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The Ronald E. McNair Post Baccalaureate Achievement Program was established by Congress in 1986 after the tragic explosion of the Space Shuttle Challenger that killed seven crew members, including Dr. McNair. Funded by the U.S. Department of Education, the program provides institutions with grants to develop and implement successful programs that recruit promising and aspiring low-income and first-generation students and those from backgrounds underrepresented at the doctoral level and prepares them for the rigors of graduate level work. Currently, the program operates at 151 institutions across the country serving over 5,000 scholars each year.

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A MESSAGE FROM THE DIRECTOR

The San José State University McNair Scholars Program is pleased to present the nineteenth SJSU McNair Scholars Research Journal. This journal represents the diverse and practical research experiences of the McNair Scholars during the 2022-2023 academic year.

I would like to congratulate the Scholars for their hard work, dedication, and accomplishments, especially during this COVID-19 Fall 2022 and Spring 2023 semesters which was very difficult but we all persevered. I also wish to express my sincere appreciation to the faculty mentors for their guidance, time, and commitment to the scholars, their research, and the program during these trying times. A particular word of thanks goes out to the families and extended support systems that made these outstanding presentations possible.

On the cover of this year's journal, we have highlighted Yeab Kebede's piece, which reflects her work in the medium of Digital Media, as well as her research, which is centered on highlighting excellence in Black art.

We are grateful for these virtuoso McNair Scholars for their continued brilliance and resilience, and hope they are striving to continue their dreams as academics and individuals.

We thank you very much for continuing to support our Scholars through your readership of our journal.

Please continue to take care during these unprecedented times.

Maria Elena Cruz, PhD.

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The Impact of Culture on Health Perceptions and Help-Seeking Behaviors Among Older Latinos with Co-occurring Diabetes and Depression: A Literature Review

Biography

Alejandra Aguirre received a Bachelor of Arts degree in Social Work from San Jose State University in 2023. Her research focused on the impact of Latino culture on the health perceptions and help-seeking behaviors of older Latinos with co-occurring diabetes and depression. Currently, she is completing her Master of Social Work in the SJSU Advanced Standing Program, where she hopes to earn her Certificate in Gerontology. She looks forward to completing her final year MSW internship at Palo Alto VA Healthcare System, where she will work closely with BIPOC and aging veterans in the Inpatient Medical Unit. Previously, she completed her senior year internship at Kaiser South Bay Hospice and was a 2021-2022 Civic Action Mentor Fellow. She is a current Irma Ferrer Health Justice Fellow (IFHJF) at Latinas Contra Cancer, where she works on various projects to create equitable healthcare access for Latina/o cancer patients. Alejandra's ultimate aim is to help create more pathways to public health equity in BIPOC and aging communities. In the future, she would like to become a Licensed Clinical Social Worker (LCSW) and pursue a Doctor of Public Health (DrPH).

The Impact of Culture on Health Perceptions and Health-Seeking Behaviors Among Older Latinos with Co-occurring Diabetes and Depression: A Literature Review

Abstract

Diabetes is one of the most common health disparities in the United States today and disproportionately affects older Latino populations. Increased recognition of the bidirectional relationship between diabetes and mental health has led to more awareness and treatments for diabetes and depression. Despite high prevalence rates, diabetes and depression are commonly undiagnosed and untreated in older Latinos. Existing literature reports that factors including genetic and behavioral factors, low socioeconomic status (SES), limited healthcare access, and language barriers may prevent this population from seeking professional treatment. Prior research also suggests that culturally based stigma toward these conditions can negatively impact health perceptions and help-seeking behaviors. Culturally tailored education strategies have demonstrated improved health outcomes for older Latinos, and this project presents important implications for social work practice and research working with Latino older adults.

Keywords: Diabetes, depression, culture, older Latinos, Latinos

Introduction

The United States has a large, rapidly increasing aging population, and older Latinos have contributed a great deal to this increase (Garcia et al., 2018; Moreno et al, 2016). Between 1990 to 2019, the percentage of Americans aged 65 and older who identified as Hispanic/Latino nearly tripled from 3.7% to 9% (Administration for Community Living [ACL], 2020). As the second-largest minority population and one of the fastest growing, Latino communities may face unique health challenges associated with aging (Valencia et al., 2014). Older Latinos, notably the foreign-born, have been observed to have longer life expectancies and lower mortality rates compared to non-Latino whites (Garcia et al., 2018). They have also been noted as having lower socioeconomic profiles, which can often lead to limited healthcare access (Washburn et al., 2021). This can create distinct health challenges for older Latinos, especially those already living with complex disease combinations. For instance, decreases in mortality without improvements in morbidity can result in a greater incidence of chronic health and mental health conditions, including diabetes and depression (Garcia et al., 2018; Inoue et al., 2021).

The past two decades have seen great advancements in the prevention, treatment, and management of geriatric diabetes. Increased screenings and diabetes-related technologies have led to greater recognition of type 2 diabetes (T2D) in this aging population (American Diabetes Association [ADA], 2022; Avilés-Santa et al., 2017; Leung et al., 2018). Despite these advances, diabetes continues to be one of the most pertinent health disparities facing older Latino communities (Avilés-Santa et al., 2017). Compared to non-Latino whites, Latinos are twice as likely to be diagnosed with diabetes and experience worse diabetes-related outcomes, such as impaired glucose control, higher prevalence of complications (e.g., kidney failure, cardiovascular disease, and diabetes-related vision loss), poorer self-management (i.e., less adherence to medication and dietary regimes), and increased mortality (Colon et al., 2013; Washburn et al., 2021). Older Latinos are a particularly vulnerable subpopulation due to their age, lower socioeconomic status, and increased risk for diabetes multimorbidity (Valencia et al., 2014).

