Reliability and Validity of using a Mobile Application to Assess Knee Valgus in Healthy and Post-Anterior Cruciate Ligament Reconstruction Participants

Brenda Benson Deaver
University of Nevada, Las Vegas, BENSOB2@UNLV.NEVADA.EDU

Tyrel Nelson
University of Nevada, Las Vegas, NELST3@UNLV.NEVADA.EDU

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RELIABILITY AND VALIDITY OF USING A MOBILE APPLICATION TO ASSESS KNEE VALGUS IN HEALTHY AND POST-ANTERIOR CRUCIATE LIGAMENT RECONSTRUCTION PARTICIPANTS

By

Brenda Benson Deaver

Tyrel Nelson

A doctoral project submitted in partial fulfillment of the requirements for the

Doctor of Physical Therapy

Department of Physical Therapy
School of Allied Health Science
The Graduate College

University of Nevada, Las Vegas
May 2018
This doctoral project prepared by

Brenda Benson Deaver

Tyrel Nelson

entitled

Reliability and Validity of Using a Mobile Application to Assess Knee Valgus in Healthy and Post-Anterior Cruciate Ligament Reconstruction Participants

is approved in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy
Department of Physical Therapy

Daniel Young, Ph.D.  
Research Project Coordinator

Kathryn Hausbeck Korgan, Ph.D.  
Graduate College Dean

Daniel Young, Ph.D.  
Research Project Advisor

Merrill Landers, Ph.D.  
Chair, Department of Physical Therapy
Abstract

Objective: To examine the reliability and validity of using a movement analysis application (MAA) to measure knee valgus angle during three functional activities used to assess return-to-sport after ACL reconstruction (ACLR).

Design: Reliability and validity study

Setting: University laboratory

Participants: Twelve ACLR participants with a non-contact mechanism of injury and 20 healthy individuals.

Independent Variables: Each subject performed single-leg drop landing, single-leg hop, and 90º cut with simultaneous 3-dimensional (3D) motion capture and video recording in the frontal plane on an iPad.

Main Outcome Measures: Peak knee valgus angle during the landing phase of each task was measured using a MAA and 3D analysis. To obtain reliability, peak knee valgus angle was measured in 2 days with at least 7 days apart. Reliability was determined using intra-class correlation coefficients (ICCs) and standard errors of measurement (SEMs). Validity was assessed using Pearson correlation coefficients by comparing peak knee valgus angles between the MAA and 3D analysis.

Results: Our data revealed excellent intra- and inter-rater reliability with low SEMs of using a MAA for evaluating peak knee valgus angle in both groups. Significant, moderate to large associations were found in comparing peak knee valgus angles between the MAA and 3D analysis in both groups.

Conclusions: Our findings suggest that a MAA is reliable for measuring peak knee valgus angle for both healthy and ACLR participants. The actual values obtained by a MAA should be viewed with caution given that the comparison against the 3D motion analysis is moderate to large.

Key words: reliability; validity; anterior cruciate ligament; movement analysis application; knee valgus
Acknowledgments

The University of Nevada, Las Vegas Physical Therapy Student Research Opportunity Grant made this research study possible. The authors would like to thank Kai-Yu Ho PT, PhD and Catherine Turner, PT, DPT, OCS for their indispensible help and guidance as faculty advisors for this research study. The authors would also like to thank Szu-Ping Lee and the UNLV Kinesiology Department for their additional help with this project.
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Introduction

