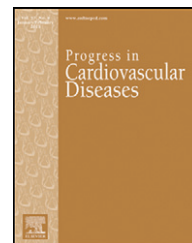


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# High Intensity Interval Training for Maximizing Health Outcomes

Trine Karlsen<sup>a, b, 1</sup>, Inger-Lise Aamot<sup>b, c, 1</sup>, Mark Haykowsky<sup>d</sup>, Øivind Rognmo<sup>b, c, \*</sup>

<sup>a</sup>Nord University, Faculty of Nursing and Health Sciences, Bodø, Norway

<sup>b</sup>K.G. Jebsen Center of Exercise in Medicine, Department of Circulation and Medical Imaging, Faculty of Medicine and Health Sciences, NTNU–Norwegian University of Science and Technology, Trondheim, Norway

<sup>c</sup>Norwegian National Advisory Unit on Exercise Training as Medicine for Cardiopulmonary Conditions, St. Olav's Hospital, Trondheim, Norway

<sup>d</sup>College of Nursing and Health Innovation, University of Texas at Arlington, Arlington, TX, USA

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## ABSTRACT

Regular physical activity and exercise training are important actions to improve cardiorespiratory fitness and maintain health throughout life. There is solid evidence that exercise is an effective preventative strategy against at least 25 medical conditions, including cardiovascular disease, stroke, hypertension, colon and breast cancer, and type 2 diabetes. Traditionally, endurance exercise training (ET) to improve health related outcomes has consisted of low- to moderate ET intensity. However, a growing body of evidence suggests that higher exercise intensities may be superior to moderate intensity for maximizing health outcomes. The primary objective of this review is to discuss how aerobic high-intensity interval training (HIIT) as compared to moderate continuous training may maximize outcomes, and to provide practical advices for successful clinical and home-based HIIT.

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\* Address reprint requests to Øivind Rognmo, PhD, NTNU, Faculty of Medicine and Health Sciences, Department of Circulation and Medical Imaging, Postboks 8905, 7491 Trondheim, Norway.

E-mail address: [ovind.rognmo@ntnu.no](mailto:ovind.rognmo@ntnu.no) (Ø. Rognmo).

<sup>1</sup> Equal contribution.

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### Abbreviations and Acronyms

BP = blood pressure
CHD = coronary heart disease
CPET = cardiopulmonary exercise testing
CR = cardiac rehabilitation
CRF = cardiorespiratory fitness
CV = cardiovascular
CVD = cardiovascular disease
DBP = diastolic blood pressure
EF = ejection fraction
ET = exercise training
HF = heart failure
HFpEF = heart failure with preserved ejection fraction
HFrEF = heart failure with reduced ejection fraction
HIIT = high intensity interval training
HR = heart rate
HR <sub>max</sub> = maximal heart rate
HR <sub>peak</sub> = peak heart rate
HTN = hypertension
LV = left ventricle
LVEF = left ventricular ejection fraction
MET = metabolic equivalent
MICT = moderate intensity continuous training
PA = physical activity
RCTs = randomized controlled trials
SIT = sprint interval training
SBP = systolic blood pressure
T2D = type 2 diabetes
VO <sub>2peak</sub> = peak oxygen uptake

one or two sessions per week may be sufficient for significantly reducing all-cause-, CVD-, and cancer mortality risks.<sup>7,8</sup> A meta-analysis of prospective cohort studies on leisure time PA found marked risk reduction in all-cause mortality in active subjects compared to sedentary persons.<sup>9</sup> Specifically, a dose-response curve was found, especially from sedentary subjects to those with mild and moderate PA level. A growing body of evidence however suggests that exercise involving

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### Epidemiological evidence of the importance of high exercise intensity for mortality reduction

Epidemiological evidence on all-cause and disease-specific mortality demonstrates that low- and moderate intensity exercise is associated with protection against chronic diseases, especially cardiovascular (CV) disease (CVD),<sup>1–3</sup> and that risk reduction can be achieved at quite low volumes of exercise.<sup>4</sup> For instance, the Nurses' Health Study found that moderate intensity activity, even as little as once a week, was sufficient to reduce mortality risk by 22%.<sup>5</sup> Another study involving 55,137 healthy adults found that running, even as little as 5 to 10 min per day, was associated with markedly reduced risks of death from all causes and from CVD.<sup>6</sup> In addition, "week-end warrior" and other physical activity (PA) patterns characterized by

high-intensity may induce larger health benefits relative to the time spent on PA, and that even small amounts of vigorous PA increase the benefits of moderate PA alone.<sup>10,11</sup> A recent Australian study found an inverse dose-response relationship between proportion of vigorous PA and mortality,<sup>12</sup> leading to the conclusion that "vigorous activities should be endorsed in clinical and public health activity guidelines to maximize the benefits of PA". To this end, a large study from Taiwan demonstrated that 15 min of daily vigorous intensity PA resulted in similar all-cause mortality risk reduction (~25%) as 60 min of daily PA at moderate intensity.<sup>13</sup> Similarly, our research group found that one single weekly bout of high intensity (~90% of peak heart rate) exercise was associated with a similar or higher protection against premature all-cause and CVD mortality compared to several hours of moderate intensity exercise.<sup>8</sup> Finally, a meta-analysis involving 459,833 participants free from CVD at baseline concluded that walking pace was a stronger independent predictor of overall mortality risk compared with walking volume (48% versus 26% risk reductions, respectively),<sup>14</sup> indicating the impact of high exercise intensity to promote mortality risk reduction.

### Exercise intensity in coronary heart disease (CHD) risk reduction

Substantial evidence has established the significance of high levels of PA, exercise training (ET), and overall cardiorespiratory fitness (CRF), not only for mortality benefits, but also for prevention and treatment of CHD.<sup>15</sup> Two studies found an inverse association between the relative intensity of PA and risk of developing CHD, independent of the amount of total PA performed.<sup>16,17</sup> Long-term aerobic ET conducted at higher intensities is associated with a reduced risk of future CVD compared to lower intensities, suggesting that the former may confer greater cardioprotective benefits.<sup>18,19</sup> Swain and Franklin examined the role that ET intensity has on the risk factors for and incidence of CHD<sup>20</sup>; they included both epidemiologic studies that evaluated the benefits of PA of varying intensity levels, and clinical trials with ET at different intensities, while controlling for the total energy expenditure. The epidemiological findings showed greater reduction in risk of CHD with high- compared to moderate intensity PA and more favorable risk profiles for individuals engaged in high-

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