Depression is one of the most widespread mental health conditions affecting Latino communities and is commonly associated with diabetes multimorbidity (Inoue et al., 2021). Research has consistently found there to be a bidirectional relationship between depression and diabetes, with depression prevalence rates being twice as high among people with diabetes than those without diabetes (Alva, 2020; Washburn et al., 2021). The co-occurrence of diabetes and depression has been reported to be as high as 33% among Latinos in primary care settings, yet there is a limited understanding of how these populations recognize their need for diabetes and depression treatment (Colon et al., 2013; Hansen & Cabassa, 2016). There are even fewer studies on how co-occurring diabetes and depression affects older Latinos (Colon et al, 2013; Park et al., 2015; Valencia et al., 2014). Because sociocultural and economic factors can make working with these medically underserved populations challenging, it is crucial that healthcare providers understand how *and* why these factors can influence help-seeking behaviors. Hence, my research aims to answer the following five questions:

1. What is the prevalence of co-occurring diabetes and depression in older Latinos?
2. What risk factors influence the comorbidity of diabetes and depression in older Latinos?
3. How does culture influence older Latinos' perceptions of diabetes and depression separately and concurrently?
4. How does culture impact help-seeking behaviors in older Latinos with diabetes and depression?
5. What can culturally tailored education strategies be used to improve diabetes and depression self-management in older Latinos?

Latino health literature indicates that culture can negatively affect perceptions towards chronic and mental diseases, such as diabetes and depression (Cherrington et al., 2005; Colon et al., 2013). This can potentially affect help-seeking behaviors among older Latinos living with diabetes multimorbidity. However, there are workable solutions for better-addressing diabetes multimorbidity in these populations; these include culturally tailored education strategies that promote family and community-based approaches to diabetes and depression care (Amirehsani et al., 2019;

Moreira et al., 2018). Such strategies may have important practice and research implications for the social work field and will be further discussed.

Methodology

Inclusion and Exclusion Criteria

This literature review on diabetes and depression included peer-reviewed articles and government data (i.e., U.S. Census Bureau) on diabetes and depression comorbidity among older Latino populations. The inclusion criteria for this review included articles that focused on older Latinos residing in the United States and Latinos with diabetes and depression (both separately and concurrently), and articles published after 1990. Exclusion criteria included dissertations, articles not in English, non-scholarly articles (e.g., magazines and newspapers), and articles not considered applied (e.g., articles focusing on Latinos not residing in the United States, articles not including T2D).

Search Strategy

The literature review was conducted from August 2022 to November 2022. The author searched PubMed, PubMed Central, and PUBLINE using Google Scholar as a search engine. The search terms used included *Hispanics, Latinos, Older Hispanics, Older Latinos, Culture, Diabetes, Type 2 Diabetes, Depression, Diabetes and Depression,* and *Help-Seeking Behaviors*. For the sake of comprehensiveness, the terms "Hispanic" and "Latino" were both used in this search strategy. The U.S. Census Bureau and Office of Management and Budget (OMB) define Hispanic or Latino as being "[any] person of Cuban, Mexican, Puerto Rican, South or Central American, or other Spanish culture or origin regardless of race" (Avilés-Santa et al., 2017). While these classifications are used interchangeably in Latino health literature, they are not the same. For this research and to align with the cited literature, Latinos will be the term used in this paper. Most of my cited studies were done on populations that migrated from Latin America (Mexico, South, and Central America) and the Caribbean.

Findings

Prevalence of Co-occurring Diabetes and Depression in Older Latinos

One of the largest difficulties in assessing health disparities facing Latinos stems from the assumption that this is a homogeneous population (Avilés-Santa et al., 2017). Latinos encompass various heritage groups and factors like nativity and country of origin can contribute to late-life health differences (Avilés-Santa et al., 2017; Garcia et al., 2018). Acknowledging Latino heterogeneity in health is important for assessing different disease risks, especially in the context of diabetes and depression. For example, diabetes prevalence rates have been observed to be higher in Mexican Americans (13.9%) and Puerto Ricans (14.8%) than in Central and South Americans (8.5%) and Cubans (9.3%) in the United States (Valencia et al., 2014). These differences can be accounted for by different sociopolitical factors related to migration, which can lead to some Latinos obtaining better social and economic services that can protect late-life health (Garcia et al., 2018). Similarly, the prevalence of diagnosed depression has been shown to vary across Latino subgroups and age groups (Alva, 2020). Because depression is commonly underdiagnosed in minority populations, the exact number of Latinos suffering from depression is unknown (Alva, 2020). This has led to disagreement in some population-based studies; most of which have been limited by small sample sizes and only focused on specific Latino subgroups. A comprehensive review by Jimenez et al. (2020) on Latino interethnic differences in depression rates highlights these discrepancies. While one study found older Latina/os tend to experience similar rates of depression as their younger counterparts and non-Latino Whites (Jimenez et al., 2020), other studies contradict this by saying older Latinos have higher rates of mental health disparities (Gonzalez et al., 2001; Markides et al., 1996; Woodward at al., 2012). Despite these discrepancies, most studies agree that depression is a prevalent issue facing older Latinos and that the mental illness burden is not equally shared across Latino subgroups. Jimenez et al. (2020) attribute low depression screening rates, lack of disclosure behaviors, and limited healthcare access as potential reasons for these underdiagnoses. Given the high rates of lifelong and geriatric depression among U.S. Latinos, there is a critical need for more depression research on this culturally distinct population (Fuentes & Aranda, 2019).

Studies on co-occurring diabetes and depression have been conducted since the early 1980s. This line of research has routinely used cohort studies and has given greater insight into the intimate relationship between diabetes and emotional health (Cherrington et al., 2005; McCurley et al., 2019). For example, co-occurring diabetes and depression have been found to lead to worse health outcomes and higher healthcare costs, especially among racial/ethnic minorities and older people (Alva, 2020; Leung et al., 2018). While a higher prevalence of comorbid diabetes and depression has been observed among racial/ethnic minorities, few studies have been conducted on U.S. Latinos and even fewer have focused on older U.S. Latinos (Colon et al., 2013; Hansen & Cabassa, 2012). There are several lines of evidence to suggest there is a bidirectional relationship between diabetes and depression, and that older minorities experience the greatest disease burden (Hansen & Cabassa, 2012; Park & Reynolds, 2015). Research also shows that older people with diabetes are at an increased risk for premature death, functional and cognitive disabilities, and mental health issues like depression (ADA, 2022; Leung et al., 2018). For these reasons, older Latinos are an important subpopulation that should be studied in the context of co-occurring diabetes and depression. Understanding the risk factors that contribute to this rampant comorbidity can inform effective health interventions.