Recent studies show incidence of an anterior cruciate ligament (ACL) injury is as high as 80% of all knee injuries requiring surgery, and approximately 38-58% are due to a non-contact mechanism.\textsuperscript{1,2} To decrease subsequent instability following an ACL injury, surgical reconstruction (ACLR) may allow return to high-level sporting activities. Rates of return-to-sport after ACLR have been reported to be as high as 85%,\textsuperscript{3} however, persons who have a history of ACLR are 15 times more likely to incur a second ACL injury to either knee, than those with no history of ACL injury.\textsuperscript{4} A combination of excessive femoral adduction, internal rotation of the hip, and increased knee abduction angle, causing what is known as “dynamic knee valgus”, increases the risk of ACL injury.\textsuperscript{5} Research has identified changes of joint kinematics following ACLR, which include increased hip adduction and internal rotation, as well as increased knee valgus.\textsuperscript{6-9} It has also been found that the kinematic changes following ACLR affect both the involved and uninvolved limbs.\textsuperscript{7}

Double and single-leg landing tasks as well as single-leg hopping tests have been widely used in making return-to-sport decisions and evaluating knee function after ACLR.\textsuperscript{10-12} Poor performance in single-leg landing tasks is correlated with poor mechanics in activities that require horizontal changes in direction, such as cutting or pivoting.\textsuperscript{13} It has also been found that individuals with excessive knee valgus participating in decelerating activities are at greater risk for ACL injury.\textsuperscript{14,15} A study examining female soccer players with a history of ACLR, showed greater knee valgus in cutting tasks,\textsuperscript{9} thereby predisposing them to increased risk of ACL re-injuries. This evidence supports the idea of using sport-specific tasks, such as landing, hopping and cutting to measure knee function prior to return-to-sport.

Due to the kinematic deviations following ACLR, it is critical to identify those deficits in clinical practice, in order to determine the appropriate time for return-to-play. The current gold standard for evaluating kinematics during dynamic movements in vivo is through the use of three-dimensional (3D) motion analysis, however, it requires expensive equipment, designated space, extensive training, and is not readily accessible for clinical evaluations.\textsuperscript{16} Two-
dimensional (2D) video analysis is more readily available, easy to use, relatively inexpensive, and can be done in clinical settings. For 2D analysis of knee motion, frontal plane projection angle (i.e., the angle formed by the thigh and leg segments) has been shown to be a reliable measure of dynamic knee valgus during various functional tasks.\textsuperscript{17-21} When comparing the data of 2D measurement with that of 3D motion analysis, the existing literature reveals moderate to excellent agreement between the two methods.\textsuperscript{19,21-25} However, it should be noted that these comparisons have all been done in individuals without a history of ACL injury/surgery.

Given that individuals with ACLR may exhibit higher degrees of frontal plane knee valgus,\textsuperscript{6-9} there is a need for validation of using a motion analysis application (MAA) to measure knee valgus angle in individuals with ACLR. The purpose of this study was to examine the reliability and validity of a MAA to measure frontal plane knee angle during three functional activities used to assess return-to-sport after ACLR (i.e., single-leg drop landing, single-leg hop, and 90° cut). We hypothesized that the MAA would be a valid and reliable tool for measuring knee valgus angle in both healthy and ACLR populations.

**Methods**

**Participants**

Participants were recruited from the University of Nevada, Las Vegas and local outpatient orthopedic physical therapy clinics in the Las Vegas metropolitan area. Twelve ACLR and 20 control individuals participated in the study (Table 1). The participants in the ACLR group were included if they 1) were 18-45 years; 2) had a non-contact, unilateral ACL injury with a surgical repair within the past 6 months to 5 years; 3) had approval to return to sports by their surgeon/physician; 4) scored a minimum of 60% on International Knee Documentation Committee (IKDC) form. Individuals with ACLR were excluded if they reported additional ligamentous injury or were pregnant. As ACL injuries are often accompanied with meniscal damage, concomitant meniscal injuries requiring surgery were allowed in our
Control participants were included if they 1) were 18-45 years; 2) scored a minimum of 6 on the Tegner questionnaire; 3) reported a minimum of 2 in the cutting and pivoting categories of Activity Rating Scale (ARS); 4) reported a minimum of 60% score on IKDC form. Participants in the control group were disqualified if they were pregnant or reported any history of lower extremity surgery or major musculoskeletal injury. Each subject was given informed consent prior to testing. This study was approved by the Institutional Review Board of University of Nevada, Las Vegas.

