Exercise and Cardiovascular Risk in Patients With Hypertension

James E. Sharman,1 Andre La Gerche,2 and Jeff S. Coombes3

Evidence for the benefits of regular exercise is irrefutable and increasing physical activity levels should be a major goal at all levels of health care. People with hypertension are less physically active than those without hypertension and there is strong evidence supporting the blood pressure–lowering ability of regular exercise, especially in hypertensive individuals. This narrative review discusses evidence relating to exercise and cardiovascular (CV) risk in people with hypertension. Comparisons between aerobic, dynamic resistance, and static resistance exercise have been made along with the merit of different exercise volumes. High-intensity interval training and isometric resistance training appear to have strong CV protective effects, but with limited data in hypertensive people, more work is needed in this area. Screening recommendations, exercise prescriptions, and special considerations are provided as a guide to decrease CV risk among hypertensive people who exercise or wish to begin. It is recommended that hypertensive individuals should aim to perform moderate intensity aerobic exercise activity for at least 30 minutes on most (preferably all) days of the week in addition to resistance exercises on 2–3 days/week. Professionals with expertise in exercise prescription may provide additional benefit to patients with high CV risk or in whom more intense exercise training is planned. Despite lay and media perceptions, CV events associated with exercise are rare and the benefits of regular exercise far outweigh the risks. In summary, current evidence supports the assertion of exercise being a cornerstone therapy in reducing CV risk and in the prevention, treatment, and control of hypertension.

Keywords: arterial; blood pressure; exercises; fitness; human; hypertension; physical conditioning.

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This paper aims to review evidence on the effect of exercise on cardiovascular (CV) risk in people with hypertension. Regular exercise is one of the most important activities for primary prevention of hypertension1 and improving long-term survival.2 Benefits of exercise extend to people with hypertension,3 as well as those with related morbidity (such as diabetes,4 renal dysfunction5 or depression6,7) or chronic disease relatively separate from hypertension including cancer,8 airway disease,9 and osteoarthritis,10 to name a few. Many chronic diseases share the risk factor of physical inactivity, which is ranked among the top 10 contributors to the global burden of disease.11 Thus, increasing exercise levels in the general population is a valuable aspiration with major health and economic gains.12 Beyond exercise alone, a CV risk reduction program for individuals with hypertension should optimally also include smoking cessation, weight reduction, alcohol moderation, and attention to diet such as that recommended with the Dietary Approaches to Stop Hypertension,13 which has been shown to lower blood pressure (BP)14,15 and improve all-cause survival.16 Thorough analysis of treating and preventing hypertension with diet is addressed by Appel et al.17

RISK FACTOR MODIFICATION WITH EXERCISE

Some data indicate that people with hypertension are less physically active than those without hypertension.18 High cardiorespiratory fitness (VO2max) has been shown to be protective against progression from prehypertension to hypertension,19 as well as future death from coronary heart disease and all causes,20 even among people with hypertension or a high burden of other CV risk factors.21,22 A sedentary or low-activity lifestyle associated with low VO2max is common among first-world communities23 and associated with a cluster of CV risk factors including higher BP, total cholesterol, body mass index, and levels of obesity, but lower high-density lipoprotein cholesterol.24 While the cause and effect relationship has not been thoroughly explored, it is possible that hypertension may be both a risk factor associated with sedentary behavior and low fitness, but it may also be that hypertension directly causes low fitness through its effect on myocardial function (hypertensive heart disease and heart failure with preserved ejection fraction). Engaging in regular aerobic exercise enhances structural, functional, and biochemical characteristics of the CV system, and CV risk factors can undergo reversal toward “normalization” among individuals with normal BP, as well as those with prehypertension or hypertension.25 Positive BP
effects include significant reductions in clinic systolic BP (SBP) and diastolic BP (DBP) and daytime ambulatory BP. Among older sedentary men with stage 1 or 2 hypertension, the reduction in BP load from an acute exercise bout of just 45 minutes is immediately apparent and can persist for 24 hours. Interestingly, 1 study has shown that 24-hour BP variability (an emergent CV risk factor) may not be amenable to change with exercise training in people with hypertension; although more controlled study data will be needed to confirm this.

