



UP TO 80% OF PATIENTS ARE NOT REACHING GUIDELINE-RECOMMENDED LDL-C GOALS WITH AVAILABLE LIPID-LOWERING THERAPIES¹⁻³

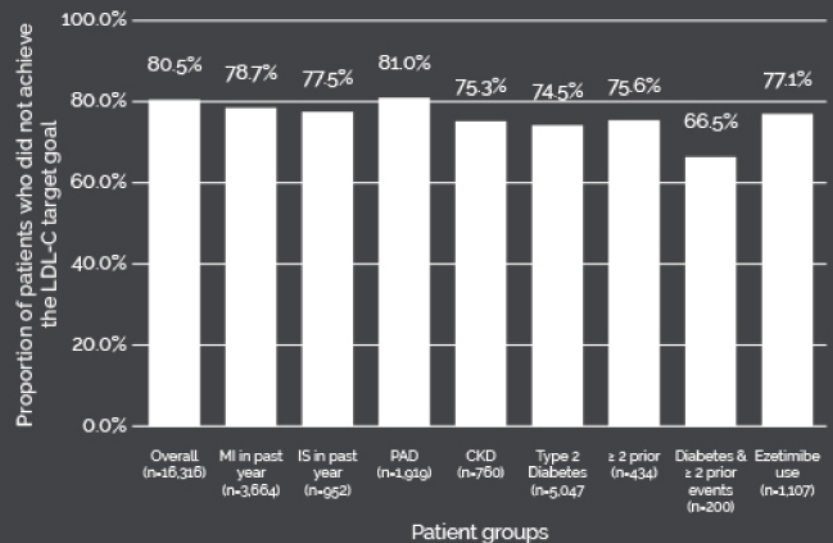
Dear Doctor,
Despite being treated with available lipid-lowering therapies, patients' LDL-C remains high.¹⁻³ A retrospective cohort study including >14,000 ASCVD patients found that up to 80% of patients had LDL-C ≥ 70 mg/dL, a level which exceeds new guideline-recommended goals.^{1,2}

Is an additional treatment option needed to complement current oral lipid-lowering therapies?

IF YOUR PATIENT'S LDL-C REMAINS HIGH, IT'S TIME TO THINK DIFFERENTLY AND ACT DIFFERENTLY

FIND OUT MORE

Percentage of patients with ASCVD not reaching LDL-C goals



Adapted from Fox et al. 2018.²

ASCVD, atherosclerotic cardiovascular disease; CKD, chronic kidney disease; EAS, European Atherosclerosis Society; ESC, European Society of Cardiology; IS, ischaemic stroke; LDL-C, low-density lipoprotein cholesterol; MI, myocardial infarction; PAD, peripheral arterial disease.

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1. ESC/EAS Guidelines for the management of dyslipidaemias. Eur Heart J. 2020; 41(1): 111-188.
2. Fox KM et al. Clin Res Cardiol. 2018; 107: 380-388.
3. Kotseva K et al. Eur J Prev Cardiol. 2019; 26(8): 824-835.

For more information on lowering LDL-C, visit: lower-ldl.eu

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Low- and moderate-intensity aerobic exercise acutely reduce blood pressure in adults with high-normal/grade I hypertension

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Abstract

The aim of the study is to compare the acute effects of low- and moderate-intensity aerobic exercise on post-exercise blood pressure in active adults with high-normal/grade I hypertension. Thirteen physically active adults (67.0 ± 8.7 years) randomly completed two aerobic exercise sessions of 30 minutes at low (30% heart rate reserve [HRres]) and moderate (60% HRres) intensity. Blood pressure was assessed pre-session and every hour until 3 hours after. Systolic blood pressure decreased after both exercise intensities without significant differences between sessions at 1 hour after the session (30%: $-10.0 \pm 12.6\%$ vs 60%: -11.4 ± 12.7 mm Hg, $P > .05$). Three hours after the 60% session, the systolic blood pressure remained significantly lower than baseline (139.9 ± 12.9 to 129.3 ± 11.9 mm Hg, $P < .05$), but without significant differences between sessions. No relevant changes were observed in diastolic and mean blood pressure. In conclusion, a single session of aerobic exercise acutely reduces systolic blood pressure in active adults with high-normal/grade I hypertension.

