Rev Andal Med Deporte. 2019; 12(3): 206-209

Revista Andaluza de
Medicina del Deporte

https://ws072.juntadeandalucia.es/ojs

Original

Exercise-induced rhabdomyolysis is not more severe or frequent after Crossfit than after Running or Strength training programs

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ARTICLE INFORMATION: Received 17 October 2018, Accepted 18 March 2019, Online 19 March 2019

ABSTRACT

Objective: Rhabdomyolysis is the death (lysis) of muscle fibers due to direct or indirect muscle injury, with release of the fiber content into the bloodstream. Several conditions are triggering the rhabdomyolysis, for example, changes in body temperature, intoxications and strenuous exercise. Although often the condition of the disease in question are associated with programs of extreme conditioning, specifically to Crossfit, there are few scientific data that prove such a relationship or lack thereof. The aim of this study is to assess the incidence and severity of cases of rhabdomyolysis in different modalities of training, Crossfit, strength training and Running.
Method: A case study was carried out in 20 clinics in the city of Belém in the state of Pará. Data analysis was used to characterize the sample. The Shapiro-Wilk normality test was used and, based on the results, the data were submitted to non-parametric Mann-Whitney and Kruskal-Wallis tests.
Results: The results showed that no differences were found between the proportions ($\chi^2 = 3.44$; $p = 0.17$).
Conclusions: The frequency of cases and their severity is similar between running, training and Crossfit.
Keywords: Rhabdomyolysis; Physical exercise; Crossfit.

La rabdomiolisis inducida por el ejercicio no es mas severa o frecuente después de Crossfit que después de carrera continua o programas de entrenamiento de fuerza

RESUMEN

Objetivo: La rabdomiolisis es la muerte (lisis) de las fibras musculares debido a una lesión muscular directa o indirecta, con liberación del contenido de las fibras al torrente sanguíneo. Varias condiciones son desencadenantes de los cuadros de rabdomiólisis, por expor, cambios de la temperatura corporal, intoxicaciones y ejercicio extenuante. Aunque a menudo los cuadros de la enfermedad en cuestión se asocian a programas de condicionamiento extremo, específicamente a Crossfit, poco se tienen datos científicos que demuestren tal relación o la falta de ella. El estudio en cuestión tiene por objetivo hacer un levantamiento de incidencia y severidad de casos de rabdomiólisis en diferentes modalidades de entrenamiento, Crossfit, entrenamiento de fuerza y Carrera.
Método: Se realizó un relevamiento de casos en 20 clínicas en la ciudad de Belém do Pará. Para el análisis de los datos se utilizó la estadística descriptiva para la caracterización de la muestra. Se utilizó la prueba de normalidad de Shapiro-Wilk y, sobre la base de los resultados, los datos se sometieron a las pruebas no paramétricas de Mann-Whitney y Kruskal-Wallis.
Resultados: Los resultados demostraron que no se encontraron diferencias entre las proporciones ($\chi^2 = 3.44$, $p = 0.17$).
Conclusiones: La frecuencia de casos y la severidad de los mismos es similar entre carrera, entrenamiento de fuerza y Crossfit.
Palabras clave: Rabdomiolisis; Ejercicio físico; Crossfit.

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https://doi.org/10.33155/j.ramd.2019.03.009

A rabdomiólise induzida pelo exercício não é mais grave ou frequente após o Crossfit do que após programas de corrida contínua ou de treinamento de força