In this study, three questionnaires were used to examine participants’ knee function and activity level to ensure that the participants could safely perform the activities. The IKDC Subjective Knee Evaluation form is a reliable measure that was used to assess current function and symptoms of the knee. The cut-off score of 60% was based on normative data to confirm that the subject’s knee function was well enough to perform the required activities. The ARS is reliable in identifying the frequency of participation during activities that require movements such as cutting and pivoting. A score of 2 or higher (out of 4) indicates the subject is performing the activity at least once per week. The Tegner Scale is a reliable tool to identify level of sports participation by type of activity and competition level. A score of 6 or higher (out of 10) indicates the subject is participating in sports that require cutting and pivoting. Both the ARS and Tegner questionnaires were used to certify that the control participants were regularly performing the activities being tested.

**Instrumentations**

A ten-camera motion analysis system (Vicon, Oxford Metrics Ltd., Oxford, UK) was used to capture lower extremity and trunk kinematic data at 250 Hz. For 2D analysis, video recordings of the 3 tests were captured on an iPad Air 2 tablet at 30 frames per second and 1080p HD. The iPad was mounted on a tripod to capture frontal plane kinematics during collection. The tripod was kept at a fixed distance of 359 cm from the landing zone and 35 cm from the floor to the aperture of the iPad to ensure consistency while maximizing video quality without interfering with the Vicon capture. A MAA (Simi Move, Simi Reality Motion Systems GmbH, Unterschleissheim, GER) was used for video analysis. This MAA was chosen due to the feature of a magnified window and dot representing the tip of the stylus or
finger point. This allowed measurements to be more accurate by easily visualizing the anatomical landmarks while the finger was placed on the screen.

**Procedures**

Prior to the testing, 43 reflective markers were applied by the same investigator to the following anatomical locations: midline of the body at the L5-S1 junction; bilateral markers on the anterior superior iliac spine (ASIS), highest point of the iliac crest, greater trochanter, medial and lateral femoral epicondyles, medial and lateral malleoli, first metatarsal head, fifth metatarsal head, most distal point of shoe/foot. Reflective clusters were also placed on each subject’s thighs, lower legs, and heels. These landmarks are the same or similar to other protocols comparing 2D and 3D landing tasks.19,21,25 After obtaining a static calibration trial, most anatomical markers were removed leaving the clusters, L5-S1 junction, and iliac crest markers in place for the dynamic trials. Following the static trial, each subject performed three functional tests in this order: single-leg drop landing,13 single-leg hop,11,12 and a 90° cut.33,34 All tasks were performed bilaterally.

Participants received verbal instruction and demonstration prior to each task before they were allowed to perform their practice repetitions. During the single-leg drop landing task each subject stepped off of a 30-cm box.13,23 Participants were instructed to stand on the contralateral leg, step forward off the box with the test leg, landing at least 30 cm from the box, and then repeat for the opposite leg.23 Single-leg hop for distance was performed with the subject being instructed to hop as far as possible. During the 90° cut, participants were instructed to approach the marked cutting point at the maximum speed they could confidently perform the task. Participants began the approach 7 meters from the cutting point, which has been shown to produce similar approach speeds in healthy and ACLR participants.35

For each task, participants were allowed to perform a maximum of two practice repetitions to become familiar with each task, which is consistent in the literature.21 After completion of the practice repetitions participants were asked to successfully perform each task three times, with a maximum of 10 attempts allowed to avoid fatigue. For both the single-leg drop landing and hop tasks, a successful attempt required maintaining balance upon landing for 3 seconds without shifting the landing foot. A successful
cutting maneuver attempt required a 90° change in direction from the approach away from the plant leg while maintaining a forward facing direction.

