baroreceptor sensitivity and parasympathetic tone, and decreased fat mass and body weight (5). Hypertensive individuals are one of the most important candidates for CR. PA and exercise are the most important components of cardiac rehabilitation (CR). CR could be implemented in several ways. In a scientific statement, the American Heart Association explains CR forms: center-based, virtual, and remote CR. In the literature, home-based exercise training commonly involves calisthenic exercises, which do not require individuals to use any equipment (6). Calisthenic exercises enable individuals to safely perform exercises using their body weight, while increasing heart rate through the engagement of large muscle groups. In home-based settings, CR could deliver with telecommunication technologies via synchronous and asynchronous ways. In the literature, there are some studies analyzing clinical outcomes of cardiac telerehabilitation. But, there are very limited studies examining the effect of cardiac telerehabilitation on exercise capacity, cardiac systolic and diastolic functions, and physical activity. The aim of this study was to determine the effect of cardiac telerehabilitation on cardiac functions and exercise capacity conducted via synchronous manner in a patient with HTN.

CASE PRESENTATION

A 48-year-old female patient was admitted to the hospital 9 years ago with recurrent headaches radiating from the base of the neck to the head and was diagnosed with systemic HTN after cardiological evaluations. The patient's height was 155 cm, and the body weight was 75.95 kg. She has a family history of CVD. Upon admission to the Sorgun State Hospital Cardiology Department, she was invited to participate in an 8-week, 24-session exercise training program. Written informed consent was obtained from the patient before including her in the study.

As part of the study, the patient was provided with a smartwatch (Xiaomi Mi Band 5, MB5, Xiaomi Corporation, China) to monitor heart rate (HR) during exercise sessions and an electronic blood pressure monitor (HEM-7143-E; Omron Healthcare Co., Ltd., Japan) to measure blood pressure before and after exercise sessions. Before initiating the exercise training, a cardiologist performed echocardiography (Vivid Pro 7, GE Horten, Norway) to record early and late diastolic velocities (E and A, respectively) and ejection fractions (%) to examine systolic functions. To assess exercise capacity, a symptom-limited maximal stress test and a 6-minute stepper test (6MST) were conducted. Vital parameters, perceived fatigue and dyspnea scores were recorded before and after (6MST). In the stress test, predicted oxygen consumption was calculated according to [(4.38 × duration) - 3.9] formula (7). Ambulatory blood pressure monitoring was performed to evaluate 24-hour blood pressure. Additionally, the patient's physical activity levels and body composition were assessed before and after the exercise training. Physical activity assessment was conducted both objectively (via the activity record from the smartwatch) and subjectively (using the International Physical Activity Questionnaire-short form-IPAQ) and body composition analysis was conducted with bioelectrical impedance analysis (Xiaomi Mi Scale 2, Xiaomi Corp., China).

During exercise sessions, submaximal intensity (65% to 84% of maximal heart rate) was targeted (according to Karvonen formula; 220-age); maximal and mean HR were recorded and analyzed. Mean HR recordings included the warming, exercise, and cooling periods of each exercise session. The rehabilitation program includes unilateral and bilateral extremity and body calisthenic exercises. Some exercise examples were high knee, side-to-side hoops, leg kicks, high knee jack, and jogging in place (8). Exercise sessions last 45 minutes and include 5-minute warming and cooling periods. Blood pressure, perceived general fatigue, leg fatigue, and dyspnea based on the Modified Borg Scale were recorded before and after exercise. Each session's mean and maximal HR were recorded via smartwatch. When the target heart rate could not be achieved during exercise, the exercises were progressed. While progressing the exercises, the aim was to activate a greater number of muscle groups (For example unilateral to bilateral exercises).

Table-1. Exercise Capacity Outcomes

Variables		Telerehabilitation	
		Before	After
Predicted oxygen consumption (mL/kg/min)		31.21	41
Step counts (n)		159	218
HR (beats/minute)	Before test	98	86
	After test	153	149
	ΔHR	55	63
	Predicted Maximal (%)	88.95	86.63
SBP (mmHg)	Before test	139	125
	After Test	154	131
DBP (mmHg)	Before test	90	86
	After test	97	89
Perceived Leg Fatigue (MBS)	Before test	0	0
	After test	7	3
Perceived Body Fatigue (MBS)	Before test	0	0
	After test	6	0
Perceived Dyspnea (MBS)	Before test	0	0
	After test	0	0

Δ: Delta, HR: Heart Rate; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; MBS: Modified Borg Scale.