RESUMO

Objetivo: A rabdomiólise é a morte (lise) das fibras musculares devido a uma lesão muscular direta ou indireta, com liberação do conteúdo das fibras para a corrente sanguínea. Várias condições são desencadeadoras dos quadros de rabdomiólise, por exempo, alterações da temperatura corporal, intoxicações e exercício extenuante. Ainda que por muitas vezes os quadros da doença em questão serem associadas a programas de condicionamento extremo, especificamente ao Crossfit, pouco se tem dados ciêntificos que comprovem tal relação ou a falta dela. O estudo em questão tem por objetivo fazer um levantamento de incidência e severidade de casos de rabdomiólise em diferentes modalidades de treinamento, Crossfit, treinamento de força e Corrida.
Método: Foi realizado um levantamento de casos em 20 clínicas na cidade de Belém do Pará. Para análise dos dados utilizou-se da estatística descritiva para a caracterização da amostra. Utilizou-se o teste de normalidade de Shapiro-Wilk e, com base nos resultados, os dados foram submetidos ao testes não paramétrico de Mann-Whitney e Kruskal-Wallis.
Resultados: Os resultados demonstraram que não foram encontradas diferenças entre as proporções ($\chi^2 = 3.44$; $p = 0.17$).
Conclusões: A frequência de casos e a severidade dos mesmo é semelhante entre corrida, treinamento de força e Crossfit.
Palavras-chave: Rabdomiólise; Exercício físico; Crossfit.

Introduction

The practice of strength exercises is often accompanied by muscular pain, and pain is a constant recognized in the adaptive process involving tissue injury and inflammation.1 Much is already known that physical exercise is a form of physiological stress, giving rise to the general adaptation syndrome, which is divided into: 1) stress; 2) alarm; 3) adaptation and 4) plateau.2 In a situation where the training load is well distributed and with sufficient intensity, the exercise generates an initial phase that mimics an inflammatory reaction in response to tissue damage and production of reactive oxygen species (ROS).3 However, if an imbalance occurs in this process and the relative limit exceeds, this excess can generate physiologically negative responses, that is, responses that compromise the health of the individual.4

The pain that originates from the muscular damage caused by an unusual physical effort, is usually overcome by the adaptation mechanism, however, there are cases where late muscle pain lasts for more than 48 hours after intense muscle activity, might being one of the indicators of a syndrome known as Rhabdomyolysis.5

Rhabdomyolysis is the death (lysis) of muscle fibers due to direct or indirect muscle injury, with release of the fiber content into the bloodstream, including electrolytes, myoglobin and other sarcoplasmic proteins, notably creatine kinase (CK),6,7 as well as alanine aminotransferase (ALT), asparate aminotransferase (AST), among others.7

The most characteristic symptoms of the syndrome are myalgia, muscle weakness and dark urine. Clinical manifestations can range from asymptomatic disease to a life-threatening condition with very high enzymes, acute renal failure (ARF), and electrolyte disturbances. Acute renal failure occurs in approximately 15 to 30% of cases, a clinically important condition due to the high associated morbimortality.8

The exact clinical diagnosis of rhabdomyolysis is based on laboratory tests, where the elevation in plasma levels of the enzyme CK and electrolytes is observed.9 The complexity of the syndrome is identified from the symptoms present in the subject, and they are: Level I – where there is fever, nausea, severe muscular pain and chills; Level II – that presents fever, nausea, severe muscular pain, chills evolving for paralysis of muscular area and Level III – almost always presents the symptoms mentioned in the previous levels together with the acute renal failure, being able to evolve to death.5

Given the importance of a more precise understanding of the aspects of this syndrome, its incidence derived from muscular effort is fundamental. Furthermore, the actual occurrence of rhabdomyolysis external to the military milieu is susceptible, probably due to its sub-report, to its presumed disregard and to the lack of knowledge about the syndrome. It is suggested that, possibly, this occurrence is higher than that identified.10 Thus, the aim of the present study is to contribute to the construction of an updated perspective on the incidence and severity cases of rhabdomyolysis in different training modalities: Crossfit, strength training and Running.

Methods

Sample

The present study consisted of a field study, of an analytical and epidemiological character, in which the data were obtained through a survey made through the analysis of exams and medical reports of subjects who were attended in the period of March 1998 to December 2015 in 20 clinics, hospitals and hemodialysis centers of the city of Belém – PA.

