**How do Social Disparities Affect Individuals with Prosthetics and Implants**

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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

Knee osteoarthritis poses a significant health challenge, impacting the quality of life for millions worldwide. There are fourteen million individuals in the US who have symptomatic knee osteoarthritis. This includes nearly two million people under the age of 45 years old and six million people between 45 and 64 years (Deshpande, 2016). Current interventions, including knee braces, aim to alleviate pain and improve function. However, a nuanced understanding of their impact on gait dynamics and muscle activity is crucial for optimizing therapeutic outcomes. Among these interventions, knee braces emerge as a promising avenue for managing symptoms and enhancing mobility. However, a comprehensive understanding of how these braces influence the intricate mechanics of gait, muscular activation, and bone health is crucial for refining their efficacy and ensuring optimal patient outcomes. That is why I am working under Icarus Medical to investigate how the inclusion of an extension stop affects the amount of mechanical load that the knee brace can withstand. Icarus Medical is a medical company that specializes in orthopedic brace development. The analysis will be conducted using metrics found in literature to run finite element analysis simulations to determine the changes in received load by the knee brace. The social dimension of my topic is the economic implications implants and other prosthetics have on people of different socioeconomic classes. As new devices, technologies, and remedies are created, the price of those aids has increased. Prostheses, like artificial legs and hands, and orthoses, such as braces and splints, play a crucial role in empowering individuals with physical impairments or functional limitations to lead fulfilling lives (WHO, 2017). These devices not only support daily activities but also promote independence, dignity, and participation in various aspects of life, including education, work, and social engagements. By utilizing prostheses or orthoses, individuals can often decrease their reliance on formal healthcare services, support

systems, long-term care facilities, and caregivers. This independence not only benefits the individuals directly but also alleviates the strain on healthcare resources and support networks (WHO 2017). Unfortunately, without access to these vital devices, individuals who require them face significant challenges. They may experience exclusion, isolation, and financial hardships, which can perpetuate a cycle of poverty and exacerbate health issues and disabilities (WHO 2017). This creates a wealth gap for those in need of medical prosthetics but are unable to either receive them, conduct maintenance on them or have them replaced as needed. I will investigate the previous history to see if as technology improves, the disparities also increase. The investigation of how socioeconomic classes affect a user's experience with prosthetics and implants is particularly important to create a more inclusive atmosphere in healthcare. It highlights the importance of ensuring that all individuals have the same opportunities for good health, regardless of their socioeconomic status. Healthcare disparities can lead to higher healthcare costs. Preventing and managing diseases at earlier stages, rather than addressing them in advanced and costly stages, can result in cost savings for healthcare systems. Reducing socioeconomic gaps in healthcare can lead to improved public health outcomes. When people have equal access to healthcare services, preventive measures, and treatment, it benefits the entire population by reducing the prevalence of diseases and promoting overall well-being. Not to mention, with an increased representation of other demographics services and healthcare products can better serve a larger population of patients, resulting in improved outcomes for all users. Therefore, this thesis will perform a quantitative analysis of while determining how socioeconomic factors users of such braces and other assistive prosthetic/implantation devices.

## Significance

The social dimension of my topic is the economic implications implants and other prosthetics have on people of different socioeconomic classes, how this could affect future generations and the regulation of such equipment. As new devices, technologies, and remedies are created, the price of those aids increases (CMS, 2023). If humans advance to the point that certain implantation is a requirement to be a functioning member of society this will only affect low-income demographics. The implantation of a device and/or application of a prosthetic can be life changing. If the difference between a high quality of life versus a poor one post operation is a matter of status and money this should be investigated because healthcare systems should be looking to reduce such disparities. Lifetime estimates for directly associated costs range from $345,000 to nearly $600,000, depending on how often the prosthesis is replaced and the age at the time of amputation (Pasquina, 2017). The direct and indirect health costs because of amputation could easily exceed $1 million for an individual before accounting for any loss of wages or salary due to an inability to work (Pasquina, 2017). These are just estimates of currently available treatment plans. The costs of new treatment plans will surely increase leaving the average client unable to afford the full care plan they need (Pasquina, 2017). This is important because understanding this phenomenon will be important to make sure that any inequalities that may arise with innovative technologies are mitigated to prevent a greater wealth gap.

