Application for Summer Undergraduate Research with Faculty (SURF) Grant

Applicants should refer to the SURF Program Description and Guidelines and the SURF Application Check List to ensure a complete application. Incomplete applications will not be considered for funding.

PROPOSAL TITLE: Influence of Lower Extremity Alignment on Lower Extremity Joint Motion During Functional Tasks

MENTOR APPLICANT(S)*: (Name, CofC email address, and Department):

UNDERGRADUATE APPLICANT*: (Name, CofC ID number, CofC email address, and Primary Major):

REQUESTED DATES OF PROJECT SUPPORT: From May 10, 2010 To July 23, 2010

TOTAL AMOUNT REQUESTED FROM URCA: $6500

Project Information

1. Does the proposal involve research on human subjects? [ ] Yes [ ] No

2. If yes, status of the IRB request (no funds can be awarded until IRB is approved)
   [ ] Yes [ ] No
   Submitted [ ] Approved
   [ ] Yes [ ] No
   [ ] No

3. Does the proposal involve research with live vertebrate animal subjects?
   [ ] Yes [ ] No

4. If yes, Status of the IACUC request (no funds can be awarded until IACUC is approved)
   [ ] Yes [ ] No
   Submitted [ ] Approved
   [ ] Yes [ ] No
   [ ] No

5. Have student or faculty applicants received URCA support for this or any other project in the past year or do they currently hold funding through the URCA program? If so, list type and amount of grant and dates of project period:
   [ ] Yes [ ] No
   Amount: $4000
   List the source(s) as well as amount of request and dates of award:
   CofC Faculty R&D Grant (In Review)
   [ ] Yes [ ] No
   Amount: $4000

6. Does the student have another proposal under consideration by URCA during the current cycle? If so, what type of grant proposal is it?
   [ ] Yes [ ] No
   Amount: $4000
   List the source(s) as well as amount of request and dates of award:
   CofC Faculty R&D Grant (In Review)
   [ ] Yes [ ] No
   Amount: $4000

7. Does the faculty mentor have another proposal under consideration by URCA during the current cycle? If so, what type of grant proposal is it?
   [ ] Yes [ ] No
   Amount: $4000
   List the source(s) as well as amount of request and dates of award:
   CofC Faculty R&D Grant (In Review)
   [ ] Yes [ ] No
   Amount: $4000

8. Is there another internal proposal current or pending for this research/creative work?
   [ ] Yes [ ] No
   Amount: $4000
   List the source(s) as well as amount of request and dates of award:
   CofC Faculty R&D Grant (In Review)
   [ ] Yes [ ] No
   Amount: $4000

9. Is there an external proposal current or pending for this research/creative work?
   [ ] Yes [ ] No
   Amount: $4000
   List the agency(s), as well as amount and dates of award:

10. Does the project involve biohazards or other safety issues?
    [ ] Yes [ ] No

11. Does this project have potential for copyright or invention?
    [ ] Yes [ ] No
FERPA WAIVER

The Family Educational Rights and Privacy Act (FERPA) of 1974 establishes the rights of students with regard to educational records. The act makes provision for inspection, review and amendment of educational records by the students and requires, in most instances, prior consent from the student or their parent/guardian if under the age of 18 for disclosure of such records to third parties. The consent must be in writing, signed and dated by the student and must specify records to be released, reason for release, and the names of the parties whom such records shall be released. The act applies to all persons formerly and currently enrolled at an educational institution. Access to educational records does not give permission to make changes to the student’s record.


I hereby give permission for the College of Charleston Undergraduate Research and Creative Activities personnel and committee members to obtain

- information concerning my academic transcript
- information concerning my academic advising notes
- information concerning my in-class performance and grades

This waiver will be in effect as long as I am a student at the College of Charleston, or seeking the services of faculty and staff on the College of Charleston campus.

Signatures (Required for All participants): Please read the SURF Guidelines prior to signing this page. Signatures below indicate awareness of and intention to follow appropriate Program, FERPA Waiver, Departmental, School, College and State rules and regulation for conducting projects, travel, and expenditure of funds.

SIGNATURE & DATE, Undergraduate Applicant: ________________________________

SIGNATURE & DATE, Faculty/Mentor Applicant: ________________________________

Chair/Dean: I acknowledge that the above student and faculty mentor are applying for a SURF Grant and that the funds for successful proposals will be transferred into the departmental R & D account for dispersal based on the budget included in this proposal.