For the composition of the sample, a visit was made prior to data collection at each clinic, hospital or hemodialysis center to identify previously possible cases. Those responsible for the clinics signed a consent agreement and research science. The subjects who agreed to participate in the research with the supply of their laboratory data, signed the informed consent form approved by the research ethics committee of the Pará Federal University. In cases of individuals already deceased, the term was signed by a family member. The project was submitted to the research ethics committee under the protocol CAAE 73035517.1.0000.0018, according to resolution 466/2012 of the National Health Council for research with human beings.

The subjects selected to compose the sample, practiced before developing the symptoms of the disease, one of the following three modalities: Crossfit, Strength Training (Bodybuilding) or running, with moderate to high intensity with an average duration of 45 minutes.

Exclusion criteria were cases in which the individual presented some genetic or metabolic disease, trauma due to accidents, burns or any other factor outside the physical exercise that also triggered the disease. Also excluded from the sample were cases where it was not possible to contact the individual and neither the family of the same, thus losing some cases.

Statistical Analysis

After Shapiro-Wilk's test for normality, almost all data presented a not normal distribution. Based on that, data are presented by median and interquartile range (25-75%). Comparisons between men and women were performed by Mann-Whitney test, while Kruskal-Wallis test was applied for between training mode comparisons. The chi-squared test was used to test differences between proportions. Analysis were performed in the SPSS 22.0 software and statistical significance was set when $p \leq 0.05$.

Results

Descriptive data are presented in Table 1. For all variables presented no statistical differences were found between women and men.

Table 1. Median and interquartile range (25-75%) from descriptive data (n= 237).

	All (n=237)	Men (n=150)	Women (n=87)	Z	p-value
Age (y.o.)	34 (27–39)	31 (27–38)	35 (27–39)	-1.51	0.13
Height (cm)	173 (167–178)	173 (167–176)	173 (167–178)	-1.04	0.30
BMI	25.7 (25.1–26.8)	25.5 (25.1–26.7)	25.7 (25.1–26.9)	-0.40	0.69
CK (mg/dl)	1.80 (1.60–1.90)	1.80 (1.50–1.90)	1.80 (1.70–1.90)	-1.10	0.27
Axillary Temperature (ºC)	37 (36–38)	37 (36–38)	37 (37–38)	-1.43	0.15

CK: Creatine Kinase; BMI: Body Mass Index; Z: Mann-Whitney test score.

Regarding comparisons between training modalities, also no difference were found from Kruskal-Wallis test (χ^2= 2.56; p= 0.27) as presented in figure 1. In addition, axillary temperature did not differ between training mode (χ^2= 1.03; p= 0.59).

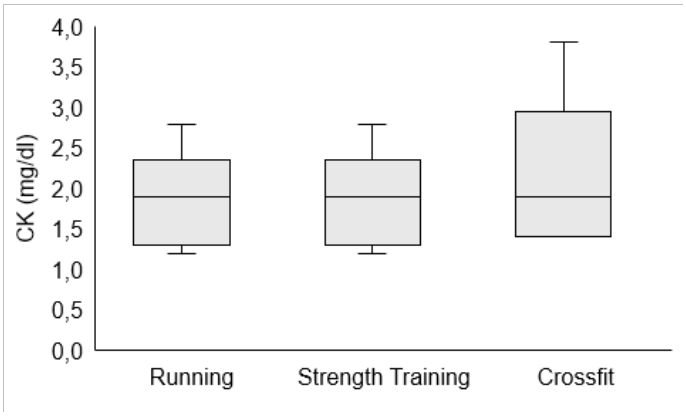

Figure 1. Creatine Kinase levels, by modality.

Considering total of rhabdomyolysis cases included, 44 (18.6%) were from people enrolled in running, 136 (57.4%) in strength training and 57 (24.1%) in Crossfit. From those, 87 (36.7%) and 150 (63.3%) were female and male subjects, respectively. Regarding training mode and rhabdomyolysis level, 81% (n= 192) of total sample were classified as Level I and 19% (n= 45) as Level II. Data presented in figure 2 showed that no differences were found between proportions (χ^2= 3.44; p= 0.17), which means that in relative terms the frequency of worse cases are similar between running, strength training and Crossfit.

