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Heart rate recovery after the 10-m incremental shuttle walking test in older adults with intellectual disabilities

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ABSTRACT

Heart rate recovery (HRR) after exercise is an independent predictor for cardiovascular and all-cause mortality. To investigate the usefulness of HRR in cardiorespiratory exercise testing in older adults with intellectual disabilities (ID), the aims of this study were (a) to assess HRR in older adults with ID after the 10-m incremental shuttle walking test (ISWT) and (b) its association with personal characteristics (gender, age, distance walked on the ISWT, level of ID, genetic syndrome causing ID, autism, behavioral problems, and peak heart rate (HRpeak)). HRR was assessed after the 10-m incremental shuttle walking test in 300 older adults (>50 years) with borderline to profound ID. HRR was defined as the change from HRpeak during the ISWT to heart rate measured after 1, 2, 3, 4, and 5 min of passive recovery. The largest decrease in heart rate was in the first minute of recovery leveling off toward the fifth minute of recovery. An abnormal HHR (≤12 bpm) was seen in 36.1% of the participants with Down syndrome (DS) and in 30.7% of the participants with ID by other causes. After the fifth minute the heart rates of 69.4% of the participants with DS and of 61.4% of the participants with ID by other causes returned to resting levels. HRpeak and distance walked on the ISWT were positively related to all HRR measures. More severe ID was negatively related and having DS positively related to HRR after 3–5 min of recovery. The other characteristics were not significantly associated to HRR. HRR is a potentially useful outcome measure in cardiorespiratory fitness testing of older adults with ID with a direct, objective, and non-invasive measurement. Further research is needed to identify the relation between HRR and adverse health outcomes in this population.

1. Introduction

After exercise, heart rate returns to resting levels due to the combination of parasympathetic reactivation and sympathetic withdrawal, and therefore reflects the activity of the autonomic nervous system (Pierpont, Adabag, & Yannopoulos, 2013). A delayed heart rate recovery (HRR) after exercise is an independent predictor for cardiovascular events and all-cause mortality in healthy adults and those with cardiovascular diseases and systemic disorders, such as diabetes

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mellitus and hypertension (Cahalin et al., 2013; Johnson & Goldberger, 2012; Messinger-Rapport, Pothier Snader, Blackstone, Yu, & Lauer, 2003; Okutucu, Karakulak, Aytemir, & Oto, 2011; Sharma, Kohli, & Gulati, 2012). Because increasing age is a risk factor for cardiovascular diseases, assessment of HRR in older adults is an important outcome measure in cardiorespiratory fitness testing of older adults (American College of Sports Medicine, ACSM, 2013; Kligfield & Lauer, 2006; Shetler et al., 2001; World Health Organization, WHO, 2007).

Despite of its clinical importance, HRR is little used in cardiorespiratory fitness evaluations of individuals with intellectual disabilities (ID). The few studies of HRR in adults with DS showed that individuals with DS had lower peak heart rates and lower HRR than controls with normal intelligence (Figueroa et al., 2005; Mendonca & Pereira, 2010; Mendonca, Pereira, & Fernhall, 2013). However, most studies regarding cardiorespiratory fitness of individuals with ID have focused on heart rate response during exercise and maximal oxygen uptake ($\dot{V}_{O_2}$ max). These studies show that individuals with ID have poor cardiorespiratory fitness and low peak heart rates (HRpeak), especially individuals with Down syndrome (DS) (Fernhall & Pitetti, 2001; Mendonca, Pereira, & Fernhall, 2010; Oppewal, Hilgenkamp, van Wijck, & Evenhuis, 2013). This may be because of an altered autonomic control (Acampa et al., 2008; Dipla et al., 2013; Guideri et al., 2004; Mendonca et al., 2010). HRR may therefore be an interesting outcome measure in cardiorespiratory fitness testing of individuals with ID.

