

Undergraduate Thesis Prospectus

Development of a Mechanical Model of the Male Reproductive Tract

(technical research project in Biomedical Engineering)

Public Health in the US: Reaching Low-Income Communities

(sociotechnical research problem)

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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General Research Problem

How may medical professionals better serve communities?

Medical professionals' passion for serving communities is burdened by being underpaid and overworked. Kluge (2023), Regional Director for Europe of The World Health Organization (WHO) says, "A health system is only as strong as the health workforce that sustains it." Still, professionals strive for greatness. Terry Vester and her husband, responsible for 2,700 individuals in Lafayette, Alabama, prove this to be true. With retirement nearing, Vester is against the idea of leaving the community with no doctors, stating "we want to stay here to take care of them until someone else is here to take care of them" (Zoints, 2023). Globally, the question is, how will policies and decision makers support medical professionals to enhance their communities?

Development of a Mechanical Model of the Male Reproductive Tract

How can the male reproductive tract be accurately mechanically modeled?

Females have primarily been the candidate for birth control, with men having few options. Despite high percentages of hormonal birth control use in the US, the unintended pregnancy rate remains high. Due to its side effects, 30 to almost 60 percent of women opt out of birth control within six months of use (Westhoff et al. 2007). With concerning statistics, companies are racing to create minimally invasive and non-hormonal contraceptive options for men.

Condoms, with low efficacy, and vasectomies, invasive and only reversible 20 to 40 percent of the time, are popular yet undesirable forms of male contraceptives (Merwin, 1974). The mechanism of action used in male hormonal birth control blocks sperm development but has similar side effects to the female "pill," steering users away (Kean, 2012). Reversible Inhibition

of Sperm Under Guidance (RISUG), an injectable copolymer, is minimally invasive and reversible, but renders sperm infertile (Sen, 2002). To persuade increased usage in male contraceptives, a wide variety of options will need to pass clinical trials and make it to market. There is room for improvement regarding how male birth control can be transformed using different techniques to block sperm.

Contraline's male contraceptive, ADAM, is a non-permanent hydrogel that is implanted into the vas deferens, hindering the passage of sperm without rendering them infertile. The project model will help Contraline perform tests with a physiologically accurate response and serve as a stepping stone for bringing reversible, minimally invasive and non-hormonal male contraceptives to market.

The mechanical model of the male reproductive tract must be physiologically accurate. Pressurization and deformation will be stress tested to ensure the model's walls mimic the vas deferens bodily response during injection of the hydrogel. Histology testing on canine samples will be performed to obtain ideal values for inner lumen cross-sectional area. The biomimetic material used for the final replica must be transparent with the correct size and shape of the tract. The final product will be an accurate model of the male reproductive tract, allowing Contraline to perform in-lab hydrogel injection testing.

Public Health in the US: Reaching Low-Income Communities

In the US, how do residents of low-income communities, local community advocacies, state and local healthcare services, public health agencies, and organized health professionals strive to influence community health and education?

In the US, social groups disagree about the best approach to improve public health standards in low-income communities. Inconsistency in US healthcare is strongly correlated with education, WHO (2023) states, “There are also enormous variations in levels between and within countries. Adolescent pregnancy tends to be higher among those with less education or of low economic status.” Residents are concerned about how policymakers are reacting to such evidence. Researchers at Michigan State University College of Education emphasize how policymakers’ decisions do not align with the financial state of their communities, “School reforms favored by policymakers over the past 20 years have had a ‘decidedly urban emphasis’.” Among urbanization in low-income communities, teacher retention remains a challenge (Garcia, 2022). Teachers and medical professionals align closely, both extremely valuable yet underappreciated. With the absence of a single solution, how will groups try to influence their communities’ health and education?