1 | INTRODUCTION

The global burden of arterial hypertension was projected to rise from 918 million adults in 2000 to 1.56 billion in 2025.¹ Hypertension is a major, modifiable risk factor for serious health conditions, such as heart failure, and cardiovascular and cerebrovascular acute events.²

Regular physical exercise has been widely recognized as an important strategy to control blood pressure (BP) in individuals with hypertension.^{3,4} The reduction in BP observed after a single session of exercise, that is post-exercise hypotension, showed a strong positive correlation with the chronic reduction in BP observed after 8 weeks of exercise training⁵; suggesting that the acute decrease in BP may be linked to long-term adaptations to exercise.⁶

The studies in older adults are scarce, and there is a lack of studies in active hypertensive individuals. In addition, controversial results have been described regarding BP response depending on the intensity of the exercise^{7,8} or physical fitness status of the subjects (trained or untrained), as some studies showed no

differences⁹ and others showed that untrained subjects present a greater BP decrease than trained subjects.¹⁰ Therefore, this study aims to compare the acute effects of two aerobic exercise intensities (low and moderate) on post-exercise BP in adults with high-normal BP/essential grade I hypertension and regular exercise participation.

2 | METHODS

2.1 | Study design

This is a cross-over, repeated-measures study. Each participant completed two randomly assigned experiments (aerobic exercise at 30% and 60% of the heart rate reserve (HRres)). The order of the experiments was randomized using a sealed, opaque, envelope. BP was measured before and after the acute experiments, and at every hour until 3 hours post-exercise. Both experiments were conducted at the

same time of day (between 08:30 and 10:00 AM) to account for diurnal variation in BP, separated by a minimum of 48 hours to avoid acute exercise effects, and completed within 2 weeks of the beginning of the study participation.

2.2 | Participants

Physically active adults (age ≥ 45 years old) with regular participation in an aerobic exercise training program (5 \times 60 minutes sessions/wk) for at least 12 months, and high-normal BP or essential grade I arterial hypertension¹¹ were recruited in a community exercise program. Both genres were included because the transient reduction in BP after exercise does not appear to be affected by genre.¹² Exclusion criteria: changes in hypertensive medication in the preceding 3 months, peripheral arterial disease, lung disease, cancer, or any other contraindication to exercise. The local review board approved the study; written informed consent was obtained, and all procedures were conducted in accordance with the Declaration of Helsinki.

2.3 | Procedures

Potential participants of a community exercise program were asked to participate. Those who agreed to participate received detailed explanations about the procedures, monitoring techniques, and apparatus, and visited the laboratory three times. On the first visit, the participants were introduced to the study protocol, procedures, and equipment for home BP self-assessment; then, clinical history, medication, body weight and height, resting office BP, and heart rate (HR) were assessed as recommended.¹¹ On the second and third visits, participants completed two randomly assigned exercise sessions, one at an intensity of 30% of the HR_{res} and the other at 60%. To calculate the HR_{res}, the theoretical maximum HR was calculated using the formula of Tanaka: $208 \text{ bpm} - (\text{age} \times 0.7)$. Each exercise session lasted 40 minutes, that is, 5 minutes of warm-up, 30 minutes of aerobic exercise on a treadmill, and 5 minutes of cool-down. HR (HR monitor) and levels of exertion (ie, Borg scale) were monitored during exercise sessions.

Blood pressure was self-assessed, with the participants seated, using a digital automatic BP monitor (M6; Omron Healthcare Co.) at rest 10 minutes before the exercise sessions, after the session (with supervision), and at 1, 2, and 3 hours (at home) after the end of the exercise session. Subjects were instructed to perform their habitual daily activities, to assess BP in a quiet room (replicating the conditions of the assessment previous to exercise) following the recommended procedures¹¹ and register the BP values in a standardized datasheet. In brief, participants were seated comfortably in a quiet environment for 5 minutes before BP and HR measurements. The measurements were performed with the right arm, relaxed, on a table at heart level. Three measurements were made at intervals of 1 minute; the average of the last two measurements was recorded.

All subjects were asked to avoid strenuous exercise on the 48 hours before the visits and to have a light breakfast, without any stimulants (coffee, tobacco, and alcohol), no less than 2 hours before the start of the sessions. All subjects maintained the same antihypertensive treatment during the study period.

