COE Internal Grant Proposal – David W. Keeley, PhD

Part I: General Information

- *Upper Extremity Mass Distribution and its Relation to Performance in College Tennis Players*
- David W. Keeley, PhD; Department of HPDR
- Assistant Professor; August 15, 2012

Part II:

- *Professional Impact of Proposal*

Receipt of this funding would allow me to expand my sport performance research line outside of throwing investigations as well as allowing me to develop the skills necessary to assess body composition, segmental mass characteristics, and inertial parameters. These expansions would improve my professional vita so as to aggressively pursue larger funding opportunities (e.g. – NIH, NSF, ORS) against more experienced research teams.

- *Impact of the Field of Study*

The proposed study has the potential to improve biomechanists' understanding of segmental mass distributions and their impact on human movement. Through increased understanding of the impact segmental mass ratios have on motion, researchers may be better able to diagnose the underlying causes of inefficient movement and overuse injury in repetitive motions.

- *Brief Review of Literature*

Although the musculoskeletal adaptations associated with playing tennis are thought to have a positive impact with regard to decreasing injury risks, their impact on performance has yet to be studied. The goal of tennis athletes is to produce effective performances. Effective performance in basic terms relates to the ability of the tennis player to strike the ball with

precision, accuracy, and the correct ball velocity for as much of a match as possible. By accurately placing shots with appropriate velocity, a player is often able to win points directly (i.e. passing shots), win points indirectly (i.e. force opponents into errors), or maintain consistency throughout the performance (i.e. limit unforced errors). Although previous research has shown there are body segment parameter (BSP) differences in tennis players (Brossueau, Hautier, & Rogowski, 2006) and discussed injury implications of these results (Murphy, Connolly, & Beynnon, 2003), little research has been conducted that investigates the impact of BSP parameters on tennis performance.

In order to identify the impact of body segment parameters (BSP's) on performance, accurate information describing segment mass and segmental center of mass location is necessary. These parameters are often estimated using scaling factors established from human cadaver measurements that provide statistical meaning (Dempster, 1955). Although non-invasive as they are anthropometric measurements, they tend to vary greatly between from individual to individual and are inaccurate for any specific individual (Wicke & Keeley, 2009). Thus, obtaining these mass parameters in human participants using these techniques can be very difficult because body segments of a live human cannot be taken apart for measurement.

In contrast to scaling factors, the use of dual energy x-ray absorptiometry (DXA) has emerged as a highly accurate technology that can be effectively used to capture segment mass densities (Durkin, Dowling, & Andrews, 2002; Wicke & Dumas, 2008) and demonstrate little bias with regard to musculoskeletal development, and/or athletic status (Peitrobelli et al., 1996).

Part III: Research Plan

- *Facilities and Setting*

Data will be collected at area University tennis centers and the DXA unit housed in AC 122. Although it may be necessary to travel to secondary University tennis facilities for collecting performance data, all DXA testing will be completed on the NMSU campus.

- *Procedures (data collection and analysis)*

All protocols to be used have been submitted to the New Mexico State University Institutional Review Board (IRB) and approved for use. Also, the required use of radiation permit application has been submitted to the NMSU Radiation Safety Committee and will be approved prior to DXA scanning. A pool of 12-15 tennis players who are deemed to be free of from injury for 12 months, have five years experience, and are at least 18 years of age will be selected for analysis, informed to the risks and benefits of participating and asked to provide written consent.

BSP data will be collected at the onset of the study through a whole body DXA scan performed using established protocols. Whole body mass will be determined and individual BSP's of the upper and lower arm will be determined and scaled as a percentage of participant mass. Following mass ratio determination, the position of the center of mass for the upper and lower arms will be determined and scaled as a percentage of participant height.

Performance data will be collected during a single bout testing protocol during which participants report to the tennis center of their respective University. They will dress in their normal competitive attire and complete their personal pre-competition warm-up routine. Following the warm-up participants will complete a series of 100 forehand passing shots (50 down line / 50 cross court), 100 backhand passing shots (50 down line / 50 cross court), and 100 served (50 mid-line / 50 wide). Throughout testing, participants will be instructed to hit each shot as close as possible to a stationary target. The 2-D position of each shot relative to the target will

be recorded using two Panasonic digital video recorders positioned above and beside the target. To calculate accuracy, the distance from the target for each shot will be determined using a simple pixel ratio describing mean radial deviation, lateral (left/right) deviation, and depth (front/back) deviation. The velocity of each shot will be measured using a portable radar gun.

Following the data collection process, descriptive statistics will be calculated and distributional shape analyses will be conducted for both mass ratios and performance variables. After distributional and normality assessments are completed, correlation analyses will be conducted to identify the relationships between BSPs (independent variable) and both accuracy and velocity parameters (dependent variables).

- *Study Timeline*

The proposed project is a two-year study with DXA scans beginning in the Summer of 2012 and completed in the Fall of 2012. The single bout performance data will be collected throughout the Fall of 2012, the Spring of 2013, and the Summer of 2013. Data reduction and analysis will be completed in the Fall of 2013 with result being disseminated during the Spring of 2014.

- *Use of Finding / Dissemination of Results*

Results will be distributed through conference abstract presentations and submission to peer-reviewed Journals within the biomechanics field of study.

Part IV: Budget and Budget Justification

The total requested funds for the completion of this project are $2,000 (USD), broken into salary, equipment, and supplies.

- Salary ($400.00) is requested to hire a certified radiation technician to administer the DXA scans as per State of New Mexico Radiation Safety Guidelines. DXA scans are vital in determining the segment mass ratios of interest in the proposed study.

- Two Panasonic HDC-TM41 Digital Video Cameras ($675.00, $337.50/camera) capable of filming at a rate of 1000 Hz are requested to accompany departmental camera. These will be utilized to assess position of all shots in an effort to calculate shot accuracy in multiple dimensions.
- One Stalker Radar Gun ($825.00) is requested to determine shot velocity, a key parameter investigated in this study.
- Urine Based Pregnancy Tests ($100.00) are required to evaluate the pregnancy status of female participants. This safety measures has been required by the NMSU Compliance Office due to the low doses of radiation exposure during the DXA testing.

Part V: References

Brosseau O, Hautier C, & Rogowski I. (2006). A field study to evaluate side-to-side differences in the upper limbs of young tennis players. *Medicine and Science in Tennis*, XX; 18-19.

Dempster WT. (1955). Space requirements of seated operator, geometrical, kinematic, and mechanical aspects of the body with special reference to the limb. *WADC technical report*, 55-159.

Durkin JL, Dowling JJ, & Andrews DM. (2002). The measurement of body segment inertial parameters using dual energy x-ray absorptiometry. *Journal of Biomechanics*, 35; 1575-1580.

Murphy DF, Connolly DAJ, & Beynnon BD. (2003). Risk of factors for lower extremity injury: A review of the literature. *British Journal of Sports Medicine*, 37; 13-29.

Pietrobelli A, Formica C, Wang Z, et al. (1996). Dual-energy x-ray absorptiometry body composition model: Review of physical concepts. American Journal of Physiology, 271; E941-E951.

Wicke J & Dumas GA. (2008). Estimating segmental inertial parameters using fan-beam DXA. Journal of Applied Biomechanics, 24; 180-184.

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