RESULTS

The patient completed 24 exercise sessions with 100% session attendance. No injuries or adverse events were observed during the exercise sessions. As expected, the patient's exercise capacity improved, perceived fatigue and dyspnea scores decreased during the exercise. A 37.1% improvement was seen in exercise capacity.

24 hours of blood pressure was decreased and systolic and diastolic functions improved. Mean daytime SBP decreased 6.1% and similarly, DBP decreased 5.6% (Table-2). The results of exercise tests were illustrated in Table-1 and cardiac functions and ambulatory blood pressure measurements were illustrated in Table-2. The patients' body composition improved as that fat-free mass increased and fat mass and body mass index (BMI) decreased (Table-3). Patient's achieved HR's percentage (according to predicted maximal heart rate) during exercise sessions was shown in Figure-1. Similarly, the patients' objective and subjective physical activity levels showed progression (Figure-2). The percentage of mean HR of exercise sessions were between 66% to %78.

DISCUSSION

This study describes the effect of real-time cardiac telerehabilitation on exercise capacity and response to exercise, cardiac functions and blood pressure, body composition, and physical activity levels of a hypertensive individual. Aerobic-based calisthenic exercises improved cardiac functions, exercise capacity, body composition, and physical activity. Aerobic exercises produce some physiological adaptations. As a consequence of aerobic exercise training, mitochondrial density, capillarization, and lactate threshold increase, and parasympathetic tone improves (9). These adaptations enhance the exercise capacity of the individual.

Table-2. Ambulatory Blood Pressure and Cardiac Functions

Variables		Before Telerehabilitation	After Telerehabilitation
Diastolic Velocity	Early (E) (sec)	0.60	0.65
	Late (A) (sec)	0.80	0.54
Ejection Fraction (%)		67	69
Mean SBP	Daytime (mmHg)	132	124
	Nighttime (mmHg)	125	110
	24 hours (mmHg)	130	121
Mean DBP	Daytime (mmHg)	90	85
	Nighttime (mmHg)	87	68
	24 hours (mmHg)	89	81

sec: Seconds; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure.

Table 3. Body Composition Analysis

Variables	Before Telerehabilitation	After Telerehabilitation
Body Fat Mass (%)	45.80	42.70
Muscle Mass (kg)	36.13	38.02
Basal Metabolic Rate (kcal/day)	1130	1227
Visseral Fat rate	10	9
Waist circumference (cm)	93	86
Waist/hip ratio	0.89	0.85
Waist/height ratio	0.60	0.55

cm: centimeters, kg: kilograms.

This result is parallel to the literature. In a meta-analysis analyzing the results of exercise training, reported improvement in oxygen consumption above the minimal clinical importance level (2 ml/kg/min) (10). Our cases' oxygen consumption has improved higher than minimal clinical importance level, similarly. Obesity is an independent determinant of HTN and CVD. Generally, obesity is concomitant to HTN and obesity disrupts blood pressure control.

In a study analyzing body composition and blood pressure showed patients who had the worst blood pressure profile had the lowest muscle mass and highest fat mass (11). Similarly, Linderman analyzed 1.7 million adults' BMI and blood pressure levels. Every increment in BMI elevates the blood pressure from 0.8 to 1.7 mmHg (12). In conclusion of this, the management of fat mass and body composition optimizes blood pressure levels.

Physical inactivity is a prominent cardiovascular risk factor in today's world. HTN is one of the important CVD risk factors and a vicious cycle was shown in CVD. Individuals having CVD have lower functional capacity and patients having lower functional capacity show more sedentary time (13).