2.4 | Statistical analysis

Data were analyzed using IBM SPSS Statistics 20 (IBM Corporation). The normality of the data distribution was tested with the Shapiro-Wilk test. Absolute values and BP change (BP delta [Δ] = BP post-exercise - BP pre-exercise) are reported as mean \pm SD values. To examine the effect of the exercise intensity on BP, a repeated-measures analysis of variance (30%/60% session \times pre-exercise/post-exercise/1 h post-exercise/2 h post-exercise/3 h post-exercise) was used to compare results between sessions over time (session \times time). When a significant interaction was observed, post hoc mean comparisons were performed. Paired sample *t* tests were performed to compare BP values between exercise sessions at baseline and at each time point after exercise. $P < .05$ was considered to be significant.

3 | RESULTS

Overall, participants ($n = 13$) were 67.0 ± 8.7 years old (weight: 64.6 ± 9.3 kg; height: 1.63 ± 0.11 m; BMI: 24.1 ± 2.3 kg/m²) and mostly women ($n = 8$, 61.5%). Six participants (46.2%) were classified as high-normal BP and seven as grade I hypertension (53.8%). Six (46.2%) participants were on medication (angiotensin converting enzyme inhibitor, 66.7%; diuretics, 66.7%; and angiotensin II receptors blockers, 33.3%).

There were no differences between sessions at baseline in SBP and mean BP, but diastolic BP was slightly lower before the 60% session ($P = .023$) (Table 1).

There was a significant effect of time in SBP ($P = .034$), and an interaction between time and exercise condition ($P = .026$). Systolic BP decreased after exercise in both sessions of exercise, although the pattern of response differed across time, that is, the decrease in systolic BP was significant immediately after the 30% protocol and this effect lasted until 2 hours post-exercise, whereas after the 60% protocol the systolic BP decreased significantly 1 hour after the session and remained below the baseline values until 3 hours post-exercise (Table 1, Figure 1). However, no differences were found between protocols at any time point after the exercise bout (Table 1). In addition, no interaction was observed between time, exercise condition, and antihypertensive medication ($P = .718$).

Significant differences were observed across time ($P = .039$), but no interaction between time and exercise sessions in diastolic BP ($P = .607$) (Table 1). Diastolic BP increased immediately after the 60% exercise protocol ($P = .018$), but values returned to baseline after 1 hour. No significant changes were observed between sessions in

TABLE 1 Blood pressure response to the exercise bouts and absolute change to baseline (delta [Δ])

Assessment moment										
Variable	Group (%)	Baseline	After	ΔBP After	1 h post	ΔBP 1 h post	2 h post	ΔBP 2 h post	3 h post	ΔBP 3 h post
SBP (mm Hg)	30	142.5 ± 10.4	134.6 ± 11.1*	-7.9 ± 11.6	132.5 ± 13.1*	-10.0 ± 12.6	133.5 ± 14.8*	-9.0 ± 12.6	133.8 ± 14.7	-8.7 ± 17.4
	60	139.9 ± 12.9	136.2 ± 14.3	-3.7 ± 14.0	128.5 ± 10.3*	-11.4 ± 12.7	128.5 ± 14.4*	-11.4 ± 15.8	129.3 ± 11.9*	-10.5 ± 12.2
DBP (mm Hg)	30	81.4 ± 7.7	81.9 ± 7.8	0.5 ± 4.7	82.0 ± 10.0	0.6 ± 6.2	80.4 ± 10.3	-1.0 ± 7.5	78.4 ± 12.1	-3.0 ± 10.7
	60	76.8 ± 5.1**	81.2 ± 5.2*	4.4 ± 3.6**	76.9 ± 5.2	0.1 ± 5.3	76.8 ± 6.2	0.1 ± 6.1	76.4 ± 6.8	-0.4 ± 4.5
Mean BP (mm Hg)	30	101.8 ± 7.4	99.5 ± 7.3	-2.3 ± 6.0	98.9 ± 9.4	-2.9 ± 7.5	98.1 ± 9.9	-3.7 ± 7.2	96.9 ± 11.5	-4.9 ± 12.0
	60	97.8 ± 6.2	99.5 ± 6.2	1.7 ± 6.8	94.0 ± 3.6	-3.8 ± 6.4	94.1 ± 6.6	-3.8 ± 7.2	94.0 ± 5.2	-3.8 ± 5.7

Note: ΔBP (BP post-exercise – BP pre-exercise).
 Abbreviations: BP, blood pressure; DBP, diastolic blood pressure; SBP, systolic blood pressure.
 *Significantly different from baseline, $P < .05$;
 **Significantly different from 30% session, $P < .05$.

diastolic BP changes at 1, 2, or 3 hours post-exercise (Table 1). In mean BP, there was a trend to decrease over time ($P = .053$) but no interaction between time and sessions ($P = .342$).