Repeated physiological challenge through the stimulus of exercise is hypothesized to produce beneficial adaptive responses after a period of temporary impairment. An example of this delayed response on the vasculature has been demonstrated by an immediate decrease in nitric oxide–mediated endothelial function, then followed by “supranormal” function in the period 1–24 hours after exercise, before returning to baseline levels at 24–48 hours. One of the physiological reasons explaining the supra-normal function from regular exercise is thought to be protection against increases in BP. Another major mechanism of BP lowering from exercise is decreased sympathetic drive, as evidenced by lowered plasma norepinephrine and renin activity, as well as decreased renal and muscle sympathetic activity. The lack of effect of aerobic exercise on nighttime BP (especially in nondippers) when sympathetic activity is low, tends to support an autonomic-related hypertensive effect. Regular aerobic exercise enhances sleep quality and duration (which in itself protects against hypertension) and also improves a broad range of other CV risk factors, hemodynamic, metabolic, neural, and arterial and cardiac features, with the overall result of reduced clinical events. A summary of these effects is presented in Figure 1.

AEROBIC VS. RESISTANCE TRAINING ON CV RISK FACTORS

Moderate intensity resistance training is recommended as a supplement to aerobic exercise training for BP and CVD risk reduction in patients with hypertension, as well as healthy individuals and men with low risk CV disease. Resistance training also appears to be safe and effective for increasing strength and improving functional capacity and hemodynamic function, even in higher risk patients with major cardiac disease. Both aerobic and resistance training promote improvements in a variety of general health and CV risk factors; however, the relative improvement in these factors differs between the exercise modalities. For example, aerobic training generates substantially greater increases in VO2 max, together with greater reductions in body fat compared with resistance training. On the other hand, more effective increases in basal metabolism and strength can be achieved with resistance compared with aerobic training. Having said this, readers should be aware that measuring physical activity as well as the response to exercise programs can be complex and that differences in measurement methods, reporting of results, and lack of standardized reference can make comparisons between studies difficult.

Data are incomplete regarding the comparative health effects between exercise modalities exclusively in people with hypertension. In this population, clinic SBP is relatively unaffected by dynamic resistance training but small reductions in clinic DBP (−3.1 (95% CI −5.1 to −1.2) mm Hg) may be achievable. Despite reliance on small cohorts, few of which have recruited only hypertensive patients, meta-analyses have provided reassurance in demonstrating that BP does not increase as a result of dynamic resistance training. On the other hand, Bertovic et al. observed that vascular stiffness was greater among strength-trained athletes as compared with age-matched controls. However, these findings are yet to be consistently replicated and it is difficult to know the extent to which observations in strength athletes can be extrapolated to nonathletes undertaking more moderate strength training regimes. Furthermore, few resistance training intervention studies have been performed specifically in hypertensive cohorts. Remarkably, isometric resistance training, which is a form of weight training involving sustained muscular contraction without a change in muscle length, has been demonstrated to have stronger BP-lowering effects (SBP, −4.3 (95% CI −6.4 to −2.2) mm Hg; P < 0.001) than dynamic resistance training in people treated for hypertension, where the drop in DBP was higher than for normotensive individuals (−5.5 (95% CI −7.9 to −3.0) mm Hg vs. −3.1 (95% CI −3.9 to −2.3) mm Hg) and overall effects on heart rate were slight but statistically significant compared with control (−0.8 (95% CI −1.2 to −0.4) bpm; P = 0.003).