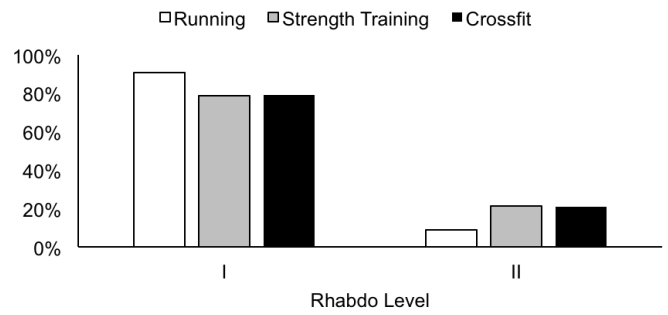

Figure 2. Severity of the syndrome by modality

Discussion

Rhabdomyolysis is characterized by muscle necrosis and release of intracellular contents such as myoglobin and creatine kinase, into the bloodstream and can develop under any circumstance where the demand for energy in muscles exceeds the available energy supply. Previously considered rare, rhabdomyolysis is recognized in increasing frequency for attention the clinical causes and conditions that may predispose muscle necrosis.

In the present study, we investigated whether exercise-induced rhabdomyolysis is more severe or frequent after Crossfit than after strength training or running programs. Statistical data showed, in general terms, that the level of incidence of rhabdomyolysis in CrossFit is not different from other training modalities that have the same characteristics (intensity, volume, duration). Of the total of 237 cases, only 24.1% are directly related to CrossFit, presenting rates inferior to the strength training associated to 57.4% and superior to the present race in only 18.5% of the cases.

Our results are in agreement with those obtained by Dominski et al.,[11] who affirm that rhabdomyolysis is not an exclusive or predominant condition in CrossFit, since it is usually related to low prescription or exercise without adequate supervision, which can occur in other training modalities.

When discussing the complexity of the syndrome, its levels of development, our results showed that there was no significant difference between the modalities, as shown in figure 2. This evidence is in agreement with Guimarães et al.,[12] who stated that the severity levels in injuries between running, strength training and Crossfit practitioners do not present significant differences.

Our study shows us data that lead us to believe in a predominance of the development of the male pathology, obtaining a percentage of 63.3% of the total cases studied, but it must be taken into account that the sample is not uniform, with 150 males and 87 females, which does not allow us to affirm a direct relation of sex to the development of the disease. Keogh & Winwood[13] conducted a systematic review on the epidemiology of injuries in all sports strength training. The authors concluded that, in general, intrinsic factors such as gender, level of competition, age and body weight have a relatively low effect on the occurrence of injuries in strength training exercises. In another study, conducted by Salicio, Shimoya-Bittencourt, Dos Santos and Da Costa & Salício[14] in which they verified the prevalence of muscular injuries and associations in recreational corridors, they also did not find an association between sex and age.

It is important to emphasize that, although the study is composed of a relatively large sample, there is a disparity in the time period of the syndrome events; In addition, the research was concentrated in a small number of clinics in a specific city. This makes it difficult to extrapolate the results obtained in the present study to the general population.

The above findings suggest that, in relative terms, the frequency of cases of rhabdomyolysis and its severity do not differ between running, strength training and Crossfit. Exhaustive physical exercise is a recognized cause of rhabdomyolysis, but there is no evidence that a specific training modality has a greater responsibility for its development.

Authotship. All the authors have intellectually contributed to the development of the study, assume responsibility for its content and also agree with the definitive version of the article. **Conflicts of interest.** All the authors report no conflicts of interest. **Provenance and peer review.** Not commissioned; externally peer reviewed. **Ethical Responsabilities.** *Protection of individuals and animals:* The authors declare that the conducted procedures met the ethical standards of the responsible committee on human experimentation of the World Medical Association and the Declaration of Helsinki . *Confidentiality:* The authors are responsible for following the protocols established by their respective healthcare centers for accessing data from medical records for performing this type of publication in order to conduct research/dissemination for the community. *Privacy:* The authors declare no patient data appear in this article.

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