4 | DISCUSSION

Our results indicate that both aerobic exercise intensities induced an immediate decrease in systolic BP. Even low-intensity exercise—which can be more easily tolerated by older adults with hypertension—induced an immediate benefit in active adults.

The results observed in systolic BP are in line with those reported in a previous review that included 65 studies and showed an acute reduction of 8 mm Hg of systolic BP in hypertensive individuals.¹⁰ In the present study, we observed a systolic BP decrease after the session between 8.7 and 10 mm Hg in the 30% session and between 10.5 and 11.4 mm Hg in the 60% session. A previous study in very old persons with hypertension, and without regular exercise practice, also showed that two periods of 10 minutes of walking at an intensity of 40% to 60% of the HRres acutely decreases systolic, but do not change diastolic BP.¹³ The lack of significant reduction in diastolic BP is not surprising, since the baseline values were close to normal, making it is less likely to achieve a lower BP after an exercise bout.¹⁰

Inactive subjects usually have a greater post-exercise reduction in BP than athletes.¹⁰ Therefore, the fact that our study included only physically active adults and, even though, a considerable reduction of BP levels was observed, reinforces the value of exercise in the control of BP.

Regarding exercise intensity, Eicher et al⁹ compared the antihypertensive effects of a single session of low, moderate, and vigorous intensity exercise among men with pre- to stage 1 hypertension and reported that higher exercise intensities elicited the largest BP reductions (2.8 ± 1.6 , 5.4 ± 1.4 , and 11.7 ± 1.5 mm Hg, respectively for low, moderate, and vigorous) compared to non-exercise control session over the course of 9 hours. Similar results were found in others studies, in which the decrease in BP after exercise was superior and longer after more intense aerobic exercise.¹⁴

As post-exercise blood pressure reduction is influenced by baseline value, we reported the assessment of individual responses to exercise (Figure 1), which clearly shows that some of the participants were non-responders to both exercise intensities, while some of them showed a huge decrease in systolic BP. Those showing the largest decrease in BP were those who also showed the highest values at pre-exercise. This is in line with the current evidence suggesting that those with higher BP values before exercise exhibit a greater reduction post-exercise.⁵

This study has some limitations. First, the short period of time used to monitor the BP after exercise may have masked possible longer-lasting effects of greater magnitude. In our study, measurements of BP levels were made only in the morning and until lunch time, in order to avoid the interference of post-lunch nap, usually performed by some of the participants. Second, the use of

