CARDIAC ANALYSIS OF PROFESSIONAL BASKETBALL PLAYERS: A REVIEW

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A Thesis Submitted to The W.A. Franke Honors College

In Partial Fulfillment of the Bachelors degree
With Honors in

Physiology

THE UNIVERSITY OF ARIZONA

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Abstract

Regularly participating in strenuous physical activity can cause physiological changes within the cardiovascular system. This thesis examines the types of changes the hearts of professional basketball players undergo. Keywords such as physiological cardiac remodeling, professional basketball athlete, and cardiac hypertrophy were used to search various cardiology research databases. The most prevalent physiological changes among professional basketball players were increased left ventricular wall thickness and t-wave inversion, associated with early repolarization. Studies used echocardiography, electrocardiography (ECG) and cardiopulmonary exercise testing (CPET) to identify structural and functional physiological changes.

Introduction

Nearly one in four athletes in the National Basketball Association players has an abnormal electrocardiogram. Basketball is a rigorous contact sport, especially at the professional level. During four-twelve minute quarters, athletes run within the bounds of a court ninety-four feet long, fifty feet wide. An athlete is estimated to cover 4500 - 5000 meters during regular play (Al et Kinet). In addition to regular season games, athletes train year-round, participating in vigorous strength and conditioning programs to maintain elite cardiorespiratory fitness. Intensity increases with level, with training becoming progressively vigorous and frequent. Due to these changes in exertion, the body's demands also change, causing the heart to adapt. The heart of a competitive athlete adapts to meet the oxygen and nutrient needs of the body. Physiological remodeling causes changes in the proportions and functions of the heart. Repeated changes in hemodynamic loading over an extended period stimulate cardiac adaptation and remodeling (Shave and Dickson 2017). Stretching caused by increased hemodynamic load causes hypertrophic changes. To adapt to the increase in volume and pressure, the heart increases its left ventricular internal diameter and left ventricular wall thickness. The cardiomyocyte is the primary cell type to undergo adaptations (Shave and Dickson 2017). This review aims to identify and analyze the structural and functional changes in the hearts of professional basketball players.

Methods

The data in this review was collected from mandatory pre-season medical evaluations. Cardiac structure and function were measured using non-invasive techniques which include echocardiograms, electrocardiograms (ECG), and cardiopulmonary exercise testing (CPET). Echocardiograms were performed by team-associated physicians and reviewed by physician-researchers involved with the study. Investigators used pre-existing guidelines such as those provided by the American Society of Echocardiography (ASE) and European

Association of Cardiovascular Imaging (ESCI) guidelines. Electrocardiograms (ECG) were performed by team-associated physicians and reviewed by two cardiologists. ECGs were also analyzed using athlete-specific criteria. Cardiopulmonary exercise testing (CPET) was performed following American Heart Association guidelines.

Structural and Functional Changes

In a study of 519 male athletes in the National Basketball Association, 25.2% had an abnormal ECG. ECGs were analyzed using athlete-specific interpretation criteria. Age and ethnicity were categorical variables used to interpret findings. T-wave inversion was the most prominent ECG abnormality identified in 6.2% of participants. Researchers determined that a relationship exists between T-wave inversion and relative wall thickness. There was an increase in the prevalence of T-wave inversion as relative wall thickness increased and ventricular cavity size decreased (Waase et al., 2018). Early repolarization was the most common training-related ECG abnormality found in 69% of athletes that participated in the study. African American and White athletes were equally likely to have at least one training-related ECG finding. There was no difference in the prevalence of T-wave inversion between African American and White athletes (Waase et al., 2018). Age and left ventricular wall thickness were also associated with ECG abnormalities. There were more ECG abnormalities in the older athlete group (27-39 years) versus the younger athlete group (18-22 years). From this observation, researchers speculate that increased years of intense training may lead to identifiable ECG changes.

In an analysis of cardiac imaging from 526 athletes in the National Basketball Association, the most predominant morphological change was left atrial enlargement (Engel et al, 2016). Left ventricular cavity dilation (LVEDD $\geq$ 59 mm) was present in 36.5 % of athletes included in the study. However, when the left ventricle end-diastolic-diameter was indexed to height and body surface area, left ventricle cavity size was normal. The predominant form of hypertrophy in African American athletes was non-dilated concentric hypertrophy and eccentric dilated hypertrophy was the primary type in white athletes. Most of the athletes included in the study had an average left ventricle ejection fraction. Of the athletes included in the study, 1% had a left ventricle ejection fraction under 50%, and none had a left ventricular ejection fraction under 45% (Engel et al., 2016). The study also provided a measure of aortic root diameter. According to the American Heart Association, aortic root diameter should not exceed 40mm. However, 4.6% of professional athletes had an aortic root diameter > 40 mm, and the maximum diameter recorded was 42 mm (Engel et al., 2016). The study reported that aortic root diameter reached a plateau as height and body surface area increased. Aortic root diameter findings were compared to other elite athlete groups and found to be similar.

A German study of 27 professional basketball players used CPET to measure cardiac function. Investigators also performed ECGs and echocardiograms to measure cardiac structures. After performing ECGs, athletes were split into two groups: those with early repolarization patterns and those without early repolarization patterns. Early repolarization pattern was present in 44.4% of athletes (Zimmermann et al., 2022). Athletes with early repolarization patterns had greater left atrial end-systolic diameter, right atrial end-systolic diameter, peak performance (VO_2 max), and maximum workloads than athletes without early repolarization pattern (Zimmermann et al., 2022).

In 2020, a study was done on female professional basketball players of the Women's National Basketball Association, using pre-season medical evaluation data. Although 26% of athletes had left ventricular dilation, left ventricular cavity size was normal when indexed to body surface area. There was a positive linear association between left ventricular end-diastolic diameter and body surface area. (Shames et al., 2020). Of the athletes with left ventricular hypertrophy, 69.6% had eccentric remodeling, and 30.9% had concentric remodeling. The study also measured left ventricular function and aortic root diameter. Left ventricular function was measured via a stress test and only 2.9% had left ventricular ejection fractions < 50%. Left ventricular diastolic function was normal at rest in all athletes (Shames et al., 2020).

Discussion

Several investigators expressed concern about the need for athlete-specific criteria for identifying cardiac abnormalities. Investigators also noted the lack of cardiac data from healthy individuals with similar characteristics (height, weight) as professional athletes for comparison. Multiple studies compared the cardiac function and parameters between professional football athletes and basketball players. Female athletes were shown to have similar changes to males; however, there is a significant lack of research on female professional basketball athletes. Most studies on cardiac remodeling in female athletes were not basketball-specific. One important finding was the correlation between t-wave inversion and relative wall thickness. Further research on this correlation is desired, to determine risk factors and other health implications. One limitation in this review is the lack of follow-up data on athletes with cardiac abnormalities.

Conclusion

Various studies have identified a significant number of cardiac abnormalities in professional basketball players. The abnormalities affecting the majority of the study participants include early repolarization, left atrial enlargement, and increased left ventricular cavity size. Categorization of characters (such as age, height, weight, and ethnicity) revealed patterns and correlations. Creating criteria for athletes presents researchers with a unique challenge, as variations in training, playing time, and genetics are also factors that may contribute to an athlete's predisposition to cardiac abnormalities and cardiovascular changes. The data collected from studies within this review and future follow-up studies on athletes with identified abnormalities can help create athlete-specific criteria.

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