Predicting Adolescent Anxiety: A Mobile Sensing Data Approach

Navigating Women's Health in a Post-Roe Era: The Sociotechnical Evolution of Wearable Technologies

A Thesis Prospectus
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By
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On my honor as a University student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

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Introduction

For my thesis, I plan to investigate the sociotechnical implications of wearable technologies and the potential power they have for personal preventative medicine. Wearable technologies include smartwatches (Apple, Garmin), bracelets (Fitbits), rings (Oura Rings), and glasses (Meta glasses) (Brophy et al., 2021). Additionally, these devices extend to life-enhancing technologies for managing chronic conditions, such as insulin pumps (eg. Omnipod) for diabetes (Polonsky et al., 2016). While these wearables offer promising avenues for monitoring health metrics, enhancing lifestyle habits, and providing early warnings for medical conditions, they also raise significant concerns about data privacy. The guiding question for my thesis is: "How does the use of historical male-centric clinical research influence how modern technology is developed and negatively affect women's health?"

My technical project analyzes the accuracy of using personal mobile sensing data to predict anxiety and depression in adolescents. My STS project aims to investigate how the overturn of Roe v. Wade has influenced the development of wearable technology for women. Investigating the sociotechnical implications of wearable technologies, particularly in relation to women's health, is crucial in the context of the increasing popularity of using wearable devices for health monitoring and preventative medicine (NHLBI, 2023). The development of wearable devices has raised significant ethical and social concerns, particularly regarding data privacy and gender-specific health. The fear that sensitive health data, such as menstrual cycle information, could be misused or accessed without consent is especially relevant due to the Roe v. Wade overturn, which has heightened public awareness and anxiety over reproductive rights and data privacy. By examining how the overturn of Roe v. Wade influences the usage and development

of wearables, this thesis looks to see how the future of wearables can be more inclusive and conscious of data privacy.

The connection between my technical and STS projects is the focus on using personal private data to address health challenges. My technical project looks into the limitations and capabilities of using sensing data to improve mental health diagnoses while my STS project analyzes how societal shifts - such as changes in reproductive health laws - impact the development of wearable technology for women. Both projects look into the influences of the advancement of wearable devices.

Next, I will delve into my research question for my technical project and outline my timeline for conducting my experiment. Then, I will discuss my STS project emphasizing how it will address the sociotechnical challenges related to wearable technologies and women's health. During this, I will highlight key literature that frames the discussion around my topic.

Technical Project

In my technical project I will perform analysis on the accuracy of different machine learning models to predict anxiety and depression in adolescents. This project focuses solely on adolescents mobile sensing data in partnership with a children's psychiatric hospital. Researching the accuracy of machine learning models to predict anxiety and depression in adolescents is important due to the growing mental health crisis among young people. Adolescents face increasing rates of anxiety and depression, with many experiencing symptoms that go untreated. Traditional methods for diagnosing mental health conditions often rely on self-reports or clinical evaluations. Mobile sensing data can offer a promising solution for monitoring and early detection. However, it is important to assess the accuracy and reliability of machine

learning models that utilize this data to predict mental health outcomes, especially in a diverse population with varying behaviors.

A large part of this process will be testing how different methods of cross validation impact the quality of the machine learning model's predictions. Cross validation is a method used in machine learning to train on a specific subset of data and test on the rest of the subsets to provide an estimation of the generalizability of the model. I am curious to see how different definitions of the specific subsets can influence the capabilities of the models. For example, I plan to compare a personalized approach versus a generalized approach to cross validation. The personalized approach would cross validate based on leaving one week out for the test set and utilizing the rest of the weeks for the training set. This method of cross validation would examine if a machine learning model that learns based on the other weeks of a patient's data can accurately predict a different week of data. The generalized approach would predict all of a singular patient's weeks of data based on the rest of the patient's data. There are other cross validation methods I plan to look at, but this is beneficial for improving a machine learning's model ability to generalize on future unseen data.

Furthermore, I will also be testing different machine learning algorithms to compare and select the best performing algorithms. The culmination of this research is to integrate the models into a phone app to aid in the monitoring and rehabilitation of anxiety and depression amongst adolescents at a children's psychiatric hospital.

The timeline for this project will occur over a year where I will first do intensive data cleaning and processing. This step is imperative to remove potential data leakage into the test set, ensuring the consistency of the data, and preparing it for accurate training and evaluation of the machine learning models. Following this, I will select the main algorithms I want to run my

different cross validation methods on. Lastly, I will analyze the results of the models through feature selection, Shapely values, and more. I will summarize my findings in my technical report.