Risk Factors for Comorbidity of Diabetes and Depression in Older Latinos

Many studies have argued that minority groups are more likely to experience physical and mental health disparities compared to non-Latino Whites (Alva, 2020; Cherrington et al., 2005; Hansen & Cabassa, 2012). This may be due to the unique stressors many minority groups experience such as discrimination, high poverty rates, limited healthcare access, low acculturation, and recent immigration status (Cherrington et al., 2005; Moreno et al., 2016; Washburn et al., 2021). Research by Hansen and Cabassa (2012) along with other researchers (Caballero, 2005; Kim et al., 2019; Mercader & Flores, 2017; McCurley et al., 2019; Moreno et al., 2016; Moreira et al., 2018; Qi et al., 2017; Valencia et al., 2015; Washburn et al., 2021) have identified three risk factors that may contribute to diabetes and

depression co-morbidity in older Latinos: Genetic and behavioral factors, limited healthcare access, and language barriers.

Genetic and Behavioral Risk Factors

There are two types of risk factors associated with T2D: non-modifiable risk factors and modifiable risk factors (Valencia et al., 2015). Non-modifiable risk factors include characteristics like genetics, age, race, and ethnicity (Mercader & Flores, 2017; Valencia et al., 2014). Modifiable risk factors include behavioral risk factors like obesity, diet, and physical activity (Amirehsani et al., 2018). Older U.S. Latinos have been observed to have higher levels of non-modifiable and modifiable risk factors (Valencia et al., 2014). Understanding these genetic and behavioral risk factors may lead to a better understanding of *why* this population is so affected by diabetes-depression comorbidity.

Prior research on diabetes pathophysiology has revealed there to be over 100 genetic regions associated with modified risk for T2D (Mercader & Flores, 2017). Until recently, genome-wide association studies (GWAS) had mainly focused on European populations and seldom focused on minority and older minority populations (Mercader & Flores, 2017; Qi et al., 2017). The few genetic studies that have solely focused on U.S. Latinos have agreed that this group is more genetically prone to developing T2D, especially with age (Caballero, 2005; Mercader & Flores, 2017; Qi et al., 2017). This is often attributed to a mixture of genetic factors, including ancestry-specific loci, insulin resistance, β-cell dysfunction (Mercader & Flores, 2017; Qi et al., 2017). In their mini-review, Mercader and Flores (2017) summarize the main genetic findings discovered in Hispanic/Latino GWAS studies. Researchers focused on which genetic factors most contribute to T2D in the U.S. Hispanic/Latinos and the potential challenges for studying these populations. The first GWAS for T2D in Latino populations was performed in the Mexican American population of Starr County in 2011. Researchers replicated several loci found in European GWAS, indicating that many common genetic risk factors are transferable to Latino populations (Below et al., 2011, as cited in Mercader and Flores, 2017). This research was expanded on by the Slim Initiative for Genomic Medicine (SIGMA) T2D Consortium, which focused on genome-wide significant associations in a sample of 8,214 Mexican and Mexican

Americans. Researchers found three statistically significant loci that were unique to these populations (i.e., SLC16A11, HNF1 Homeobox a Gene, and Insulin-Like Growth). However, these studies have limitations with generalizability and scope. Their samples only included Mexican populations and there are more heritage groups within the Latino community. Each of these heritage groups has different ancestral and genetic makeups that differentially influence their likelihood of developing T2D (Mercader & Flores, 2017).

Recent GWAS studies have started developing methods for addressing these particularities of Latino populations. The Hispanic Health Study/Study of Latinos (HCHS/SOL) was one of the first comprehensive T2D GWAS focusing on a large, diverse sample of U.S. Latinos (Qi et al., 2017). The study included 2,499 T2D case subjects and 5,247 control subjects from six Latino heritage groups, which provided the opportunity to identify ancestry-specific alleles associated with T2D. Specifically, researchers were able to identify an African ancestry–specific allele at *KCNQ1* across all Latino ethnic groups. These results were later replicated in the Meta-analysis of T2D in African Americans (MEDIA) consortium and added to the existing literature on the biology of T2D. Research has also identified insulin resistance and β-cell dysfunction as genetic factors that may contribute to high diabetes prevalence in Latino populations (Caballero, 2005).

Likewise, behavioral risk factors like poor diet, physical inactivity, and related obesity can worsen disease outcomes for this population (Valencia et al., 2014). Research has commonly identified poor diet and physical activity as risk factors for diabetes onset and complications (ADA, 2022; Valencia et al., 2014). In Latino populations, these risks may be more pronounced due to cultural and social pressures to eat traditional foods high in calories and fat (Valencia et al., 2014; Washburn et. al., 2021). These risk factors may be further affected by levels of acculturation, adaptation, and assimilation to U.S. dietary and exercise habits. Valencia and colleagues (2014) added to prior research on how obesity and weight gain are highly common among immigrant populations, particularly older Latino populations. In their mini-review, researchers found that older Latinos tend to experience a significant shift in macronutrient profiles after migrating

and living longer times in the United States. Specifically, Latino populations were more likely to eat diets high in sugar and starch compared to their non-Latino White counterparts. Because increased carbohydrate consumption is associated with higher BMI, larger waist circumference, and increased diabetes risk; poor diet can be characterized as a behavioral risk factor for T2D (Valencia et al., 2014; Washburn et al., 2021). Physical inactivity is another behavioral risk factor that commonly affects older Latinos. Like dietary consumption, physical inactivity can be confounded by variables like race/ethnicity, socioeconomic status, age, and acculturation. Research has shown that older Latinos are disproportionately sedentary compared to their non-Latino White counterparts, with levels of regular physical activity being as low as 10% (Piedra et al., 2018). Because physical inactivity is a potential precursor to multiple chronic conditions that older Latinos are at elevated risk for (e.g., T2D, cardiovascular disease, and obesity), it can also be classed as a behavioral risk factor. If unaddressed, behavioral risk factors can contribute to increased diabetes multimorbidity for this population.

