

## **Thesis Project Portfolio**

### **Carbon Source and Biofilm Formation: Implications for Bacterial Vaginosis Treatment Strategies**

(Technical Report)

### **Investigating How Different Cultural Beliefs of Korean Americans Shape Their Participation in Cervical Cancer Screening**

(STS Research Paper)

An Undergraduate Thesis

Presented to the Faculty of the School of Engineering and Applied Science  
University of Virginia • Charlottesville, Virginia

In Fulfillment of the Requirements for the Degree  
Bachelor of Science, School of Engineering

**Peyton C. Johnston**

Spring, 2023

Department of Biomedical Engineering

## **Contents of Portfolio**

Executive Summary

Carbon Source and Biofilm Formation: Implications for Bacterial Vaginosis Treatment Strategies

(Technical Report)

Investigating How Different Cultural Beliefs of Korean Americans Shape Their Participation in Cervical Cancer Screening

(STS Research Paper)

Prospectus

## Executive Summary

Within the United States, there is a stigma surrounding women's reproductive and sexual health. While there has been an increase in research funding and campaigns to spread awareness of its importance in recent years, the stigma has prevented the research and development of treatments for many common issues women face. One specific infection that demonstrates this lack of understanding is bacterial vaginosis (BV). This is the most common vaginal infection in reproductive-aged women with a prevalence rate of 27% in North America, yet there is a lack of knowledge on the metabolic mechanisms underlying the condition. This means that an effective treatment has not been able to be developed for recurrent BV cases. This stigma has also created a gap in knowledge and understanding of women's health care for the general female public, not just scientists. One way this is shown is through the declining rates of cervical cancer (CC) screening. This screening is a known way to detect early cervical cancer, increasing chance of survival of the cancer. Despite this, the rate of women overdue in the United States is rising, going from 14% in 2005 to 23% in 2019. The overdue rate rose to 31% for Asian American women when looking at the data by race and ethnicity. This thesis portfolio examines the two topics of BV and CC screening compliance rates furthering developments to women's healthcare treatments and developing a stronger understanding of social and cultural barriers associated with females seeking and receiving reproductive and sexual health care.

As mentioned earlier, BV is the most common vaginal infection in reproductive-aged women. It is caused by the overgrowth of multiple pathogenic anaerobes, including *Gardnerella*. This bacterium is capable of forming a biofilm that protects the pathogenic anaerobes and limits the effectiveness of antibiotics, leading to the issue of recurrent cases in patients with BV. Due to the biofilm's composition being understudied, there is no effective treatment to disrupt it. Through

this technical research the biofilm's composition was examined, then that knowledge was utilized to select for enzymes that would disrupt the biofilm. First, ten individual carbon sources were examined to see if they were incorporated into the biofilm. Second, five enzymes were tested on the biofilm to see how much they disrupted it. The first part showed that the carbon sources N-acetylglucosamine and L-fucose were not incorporated into the biofilm. This means that these carbon sources should not be targeted by enzymes, as inhibiting them would have no effect on the biofilm formation. The second part showed that all five enzymes caused biofilm disruption, with proteinase-k being the most effective. As it is the most effective, it should be utilized to create a treatment option for recurrent BV. This research provided a better understanding of BV biofilm composition, allowing for further development in potential targets for treatment options.

The STS portion of the thesis portfolio specifically investigated the question: "Why are there low rates of cervical cancer screening for Asian American women, specifically the subgroup of Korean American women?" As the screening procedure is relatively fast and painless, it implies there are other social factors preventing Korean American women from getting screened; however, there is a lack of knowledge on what these are specifically. Through literature reviews, seven cultural values were identified to impact health beliefs and practices: collectivism, familism, a holistic view of health, gender roles, embarrassment, fatalism, and the level of acculturation. These cultural factors were then used to analyze the effectiveness of intervention programs aimed to increase screening among Korean Americans. It was concluded that successful intervention programs are modified for cultural context. They should emphasize the positives of the medical service in terms of the traditional cultural structure and not impede the daily lives of the participants. Together these findings can be used to create effective intervention programs in the future.

Both of these projects were successful in reaching their goals. The technical portion provided more information on the biofilm composition of bacterial vaginosis and what enzymes are effective in disrupting it. However, this research can be taken further by designing a therapeutic to treat recurrent BV. The STS portion investigated cultural components that influence Korean American beliefs and practices about healthcare. They were then used to evaluate existing intervention programs aimed at increasing Korean American women's use of cervical cancer screening. However, this can be examined further by evaluating healthcare access. Together these can be used to design future intervention programs to increase CC screening compliance. Overall, these research efforts have aimed to further the understanding of women's reproductive and sexual health, while lessening the stigma surrounding it.