STS Project

In my STS project I will investigate this key question, “How does the lack of equity in wearable device development, driven by a reliance on male health statistics impact the advancement of technology for women’s health?” I will also further investigate the key obstacles that must be overcome to bridge this gap of inequity. This project will focus on the historical development of women's health technologies, exploring how wearable devices, like smartwatches and fitness trackers, have addressed or failed to address women specific health concerns. Historically, medical research has often overlooked women’s unique health needs, especially because much of research excludes female participants (Villarraga et al., 2022). In health research it has been found that analyzing results from a gender perspective is rare which continues to exacerbate gender disparities in health outcomes and reinforces the limitations in medical technologies, such as wearables, that are designed based on male research (Figueroa, 2021). It wasn’t until 1993 when Congress signed an act requiring clinical research to include women and minorities (Murtha, 2022).

Coupled with a lack of inclusion in clinical trials, women also face significant gaps in digital technology's ability to accurately track health metrics for them (Figueroa, 2021). Although women are the most likely to utilize wearable technologies, only 3% of the venture capitalist funding for digital health has focused on women’s health (Figueroa, 2021). These issues in clinical research indicate that gender biases in the development of health focused

wearables are not just a result of oversight but reflect longstanding disparities in research priorities and design.

Moreover, with the recent overturn of Roe v. Wade, there are fears regarding data privacy, particularly for women using wearable technologies. The concern is that data from menstrual tracking apps and other health-related wearables (e.g. Garmin and Fitbit watches) could be used against individuals in legal contexts, potentially deterring women from using these technologies. Examples of this are fears related to the usage of menstrual data to track carrying babies to term and location data to track if a person has visited an abortion clinic. This privacy risk, coupled with the historical lack of focus on women's health, perpetuates gender bias in wearable technology development, as companies may deprioritize addressing women-specific concerns due to perceived legal risks. By connecting these issues, this project aims to highlight limitations and challenges of wearable technologies, especially in the context of reproductive rights and privacy. On the one hand, women's health has been seriously neglected in the context of wearable technologies and have untapped potential in the realms of helping with infertility and Polycystic Ovary Syndrome (PCOS) (Narwani, 2023). On the other hand, the tightening of policies related to women's health has resulted in growing fears over data privacy and surveillance, leading to women dropping the use of these features that have the potential to improve their lives.

Key Papers and Timeline

In order to conduct this research I plan to do an extensive literature review to analyze this topic using the feminist critique framework to see how gender bias – political and non political –

is involved in the development or lack thereof of wearable technologies. Here are key papers that I want to highlight for my STS Project.

My first paper by Kieran Brophy and co-authors and it is called “The Future of Wearable Technologies.” This paper discusses the policies related to medical and wellness devices and how there are much less regulations in place for wellness devices. Within the wellness industry there are growing concerns about the privacy and security of personal data, which can be used unbeknownst to the user. The lack of regulations is concerning, especially given the rapid expansion of wearable devices and the expectation that the industry will continue to grow. This paper is important in addressing a very real fear from the general public and how it can inhibit the development of better wearable technologies that are more inclusive, specifically for women.

The second paper is by Caroline Figueroa and co-authors and it is called, “The Need for Feminist Intersectionality in Digital Health.” Here, the authors discuss how women are underrepresented in digital health, particularly through the lack of analyzing device results through a gender perspective. They also touch on algorithm bias that can arise in the new age of artificial intelligence and the consequences this may have on women’s health. This paper is important because it highlights the underrepresentation of women in the digital health realm which decreases the performance of wearable technologies.

My next paper is by Elinor Cleghorn and it discusses the existence of gender divisions in medicinal studies that have long existed since before the third century BCE. Medicine has constantly placed women’s bodies as faulty due to their differences from men and their sole purpose as child bearers. Furthermore, they detail the misdiagnoses that women face because of this history. This paper is useful for my research project because it provides a historical perspective on the gender bias in medicine, demonstrating how misconceptions about women's

health have contributed to inadequate research. I can further use this paper to support the idea that wearable technology must move beyond using data that is entrenched in biases to support the health of women and remove the dangers that come with using such biases. A side note is that this paper is also based on a book called Unwell Women.

Lastly, there is a paper by Jiaxun Cao and it is called "'I Deleted It After the Overturn of Roe v. Wade': Understanding Women's Privacy Concerns Toward Period-Tracking Apps in the Post Roe v. Wade Era." This paper conducts a survey to create a summary of opinions related to data privacy and period tracking. Many participants felt a lack of trust of menstrual trackers due to the fears of their data being used by the government. They also held fears over how they could mitigate the risks of such practices. This paper is especially relevant as I plan to research how the overturn of Roe v. Wade changes the landscape of wearable technology for women's health.

The literature review should take about 3 weeks to complete. Then, an analysis on the information I have gathered will be done using the feminist critique framework. I plan to spend around 3 – 4 weeks completing this section. Lastly, I will focus on refining and organizing my thesis. By the end of this, I should accomplish a research paper that analyzes the historical significance of how the development of wearables disproportionately left women out and how the overturn of Roe v. Wade influences the publics view of wearable devices and data privacy.

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