**Data Processing**

The frontal plane knee angle during the landing phase was obtained for each task using the 3D motion analysis and a MAA. The landing phase began at initial contact of the landing leg and ended at maximal knee extension.

**3D Motion Analysis**

The reflective markers were labeled and digitized using Vicon Nexus software (Oxford Metric Ltd., Oxford, UK). Visual 3D software (C-Motion, Rockville, MD) was used to quantify frontal plane knee joint motions during the landing phase of each task. Kinematic data were filtered using a 4th order, 6 Hz, low-pass Butterworth filter with zero lag compensation. Peak knee valgus for each trial was obtained, and the mean across all three trials for each task was calculated. If knee valgus was not present during landing phase, the minimum varus angle was used for analyses.

**2D Motion Analysis**

The recorded video was uploaded to the MAA and peak knee valgus angle was measured during the landing phase. Knee valgus angle was determined using the frontal plane projection angle formed by a line along the midline of the thigh to the center of the patella, and a line from the center of the patella to a point bisecting the malleoli (Figure 1). The investigator visually determined the time-point of peak knee valgus angle for measurements. If knee valgus was not observed then the investigator measured the minimum varus angle. Mean peak knee valgus was calculated using the same methodology for each task across all three trials.

To establish intra-rater reliability, one investigator analyzed each trial on 2 separate days with at least 7 days apart. Inter-rater reliability was determined by comparing the measurement of the investigator to that of the other investigator.

**Statistical Analysis**
Values from both legs were combined for each task during analysis. Inter- and intra-rater reliability were analyzed using intra-class correlation coefficients (ICC_{3,k}) and standard error of measurement (SEM). ICC values were classified according to the following criteria\textsuperscript{21}: poor <0.4, fair 0.4-0.7, good 0.7-0.9, excellent 0.9. The SEM was estimated by multiplying the standard deviation by \( \sqrt{1 - r} \) minus the reliability coefficient.\textsuperscript{36} The validity was determined by comparing 2D and 3D measurements of knee valgus using a Pearson correlation coefficient. Correlation was defined as small 0.1-0.3, moderate 0.3-0.5, large 0.5-0.7, very large 0.7-0.9, extremely large >0.9.\textsuperscript{37} A significance level was set \textit{a priori} at 0.05. ICCs and Pearson correlation coefficients were analyzed using IBM SPSS 22.0 statistical software (International Business Machines Corp., Armonk, NY, USA) and SEMs were calculated using Microsoft Excel (Microsoft, Redmond, WA).

\textbf{Results}

Our data demonstrated excellent intra-rater reliability with low SEM when using a MAA to measure knee valgus angle in all tasks. The ICC values in the control group ranged from 0.97 to 0.98 with a SEM of 1.09° to 2.44°, and the ICC values in the ACLR group were between 0.98 and 0.99 with a SEM of 0.60° to 1.33° (Table 2). The inter-rater reliability was excellent in all tasks with ICC values of 0.94 to 0.97 and a SEM of 1.64° to 2.25° for the control group, and the ICC values ranged from 0.92 to 0.98 with SEM of 0.85° to 2.08° for the ACLR group (Table 2). For validity, Pearson correlation coefficients were moderate to largely correlated and significant across all three tasks for healthy controls (single-leg drop landing: \( r = 0.57; \) single-leg hop: \( r = 0.46; \) 90° cut: \( r = 0.52; \) \( p < 0.05 \) (Figure 2 A-C)) and individuals with ACLR (single-leg drop landing: \( r = 0.52; \) single-leg hop: \( r = 0.66; \) 90° cut: \( r = 0.57; \) \( p < 0.05 \) (Figure 2 D-F)).

\textbf{Discussion}

To the authors’ knowledge, this is the first study measuring reliability and validity of knee valgus using a MAA in both healthy and ACLR populations. In support of our hypothesis, excellent inter- and intra-rater reliability was found for measuring frontal plane knee angles during functional activities using
a MAA. Moderate agreement was found in knee valgus angles measured between a 3D motion analysis system and a MAA in both groups.