## Methodology

Within my methodology, I adopt an ethics of care approach to investigate how socioeconomic factors affect individuals using prosthetics and implants. By utilizing an ethics of care approach, I will highlight problems within healthcare systems and show that these "ethical issues…cannot be handled deductively by applying concrete and prefabricated norms, but only inductively in social processes, which respect the multidimensionality of problems and the singularity of human destiny" (Schuchter, 2018). The research design integrates elements of literature review and case studies to explore this intersection comprehensively. Through a relational lens, I recognize prosthetics and implants not only as technological artifacts, but also as relational constructs situated within broader socio-cultural contexts. To understand the multifaceted relationships between socioeconomic factors (e.g., income, education, access to healthcare) and experiences with prosthetics and implants, I conducted a thorough literature review and engaged with existing scholarly works. Using the ethics of care framework, I emphasize the importance of empathizing with patients' needs and experiences within the healthcare system. The methodology involves the analysis of case studies, examining real-world scenarios and narratives to uncover the nuanced ways in which socioeconomic disparities intersect with the utilization and access to prosthetic and implant technologies. This approach aims to shed light on the ethical dimensions of care provision and the relational dynamics shaping individuals' experiences with prosthetics and implants. By synthesizing insights from the ethics of care and literature/case studies, this study seeks to contribute to a deeper understanding of how social, cultural, and economic factors influence the prosthetic and implant experience, ultimately informing more compassionate and equitable healthcare practices.

## Literature Review/Discussion

The World Health Organization reports that in the developing world, there are approximately forty million amputees, yet only 5% of them have access to any form of prosthetic care. As the number of people requiring amputations continues to rise, the necessity of establishing robust systems for providing proper care becomes increasingly critical (Marino, 2015).

In developing regions worldwide, suppliers, especially in areas like Sub-Saharan Africa, face significant challenges in effectively delivering prosthetic devices to local communities. This challenge primarily stems from a lack of funding (Marino, 2015). Marino also states that "The need for external funding arises because the recipients of the prostheses, with an average yearly income of $1,686 US across Sub-Saharan Africa, lack the income to pay any or all of the cost of a prosthesis."

Furthermore, Marino and colleagues highlight that one of the primary reasons for prosthesis abandonment, as concluded from an Indian study, is the prohibitively excessive cost of repairs and replacements. This issue underscores the complex challenges faced in ensuring long-term accessibility and usability of prosthetic devices in resource-limited settings (Marino, 2015). Low socio-economic status and lack of dental insurance are associated with increased dental treatment needs due to lack of oral health knowledge, poor dental care, or poor oral hygiene habits (Chatzopoulos, 2018). Socioeconomic status influences education levels and access to information. Individuals with lower socioeconomic status may have limited knowledge about oral health practices and preventive measures. This lack of awareness can contribute to poor oral

hygiene habits, increasing the risk of dental problems that necessitate interventions like dental implants.

Individuals from disadvantaged socioeconomic backgrounds may face barriers such as financial constraints, transportation issues, or a lack of nearby dental facilities. As a result, they may delay seeking dental treatment until issues become severe, leading to a higher need for interventions like dental implants which are costly leading to even further delay of care.

Moreover, in implant dentistry, infrequent dental care or poor oral hygiene following an implant treatment may affect the long-term treatment outcome. The impact of access to care on oral health disparities is particularly significant for low-income individuals, racial and ethnic minorities, and rural populations, who are excessively affected by oral health disparities. According to Attanasi, while it is known that children, up to age 18, of families living below the poverty level, are in greater jeopardy than other equally aged associates of developing dental cavities, it is also significant that the apparent threats due to dental ailment, have originated to be low in teenage populations (Attanasi, 2020). Dental insurance coverage is often linked to socioeconomic status. Those with lower incomes or unstable employment may be less likely to have dental insurance or access to comprehensive coverage (Hardgraves, 2019). Without insurance, the cost of dental procedures, including implants, can be prohibitive, leading individuals to postpone or forego necessary treatments until complications arise.