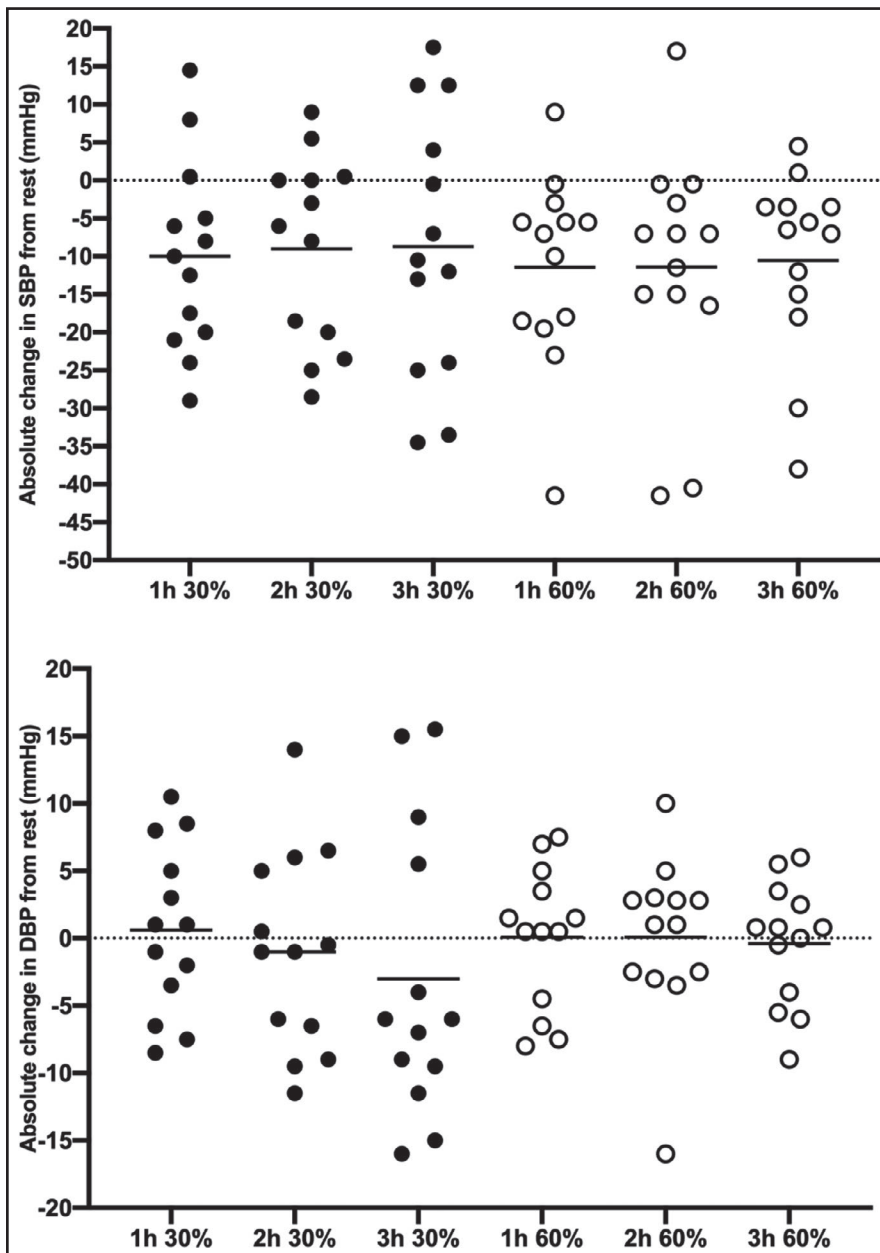


FIGURE 1 Absolute change in systolic (SBP) and diastolic blood pressure (DBP) at 1 h, 2 h, and 3 h after aerobic exercise protocol at 30% and 60% intensities of heart rate reserve

self-measurement of BP at home instead of ambulatory BP monitoring could be seen as a limitation. However, a recent study indicated that adults self-monitoring their BP at home showed greater adherence both to a supervised and unsupervised exercise, compared with those that did not use BP self-monitoring.¹⁵ Third, in the present study we cannot conclude about post-exercise hypotension, as the formula used to assess the difference between BP levels pre- and post-exercise (post-exercise BP - pre-exercise BP) does not cover possible changes in BP that can occur independently of exercise (eg, circadian effects).¹⁶ To determine post-exercise hypotension, a control session should be included. In addition, our sample was composed by participants with different characteristics (eg, sex and antihypertensive medication); although normotensive and hypertensive subjects present an acute reduction in blood

pressure after exercise, the decrease is dependent on the pre-exercise levels of blood pressure.

In conclusion, the results of this study suggest that a single session of aerobic exercise acutely reduces BP in active adults even at low intensities of aerobic exercise. These results add evidence supporting the importance of physical activity as a nonpharmacological tool to control hypertension in this population. Even a low-intensity aerobic exercise session, which could be more easily tolerated by some older adults with hypertension, promoted an immediate benefit, and could be considered when aiming to control BP.

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CONFLICT OF INTEREST

None.

AUTHOR CONTRIBUTIONS

All authors contributed to reviewing and revising the manuscript. The initial drafts and incorporation of revisions of the manuscript were performed by JL, MF, ATC, and PLM. The interventions described in the manuscript were designed by FR, PM, and MF, and implemented by MF and PM. The analysis was overseen and conducted by JL, FR, AJA, and PM.

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