SIGNATURE & DATE, Chair: ________________________________________________

SIGNATURE & DATE, Dean: ________________________________________________
Student Statement of Intent:

During my last year in high school, I knew that in the future I wanted to do something in the healthcare field, but I had no idea what. Therefore, my college search was not very specific. I wanted a liberal arts education, someplace warm, with a good exercise science or kinesiology program. It was not until I had chosen the College of Charleston and attended orientation that I even considered Athletic Training as a major or career. I went to an orientation meeting where they discussed the athletic training major, clinical experiences, interesting classes, and future careers in the field. I loved the topics that the degree would cover and the fact that I could work almost instantly after completing my bachelor's degree. I knew this was the major for me, but I still wanted to earn a degree in Exercise Science, so I am double majoring in Athletic Training and Physical Education, with a concentration in Exercise Science.

During my past three semesters in the Athletic Training program, I have already learned so much through the classes and hands-on clinical experiences. I wanted to seek opportunities to continue learning outside of the classroom and was introduced to the world of research in Sports Medicine. I welcomed the chance to become a part of the research that I only read about in journals. Working with [omitted] on this project would give me the opportunity to delve into the subject beyond the required coursework. This will build on my current research experiences and continue to set me up for future research projects. From these collective experiences, I anticipate learning proper design of a research study, collection and interpretation of scientific data, and refining my scientific writing skills. Specifically, I will become proficient in measuring lower extremity alignments, analyzing and interpreting these alignments, and using high tech motion analysis equipment to understand how these alignments relate to dynamic motion. Experience with the clinical methods used in this project will provide me the knowledge to be successful in graduate school and are clinical tools that I will use in the future as a clinician. In addition, we anticipate that completion of this project will give me the opportunity to co-author a manuscript in a scientific journal, which would make me more competitive in gaining acceptance to graduate school.

This summer I will have plenty of time to work in the lab, as it is the only thing that I have planned for the summer. Also, as I am only a junior and this proposed project is a part of a long-term program, I anticipate being an active part of future projects. Eventually we hope to become proficient in taking alignment measures to perform a large-scale athlete screening during pre-participation physicals at the College of Charleston, allowing us to better understand alignment risk factors associated with lower extremity injuries. My schedule next year allows for my continued involvement in clinical research with a lighter course load compared to my current course load.
I. Project Description
(a) Non-Technical Project Abstract: (No more than 250 words in length).

The anterior cruciate ligament (ACL), the major ligament in the knee, and is the most frequently injured ligament with over $850 million spent annually on surgical interventions.\textsuperscript{14} The common mechanism of this injury is described as a "functional valgus collapse", characterized by an inward collapse of the hip and knee.\textsuperscript{10,18} Females are 2 to 8 times more likely to sustain an ACL injury\textsuperscript{14} and demonstrate greater inward motion of the hip and knee compared to males during functional activities.\textsuperscript{4,22} However, the reasons to explain the increased risk of ACL injury in females is unknown. Gender differences in alignment of the lower extremity, which have also been proposed as an ACL injury risk factor, may alter muscle function and contribute to the differences in dynamic motion between males and females.\textsuperscript{13,21}

Previous studies have examined the relationship between static lower extremity alignment and dynamic motion but are limited to examination of only one or a select set lower extremity alignment characteristics.\textsuperscript{1,8,13,22} No published studies have examined the relationship between lower extremity alignment and dynamic motion using a comprehensive set of anatomic alignment variables that are sufficiently descriptive of gender differences in lower extremity alignment. This is important since one skeletal malalignment may cause compensatory alignment changes at other bony segments resulting in abnormal stress patterns or compensatory motions along the lower extremity. Therefore, the purpose of this project is to determine the relationship between static lower extremity alignment and lower extremity joint motion during functional activities.

(b) Project Objectives:

The novel approach to this project is that multiple variables will be examined with the goal of providing a more complete understanding of those factors that may increase the risk of ACL injury. This endeavor requires multiple skilled individuals as part of a research team. This project will be a collaborative effort among a research team consisting of two faculty members and two undergraduate students. Each student will be primarily responsible for assessing one of the three variables and will assist the other student with assessing and analyzing the third (more complex and time consuming) variable. The student will be solely responsible for gathering alignment measurements and analyzing the data while the other student will be solely responsible for assessing lower extremity strength in the subjects and managing this collected data. The two students will work together to assess lower extremity motion during a functional task using our 3-dimension motion analysis system. The faculty mentors have established a line of research investigating the anatomical and neuromuscular risk factors that contribute to ACL injury and will oversee all aspects of the project. This proposal is requesting support for who will be directly mentored by. A separate SURF proposal has been submitted for who will be directly mentored by.