Total hip arthroplasty (THA) is a surgical procedure that involves the replacement of the hip joint with a prosthetic implant. Several studies have examined the impact of insurance types on access to THA evaluation and outcomes, revealing substantial disparities. Privately insured patients were found to have a significantly higher success rate in THA evaluation appointments

(99%) compared to Medicaid beneficiaries (72%) (Almaguer, 2019), indicating discrepancies in the level of care based on insurance status. Additionally, Medicaid recipients experienced longer average wait times for appointments compared to those with private insurance (Almaguer, 2019), suggesting delays in care associated with lower-quality insurance.

The use of technological assistance in total knee and hip arthroplasty (TKA/THA) further underscores insurance-related inequities. Research by Boylan demonstrated that technology utilization was notably higher among privately insured patients (5.9%) compared to Medicare (4.7%) or Medicaid recipients (2.2%) (Boylan, 2017). These findings highlight disparities in access to advanced treatment modalities based on insurance coverage. Moreover, socioeconomic status and insurance coverage significantly influence utilization rates for primary TKA. Hanchate reported that Medicare patients with supplemental insurance, whether private or Medicaid, were more likely to receive a primary TKA compared to those without it (Hanchate, 2008). Conversely, uninsured middle-aged patients were markedly less likely to undergo primary TKA compared to their privately insured counterparts (Hanchate, 2008).

Furthermore, Medicaid insurance was identified as an independent predictor of receiving TKA at low-volume hospitals (SooHoo, 2008). Additionally, Veltre found that privately insured patients were more likely to undergo total hip replacement at higher-volume hospitals compared to Medicaid-insured or uninsured patients (Veltre, 2019). These findings collectively underscore the influence of socioeconomic factors and insurance status on access to care and treatment outcomes in orthopedic implant procedures.

The evaluation of mortality and complications within this study yielded significant findings from several authors, shedding light on the nuanced relationship between insurance status and postoperative outcomes. investigation revealed a notable association between Medicaid insurance and an increased risk of postoperative mortality, underlining the importance of insurance coverage in determining patient outcomes (Adelani, 2012). Moreover, research highlighted the vulnerability of Medicaid patients to various postoperative complications, including in-hospital infections, wound dehiscence, and hematoma or seroma formation following total joint arthroplasty (TJA), emphasizing the multifaceted impact of insurance status on surgical recovery (Brown, 2014).

Further insights from Maman underscored the pervasive influence of Medicaid insurance on patient outcomes, with Medicaid beneficiaries facing heightened odds of in-hospital mortality, postoperative complications, extended length of stay, and elevated total charges (Maman, 2019). These findings underscore the urgent need for targeted interventions to address the underlying disparities in healthcare access and quality among different insurance groups.

Conversely, Menendez identified Medicaid insurance, but not Medicare or uninsured status, as a significant risk factor for in-patient dislocation following total hip arthroplasty, indicating the complex interplay between insurance status and surgical outcomes (Menendez, 2019). Plate's study further elucidated this relationship by demonstrating that despite exhibiting outcomes similar to Medicare patients, Medicaid beneficiaries presented with significantly higher ASA scores and BMI, leading to prolonged procedure duration and hospital stays (Plate, 2019).

These comprehensive findings collectively emphasize the multifaceted impact of insurance status on orthopedic surgical outcomes, highlighting the need for tailored interventions to address the unique challenges faced by Medicaid-insured patients. By addressing the underlying socioeconomic disparities and improving access to high-quality care for all patients, healthcare providers can strive towards achieving equitable surgical outcomes across diverse patient populations.

Moreover, Veltre noted that patients with private insurance experienced fewer medical complications (OR 0.80; $P < 0.001$) post-THA compared to those with Medicaid, Medicare, or no insurance. Privately insured patients also displayed fewer surgical complications and lower mortality rates following THA than other groups (Veltre, 2018). Additionally, it was observed that Medicare patients faced a heightened risk of mortality (relative risk [RR], 1.34; $P < 0.001$) post-total knee arthroplasty (TKA) compared to privately insured patients [16]. Lastly, Xu identified Medicaid payer status as being associated with the highest statistically significant adjusted odds of mortality (OR 2.25, 95% CI 1.01–5.01), any complications (OR, 1.26), cardiovascular complications (OR, 1.37), and infectious complications (OR, 1.66) when contrasted with patients covered by private insurance post-THA (Xu, 2017).

