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The Importance of Measuring Heart Rate Recovery Alongside Aerobic Capacity; A Role For HRV?

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Abstract

The article outlines the interplay between both branches of the ANS and explains why HRR should be utilised alongside conventional aerobic tests which are underpinned by sympathetic dominance. The article proposes HRVB as a practical solution to improve PNS efficiency and discusses why this should form an essential part of any cardiac health programme, and how research in this area can improve to facilitate better guidelines and field-based outcomes.

Abbreviations: HRR: Heart Rate Recovery; ANS: Autonomic Nervous System; HRVB: Heart Rate Variability Biofeedback; WHO: World Health Organization; SNS: Sympathetic Nervous System; PNS: Parasympathetic Nervous System; VN: Vagus Nerve; ACSM: American College of Sports Medicine; EBP: Evidence Based Practice; RSA: Respiratory Sinus Arrhythmia; BR: Baro-Receptors.

Introduction

The article introduces the need to address both branches of the ANS when assessing cardiac health, and outlines HRVB as a method to complement conventional approaches to improving or preventing cardiac pathology.

The purpose of this short article is to expand on traditional approaches that measure cardiac health and disease by advocating concomitant use of Heart Rate Recovery (HRR) assessment to give a more comprehensive insight into the interplay between both branches of the Autonomic Nervous System (ANS). The article intends to highlight why this is important and encourages the use of Heart Rate Variability BiofeedBack (HRVB) which can be applied by trainers and clinicians alike to optimise subsequent interventions that are tailored towards improving cardiac health outcomes. The article briefly explores

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the current limitations of HRVB research and proposes solutions to improve the scientific rigour of methods in intervention studies to clarify existing uncertainty and improve Evidence-Based Practice (EBP).

The World Health Organisation (WHO) places cardiac disease as the leading cause of death annually [1]. Research demonstrates that good aerobic capacity is deemed preventive against cardiac disease in health populations [2] while also representing an integral pillar of cardiac rehabilitation. An improvement in aerobic capacity has been shown to improve outcomes in populations with cardiac pathology [3] which has been shown to decrease the risk of mortality [4]. As a result, programmes are devised to improve aerobic capacity, which is subsequently measured by objective outcome measures including vo2max, maximal aerobic speed tests, and sub maximal test (i.e. Rockport walking test).

While there is a clear association between aerobic fitness and improved cardiac health [5], the assumption that good aerobic fitness guarantees better cardiac health is oversimplified because aerobic capacity tests measure work output, which requires parasympathetic withdrawal and simultaneous sympathetic dominance. It is essential that both branches of the autonomic nervous system are considered for optimal cardiac health and the reader is referred to Wiyarta and Karima [6] for a detailed explanation of the Autonomic Nervous System (ANS) role in cardiac health.

What is most pertinent to this article is the awareness and acknowledgement that optimal cardiac health is dependent on the balance between the Sympathetic and Parasympathetic Nervous System (SNS and PNS). While often underemphasised and less tested, the PNS is equally important for health as this improves vagal rebound which has been shown to decrease cardiovascular morbidity [7]. While many professionals are aware of tests to measure aerobic capacity, fewer are aware of tests that measure PNS status and Vagal Nerve (VN; one of the main nerves of the PNS) efficiency.

One method which is feasible and cost effective is Heart Rate Recovery (HRR) which measures the hearts' ability to recover from an exertion [8]. This initially involved subtracting an individual's heart rate at 60 seconds post exertion from the maximal value recorded during the exertion. More contemporary findings on HRR show that measuring heart rate at 10 seconds is more sensitive in predicting risk of mortality from cardiac origin than other post exertion intervals [9].

Along with various authors urging for greater awareness of ANS balance for cardiac health [10,11], there is evidence that clearly corroborates with the theory that aerobic capacity improves both branches of the ANS and subsequent cardiac outcomes. For example, Jolly, et al. [4] and Souza et al. [12] showed that cardiac rehab in phase two cardiac rehab patients improved both aerobic capacity and heart rate recovery (i.e. 0.64, p=0.03).