The overall objective of this proposal is to determine the influence of static lower extremity alignment and hip strength on dynamic lower extremity joint motion during functional activities. The central hypothesis is that abnormal static lower extremity alignment and decreased hip strength will contribute to greater dynamic joint motion during functional activities. Our approach will be to examine males and females who represent a broad range of lower extremity alignments and determine the extent to which static lower extremity alignment and hip strength explains dynamic joint motion during functional activities.
Specific Aim: To examine the influence of static lower extremity alignment and hip strength on knee and hip joint motion during functional activities.

Hypothesis 1: Gender differences in static lower extremity alignment (increased pelvic tilt, hip angles and knee angles) and decreased hip strength will explain greater functional valgus collapse (increased hip and knee joint motions) during functional tasks in males and females.

Hypothesis 2: The static lower extremity alignment and hip strength risk factors will be gender specific with separate risk factor profiles for males and females.

The rationale for examining the influence of static lower extremity alignment and hip strength on hip and knee joint motion is that successful completion of this work will provide a better understanding of the risk factors which may contribute to joint positions that are known to strain and injure the ACL. Characterizing the role of static lower extremity alignment and hip strength on dynamic hip and knee control during weight bearing activity will provide additional information in the continuing effort to effectively identify those at greater risk for injury and, therefore, help us develop intervention strategies to subsequently reduce the risk of this disabling injury.

(c) Project Significance:
Injuries to the ACL result in significant health costs and can greatly increase the potential for re-injury.\textsuperscript{2,6} Beyond these initial costs, there is significant potential for long term complications associated with ACL injury (e.g. early onset osteoarthritis\textsuperscript{5,11,12,13}), which can further impact health care costs and lead to a premature decrease in physical activity across the lifespan. ACL injury prevention programs have been developed to provide targeted training where decreases in lower extremity control have been postulated to increase risk of injury. However, according to the classic injury prevention model of van Mechelen et al.\textsuperscript{20} once the extent of the problem is established (i.e. that ACL injuries are a public health concern), researchers must begin to understand the etiology and associated risk factors before prevention methods can be effectively implemented. To that end, this proposal will examine the influence of lower extremity alignment and hip strength on dynamic joint motion during functional activities.

Successful completion of this work will advance our understanding of the factors contributing to joint positions that are known to strain and injure the ACL. Specifically, if our hypotheses are correct, prevention strategies aimed at improving functional alignment (e.g. orthotic intervention) and specific strengthening may be employed to improve hip and knee alignment and reduce functional valgus collapse in females. Advancing our understanding of the factors that potentially contribute to ACL injuries will provide additional information in the continuing effort to effectively identify those at risk and in development of intervention strategies to subsequently reduce the risk of this disabling injury.

(d) Methods of Work:

Participants
Healthy males (N=20) and females (N=20), ages 18-35, who represent a broad range of lower extremity alignment postures. Sample sizes were calculated based on a multiple regression with moderate effect (d=0.5) and power (1-\(\beta\)) = .80. Participants will have no previous history of surgery in either lower extremity, no previous hip or knee joint injury within the last 6 months, and no current injury to the lower extremity that would detract from the ability to
perform the functional tasks. All testing will be completed in one session beginning with measurement of static lower extremity alignment characteristics, followed by hip strength testing, and ending with motion analysis of the lower extremity during functional landing tasks.

**Measurement of Lower Extremity Alignment**

Height and mass will be measured and recorded manually. Age and sex, will be subjectively reported by the subject and manually recorded by the examiner. Then 7, non-invasive lower extremity posture variables will be measured on both lower extremities: 1) anterior/posterior pelvic angle (pelvic tilt), 2) hip rotation, 3) quadriceps angle (thigh muscle angle in standing), 4) tibiofemoral angle (knee angle), 5) genu recurvatum (knee hyperextension), 6) navicular drop (arch height), 7) femur (thigh) length, and 8) tibia (lower leg) length. The lower extremity postural alignments will be measured using one of the following instruments: an inclinometer, a standard goniometer, a caliper, and a straight ruler. All of these measuring techniques are non-invasive and have been used in a previously published study with established reliability.19