The profound effects of isometric resistance training is surprising because most of the studies from which these pooled data were derived used isometric hand-grip contraction as the intervention, which only exercises a small muscle group over a short time period (e.g., <15 minutes) and only elicits transient moderate hemodynamic responses (i.e., SBP and heart rate increases of 16 ± 10 mm Hg and 3 ± 4 bpm; although hypertension severity is associated with greater responses) that rapidly return to baseline levels (i.e., 1 minute). Carlson et al. contend that the reduced time commitment, as well as simplicity and lower cost should lead to greater adherence to exercise in comparison with aerobic interventions, which is plausible but yet to be confirmed. Isometric resistance training appears to be safe, with no adverse events reported from >7,000 isometric exercise training sessions in patients with CV risk factors and comorbidities including hypertension. There are few reports on the mechanisms of BP lowering after chronic isometric training in patients with hypertension, although improved brachial flow–mediated dilatation, decreased sympathetic activity, and enhanced parasympathetic modulation of BP and heart rate have been observed. Table 1 presents a summary comparison of the chronic effects of aerobic vs. resistance training in people with hypertension.

INFLUENCE OF PARTICIPANT CHARACTERISTICS ON RESPONSES TO AEROBIC AND RESISTANCE TRAINING

Analyses of more than 50 randomized controlled trials of aerobic exercise intervention have determined that significant clinic SBP- and DBP-lowering effects can be achieved irrespective of participant age (<250 or <50 years), frequency of exercise sessions per week (<3, 3 or 4, or >4/week), or...
baseline body mass index. Importantly, hypertensive status influences the magnitude of clinic SBP and DBP fall after aerobic training, with largest effects in people with hypertension (SBP, −8.3 (95% CI −10.7 to −6.0) mm Hg) compared to those with prehypertension (SBP, −2.1 (95% CI −3.3 to −0.83) mm Hg), and only a small clinic DBP-lowering effect in normotensive individuals (−1.1 (95% CI −2.2 to −0.07) mm Hg). Male participants appear to have greater responses of both SBP and DBP compared with women, and greater BP reductions are related to greater increases in cardiorespiratory fitness with aerobic training. Pooled data reveal trends toward larger reductions in clinic SBP and DBP associated with greater weight loss after aerobic training. Contrary to aerobic training, the BP-lowering effects of dynamic resistance training do not appear to be impacted by sex or age, but larger reductions may be conferred upon people with prehypertension vs. normotensive and hypertensive individuals. Among patients with hypertension, the overall BP reduction effect is greater after aerobic compared with dynamic resistance exercise training, and as such, aerobic training should be the preferred option where BP lowering is the main goal.

**HOW MUCH EXERCISE IS ENOUGH?**

The idiom that “something is better than nothing” holds true for exercise volume, where even a small but consistent quantity (i.e., 15 min/day or 90 min/week) performed at moderate intensity can translate to significant health benefits, irrespective of hypertensive status, age, CV disease risk, or lifestyle habits such as smoking or alcohol consumption (Figure 2). In people with hypertension assigned to different exercise durations, but fixed low-to-moderate intensity programs (50% of estimated VO2max), clinically significant reductions in BP were attained from only 30 to 60 min/week of exercise, with the largest falls in SBP and DBP at 61–90 min/week of exercise. Many other studies are consistent with the message of an inverse relationship between physical activity volume and health outcomes, including incident hypertension, incident diabetes, obesity, and death from coronary artery disease and all causes (including in older men with hypertension). Improvement in inflammatory (high sensitive C-reactive protein) and hematocrit factors (e.g., fibrinogen), as well as conventional CV risk factors (especially BP, lipids, and body mass index)

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Figure 1. Summary of some of the cardiometabolic beneficial effects of regular exercise. ↑ increase or improvement; ↓ decrease or improvement; *borderline improvement.
could explain most of the variance in the reduction of CV events associated with physical activity level.58

IS TOO MUCH EXERCISE HARMFUL?