Only five states within the United States of America have enacted legislation that will increase equitable access to necessary prosthetic devices to conduct daily activities. Illinois being the most recent, had the SB 2195 bill signed by Governor Pritzker. This bill defines a prosthetic device as a “supportive device for the body or a part of the body, the head, neck, or extremities, and includes the replacement or repair of the device based on the patient's physical condition as

medically necessary, excluding foot orthotics defined as an in-shoe device designed to support the structural components of the foot during weight-bearing activities" (SB 2195, 2023). It then ensures that enrollees of any age receive coverage not only for a basic prosthetic or custom orthotic device but also for the most appropriate model that is medically necessary for performing physical activities such as running, biking, swimming, and lifting weights. This legislation will provide those who previously did not have access to prosthetic care with the help that they rightfully deserve and need. This bill also states that "repairs and replacements of prosthetic and orthotic devices are also covered, subject to the co-payments and deductibles, unless necessitated by misuse or loss" (SB 2195, 2023). Therefore, increasing the affordability of not only the medical devices but the aftercare required to maintain these devices ensures the user's well-being. Policies such as this show the lack of attention provided to those in need of prosthetic care.

## Conclusion

The findings of this study illuminate the intricate interplay between socioeconomic status, insurance coverage, and outcomes in both dental and orthopedic implant procedures. Within the realm of dental health, individuals from low socioeconomic backgrounds or without adequate dental insurance exhibit heightened dental treatment needs due to factors such as limited oral health knowledge, poor access to care, and suboptimal oral hygiene practices. This often leads to delayed interventions, including dental implants, further exacerbating oral health disparities. The lack of awareness about preventive measures and the financial barriers associated with dental care contributes to a vicious cycle wherein individuals forego necessary treatments until complications arise, necessitating more extensive and costly interventions.

Similarly, in the domain of orthopedic implants, disparities in insurance coverage significantly influence access to total hip and knee arthroplasty (THA/TKA) evaluations and subsequent outcomes. Medicaid-insured patients consistently experience higher rates of postoperative mortality, complications, and prolonged hospital stays compared to their privately insured counterparts. These disparities extend beyond the immediate postoperative period, with Medicaid insurance also being associated with increased mortality and complications following THA. The delay in seeking care, coupled with the higher risk profiles associated with certain insurance types, underscores the complex interplay between socioeconomic factors, insurance coverage, and health outcomes.

The stark reality illuminated by the World Health Organization's findings regarding limited prosthetic care access in the developing world highlights the pressing need for sustainable solutions. Marino's research underscores the intertwined challenges of affordability and maintenance, particularly in regions like Sub-Saharan Africa. These insights emphasize the necessity of collaborative efforts among healthcare stakeholders, policymakers, and philanthropic organizations to establish robust systems that ensure ongoing support and affordability for prosthetic users in resource-limited settings.

These findings underscore the urgent need for targeted interventions to address the socioeconomic and insurance-related barriers that perpetuate disparities in dental and orthopedic implant care. Such interventions may include policies aimed at improving access to comprehensive dental insurance coverage and reducing financial barriers to care, as well as

initiatives to enhance oral health education and promote preventive dental practices among underserved populations. In the realm of orthopedic care, efforts to ensure equitable access to THA/TKA evaluations and procedures, regardless of insurance status, are crucial for mitigating disparities and improving overall health outcomes. By addressing these systemic inequities, healthcare systems can work towards achieving more equitable access to quality dental and orthopedic care for all individuals, regardless of socioeconomic status or insurance coverage.

As a final note, the enactment of SB 2195 marks a landmark step towards equitable access to prosthetic devices, setting a precedent for health policies prioritizing patients' well-being and independence. In addition to defining prosthetic devices comprehensively, the legislation ensures that the most appropriate models are covered based on individual needs, including devices necessary for daily physical activities. A major benefit of the bill is that it extends coverage to a range of activities that contribute to patients' overall well-being in addition to basic prosthetics and orthotics. It underscores an integrated approach to prosthetic care by including coverage for repairs and replacements, recognizing the need for ongoing support. The introduction of progressive measures such as these not only eases financial burdens for people previously underserved by health insurance but also indicates a broader recognition of the importance of assistive devices in improving quality of life. As a result of this initiative-taking approach to prosthetic care, similar considerations can be made within the realm of implantation devices in the future, fostering more inclusive and equitable healthcare systems in the future by prioritizing affordability and accessibility across a range of medical interventions.

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