**Measurement of Hip and Knee Motion During a Functional Tasks**

A motion analysis system, the *Motion Monitor* (Innovative Sports Training; Chicago, IL), will be used to collect and analyze 3 dimensional motions of the hip and knee during the functional tasks. Motion sensors will be secured to the foot, lower leg, thigh and pelvis to obtain positions and orientation of each lower extremity segment. A digital, anatomical model will be created for each participant. (see Figure) Joint motion of the lower extremity will be collected during a: 1) double leg landing, 2) single leg landing, 3) single leg forward hop, and 4) run and cut maneuver. These functional activities are commonly used in the literature and are accepted as appropriate modes of activity towards examining risk of ACL injury.

**Data Reduction and Analyses**

The average of 3 measurements for each lower extremity alignment characteristic and hip strength measure will be used for analyses. Hip and knee joint angles in the coronal, transverse, and sagittal planes will be extracted at initial ground contact and at maximum knee flexion angle of the landing phase. The average of final and initial joint angles of 5 trials will be calculated and the difference (final minus initial) will determine total joint motion used for statistical analysis. Separate linear regression models will examine the extent to which lower extremity alignment variables and hip strength measures contribute to joint motion for each functional task.

**Anticipated Timeline**

<table>
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<tr>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
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<tr>
<td>Subject recruitment and data collection</td>
<td>Data collection</td>
<td>Data collection, reduction, analysis, preparation of scientific abstracts and manuscripts</td>
<td>Complete scientific abstracts and manuscripts, present at URCA poster session, complete final report</td>
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**Additional Personnel**

In collaboration with, we are currently providing undergraduate students an opportunity to participate in
an intensive, mentored clinical research experience. The purpose of this experience is to encourage the development of research skills in the undergraduate student in preparation for future graduate studies. Through this experience, undergraduate students are mentored in the areas of research design, review of the current literature, data collection, and analysis and interpretation of data through ongoing projects. Currently, there are 2 students participating in this experience.

It is anticipated that these students will continue as part of the research team for the current proposed project and the SURF award (separate applications) would provide the students the financial support to continue working in a collaborative research environment.

**IRB Application Status**

The IRB application is under review. It is understood that IRB approval is required before grant funds can be released.

(e) **Faculty Mentor and Student Participant Roles:**

**Role of faculty mentor:** The faculty mentor serves as an Assistant Professor and Co-Investigator for this project. He has established a line of research investigating the anatomical and neuromuscular risk factors that contribute to ACL injury. The faculty will mentor the student in the areas of research design, review of the current literature, subject recruitment, data collection, analysis and interpretation of the data, and scientific writing skills in the development of a manuscript suitable for publication. In addition, the research team will also meet weekly during scheduled times to discuss progress on the project. The faculty mentor will be involved in all data collection sessions to create a positive, stimulating research environment that promotes positive interactions between the undergraduate student and research faculty. It is understood that the faculty mentor and student are responsible to submit a final expense and project report no later than 4 weeks after the project end.

**Role of the student:** Through on-going projects during the 2009-2010 academic year, has been trained and will be proficient in all of the data collection and reduction procedures for this project. She will be responsible for subject recruitment, and data collection and reduction of the static lower extremity alignment measures. will also assist in the collection and reduction of joint motion data during the functional tasks using the motion analysis system. She will contribute to the preparation of scientific abstracts and manuscripts suitable for presentation and publications at the national level.

(f) **Current and Pending Support:**

Currently, there is no monetary support for this proposed project. Request for funding through the College of Charleston Faculty Research and Development grant was submitted to provide faculty salary during the time needed to devote to complete data collection (May 10-June 30, 2010). Funding provided through the College R&D grant will provide the support to free the faculty mentor from the need to teach summer courses, allowing the faculty mentor to stay fully focused on the data collection portion of the project and develop the student’s research skills and competence during the first half of the summer.