Since an acute bout of exercise causes temporary physiological stress,29 there remains the possibility that excessive exercise volume combined with little recovery time could tip the balance toward harmful effects. Indeed, some data suggest an asymptote at which more intense exercise training provides little incremental benefit59 or even a U-shaped association in which events increase among the most highly trained. 60 Similarly, a higher incidence of myocardial infarction was shown in The British Regional Heart Study among men exercising at the highest levels when compared with moderate levels,61 and higher rates of CV disease and hypertension were also found among the most active men in the Michigan State University Longevity Study.62 In patients with manifest coronary heart disease, daily strenuous exercise conferred higher mortality risk (on par with exercising only 1–4 times/month), and this was independent of numerous covariates including hypertension status.63 However, the premise that “extreme” exercise may portend an increased risk of CV events remains highly controversial64,65 and there are a number of studies that suggest that longevity may be increased among athletes undertaking the very highest volumes of intense exercise.66,67

Little is known regarding the causes underlying associations between chronically higher exercise volume and higher CV risk in some epidemiological studies. However, homeostatic imbalance across multiple organ systems occurs with overtraining and this can result in muscle trauma, inflammation, oxidative stress,68 adrenal gland dysfunction, 69 and immunosuppression.70 The heart may be particularly vulnerable to overtraining as chronically high exercise volume is associated with adverse cardiac remodeling (especially atrial enlargement and left ventricular hypertrophy), functional abnormality (favoring damage to the right ventricle),71 and arrhythmias (especially atrial fibrillation and complex ventricular tachyarrhythmias).72–74 The role of BP exposure on these adverse heart outcomes is unknown. Overall, these data imply that regular exercise is a potent elixir for CV and general health in which moderate doses may be just as efficacious as more extreme doses.

EXERCISE PRESCRIPTION RECOMMENDATIONS

Resting SBP > 200 mm Hg or DBP > 110 mm Hg is a relative contraindication to exercise stress testing and an excessive BP response to exercise (defined as SBP > 250 mm Hg or DBP > 115 mm Hg) is a relative indication to terminate exercise.57 In the absence of major comorbidities, patients with hypertension (stage 2 or below)75 should be encouraged

Table 1. Chronic responses to aerobic and resistance training in people with hypertension

<table>
<thead>
<tr>
<th>Variable</th>
<th>Aerobic (endurance)</th>
<th>Resistance (dynamic)</th>
<th>Resistance (static)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blood pressure</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clinic systolic blood pressure</td>
<td>Large decrease</td>
<td>No change</td>
<td>Large decrease</td>
</tr>
<tr>
<td>Clinic diastolic blood pressure</td>
<td>Large decrease</td>
<td>Small decrease</td>
<td>Large decrease</td>
</tr>
<tr>
<td>Day time blood pressure</td>
<td>Decrease</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Nighttime blood pressure</td>
<td>No change</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Other cardiovascular risk factors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obesity markers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body mass index</td>
<td>Decrease</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Body weight</td>
<td>Decrease</td>
<td>No change</td>
<td>—</td>
</tr>
<tr>
<td>Waist circumference</td>
<td>Decrease</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Percentage body fat</td>
<td>Decrease</td>
<td>Decrease</td>
<td>—</td>
</tr>
<tr>
<td>Blood glucose</td>
<td>Decrease</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Lipid</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total cholesterol</td>
<td>No change</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Low-density lipoprotein</td>
<td>No change</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>High-density lipoprotein</td>
<td>Increase</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Triglycerides</td>
<td>Borderline decrease</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>Heart rate</td>
<td>Decrease</td>
<td>No change</td>
<td>Small decrease</td>
</tr>
</tbody>
</table>

Summary data from multiple meta-analyses, review articles25,26,31,37,41,46–48 and large well-conducted clinical trials involving people with high blood pressure.49 Dashed line indicates no, or minimal, available data to draw conclusions regarding training effects.50