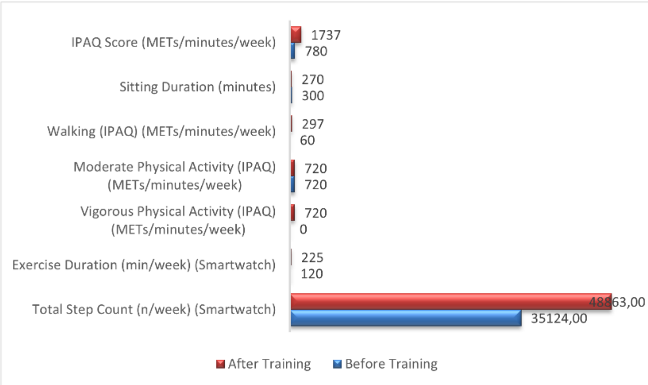

Figure 2. Physical Activity Outcomes

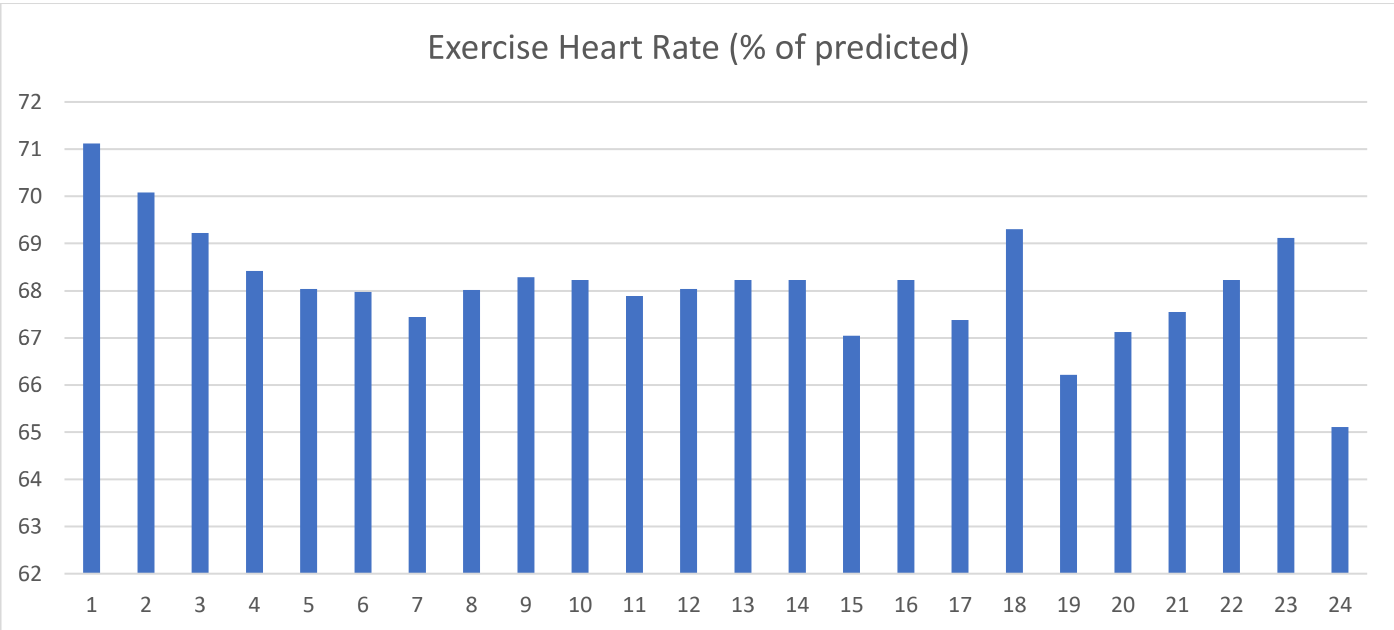

Figure 1. Exercise Sessions' Heart Rate

In a systematic review, a negative correlation is shown between HTN and physical activity level. In addition to this, physical activity is protective for HTN-mediated organ damage in hypertensive individuals (14). World Health Organization suggests at least 150 minutes of moderate-intensity or 75 minutes of vigorous physical activity for individuals having chronic disease (15). An increase of 1,000 steps in daily step count has been shown to reduce all-cause mortality by 15% (16). In this regard, higher physical activity is related to better cardiovascular functions and blood pressure levels.

CONCLUSION

In this case, oxygen consumption improved by 30% and blood pressure decreased by 7%. Similar to center-based or conventional cardiac rehabilitation programs, telerehabilitation leads to beneficial effects on cardiovascular functions, blood pressure, body composition, and physical activity. Ensuring blood pressure control prevents cardiovascular complications of HTN so blood pressure control is critical for hypertensive individuals. With this case report, it was seen that real-time calisthenic-based aerobic exercise training is safe and effective in hypertensive individuals. In future studies, we suggest to compare the effectiveness of different telerehabilitation interventions.

Acknowledgments

Author Contributions: BND: Concept, design, data collection and or processing, literature search, writing manuscript. FJ: Data collection, supervision, critical review. YBC, ZTO: Supervision, critical review. NVY, YBC: Supervision, writing manuscript, critical review.

Financial Support: The authors declare that no funds, grants, or other support were received during the preparation of this manuscript.

Conflict of Interest: The author(s) state that there are no potential conflicts of interest concerning the research, writing, and/or publication of this article.