Limited Healthcare Access

Compared to any other minority group, Latinos are more likely to underutilize primary and mental health services (Moreno et al., 2016; Washburn et al., 2021). One reason for this persistent underutilization of healthcare services is limited healthcare access (Moreira et al., 2018). For many low-income Latinos, limited insurance coverage can make it difficult to access diabetes and depression services. Both diabetes and depression are associated with high medical costs due to the routine screenings, check-ups, and multiple medications required to manage these conditions (Leung et al., 2018; Moreno et al., 2016). Research has indicated low rates of health insurance coverage among disadvantaged populations, particularly older Latinos (Valencia et al., 2014). Because health insurance coverage is a mediator between ethnicity and healthcare access, the lack of coverage for these populations can contribute to this population's high comorbidity (Garcia et al., 2018; Kim et al., 2019).

In a study by Hansen and Cabassa (2012), low-income Latinos reported limited healthcare access as one of the most prevalent help-seeking barriers. Participants commonly expressed their frustration with long

waiting times, inability to obtain appointments, and being unable to afford their medical care (Hansen & Cabassa, 2012). When they were able to obtain appointments, some reported receiving limited education on the available medications and mental health services (Hansen & Cabassa, 2012). While this study was limited by the small sample size of nineteen participants, it offers insight into the influences and barriers throughout the pathway to diabetes and depression care. It also reveals how the healthcare experiences of Latinos may be affected by immigration status. This is because immigration status may affect Latinos' access to health coverage, continuity of care, sufficient social resources, and health literacy (Kim et al., 2019; Moreno et al., 2016).

Language Barriers

Language barriers are another cause of healthcare disparities in older Latinos (Hansen & Cabassa, 2012; Kim et al., 2019). These language difficulties can lead to miscommunication between patients and providers and prevent patients from effectively communicating their diabetes and depression symptoms (Hansen & Cabassa, 2012). Indeed, language barriers have commonly been identified as the most crucial factor influencing communication and rapport between Spanish-speaking patients and their physicians (Kim et al., 2019; Lopez-Quintero et al., 2010). These linguistic disparities can contribute to the challenges that older Latinos have in managing and understanding diseases, like diabetes and depression. It can also lead to them receiving less education on how to prevent, recognize, and treat these conditions (Kim et al., 2019). One study found that Latinos with limited English proficiency (LEP) are less likely to receive information on physical activity and dietary advice than English-proficient Latinos, even after controlling for health insurance coverage and the number of physician visits (Lopez-Quintero et al., 2010). Given the high prevalence of LEP among older Latinos, especially those from immigrant backgrounds, it is important that healthcare systems consider the language needs of these communities (Kim et al., 2019).

Influence of Latino Culture on Diabetes and Depression

Studies on Latino culture and health have shown Latinos to have distinct cultural beliefs about diseases and available treatments

(Cherrington et al., 2005; Colon et al., 2013). These cultural beliefs can influence older Latino's perceptions and knowledge of diabetes and depression and play an integral role in their decision to seek treatment (Cherrington et al., 2005; Moreira et al., 2018). The most common cultural beliefs are *susto* (fright), *coraje* (anger), *fatalismo* (fatalism), and *familismo* (strong family ties). If these beliefs are not well understood by healthcare professionals, this has the potential to interfere with treatment adherence and exacerbate pre-existing risk factors such as language barriers and social pressures to eat traditional foods high in calories and fat (Colon et al., 2013; Moreira et al., 2018; Washburn et al., 2021). Understanding these cultural beliefs can lead to the implementation of more culturally relevant interventions that could better serve these populations' health needs.

Emotional Causation: Susto and Coraje

Many Latinos attribute emotional causation to their diabetes and depression diagnoses. *Susto* (fright) is defined as an intense emotion after a traumatic event, like a car accident or the death of a loved one (Colon et al., 2013; Moreira et al., 2018). This concept is grounded in the culturally bound belief that powerful emotions can affect one's health (Moreira et al., 2018). After experiencing *susto*, it can take days or even years for diabetes and depression symptoms to occur. The treatments for *susto* are diverse and can involve prayer, *curanderos* (traditional healers), herbal medicines, and more clinical treatments, like therapy (Colon et al., 2013). Different Latino heritage groups may have different treatments for *susto*. While some Latinos believe that *susto* can be healed by itself, others believe factors like young age, calm personality, and being overweight can cure symptoms (Moreira et al., 2018).

Coraje (anger) is another Latino cultural belief thought to cause diabetes (Colon et al., 2013). *Coraje* is defined as the emotions associated with social struggles or "moral indignation" (Moreira et al., 2018). There are a number of experiences that can lead to a Latino feeling *coraje*, like being angry or experiencing family violence. In turn, some Latinos may interpret these experiences as contributing to the development of their diabetes and depression. The concept of *coraje* offers insight into how Latino populations associate interpersonal abuse as being a causal factor in disease onset (Moreira et al., 2018).

Cherrington and colleagues (2005) also contribute to studies on the bidirectional relationship between diabetes and depression. In their study of 45 self-identified middle-aged and older Latino adults with diabetes, it was revealed that external factors, like family and societal stressors, can significantly influence the relationship between diabetes and depression. They also found that Latinos were more likely to describe depression using depressive symptoms, like sadness, apathy, and loss of pleasure, and that they were more likely to attribute physical symptoms (e.g., fatigue, low energy, and dizziness) to both conditions (Cherrington et al., 2005). Most participants reported limited discussion with their providers on treatment options and few reported reliance on medication for treating depression symptoms. These findings are consistent with other research surrounding the mental health stigma in Latino communities, which may discourage this population from seeking depression treatment (Fuentes & Aranda, 2019; Washburn et al., 2021).

Fatalismo

Fatalismo (fatalism) has been connected to the origins and outcomes of diabetes and depression (Moreira et al., 2018). Latino health literature has observed *fatalismo* as being related to one's religious beliefs (as a form of punishment for past sins) and real-life circumstances (Moreira et al., 2018). While many Latinos use religion to help them endure their disease, such a coping strategy may be rooted in real-life circumstances. Economic barriers (e.g., lack of health insurance and high treatment costs) may lead to these underserved populations turning to religion for coping. If these populations believe their lives are shaped by fate and there is nothing they can do to improve their health outcomes, this may limit their willingness to seek diabetes and depression help even when treatment is available (Moreira et al., 2018; Washburn et al., 2021).