Significant effect for patients with prehypertension,50 but small to no significant effect for patients with hypertension.48 Examples of aerobic training include running, cycling, swimming, or rowing. Examples of dynamic resistance training include push-ups, abdominal crunches, or shoulder presses. Examples of static resistance training include holding the position of hand grip using a dynamometer, plank bridges, or wall sit.
to undertake a light-to-moderate intensity exercise program without needing to consult with their doctor. This intensity approximates that achieved at <3 to <6 metabolic equivalents or <40% to 60% of VO\textsubscript{2} reserve (VO\textsubscript{2max} – VO\textsubscript{2rest}) and this equates to walking at about 5–7 km/h for a 70-kg person. Other types of activity that can achieve this level of light effort include such things as ballroom or aerobic dancing at low effort, noncompetitive badminton, bicycling (up to 100 W or 15 km/h), bowling, golf (carrying clubs or pulling cart), rowing at ≤4 km/h, small boat sailing, or swimming at ≤2 km/h to name a few examples. Progression of exercise intensity, frequency, and duration should be gradual with a “start low, go slow” approach.

Exercise prescription recommendations for people with hypertension broadly follow guidelines that are known to promote and maintain health in the general adult population. An overview of preexercise risk evaluation and exercise prescription according to latest guidelines is provided in Figure 3. Only high risk individuals with hypertension (i.e., symptomatic or with known disease) planning to engage in moderate or vigorous intensity exercise are recommended to have a medically supervised exercise stress test prior to beginning an exercise program. Furthermore, people with uncontrolled severe hypertension (e.g., ≥ stage 3) are recommended to have a clinical evaluation prior to regular exercise training. Ideally, this evaluation will involve out-of-office BP measures such as 24-hour ambulatory BP or home BP monitoring to confirm BP status. Finally, recent data suggest that it may be necessary to promote incentives for staff to maintain participant adherence to lifestyle/exercise programs in the primary care setting.

HIGH-INTENSITY INTERVAL TRAINING

The efficacy of HIIT, which is derived from the Swedish Fartlek (“speedplay”) method, has been tested among different patient populations including some data in people with hypertension. Lack of time is cited as a barrier for people engaging in regular physical activity and HIIT offers a way to derive exercise benefits in a more time efficient manner. The approach involves alternating several (e.g., 3 or 4) short bursts (e.g., 3–4 minutes) of high-intensity (e.g., 85%–95% of peak heart rate) exercise with a few minutes of rest or light exercise (active recovery at ≈70% of peak heart rate) in the intervening periods. A whole exercise session, including warm-up and cool down, can be completed in ≈40 minutes. HIIT should not be confused with sprint interval training (SIT) that has participants exercising supra-maximally (e.g., all-out 30-second sprints on a cycle ergometer interspersed with recovery slow cycling). SIT has not been investigated.
in individuals with hypertension and should be avoided by people who do not engage in regular exercise because of the increased (albeit small) CV risk potential.84

Compared to conventional moderate intensity continuous training over longer time intervals in patients with hypertension, HIIT has been shown to produce significantly greater improvements in 24-hour ambulatory SBP and DBP, VO_{2max}, total peripheral resistance, and left ventricular systolic and diastolic function.85 Young normotensive women with a family history of hypertension engaging in HIIT showed greater improvements in VO_{2max}, as well as metabolic and hormonal factors related to hypertension compared with moderate intensity exercise.86 Even small doses of HIIT before meals, touted as “exercise snacks” (6-
1-minute walking intervals at 90% maximal heart rate with 1-minute active recovery intervals), were more effective for improving postprandial glucose and 24-hour glycemic control compared with continuous moderate intensity exercise in people with insulin resistance and raised BP.87

HIIT appears to be safe and well tolerated in higher risk individuals (e.g., only two nonfatal cardiac arrests in 46,364 exercise hours among 4,846 patients with coronary heart disease).88 In patients with heart failure and cardiometabolic disease, HIIT can effectively improve cardiac function89 as well as CV risk factors, including high-density lipoprotein cholesterol, triglycerides, fasting glucose, and insulin sensitivity.85 Enhanced enjoyment of exercise and quality of life can also be gained,85 and positive changes in appetite independent from resting BP 100,101

Table 2. General protocol recommended for high-intensity interval training

<table>
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<th>Recommendation</th>
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<tr>
<td>Duration</td>
<td>40 minutes (includes 10-minute warm-up and 5-minute cool down at 60% peak heart rate)</td>
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<tr>
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<td>85%–95% peak heart ratea</td>
</tr>
<tr>
<td>Rest/recovery intensity</td>
<td>70% peak heart rate (RPE 11–13)</td>
</tr>
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<td>Interval times</td>
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aFor people using beta blocker medication, this should be a rating of perceived exertion (RPE) 15–17 on the Borg 6–20 scale. Adapted from ref. 85 with permission from BMJ Publishing Group Ltd.