Ethical approval: Informed consent was taken from the patient.

How to cite this article: Durukan BN, Jam F, Buran Cirak Y, Ozan ZT, Sener YZ, Vardar Yagli N. Effect of Telerehabilitation on Exercise Capacity, Cardiac Function and Physical Activity in a Patient with Systemic Arterial Hypertension: A Case Report. Journal of Hacettepe University Physical Therapy and Rehabilitation. 2025;3(1),48-53.

REFERENCES

1. Beevers G, Lip GY, O'Brien E. The pathophysiology of hypertension. BMJ. 2001;322(7291):912-6.
2. McEvoy JW, McCarthy CP, Bruno RM, Brouwers S, Canavan MD, Ceconi C, et al. 2024 ESC Guidelines for the management of elevated blood pressure and hypertension: Developed by the task force on the management of elevated blood pressure and hypertension of the European Society of Cardiology (ESC) and endorsed by the European Society of Endocrinology (ESE) and the European Stroke Organisation (ESO). Eur Heart J. 2024;45(38):3912-4018.
3. Mancia Chairperson G, Brunström M, Burnier M, Grassi G, Januszewicz A, Muiesan ML, et al. 2023 ESH Guidelines for the management of arterial hypertension The Task Force for the management of arterial hypertension of the European Society of Hypertension Endorsed by the European Renal Association (ERA) and the International Society of Hypertension (ISH). J Hypertens. 2023.
4. McEvoy JW, McCarthy CP, Bruno RM, Brouwers S, Canavan MD, Ceconi C, et al. 2024 ESC Guidelines for the management of elevated blood pressure and hypertension: Developed by the task force on the management of elevated blood pressure and hypertension of the European Society of Cardiology (ESC) and endorsed by the European Society of Endocrinology (ESE) and the European Stroke Organisation (ESO). Eur Heart J. 2024:ehae178.
5. Diaz KM, Shimbo D. Physical activity and the prevention of hypertension. Curr Hypertens Rep. 2013;15:659-68.
6. Lee MK, Lee CJ, Goo SY, Lee TH, Moon JY, Jung J, et al. Development and application of a home-based exercise program for patients with cardiovascular disease: a feasibility study. BMC Sports Science, Medicine and Rehabilitation. 2024;16(1):51.
7. Pollock ML, Foster C, Schmidt D, Hellman C, Linnerud A, Ward A. Comparative analysis of physiologic responses to three different maximal graded exercise test protocols in healthy women. Am Heart J. 1982;103(3):363-73.
8. Liguori G, Medicine ACoS. ACSM's guidelines for exercise testing and prescription: Lippincott Williams & Wilkins; 2020.
9. McArdle WD, Katch FI, Katch VL. Exercise physiology: nutrition, energy, and human performance: Lippincott Williams & Wilkins; 2010.
10. Rijal A, Adhikari TB, Dhakal S, Maagaard M, Piri R, Nielsen EE, et al. Effect of exercise on functional capacity and body weight for people with hypertension, type 2 diabetes, or cardiovascular disease: a systematic review with meta-analysis and trial sequential analysis. BMC Sports Science, Medicine and Rehabilitation. 2024;16(1):38.
11. Han TS, Al-Gindan YY, Govan L, Hankey CR, Lean ME. Associations of body fat and skeletal muscle with hypertension. The Journal of Clinical Hypertension. 2019;21(2):230-8.
12. Linderman GC, Lu J, Lu Y, Sun X, Xu W, Nasir K, et al. Association of body mass index with blood pressure among 1.7 million Chinese adults. JAMA network open. 2018;1(4):e181271-e.
13. de Assis Ramos R, Guimarães FS, Dionyssiotis Y, Tsekoura D, Papathanasiou J, de Sá Ferreira A. Development of a

multivariate model of the six-minute walked distance to predict functional exercise capacity in hypertension. J Bodyw Mov Ther. 2019;23(1):32-8.

14. Pescatello LS, Buchner DM, Jakicic JM, Powell KE, Kraus WE, Bloodgood B, et al. Physical activity to prevent and treat hypertension: a systematic review. Med Sci Sports Exerc. 2019;51(6):1314-23.

15. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br J Sports Med. 2020;54(24):1451-62.

16. Banach M, Lewek J, Surma S, Penson PE, Sahebkar A, Martin SS, et al. The association between daily step count and all-cause and cardiovascular mortality: a meta-analysis. European journal of preventive cardiology. 2023;30(18):1975-85.