Familismo

Familismo (strong family ties) is a cultural value that can have a significant impact on diabetes and depression management in Latino populations (Amirehsani et al., 2019). It can include emotional and material support and places heightened importance on the family (Amirehsani et al., 2019; Washburn et al., 2021). Latino health literature has often found this population to turn to their families for medical advice before seeking advice

from medical professionals (Amirehsani et al., 2019; Cherrington et al., 2005). Hence, considering the role of *familismo* in treatment planning and initiation can have significant implications when working with these culturally distinct groups.

Impact of Latino Culture on Help-Seeking Behaviors in Older Latinos with Diabetes and Depression

Latino culture can influence the initiation and continuation of help-seeking for older Latinos with diabetes and depression. Stigma toward diabetes and mental health are the most well-documented barriers to diabetes and depression care in this population and can be conceptualized through cultural explanatory models (Cherrington et al., 2005; Washburn et al., 2021). Cultural explanatory models explain illness causation, symptomatology, and treatment (Fuentes & Aranda, 2019). Through explanatory models, culture directs appropriate responses to illnesses, including disclosure and help-seeking behaviors. While there is limited research on the disclosure and help-seeking experiences among Latinos with diabetes and diabetes-depression comorbidity, cultural values can direct these experiences (Fuentes & Aranda, 2019).

As discussed in prior research (Amirehsani et al., 2019; Cherrington et al., 2005; Colon test al., 2013), culture can influence older Latino's perceptions of diabetes and depression and influence their help-seeking behaviors. These cultural perceptions have been a topic of investigation in recent Latino health literature. For instance, Washburn and colleagues (2021) examined how culture influenced Latinos' stigma-related beliefs concerning diabetes and depression and found that public stigma toward those experiencing depression was moderate, and co-occurring diabetes did not moderate stigma. It was also noted that sociodemographic characteristics (e.g., participants' gender and number of children) were predictive of stigma levels. When comparing community-level stigma, the levels for female subjects were lower than for vignettes featuring males. Similarly, community-level stigma decreased as the participants' number of children increased (Washburn et al., 2021). Overall, this study shows how gender-based expectations related to cultural values can affect Latinos' perceptions of people with diabetes and depression, and depression. When

questioned on their own willingness to seek diabetes and depression treatment, participants noted how gender and family-based cultural values would affect their decision (Washburn et al., 2021). For example, cultural values that place a strong emphasis on family (i.e., *familismo*) may cause older Latinos patients to neglect certain health needs to prioritize others' needs. In terms of gender roles, *familismo* may also affect female and male patients differently. For example, female patients might feel pressured to fulfill their traditional feminine roles (i.e., *marianismo*) and fail to make the time to care for these conditions. Male patients may avoid treatment altogether for fear of losing *machismo*, or strong masculine pride. Such research supports the need for healthcare providers to understand cultural differences when working with Latino patients, especially in the context of diabetes and mental health (Washburn et al., 2021).

Research shows that *familismo* can have both a positive and negative impact on help-seeking and healthcare utilization for older Latinos (Fuentes & Aranada, 2019; Hansen & Cabassa, 2016). For example, family stressors might lead to the underutilization of healthcare services. Such stressors can include spousal problems and concerns about children or other family members (Cherrington et al., 2005). However, the positive aspects of *familismo* can help promote healthy lifestyle behaviors in Latino communities and be used to create culturally relevant diabetes and depression interventions (Amirehsani et al., 2019). The integration of *familismo* in diabetes and depression interventions *may* have a positive effect on the treatment outcomes of older Latinos with diabetes-depression comorbidity (Cherrington et al., 2005; Hansen & Cabassa, 2016). Such interventions warrant further research, especially in the context of working with marginalized populations.

Culturally Tailored Education Strategies for Diabetes and Depression in Older Latinos

There are multiple avenues to improve self-management of diabetes and depression in older Latinos. For example, culturally tailored education strategies can serve as a tool to facilitate help-seeking behaviors. Several systematic reviews have concluded that culturally competent education programs can improve diabetes and depression self-management in

minority populations, including Latinos (Amirehsani et al., 2019; Hansen, 2016; Moreira et al., 2018; Piedra et al., 2018). If healthcare providers are better able to understand Latino cultural beliefs, then treatment recommendations are more likely to be followed.

In their investigation of Latino populations with diabetes, Moreira and colleagues (2018) identified strategies to reduce cultural barriers between patients and healthcare providers. These strategies include but are not limited to developing trust, involving family members or *promotores* (community health workers), and making referrals. Consistent with previous studies (Colon et al., 2013; Gonzalez et al., 2001), the authors cite trust as one of the most important tools for minimizing cultural barriers between patients and healthcare providers. They observed how Latino patients have shown a higher preference for providers who are empathetic and consider their cultural beliefs. Another key finding concerned the role of family members and *promotores* in diabetes care (Moreira et al., 2018). Involving family members in Latino patient care is important, not only due to *familismo*, but because lack of family support has been reported as a barrier to effective diabetes self-management (Moreira et al., 2018). It was also found that these strong family cultural ties can be effective in reducing negative emotions related to diabetes, including depression (Moreira et al., 2018). Ultimately, this study adds to the existing research supporting the important role that *familismo* can have in diabetes and depression education. It also underscores the need for healthcare providers to understand cultural belief structures, as doing so can have positive treatment implications (Moreira et al., 2018). Older Latinos would particularly benefit from these culturally tailored, family-focused interventions due to age and cultural barriers serving as additional barriers to effective self-management.

Amirehsani and colleagues' (2019) research also contributes to studies on how culturally tailored education strategies can improve diabetes treatment in Latino older adults. The purpose of their study was to implement an intervention that centered on the role of *familismo* and examine how it can be used as a tool to improve diabetes self-management. Prominent themes from the focus group with Latino diabetic patients and their families included healthier eating habits, increasing physical activity, taking care of my sugar, coping with emotions, and empowerment and

increased self-efficacy (Amirehsani et al., 2019). Findings support the positive role that *familismo* can have in improving diabetes self-management in older Latino populations. Specifically, participants reported how family motivated them to want to maintain better glycemic control and helped them cope with negative emotions related to diabetes, like depression and anxiety (Amirehsani et al., 2019). Involving family members in healthcare planning and action plans can empower older Latinos to take initiative for their own health. For example, they may feel more motivated to start integrating healthy lifestyle choices, like regular exercise and mindful eating. While more longitudinal research is needed to assess the efficiency and effectiveness of these family-focused action plans; they may have substantial benefits for this group.

