

Study uses motion capture to determine what makes the best free-throw shooters

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Experimental set-up of the markerless motion capture system. Credit: *Frontiers in Sports and Active Living* (2023). DOI: [10.3389/fspor.2023.1208915](https://doi.org/10.3389/fspor.2023.1208915)

Every basketball coach has told their players at some point that free throws win games. A new study from the University of Kansas used innovative markerless motion capture technology to determine the mechanics of proficient free-throw shooters and help better understand one of the biggest keys to success in the game.

According to the study, proficient free-throw shooters—those capable of making more than 70% of their shots—performed the shooting [motion](#) in a more controlled manner. They had lower knee and center of mass peak and mean angular velocities when compared with nonproficient shooters. Also, proficient shooters attained greater release height and had less forward trunk lean at the point of the ball release.

"These findings imply that basketball shooting motion is not as simple as some may think. Shooting efficiency can't be simply attributed to one biomechanical variable. It is founded on a mix of multiple segmental body movements performed in a controlled manner," said Dimitrije Cabarkapa, lead author of the study and associate director of the Jayhawk Athletic Performance Laboratory.

The study examined 34 males with at least four years of basketball playing experience, ranging from recreational to collegiate competitive levels. Each participant attempted 10 [free throws](#) with a 10–15 second rest interval between each attempt. A three-dimensional markerless motion capture system developed by Southwest Research Institute (SwRI Enable, San Antonio, Texas), composed of nine high-definition cameras (120 fps), was used to record and analyze the biomechanical characteristics of free-throw shooting motion.

"We're very interested in analyzing basketball shooting mechanics and what performance parameters differentiate proficient from nonproficient shooters," Cabarkapa said. "High-speed video analysis is one way that we can do that, but innovative technological tools such as

markerless motion capture systems can allow us to dig even deeper into that. In my opinion, the future of sports science is founded on using noninvasive and time-efficient testing methodologies."

The study, conducted at the Jayhawk Athletic Performance Laboratory, also found that when differentiating between made and missed shots attempted by proficient free-throw shooters, overemphasis on release height could be counterproductive.

"These findings can be metaphorically represented by some everyday life healthy habits. Exercising, drinking water and consuming enough vitamins and minerals are all very beneficial for our health. However, overdoing these things in certain instances may be harmful, and it may actually produce the opposite effect than expected," Cabarkapa said.

The study, published in the journal *Frontiers in Sports and Active Living*, was co-written with Damjana Cabarkapa and Andrew Fry of the Jayhawk Performance Athletic Laboratory at KU; Jonathan Miller of KU's Higuchi Biosciences Center; and Tylan Templin, Lance Frazer and Daniel Nicolella of the Southwest Research Institute.

The use of markerless motion capture technology is beneficial for several reasons, authors said, as other motion capture systems that use markers that must be placed on the skin or clothing have several issues, such as not staying in place and participant's awareness of the markers, which may alter the normal movement patterns. That is vital when testing is conducted in a sport-specific setting, where efficiency is of critical importance. The use of markerless motion capture technology allows for noninvasive assessment.

Dimitrije Cabarkapa said that, to the authors' knowledge, this is the first study to use this motion capture system to examine the biomechanical characteristics of proficient free-throw shooters. Previous research has

shown that teams with better free-throw shooting, especially close to the end of the game, have a greater chance of winning.

While the current study didn't include the effects of fatigue on shooting mechanics and accuracy, researchers hope to examine that factor in upcoming studies as well as the effect of a presence of a defender on jump-shot shooting mechanics and accuracy.

The lab is part of the Wu Tsai Human Performance Alliance, a consortium of researchers working to understand optimum human performance. This alliance encompasses the University of Stanford, University of Oregon, Boston Children's Hospital, Salk Institute, University of California at San Diego and KU.

"These findings add to the [work we've done in the past](#) and the body of scientific literature pertaining to basketball shooting performance that we are continuously expanding in our lab," Dimitrije Cabarkapa said.

"We've found that both the preparation and release phases of the shooting motion are of critical importance for attaining solid levels of shooting efficiency. The implementation of innovative technology can allow us to examine the transition phase of the [shooting](#) motion and kinematic chaining in more detail. Ultimately our goal is to have an answer to the question that every basketball fan wants to know: 'Why did Steph Curry miss that shot?'"

More information: Dimitrije Cabarkapa et al, Biomechanical characteristics of proficient free-throw shooters—markerless motion capture analysis, *Frontiers in Sports and Active Living* (2023). [DOI: 10.3389/fspor.2023.1208915](https://doi.org/10.3389/fspor.2023.1208915)

Provided by University of Kansas

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