In our study, a difference in body height between groups was observed (Table 1) and this difference can be explained by the higher number of males in the control group (n=13) versus the ACLR group (n=2). Differences between groups in the questionnaires (i.e., Tegner, ARS, and IKDC) were also expected due to a history of injury in the ACLR group. ACLR participants reported lower knee function, increased overall pain, less sports participation and competed at lower levels than their healthy counterparts. Although there was no significant difference between groups in peak knee valgus angles during each task, there was a trend for greater peak knee valgus in the ACLR group during the single-leg hopping task (p=0.080) (Table 1). Insignificance in knee valgus between groups may be attributed to a smaller sample size in the ACLR group.

The excellent intra- and inter-reliability found in this study was similar to that reported in other studies using healthy populations with weight-bearing tasks and methods. Inter-rater reliability ranged from moderate to excellent, with King et al. reporting 0.45-0.99 during a drop jump task, while Herrington and Munro reported 0.97-1.0 in a single leg landing, and Mizner et al. reported 0.89 during a drop vertical jump. In terms of intra-rater reliability, Herrington and Munro reported 0.58-0.96 in a single leg landing, while Mizner et al. reported 0.95 during drop vertical jump, and Maykut et al. reported 0.96-0.98 during running. Overall, our intra- and inter-rater reliability was between 0.92 and 0.99 across both groups. It should be noted that there is a lack of evidence of reliability when using a MAA in an ACLR population, and previous studies have identified the need for research in subject populations involving musculoskeletal dysfunction and injuries. Additionally, our work is the first reliability study assessing knee valgus angle during a cutting maneuver. Based on the excellent reliability of this study and its similarity to other control studies, it can be concluded that peak knee valgus angle during dynamic activities can be measured reliably using a MAA for both healthy controls and in the ACLR population.
Our study revealed a moderate to large correlation between the measurement obtained by a MAA and 3D motion analysis across single-leg drop landing, single-leg hop, and 90° cut. The correlation values in our study (0.46-0.66) are deemed comparable to or slightly lower than those in the existing literature. Maykut et al.\textsuperscript{19} found a correlation of 0.54 for knee valgus angle when comparing 2D to 3D motion analyses during running, while other researchers reported a correlation in single-leg landing and squatting tasks ranging from 0.72 to 0.79.\textsuperscript{20,22,23} As knee valgus angle obtained from a MAA is simply a projection angle of the result of hip adduction, hip internal rotation, and knee abduction angle,\textsuperscript{5} it is thought that the differences in knee valgus angle measured between 2D and 3D measurements are due to the inability to account for joint rotation with 2D analysis.\textsuperscript{19}

Additionally, the sampling rate in 2D motion analysis also plays a critical role in determining the accuracy of 2D motion analysis. Specifically, our sampling rate is limited to 30 Hz due to hardware restriction while Gwynne and Curran\textsuperscript{22} used a sampling rate of 40Hz, and Sorenson et al.\textsuperscript{20} used a sampling rate of 240Hz. A higher sampling frequency is critical for activities that involve rapid movements in nature. For instance, the cutting task is a rapid movement and the change in direction in a short period of time often resulted in a blurred image, making it difficult to consistently pinpoint landmarks in the MAA (Figure 1C). Another contributing factor leading to variability in validity between the existing literature and our study was the presence/absence of markers for bony landmark identification. Particularly, Gwynne and Curran\textsuperscript{22} and Munro et al.\textsuperscript{21} used markers for identifying corresponding bony landmarks when making 2D measurements, which could effectively improve reliability and validity. Nevertheless, our study provides evidence regarding the validity of 2D motion analysis without the usage of additional markers, which is a common approach in clinical settings.