Conclusion

The field of diabetes and depression research remains a key area of study, especially among older ethnic minorities. Because older Latinos are at greater risk of concurrently developing diabetes *and* depression, this warrants the need for more studies solely focusing on older Latinos in the United States. As shown in the literature about disease prevalence, diabetes and depression are both serious public health issues facing older Latino populations (Avilés-Santa et al., 2017; Valencia et al., 2014). This is largely due to the intersection of their multiple marginalized identities, including being Latino, socioeconomic status, immigration status, and genetic and behavioral factors that contribute to disease risk. The additional variable of aging may further complicate diabetes and depression self-management in this group.

There are multiple avenues to creating culturally responsive interventions that address diabetes-depression comorbidity in older Latinos. For example, healthcare professionals can learn how to work with the modifiable risk factors (e.g., poor diet and physical inactivity) that affect health behaviors in this population. To accomplish this, providers will need to better understand and assess for Latino cultural values, like *susto*, *coraje*, and *fatalismo*. These values may deter individuals from initiating and/or continuing diabetes and depression treatment (Cherrington et al., 2005; Washburn et al., 2021). Specifically, strong emotions like *susto* and *coraje*

may be associated with disease onset, while *fatalismo* may discourage help-seeking behaviors (Colon et al., 2013; Moreira et al., 2018). By understanding these underlying beliefs, providers can make appropriate treatment recommendations while working on the cultural barriers. It would also allow them to improve patient-provider communication and trust and make appropriate referrals.

Other culturally responsive strategies for addressing diabetes and depression in older Latinos include health education and community outreach. Many older Latinos may not seek treatment or assistance due to cultural differences in health beliefs, lack of education, language barriers, and/or not feeling supported by their family members. Both health education and community outreach could provide workable opportunities to incorporate Latino cultural values, like *familismo* (Valencia et al., 2014). Engaging family members in the treatment process can allow older Latinos to feel more supported in their diabetes and depression management. It can also help prepare Latino families to deal with diabetes and depression if they ever encounter these conditions in their lifetimes. Finally, community outreach can be used to bridge cultural barriers to diabetes and depression treatment. Bicultural and bilingual community health workers can be used to encourage behavior changes through role modeling and provide informational and emotional support for both patients and families (Moreiera et al., 2019). Thus, culturally responsive strategies that incorporate *familismo* can be a viable solution to improving diabetes and depression outcomes for older Latinos.

Overall, findings of this project illustrate the nuanced role that culture can play in influencing the health perceptions and help-seeking behaviors of Latino older adults in the comorbid context of diabetes and depression. Future research in older Latino communities, especially low socioeconomic status, low-resource, and/or immigrant communities, should continue to account for patterns of cultural similarities and differences in the context of community-centered health beliefs. Older Latinos from low socioeconomic and/or immigrant backgrounds may experience greater health disparities due to lower acculturation, limited English proficiency, lack of insurance coverage, low health literacy, and less access to continuity of care (Inoue et al., 2021; Moreno et al., 2016). If these cultural beliefs are

better understood, this has the potential to inform more culturally tailored interventions for addressing diabetes multimorbidity in older Latino populations.

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Katherine Coll

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Understanding Our Airways: How Lung Structure and Function is Impacted by Respiratory Infections and Immune Responses

Biography

Katherine Coll will be receiving her bachelor's degree in biology with a concentration in systems of physiology from San Jose State University in the fall of 2023. Katherine excels academically, maintaining a rigorous schedule with consistent A's in her Biology classes and has been an active member of the Adams lab since 2019. Katherine plans to connect her passion for research and medicine by pursing an MD/PHD.

Katherine's passion for her future career has inspired her to give back to the community through volunteer work at the Stanford Blood Center Clinic, the Second Harvest Food Bank, and Kyo Care. Additionally, Katherine has demonstrated leadership skills by being an active member of various organizations on campus and serving as president and vice president of the San Jose State University SACNAS chapter. As a Teacher's Assistant for the human cadaver lab, Katherine has helped educate her peers and hopes to positively impact their academic experiences.

Understanding Our Airways: How Lung Structure and Function is Impacted by Respiratory Infections and Immune Responses

Abstract

Understanding the underlying functions and interplaying systems that make up the respiratory system is a crucial step in the research and development of treatments for respiratory illnesses. In this literature review, I explore the complex biochemical processes that occur in the pulmonary epithelium and endothelium. As epithelial and endothelial cells serve a multitude of functions such as host protection and nutrient regulation, discussing the interplay between these cells and intercellular junctions and their immediate impact on the respiratory system is essential to understanding the impact of respiratory dysfunctions and diseases. This review further examines the different types of intercellular junctions in pulmonary epithelium and endothelium, their overall composition, and how they maintain cell membrane integrity by appropriately responding to environmental stimuli to grant a comprehensive understanding of these systems.

Introduction

"545 million individuals currently live with a chronic respiratory condition, representing 7·4% of the world's population (GBD Chronic Respiratory Disease Collaborators, 2020)." It is important to understand the structure and function of our respiratory system to eventually find treatments for these illnesses. This review will focus on the composition of intercellular junctions in the pulmonary epithelium and endothelium and synthesis previous studies on how pneumonia can lead to disruption of these intercellular junctions. The lung is one of the main forces that drive the respiratory system wherein a complex series of biochemical processes take place that allow for the exchanges of different gasses between our bodies and the environment. The lower respiratory tract consists of the larynx, trachea, bronchi, and our lungs. Our trachea splits into two main bronchi, which further divide into smaller bronchioles. At the terminal end of the bronchioles are the alveoli (Patwa et al., 2015). Small blood vessels known as capillaries come in close contact with the alveoli, allowing oxygen to be extracted from the air into the blood, and carbon dioxide to be released from the blood into the air. Respiration continually brings air from the environment in contact with the delicate cells in our lungs to provide oxygen. Epithelial and endothelial cells are the two main cell types that help maintain and protect our respiratory tract.