Support for the majority of the research equipment proposed in the current project has been acquired through Departmental start-up money for new faculty and Departmental R&D. This allowed for purchase of the motion analysis system and equipment necessary to assess lower extremity alignment.
(g) Student Development: 

[Undergraduate Applicant] has a proven commitment to the research process and has exemplified an ideal undergraduate research assistant. She has previously collaborated on research in the Athletic Training Research Lab, and has been an active participant in ongoing research projects related to risk factors for ACL injury. Her participation on these projects was voluntary during the Fall 2009 semester and is currently completing an Independent Study during the Spring semester. She has recently completed a comprehensive literature review on the topic of lower extremity alignment as a risk factor for knee injury. Currently, the alignment measures and functional tasks examined in this project are used in many clinical settings. This experience will provide the opportunity to gain further valuable experience with clinical testing methods, and will further prepare her toward achieving her academic and professional goals as a future athletic trainer. She will be an active participant in all aspects of the research project and will gain greater independence in areas of research design, data collection, and analysis and interpretation of the data. Development of appropriate writing skills, through collaborative manuscript preparation, will provide a critical component to professional growth, and her preparation for graduate education. This will allow her to develop critical, scientific writing skills that are often sorely lacking in students pursuing graduate education.

(h) Project Dissemination: 

It is anticipated that a manuscript suitable for publication will result from this research study specific to the role of anatomic alignment in landing mechanics. The student will serve as a co-author on this work, and will have the opportunity to submit an abstract for presentation at regional and national level conferences such as the American College of Sports Medicine (ACSM) conference or the National Athletic Trainers' Association Annual Meeting and Clinical Symposium (NATA) held annually in June. All of these professional meetings routinely invite undergraduate researchers to submit abstracts to be considered for presentation either orally or in the form of a poster. It is also understood the student will prepare a presentation at the Summer Undergraduate Research and Creative Activities Poster Session to be held on Convocation Day. Additionally, we plan to participate in a school-wide public forum, such as that hosted by the School of Science and Mathematics, in the spring of 2011.

(i) Student Involvement in Application Process: 

Prior to [Undergraduate Applicant] involvement in the Athletic Training Research Lab, we had a meeting to discuss her academic and professional goals. In this meeting, we discussed the value of a clinical research experience towards acceptance to graduate school as part of achieving her goals. We discussed early on the possibility of submitting a SURF grant to provide a more meaningful experience during the summer. As previously mentioned, [Undergraduate Applicant] has been involved in on-going projects and we had a meeting to discuss potential projects for the summer. Based on her research experiences and completion of a literature review, we formulated the question for this project and developed the details of this proposal to build on what we have learned from our work thus far. We decided on the parts of the proposal for which we would be responsible and set-up specific deadlines for final reviews. While I was responsible for the majority of the proposal and she was responsible for writing her Statement of Intent, we shared the responsibility of developing the budget and proper allocation of the funds. We both critically reviewed the entire proposal and gave our final approval. Working towards each of our strengths, this proposal was a product of a collaborative effort.
II. Project References:


III. Proposed Budget:

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<th></th>
<th>I (For Use Prior to June 30)</th>
<th>II (For Use After July 1)</th>
<th>III (Dept/School Support)</th>
<th>IV (External Support)</th>
<th>V (Total Cost of SURF Project)</th>
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IV. Budget Justification:
(a) Student Salary: [Name] will work 40 hours per week for ten weeks. We have asked for the student salary of $4000 since she will assist in all aspects of the project and be present at all data collection sessions. She will be responsible for subject recruitment, and data collection and reduction of the static lower extremity alignment measures. [Name] will also assist in the collection and reduction of joint motion data during the functional tasks using the motion analysis system. She will contribute to the preparation of scientific abstracts and manuscripts suitable for presentation and publications at the national level. Successful award of these funds would free [Name] from the need to seek additional employment, allowing her to stay focused on the project and continue to develop her research skills and competence during the summer.
(b) Faculty Salary: [Name] has submitted a College Faculty R&D Grant Proposal (In review) requesting faculty salary for the first half of this project to complete data collection (funding period May 10-June 30, 2010). The faculty salary through the proposed SURF grant award would be used to support the faculty mentor’s summer salary for the last half of the semester (July 1 to July 23) to complete data reduction, analysis and dissemination of the data. Collectively, the pending support would free the faculty mentor from the need to teach summer courses, allowing the faculty mentor to stay fully focused on the the project and developing the student’s research skills and competence during the summer. In addition, this funding will provide the support in advancing the faculty mentor’s research agenda and toward achieving successful promotion and tenure. It is expected that the faculty mentor will spend over 40 hours per week during the summer months to complete all aspects of this project.
(c) Student Travel: N/A
(d) Faculty Travel: N/A
(e) Supplies and Materials: N/A
(f) Other: N/A

Cost-Share and External Support (Column III and IV): N/A

Revised 12/11/09