The current study had limitations that may have affected the results. First, timing of the 2D and 3D recordings were not synchronized in this study. Thus, we were unable to exactly measure the same time-point for both recordings. Second, the results obtained in this study cannot be generalized to other MAAs due to variability in application features. Future studies may compare multiple MAAs to determine which is the most valid and reliable MAA.
In conclusion, this is the first study measuring reliability and validity of knee valgus using a MAA in both healthy and ACLR populations. Our findings suggested that a MAA is a reliable tool for measuring peak knee valgus angle for both healthy and ACLR participants. The actual values obtained by a MAA should be viewed with caution given that there is only moderate to large correlation to 3D motion analysis.
Appendix

Figure 1. Measurement of peak knee valgus angle during the landing phase using SimiMove motion analysis application (MAA) during A) single-leg drop landing; B) single-leg hop; C) 90° cut.

A)

B)

C)
Figure 2. The correlations between peak knee valgus angles measured by a motion analysis application (MAA) and those measured by 3D motion analysis of healthy controls during A) single-leg drop landing; B) single-leg hop; C) 90° cut and of individuals with ACLR during D) single-leg drop landing; E) single-leg hop; F) 90° cut.
Table 1. Participant characteristics of the control and ACLR groups.

<table>
<thead>
<tr>
<th></th>
<th>Control (n = 20)</th>
<th>ACLR (n = 12)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>25.2 ± 2.8</td>
<td>24.5 ± 7.2</td>
<td>0.752</td>
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<tr>
<td>Height (cm)</td>
<td>175.1 ± 7.5</td>
<td>164.2 ± 11.2</td>
<td>0.008*</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>72.9 ± 10.4</td>
<td>67.9 ± 8.2</td>
<td>0.164</td>
</tr>
<tr>
<td>Male/Female</td>
<td>13/7</td>
<td>2/10</td>
<td>N/A</td>
</tr>
<tr>
<td>Tegner Score</td>
<td>7.2 ± 0.8</td>
<td>6.0 ± 1.1</td>
<td>0.001*</td>
</tr>
<tr>
<td>ARS Score</td>
<td>12.0 ± 2.3</td>
<td>8.4 ± 2.8</td>
<td>&lt;0.001*</td>
</tr>
<tr>
<td>IKDC Score</td>
<td>98.1 ± 2.8</td>
<td>83.4 ± 10.2</td>
<td>&lt;0.001*</td>
</tr>
</tbody>
</table>

Peak Knee Valgus during Single-leg Drop Landing
0.1 ± 2.7  1.2 ± 3.5  0.178

Peak Knee Valgus during Single-leg Hop
0.1 ± 4.1  2.0 ± 4.0  0.080

Peak Knee Valgus during 90° Cut
7.6 ± 4.8  8.0 ± 5.2  0.770

Abbreviations: ARS: Activity Rating Scale; IKDC: International Knee Documentation Committee.

Table 2. Inter-rater and intra-rater reliability of knee valgus angles measured on a MAA for the control and ACLR groups.

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>ACLR</th>
<th>Intra-Rater</th>
<th>Inter-Rater</th>
<th>Intra-Rater</th>
<th>Inter-Rater</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ICC</td>
<td>SEM (°)</td>
<td>ICC</td>
<td>SEM (°)</td>
<td>ICC</td>
<td>SEM (°)</td>
</tr>
<tr>
<td>Single-leg Drop Landing</td>
<td>0.98</td>
<td>1.09</td>
<td>0.94</td>
<td>2.00</td>
<td>0.99</td>
<td>0.60</td>
</tr>
<tr>
<td>Single-leg Hop</td>
<td>0.98</td>
<td>1.26</td>
<td>0.97</td>
<td>1.64</td>
<td>0.99</td>
<td>0.75</td>
</tr>
<tr>
<td>90° Cut</td>
<td>0.97</td>
<td>2.44</td>
<td>0.97</td>
<td>2.25</td>
<td>0.98</td>
<td>1.33</td>
</tr>
</tbody>
</table>
References