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taking alpha blockers, calcium channel blockers, or vasodilating drugs, as well as in elderly people.\textsuperscript{57,76} The potential for hypertensive-related adverse effects may be mitigated with an extended cool down period of light activity and avoidance of suddenly stopping exercise. Beta blockers and diuretics can alter thermoregulation during exercise,\textsuperscript{37,76,108} which has led to a precautionary call to those taking these medications to limit exercise intensity in hot or humid weather, as well as ensuring adequate hydration and use of clothing to encourage cooling.\textsuperscript{37}

Exposure to fine particulate matter (<2.5 μm in diameter) from automotive and other sources of air pollution is recognized as a trigger of CV-related events and mortality. Populations at increased risk include the elderly and those with preexisting coronary artery disease; however, people with diabetes, women, and also those who are obese (for which there is higher prevalence of hypertension) may also be vulnerable.\textsuperscript{109} Since the magnitude of CV risk is related to the duration, intensity and frequency of particulate matter exposure, activities that increase exposure, such as exercising alongside busy roadways, should be avoided. Instead people should exercise in areas with lower ambient pollutant concentration, which may include parks, recreation areas, and quiet roads.\textsuperscript{110}

Acute CV events induced by exercise occur more commonly in older people with atherosclerotic disease or younger people with congenital or hereditary heart disease.\textsuperscript{84} There is a slight risk of sudden cardiac death occurring during, or within 30 minutes of, unaccustomed vigorous exercise such as racquet sports or heavy yard work, although the absolute risk only approximates 1 death per 1.51 million episodes of exertion.\textsuperscript{111} Serious events occur rarely in healthy individuals\textsuperscript{112} and may be more frequent in people of older age, or with diabetes or hypertension.\textsuperscript{111} Then again, vigorous exercise itself, when performed habitually, is protective against sudden death and CV events,\textsuperscript{111,112} which reinforces the notion that the health benefits of regular physical activity far outweigh the risks.\textsuperscript{113} People with hypertension starting an exercise program may wish to consult an expert in exercise prescription for chronic and complex diseases such as a qualified Exercise Physiologist. This is especially relevant to higher risk patients or those wishing to partake in high-intensity physical activity. A summary of special exercise considerations is presented in Table 3.

**SUMMARY AND CONCLUSION**

There is incontrovertible evidence that “exercise is a cornerstone therapy for the prevention, treatment, and control of hypertension.”\textsuperscript{54} In people with hypertension, aerobic and resistance exercise promote general health and improvement in CV risk factors, including major BP-lowering effects and reduced future incident CV events and mortality. The comparative health effects of aerobic vs. resistance training have not been fully elucidated in people with hypertension, but where BP lowering is a major goal of exercise, then aerobic activity appears to be the preferred method to achieve this. There are promising data on the CV protective effects of HIIT and isometric resistance training, but with only limited data available in people with hypertension, more work is needed in this area. Exercise volume thresholds at which maximum benefits are derived are difficult to determine, although only a small but consistent weekly quantity of moderate exercise can have significant health benefits owing to the graded inverse relationship between exercise volume and adverse clinical outcomes. The benefits of regular physical activity outweigh the risks and should be recommended for the majority of people with hypertension.

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REFERENCES


64. La Gerche A, HH. Intensive exercise can harm the heart: you can get too much of a good thing. *Circulation*, in press.


71. La Gerche A, Burns AT, Mooney DJ, Inger WJ, Taylor AJ, Bogaert J, MacIsaac AI, Heidbuchel H, Prior DL. Exercise-induced right