Structure of the respiratory epithelium

Epithelial cells line the respiratory tract offering protection from pathogens as well as aiding in gas exchange. The three main types of epithelial cells are goblet, cilia, and basal cells. Goblet cells secrete mucus, which not only lubricates but also helps to entrap pathogens. Cilia cells facilitate the movement of mucus up and out the respiratory tract. Thereby, propelling out the entrapped particles. Lastly, basal cells restore and help maintain a healthy epithelial layer. (Invernizzi et al., 2020). Each cell type has a distinct function in maintaining the integrity of the respiratory system and aiding in host defense. In addition, the pulmonary epithelium produces surfactant, a substance that helps to reduce surface tension within the alveoli and prevents them from collapsing.

Epithelial cells contain junctions that serve as a form of barrier control, protecting our body from the outside environment. Intercellular junctions are specialized structures that connect adjacent cells. Intercellular junctions, including tight junctions, adherens junctions, and gap junctions all function to connect the cells of the respiratory epithelium. This acts as both a physical and immunological barrier that continuously responds to physiological and pathological stimuli.

Structure of the respiratory endothelium

The pulmonary endothelium consists of the pulmonary capillaries and arteries. Flat squamous cells form a continuous layer throughout. The different cell types present in the respiratory endothelium work together to regulate blood flow and gas exchange, ensuring that oxygen is delivered to the tissues that need it, as well as providing a semipermeable barrier, allowing for regulation of nutrients, macromolecules, and fluid transfer. The structures that promote this vital state of homeostasis are Intercellular junctions. Intercellular junctions in the respiratory endothelium play a critical role in maintaining the integrity of the alveolar-capillary membrane. These junctions link endothelial cells through cytoskeletal microtubules and actin microfilaments to maintain barrier function and modulate signal transduction in response to mechanical ventilation (Hartsock et al.,, 2008). The zonula occludens family connects tight junctions to the actin cytoskeleton of endothelial cells. Vascular endothelial cadherin (VE-cadherin) makes up the majority of adherens junction components in the endothelium. Intracellular junctions in the respiratory endothelium are similar to those found in the respiratory epithelium, which include tight junctions, adherens junctions, and gap junctions.

The respiratory endothelium is closely connected to the respiratory epithelium. The close proximity of these two cell types allows for efficient gas exchange, as oxygen and carbon dioxide can easily diffuse across the thin barrier between them. Dysfunction in one can lead to problems in the other. For example, damage to the pulmonary epithelium can result in decreased surfactant production and impaired gas exchange, while damage to the pulmonary endothelium can lead to increased vascular permeability and the development of pulmonary edema.

Intercellular Junction of the epithelium and endothelium

Intercellular junctions play a critical role in maintaining membrane integrity by influencing cell signaling and the immune responses initiated in response to environmental exposures. Tight junctions are mainly composed of occludins and claudins proteins. In the pulmonary epithelium, claudin-3 and -4 are the most abundant, preventing the entry of harmful pathogens. Adherens junctions consist of transmembrane proteins, such as cadherins and are important for maintaining mechanical stability. In the pulmonary epithelium, E-cadherin is the predominant cadherin expressed, which is responsible for mediating cell-cell adhesion in the epithelium (Falk et al.,, 2010). Connexins, a type of protein, make up gap junctions that facilitates the sharing of metabolites and antioxidants. Strengthening the tissue's ability to react resiliently to stress and damage (Saez et al, 2003). Gap junctions in the pulmonary epithelium are involved in the response to injury and inflammation. They facilitate the communication between different cell types, allowing for the coordinated response to tissue damage and inflammation (Johnson et al., 2009).

The pulmonary endothelium is composed of a complex network of intracellular junctions. These tight junctions, are located near the apical surface of endothelial cells and are composed of occludins, claudins, and junctional adhesion molecules. Tight junctions help prevent the leakage of fluid and solutes from the blood into the lungs. VE-cadherin is the main cadherin expressed in pulmonary endothelium that help regulate the transportation of cells and solutes between the blood and interstitium and is critical for the formation and maintenance of adherens junctions Bazzoni et al, 2004). Beta-catenin and p120-catenin are intracellular proteins that regulate the stability and turnover of VE-cadherin. In the pulmonary endothelium, gap junctions play a critical role in maintaining proper lung function by coordinating the contraction and relaxation of pulmonary smooth muscle cells and regulating the flow of blood through the lungs. Connexin 40 (Cx40) and connexin 43 (Cx43) are the most prevalent connexin proteins in the pulmonary endothelium (Hartsock et al., 2008). These gap junctions allow for cells to coordinate and appropriately respond to changes in oxygen and carbon dioxide levels. When the oxygen level in

the blood drops, the endothelial cells release nitric oxide, which is a molecule that causes smooth muscle cells in the blood vessels to relax, in order to instantiate vasodilation, allowing more blood flow through to the lungs and increasing oxygenation of blood (Vassiliou et al, ,2020).

Intercellular Junctions affected by respiratory illness

Many respiratory illnesses are characterized to have disruption of adherens and tight junctions. Common respiratory illness that can affect intracellular junctions are pneumonia, asthma, and COVID-19. For instance, pneumonia is an infection of the lungs that can cause inflammation and damage to the respiratory tissue (Rayner et al., 1995). This inflammation can disrupt the tight junctions between epithelial cells, leading to increased permeability of the tissue and allowing bacteria or other harmful substances to pass through the epithelium into the bloodstream or surrounding tissue. Pneumonia can affect the tight junctions in the pulmonary epithelium in several ways. First, the inflammatory response that occurs during pneumonia can cause damage to the tight junctions. The release of pro-inflammatory cytokines such as tumor necrosis factor-alpha (TNF-α), interleukin-1 (IL-1), and interleukin-6 (IL-6) can disrupt the structure and function of tight junctions, leading to increased permeability and tissue damage (Gon et al., 2018). Secondly, the immune response to pneumonia can also affect adherens junctions. The release of cytokines and chemokines, such as tumor necrosis factor-alpha (TNF-α) and interleukin-1 beta (IL-1β), can cause the downregulation of cadherins and other adhesion molecules (Kany et al., 2019). The pathogen itself can directly affect adhering junctions. Some bacteria, such as *Streptococcus pneumoniae*, can produce pneumolysin, a toxin that can directly disrupt adherens junctions (Nishimoto et al.,2020). In conclusion, pneumonia can have a significant impact on adhering junctions in the pulmonary epithelium.