An additional advantage of HRR could be that it may not be necessary for participants to perform maximal or close to maximal exercise, which is required for measurement of $\dot{V}_{O_2}$ max. This may be especially useful for older adults with ID, because in the 'Healthy ageing and intellectual disabilities' (HA-ID) study we found that 61% of the participants did not achieve 85% of their estimated maximal heart rate (HRmax) during the 10-m incremental shuttle walking test (ISWT) (Hilgenkamp, van Wijck, & Evenhuis, 2012b) which was a criterion to validly estimate $\dot{V}_{O_2}$ max (Singh, Morgan, Hardman, Rowe, & Bardsley, 1994). Another problem with estimating $\dot{V}_{O_2}$ max is that the available equations are problematic for use in individuals with ID (Oppewal et al., 2013). Although exercise intensity has been mentioned as a factor influencing HRR (Bosquet, Gamelin, & Berthoin, 2008; Lamberts, Maskell, Borresen, & Lambert, 2011; Morshedi-Meibodi, Larson, Levy, O'Donnell, & Vasan, 2002), HRR after 1 min has been found equal after exercise at 65% and 85% of HRmax (Arduini, Gomez-Cabrera, & Romagnoli, 2011). However, HRR after 2 and 3 min of recovery did differ (Arduini et al., 2011). The prognostic value of HRR for cardiovascular events and all-cause mortality has also been found to not depend upon maximal effort (Cahalin et al., 2013; Cole, Blackstone, Pashkow, Snader, & Lauer, 1999; Cole, Foody, Blackstone, & Lauer, 2000). In addition, Mendonca and Pereira (2010) suggested that the attenuated HRR of individuals with DS was independent of their low HRpeak, supporting the idea that HRpeak achieved during the test may be less important for HRR than it is for $\dot{V}_{O_2}$ max.

Therefore, to investigate the usefulness of HRR in cardiorespiratory exercise testing in older adults with ID, the aims of this study were to assess (a) HRR in older adults with ID after the 10-m incremental shuttle walking test and (b) its association with personal characteristics that are known in the general population to influence HRR (age, gender, cardiorespiratory fitness (expressed as distance walked on the ISWT)) (Okutucu et al., 2011), specific characteristics of the ID population that may influence HRR because of a possible influence on the autonomic nervous system (level of ID (Keary et al., 2012), genetic syndrome causing ID (Heilman, Harden, Zageris, Berry-Kravis, & Porges, 2011; Mendonca et al., 2010; Oppewal et al., 2013), autism spectrum disorder (Cheshire, 2012), behavioral problems (Boyce et al., 2001)), and HRpeak.

2. Methods

2.1. Study design and participants

This study was part of the large Dutch cross-sectional 'Healthy ageing and intellectual disabilities' study (HA-ID) conducted by a consort consisting of three ID care-provider services in collaboration with two university departments (Intellectual Disability Medicine, Erasmus MC, University Medical Center Rotterdam and the Center for Human Movement Sciences, University of Groningen, University Medical Center Groningen). All 2150 older clients with ID (≥50 years) were invited to participate, resulting in a near-representative sample of 1050 clients. Details about design, recruitment, and representativeness of the sample have been presented elsewhere (Hilgenkamp et al., 2011). Of the HA-ID study sample, 654 older adults performed the cardiorespiratory fitness measurements. Older adults (70–79 years) and participants with more severe ID and mobility impairments were underrepresented with respect to the total HA-ID sample ($n = 1050$) (Hilgenkamp et al., 2012b), limiting the generalizability to these groups.

For the current study, individuals who had medical conditions and/or used medication that may alter heart rates, and/or in whom information about the presence of Down syndrome (DS) was missing – which is necessary to calculate HRmax – were omitted from the analyses.

Ethical approval was provided by the Medical Ethical Committee at Erasmus Medical Center (MEC 2008-234) and by the ethical committees of the participating ID care-provider services. Informed consent was obtained from all participants or their legal representatives; however, unusual resistance was a reason for aborting measurements at all times. This study followed the guidelines of the Declaration of Helsinki (Helsinki, 2008).

2.2. Measurements

2.2.1. Personal characteristics

Gender and age were collected from the administrative systems of the ID care-provider services. Level of ID was categorized by behavioral therapists or psychologists as borderline (IQ = 70–84), mild (IQ = 50–69), moderate (IQ = 35–49),