Participants include public health agencies who strive to promote development, strengthen health systems, and provide evidence-based research that empowers disadvantaged communities to control factors shaping their health (WHO, 2010). During the COVID-19 pandemic, WHO used Twitter to post 699 tweets, including informational content in 58.8 percent of them. WHO often relies on social media to educate the public and promote health campaigns (Muñoz-Sastre, I. Rodrigo-Martín & L. Rodrigo-Martín, 2021). Exemplifying their agenda, public health agencies use these platforms to spread knowledge in disadvantaged areas and alleviate misinformation.

Community advocacy groups maintain a mission, “To protect, advocate, and advance the rights of all education professionals to promote quality public education for all students” (MEA, n.d.). Drawing from their immediate community, these advocacy groups have power in decision

making, using their cultural competence as an advantage. The Michigan Education Association (MEA) employs grassroots efforts to engage students, parents, teachers, and educational professionals to gain momentum behind their agenda. MEA Ambassador Tierra Jackson (2019) declares, “My mother was a bus driver. My aunt’s a teacher. My grandmother’s a bus driver. They were all part of unions, so I’m from a union family. I believe in the strength in numbers, and I believe in advocacy.” (Garcia, 2020). Cultural awareness and collective action play a large role in how community advocates strive to make change.

Organized health professionals such as the American Medical Association (AMA), advocate for “interests of American physicians and empowering them to deliver the best patient care,” and “improving public health and supporting sound medical policy at the federal and local levels” (AMA n.d.). A significant portion of their members are practicing physicians who leverage power on behalf of their own knowledge and expertise. To complement their agenda, the AMA often takes an authoritative approach by engaging in legal action when policies contradict the interest of their physicians. Emphasizing the need to bridge the gap between education and healthcare, the AMA states, “optimizing the social determinants of health is an ethical obligation of a civil society.” They provide statistics, “Approximately 28 percent of low-wage workers have children, which places many children at risk of living in poverty.” David H. Aizuss, M.D. (2022), AMA Trustee adds, “Simply put, decreasing poverty improves health” (AMA, 2022). Organized groups harness their legal and evidence-based power to influence decision making within their communities.

Local healthcare services advocate for policies and funding. They strive to provide high quality healthcare to all residents regardless of the ability to pay, ensuring health remains a human right. (CCH, n.d.). Nelson et. al (2007) explains, “Rural providers often encounter

situations in which they have to decide whether or not to provide necessary care with little or no reimbursement, potentially jeopardizing both the patient's health and the provider's overall practice.” Consequently, low-income residents with health coverage in Cook County are incentivized by free healthcare. Cook County Health and Hospital Services (CCHHS) proudly, “serves approximately 300,000 unique patients annually through more than 1 million outpatient visits and more than 20,000 inpatient hospital admissions” (CCHHS, n.d.). Local healthcare services take pride in maintaining a healthy patient population at no cost. CCHHS reflects the attitudes of local healthcare services in low-income areas that are dedicated to improving their communities.

Researchers have investigated the relationship between healthcare and education in low-income areas. Dubay and Lebrun (2012) report that “minority individuals have poorer health outcomes.” Taking race and socioeconomic status into account, they claim, “Only by understanding these relationships can appropriate policies to reduce disparities be developed.” Finigan-Carr et al. (2015) agree, stating, “interdependence of health and educational attainment starts early and continues throughout someone’s lifespan.” They provide statistical evidence, “the gap in standardized test scores of high and low-income families has grown by about 40% over the previous three decades.” Offering a piece of advice, they suggest, “Moving beyond the simple cataloging of barriers to educational achievement and health equality will require innovation, experimentation and, perhaps most importantly, listening to not just what is needed, but what works.” To mitigate disparities, Nelson et al. (2007) proposes an agenda, “increasing awareness and understanding of rural healthcare ethics through the development of evidence.” They conclude, “we believe there is a need to close the gap that places rural populations at risk not only for clinically disparate care but also for ethically disparate care.”

The pressing importance of recognizing the intricate connection between healthcare and education in disadvantaged regions remains. Researchers and participants continue a resolute effort to address and rectify disparities in health and educational achievement.

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