Despite such outcomes, it is vital that trainers and clinicians are aware that this relationship is a correlation and is not deemed causative, with the correlation of 0.64 [4] being moderate. A seminal multivariable analysis by Van de Vegte et al. [9] helps to explain why the correlation is moderate, as this paper showed that HRR at ten seconds was a more powerful predictor of cardiovascular linked mortality than high aerobic capacity outcomes alone. This evidence represents a paradigm shift as it can be inferred that the ability to recover quickly from an exertion is potentially more important than high aerobic capacity alone.

Exercise behaviour and improvement of aerobic capacity are not an easy option for a proportion of population segments sharing either physical [13] or mental characteristics [4,14] which reduces exercise and physical activity options. This is commonly seen in fitness and clinical domains, since the UK National Institute for Health and Care research showed that the prevalence of comorbidities is increasing and expected to rise globally [15]. This means that traditional techniques such as aerobic exercise might not be feasible for such individuals, despite the American College of Sports Medicine (ACSM) recommendations [16]. It is therefore imperative that alternative methods are sought to improve cardiac health, and methods to bias PNS are advocated. This can also be extended to healthy populations which could also be used as a valuable adjunct to frequent exercise participation inducing further improvements.

One solution that could bias PNS and vagal nerve activity is the use of HRVB**.** HRVB is a method to increase Heart Rate Variability (HRV) with widespread beneficial health effects for both physical and mental health. It is mainly impacting two cardiopulmonary functions, the Respiratory Sinus Arrhythmia (RSA) and the Baro-Receptors (BR), creating significant increases in VN activation and subsequently two PNS responses [17]. A meta-analysis by Donnelly et al. [18] showed that HRVB improved both HRV outcomes and depressive outcomes in comorbid populations. While they did not measure HRR, improved HRV is proposed to correspond with VN and PNS overload, which should elicit improved HRR.

This relationship was evidenced in related research [19,20,21] showing that HRVB can improve exercise tolerance in those with low exercise capacity. This indicates that HRVB might be able to improve PNS function to create better exercise tolerance, thus preceding exercise interventions. Aerobic training could then be applied at the appropriate time to bolster outcomes as described earlier [4].

Before guidelines for HRVB can be established for field-based application, greater precision in programming variables is required. Earlier presented meta-analysis [18] outlines that HRVB interventions are poorly defined in research, and further research should clearly delineate the training variables such as volume, frequency, duration, breathing frequency, and technique. This might represent a potential barrier to implementation since healthcare professionals and health organisations rely heavily on Evidence-Based Practice (EBP) to communicate guidelines for application. This means that the accuracy and clarity around HRVB interventions should be comparable to those that are given for aerobic activity by the ACSM, as mentioned previously. As a result, the authors recommend absolute clarity in such variables within the methodology section, so that future research can compare, contrast, and draw conclusions for optimal field-based application.

This brief review hopes to draw attention into the multifaceted nature of cardiac health. While it is acknowledged that conventional aerobic capacity training and subsequent testing serves many benefits, it is important to recognise that this might create an incomplete picture. To implement a more comprehensive approach to screen cardiac health, the feasible and accessible HRR assessment should be utilised to give a greater insight into ANS balance. For instance, does the person register

with good aerobic capacity but demonstrates poor HRR? Does a patient present with comorbidities and attenuated exercise capacity? Is a patient healthy and register's good aerobic fitness and HRR but might be able to improve cardiac health even more with a stimulus that biases vagal nerve and PNS activity? We hope that HRVB provides one practical solution for clinicians and trainers, as such modality represents an evidence-based, practical, affordable, and easily prescribed technique to improve PNS, ANS balance and cardiac health.

Discussion

The article explains why conventional aerobic capacity testing is sympathetic in nature, and why heart rate recovery should be measured alongside conventional aerobic tests when assessing an individual's cardiac health status. The later test gives insight into vagal nerve tone which is often overlooked in cardiac rehabilitation and preventative programmes. The article discusses the importance of this, given research indicating that HRR could be more important than registering high aerobic capacity scores alone. The article proposes HRVB as a viable method to complement or precede aerobic exercise, especially in populations with comorbidities. Given that clinicians are encouraged to apply an evidenced based approach, the article briefly alludes to research limitations that might compromise this and proposes solutions to address this.

Conclusion

HRVB offers a solution to stimulate the PNS and improve HRR and cardiac outcomes, either alongside, or prior to conventional aerobic exercise interventions.

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