THESIS PROJECT PORTFOLIO

Predictive Model for Baseline Serum Estradiol Concentration of Female Laboratory Mice

(Technical Report)

Breaking Barriers: Inequities in Female Athlete Sports Injury Research and Treatment in the U.S.

(STS Research Paper)

An Undergraduate Thesis

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Bachelor of Science, School of Engineering

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My thesis portfolio is composed of a technical project paper, sociotechnical research paper, and my prospectus combining a technical and sociotechnical approach to my topics of interest, focusing on women's health and treatment. My technical paper discusses my group's work on our Fourth Year Capstone project under the guidance of our advisors, Jacob Dunn and Megan Haase at the M3 Lab at the University of Virginia. Three goals were addressed in our project with varying outcomes by the end of the semester: 1) Development of an accurate tool for determining the estrous cycle stage with vaginal cytology and blood samples, 2) creation of a predictive model to output accurate concentration, and 3) validation of the model based on experimental and computational data. My group and I were exploring baseline estradiol concentrations in female mice to contribute valuable insights to women's health, where creation of such a model, has the potential to improve efficiency of research efforts in this field. After training in animal handling, I carried out main procedures (i.e. vaginal flushing and submandibular blood collection) required for our model. For our first goal, we evaluated vaginal cells to determine the estrous cycle stage, an important stage that mice and other animals experience which regulates their reproductive development. Stages of the estrous cycle were identified after cells were collected from the vaginal wall of the mouse models for 7 weeks. Based on the cycle stage the mouse was in, we would collect blood from the mice, taking into account that we wanted an even spread of each stage per week. At the end of our 7-week collection, an ELISA kit was used to quantify estradiol concentration from the blood samples which were safely stored in a freezer until needed for analysis. For our second goal, a predictive lasso regression model was used to output accurate baseline serum estradiol concentration. In addition, HALO AI software was used to determine the cell area ratios of vaginal cells; a classifier was trained to decipher between the 3 cell types (leukocytes, nucleated epithelial cells, and cornified epithelial cells) and the background of uploaded images. Lastly, we were able to validate our data with literature and found values to be almost similar, while taking into account human and computer error that may have occurred when results varied more than expected. The significance of our project is to aid researchers working with the estradiol hormone by reducing the need for lab procedures and further help with women's health research, as a result.

A main theme for my Capstone project that aligns with my sociotechnical topic is the existing bias and limited information for the women's health research. Many studies involved male mouse models being used to study estradiol, a hormone most prevalent in female mice. Thus, for my sociotechnical paper, I decided to explore the inequities that female athletes experience regarding sports injury research, and as a result, their treatment quality and availability of such treatments. The underrepresentation and lack of research and treatment concerning female athletes in the U.S. have resulted in significant burdens on their mental and physical well-being. To address these issues, I use the principle of beneficence defined as the moral obligation to do good to others. It forms the theoretical framework important for understanding and finding solutions to this relevant disparity by maximizing benefits while minimizing harm. A culture of beneficence can be fostered in the communities directly involved with female athletes, including medical practitioners, researchers, coaches, peers, and teammates. Solutions and initiatives in research, education, and community engagement are proposed in this paper drawing from current techniques used today such as social media influencers disseminating critical information online, or conferences bringing together professionals on the topic at hand. As a result of my exploration, I propose a curated mobile application that would offer personalized resources and guidance tailored to the unique needs of female athletes based on real-time biofeedback. By amplifying the voices of female athletes and fostering inclusivity, compassion, empathy and understanding, a more equitable and supportive environment can be developed. I hope that the compilation of my research papers raises awareness of the disparities in women's healthcare, particularly from the lack of research that exists and associated biases, in order to allow for a transition of more inclusive, supportive, and available platforms for the women. This can extend to issues males and transgenders face, as well, in healthcare.

I would like to acknowledge Dr. Blemker, the principal investigator at the M3 Lab at the University of Virginia, for providing funding for our Capstone research. I would also like to thank Jacob Dunn and Megan Haase at the M3 Lab for advising us on our project, particularly in sample collection procedures, computational work, and our technical report. I give my thanks to Dr. Allen for his instruction for the Capstone course, and the University of Virginia Laboratory Animal Resources caretakers and veterinary technicians for their support of the Capstone project. I would also like to thank Professor Norton and Professor Fitzgerald for their support and advice for my thesis prospectus and sociotechnical research paper, respectively.