Curriculum Vitae

Brenda Deaver
Email: brendab14@gmail.com
(801) 244-5605

Education

DPT, University of Nevada, Las Vegas, May 2018
  Physical Therapy

MS, Brigham Young University, December 2014
  Exercise Physiology

BS, Brigham Young University, April 2010
  Exercise Sciences
  Minors: Business Management, Music

Experience

Research

› Reliability and validity of using a mobile application to assess knee valgus in healthy and post-ACLR participants. Brenda Deaver and Tyrel Nelson, DPT student; Kai-Yu Ho and Catherine Turner, Faculty Advisors
› Downhill treadmill running does not induce muscle damage in FVB mice. Brenda Benson, Masters Student; Allen Parcell, Faculty Advisor
› Effect of therapeutic ultrasound on the recovery of a lacerated Achilles tendon in a runner: a case study. Brenda Benson, Masters Student; Wayne Johnson Faculty advisor

Publications and Presentations

› Reliability and validity of using a mobile application to assess knee valgus in healthy and post-ACLR participants. Brenda Deaver, Tyrel Nelson, Kai-Yu Ho, Catherine Turner. Presentation at the Combined Sections Meeting Conference in New Orleans, LA, in February 2018
› Effect of therapeutic ultrasound on the recovery of a lacerated Achilles tendon in a runner: a case study. Brenda Benson, A. Wayne Johnson, David Draper,

Teaching

› General Anatomy Instructor, Provo College, Provo UT. Taught PTA students general anatomy in lecture and lab, and assessed their knowledge. 08/2014-12/2014
› Functional Anatomy Cadaver Lab TA, Brigham Young University, Provo UT. Taught students anatomy structures on cadavers, and assisted in dissection. 08/2011-12/2014
› Activity Class Instructor, Brigham Young University, Provo UT. Soccer, basketball, swimming, tennis, weight training, volleyball, and bowling. 08/2010-06/2014

Clinical

› Fyzical Therapy and Rehabilitation – Jones, Outpatient, Las Vegas NV. 01/2018-03/2018
› George E. Wahlen Department of Veteran Affairs Medical Center, Acute Care, Salt Lake City UT. 10/2017-12/2017.
› Life Care Center of America – Las Vegas, Skilled Nursing Facility, Las Vegas NV. 07/2017-09/2017
› FIT Physical Therapy – St. George, Outpatient, St. George UT. 07/2016-08/2016

Accomplishments

› Helped organize the 5k, 10k and mile run for Freedom festival 2010-2015
› Finished numerous races: marathon, half-marathons, Olympic and sprint triathlons.
› Served an LDS mission in Romania for 18 months, 2008-09.
Summary
Doctor of Physical Therapy - Athletic Training - Sports Medicine
A highly motivated Physical Therapy graduate who provides quality care for each individual. Eagerly seeks opportunity to advance skill sets to maintain competence in practice. Seeking a career in orthopedic and sports therapy to utilize prior experience working with elite and every day athletes.

Experience
Research
Reliability and Validity of Using a Mobile Application to Assess Knee Valgus in Healthy and Post-Anterior Cruciate Ligament Reconstruction Participants.
Co-author and investigator for doctoral research project. Responsible for literature review, data collection, analysis, and disseminating results. Experience with video analysis of frontal plane knee angle.

Academic Presentation

Clinical
University of Utah Hospital - Inpatient Rehab - Oct.-Dec. 2017
George E. Wahlen Hospital of Veterans Affairs - Acute care - July-Oct. 2017
Responsibilities included delivering quality care that was centered on each patient’s therapeutic and functional goals. Provided evaluations, accurate prognosis, and therapeutic exercise prescription individualized to each patient. Conducted educational iservices centered on evidence based practice for therapist education.

Education
University of Nevada, Las Vegas - 2015-2018
Doctor of Physical Therapy
Boise State University - 2011-2015
Bachelors of Science, Athletic Training