



ORIGINAL ARTICLE

## Relation between heart rate recovery after exercise testing and body mass index<sup>☆</sup>



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Received 6 March 2014; accepted 22 July 2014

Available online 22 January 2015

### KEYWORDS

Exercise test;  
Obesity;  
Autonomic nervous system;  
Heart rate recovery

### Abstract

**Background:** Impaired heart rate (HR) recovery after exercise testing is considered a predictor of cardiovascular mortality as it reflects vagus nerve dysfunction.

**Objective:** To assess the relationship between body mass index (BMI) and HR recovery after exercise.

**Methods:** We analyzed the records of 2443 patients of both sexes, aged between 20 and 59 years, in sinus rhythm, not using negative chronotropic agents and with no myocardial ischemic response to exercise testing carried out at a specialist clinic, between 2005 and 2011. BMI was categorized as normal (18.5–<25 kg/m<sup>2</sup>), overweight (25–≤30 kg/m<sup>2</sup>) or obese (>30 kg/m<sup>2</sup>). The different BMI groups were compared in terms of HR recovery after exercise, which was calculated as the difference between maximum HR during exercise and in the first minute of recovery. Recovery was considered impaired when the difference was ≤12 bpm.

**Results:** Eighty-seven (3.6%) patients presented impaired recovery, which was three times more prevalent in the obese group and twice as prevalent in the overweight group compared with the normal group (p<0.001 and p=0.010, respectively). Obese patients presented higher basal HR and lower maximum HR, as well as reduced chronotropic reserve (p<0.001). In multivariate analysis, impaired HR recovery was associated with overweight (relative risk [RR]=1.8; p=0.035), obesity (RR=2; p=0.016), number of metabolic equivalents (RR=0.82; p<0.001) and resting HR (RR=1.05; p<0.001). The hazard ratio for hypertension was 2 (p=0.083, NS).

**Conclusion:** Impaired HR recovery was associated with higher BMI, demonstrating that obese individuals present vagus nerve dysfunction.

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<sup>☆</sup> Please cite this article as: Barbosa Lins TC, Valente LM, Sobral Filho DC, Barbosa e Silva O. Relação entre a frequência cardíaca de recuperação após teste ergométrico e índice de massa corpórea. Rev Port Cardiol. 2014. <http://dx.doi.org/10.1016/j.repc.2014.07.006>

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**PALAVRAS-CHAVE**

Teste de exercício;  
Obesidade;  
Sistema nervoso  
autônomo;  
Frequência  
cardíaca/recuperação

**Relação entre a frequência cardíaca de recuperação após teste ergométrico e índice de massa corpórea****Resumo**

*Fundamento:* Declínio atenuado da frequência cardíaca após teste ergométrico é considerado preditor de mortalidade cardiovascular, por refletir disfunção autonômica vagal.

*Objetivo:* Avaliar a relação entre índice de massa corpórea (IMC) e recuperação da frequência cardíaca após teste ergométrico.

*Métodos:* Foram incluídos registros de 2.443 pacientes de ambos os sexos, entre 20-59 anos, em ritmo sinusal, sem uso de cronotrópicos negativos e sem resposta isquêmica miocárdica ao teste ergométrico realizado em clínica especializada, entre 2005-2011. O IMC foi categorizado como: normal ( $18,5 \text{ kg/m}^2 < \text{IMC} \leq 25 \text{ kg/m}^2$ ), sobrepeso ( $25 \text{ kg/m}^2 < \text{IMC} \leq 30 \text{ kg/m}^2$ ) e obeso ( $\text{IMC} > 30 \text{ kg/m}^2$ ). A recuperação da frequência cardíaca após esforço, obtida pela diferença entre a máxima no esforço e no 1.º minuto da recuperação, foi comparada entre grupos de IMC. Foi considerada atenuada quando  $\leq 12$  bpm.

*Resultados:* Oitenta e sete (3,6%) pacientes registraram recuperação atenuada, sendo três vezes maior no grupo de obesos e duas vezes no de sobrepeso, quando comparados ao grupo adequado ( $p < 0,001$ ,  $p = 0,010$ , respectivamente). Obesos apresentaram maior frequência cardíaca basal e menor máxima, além de menor reserva cronotrópica ( $p < 0,001$ ). Na análise multivariada, identificou-se influência dessa atenuação por sobrepeso ( $\text{RR} = 1,8$ ;  $p = 0,035$ ), obesidade ( $\text{RR} = 2,0$ ;  $p = 0,016$ ), MET ( $\text{RR} = 0,82$ ;  $p < 0,001$ ) e frequência cardíaca de repouso ( $\text{RR} = 1,05$ ;  $p < 0,001$ ). A razão de risco da hipertensão arterial sistêmica igualou-se a dois, sem significância ( $p = 0,083$ ).

*Conclusão:* A recuperação atenuada da frequência cardíaca associou-se a maiores IMC, corroborando o fato de que obesos apresentam disfunção autonômica vagal.

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**Introduction**

Cardiovascular disease is more prevalent in obese individuals.<sup>1</sup> One possible pathophysiological mechanism behind this association is altered cardiovascular autonomic regulation, including reduced parasympathetic activity. This is an independent risk factor for coronary artery disease as well as a predisposing factor for arrhythmias and sudden death in obese patients<sup>2</sup>; it appears to precede the development of cardiovascular disease and is thus considered an early risk marker.<sup>3</sup> The mechanisms by which weight gain reduces parasympathetic tone have yet to be fully clarified. One possible explanation is that obesity is associated with chronic inflammation of adipose tissue.<sup>4-6</sup> Inflammatory adipokines secreted by white fat, such as tumor necrosis factor alpha and interleukin-6, affect the cardiac autonomic balance via the central nervous system, promoting sympathetic hyperactivity, especially in hypertensive obese individuals,<sup>7,8</sup> counteracting increased parasympathetic activity and acetylcholine levels, which inhibit release of these inflammatory cytokines.<sup>9</sup> It is through inflammatory states and autonomic nervous system dysfunction that obese patients have a higher risk of morbidity and mortality.<sup>10</sup>

Cardiac autonomic function can be assessed by heart rate recovery (HRR) following exercise testing, a slow decline indicating reduced parasympathetic reactivation.<sup>11</sup> Individuals who present impaired HRR after exercise have an almost four-fold greater risk of mortality.<sup>12</sup> Furthermore, there is

evidence of an association between cardiovascular risk factors and changes in cardiac autonomic regulation.<sup>9,13-15</sup>

Given that obesity is an important risk factor for cardiovascular disease and that vagal autonomic dysfunction may be an early cardiovascular risk marker, it has been suggested that obese individuals undergoing treadmill exercise testing using a ramp protocol would present impaired HRR after exercise compared to those with normal body mass index (BMI). This makes exercise testing particularly valuable, since it is one of the first exams to be performed during diagnostic investigation and may lead to early identification of patients at greater cardiovascular risk.

The aim of this study was to assess the relationship between BMI and HRR following exercise.

**Methods**

This was a cross-sectional study based on secondary data on exercise tests carried out at a specialist clinic in Recife, Brazil, between 2005 and 2011. We included individuals aged between 20 and 59 years, with  $\text{BMI} > 18.5 \text{ kg/m}^2$ , no cardiovascular disease, and not using negative chronotropic agents, who underwent exercise testing to assess functional capacity or for diagnostic purposes and presented a test duration of  $\geq 7$  min.

Exclusion criteria were non-sinus rhythm on ECG, atrioventricular or intraventricular conduction disturbances, and myocardial ischemic response to exercise testing

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