Inflammatory mediators such as cytokines, chemokines, and reactive oxygen species (ROS) can cause the disruption of tight junctions in the endothelial barrier (Boueiz et al., 2009). In current studies, it is proposed that this injury occurs directly by downregulating VE-cadherin and upregulating neutrophil adhesion molecule expression and releasing

neutrophil chemotactic factors (Boueiz et al., 2009). The disruption of the tight junctions in the pulmonary endothelium can have several consequences. First, it can lead to increased permeability of the blood-air barrier, allowing fluid and solutes to leak into the air-filled spaces in the lungs. This can lead to the accumulation of fluid in the lungs, a condition known as pulmonary edema, which can impair gas exchange and cause respiratory failure. Second, the disruption of the tight junctions can allow pathogens to enter the bloodstream, which can lead to sepsis, a life-threatening condition in which the body mounts an overwhelming immune response to the infection.

Conclusion

Intercellular junctions are a vital part in maintaining the structural integrity of respiratory epithelium and endothelium. Not only are these structures crucial for basic respiratory functioning such as the exchange of gasses to oxygenate blood, but also play an immense role in host defense. Further research is necessary to fully understand the chemical signaling mechanisms involved in the junctions' abilities to regulate external stimuli and their ability to interact with the immune system. Regardless, this review provides an overview of the current research information and overall understanding of these junctions that will serve as a basis for future research in an effort to improve clinical treatments for respiratory diseases.

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Reem Farhat

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The Effects of Exercise on the Mental Wellness of Children (ages 3-6)

Biography

Reem Farhat has a Bachelor's degree in Psychology. She has worked as a preschool teacher's assistant for 2 years and worked for 2 summers running an after-school program. In her psychology coursework, she has focused on studying early childhood development as well as been certified through CITI training to work with children.

When it comes to psychology, she has always had an interest in healing the mind of trauma and mental health disorders through the use of lifestyle changes. She is mostly interested in how simple changes such as healthy eating, exercise, and sleep could change the chemical environment of the brain and promote long-term recovery. This phenomenon became fascinating to her when she learned the impact of pharmaceutical treatments on mental health patients long-term.

She worked as a mentor for the SJSU Spartan Village program for incoming freshman and created programs to promote mental health understanding and teaching coping techniques. As a mentor, she managed upwards of 300 students, and engaged and encouraged positive mental health practices.

She also worked on a project through COMM university that paired with local elementary schools to help students utilize their energy in a productive way to better their situations and increase their education.

She also worked for a state program, Pacific Clinics, at the Hope center for Youth Opioid Rehabilitation. This was a TAY program (ages 13-25), for youth who have struggled with trauma and are seeking healing and full recovery.

The Effects of Exercise on the Mental Wellness of Children (ages 3-6)

Abstract

When it comes to mental health, young children are often not researched and their tantrums or mood swings are not taken seriously, when in reality these small behavioral issues could be pointing to a larger issue. Children are the most overlooked when it comes to mental health diagnosis and treatment, unless the child begins to display extreme behavior (Philpott et al., 2019). However, preventative mental health care is arguably more pragmatic and less taboo than diagnosis and treatment. While there is research to support the use of exercise in mental wellness, there is still not enough done within the children demographic to implement this in a strategic and routine way (Philpott, 2019). Some research has shown that teaching kids healthy habits, such as exercise, can be effective as a preventative or treatment measure (Philpott et al., 2019).

Extensive research with adults has shown that the use of non-pharmaceutical options is the optimal treatment for mood disorders in both long term and short term (Norwitz et al., 2021). Non-pharmaceutical routes of treatment are a way to avoid side effects, possible drug dependency, worsening condition, and irreversible biochemical changes (Norwitz et al., 2021). Ample evidence has highlighted the importance of non-pharmaceutical interventions for mental health. For example, lower levels of vitamin D are associated with multiple mental disorders, including depression, anxiety, and schizophrenia. In addition, prior research has shown that regular exercise, even if performed at low amounts (15-minute durations at 3 times a week) had significant ameliorative effects on depressive symptoms, likely because exercise increases concentration of a growth factor (i.e., BDNF) for the hippocampus (Hughes et al., 2013) .

During the early childhood years, the brain undergoes critical development. More specifically, neural connections are overproduced and then subjected to selective pruning; this process allows for maximum efficiency in cognitive functions (Shonkoff, 1970). Disturbances in this process can thus adversely affect behavioral, emotional, and cognitive functioning

(Shonkoff, 1970). For young children, exercise habits are critical for development due to the critical stages of brain development that they are in, and therefore the positive impacts from healthy habits may be long lasting and effective (Duman et al., 2012).

Background

The purpose of this study was to better understand the effects of physical activity alone on children's mental wellness. The study documents the cause-and-effect relationship between the exercise variable and mental wellness. This study is needed due to a shortage of research in mental wellness in children. More specifically, few studies document effects on mental wellness through the use of exercise. We hypothesize that the physical exercise and will result in a large improvement in children's mental wellness. There will be four experimental phases for all participants: Phase 1 (no intervention; week 1), Phase 2 (exercise only; week 2), Phase 3 (exercise only; week 3), and Phase 4 ((exercise only; week 4). Parents were given questionnaires once a week to provide assessments on children's mental wellness. Each child was asked to report on their mood each week by asking them to choose emotion pictures (sad face, happy face, etc.) that best describe how they feel. This was done to compare the effectiveness of each intervention over the 4-week period.

Methods and Materials

The researchers will be leading the exercise program, which was approved and created with the help of 4 professionals in sport medicine (*see figure 1).* The exercise will take place at school during regular school hours with the entire class of children. Any child who wants to participate will be able to take part in the exercise activity regardless of their research participation. Exercise intervention occurs during free activity time and does not interfere with class time. For the exercise intervention, each session lasted approximately 20-30 minutes (see Figure 2 for participation). Exercise sessions during the exercise intervention phases (Phases 2, 3, and 4) will occur 3 times a week. The total time commitment for the exercise intervention over 4 weeks is between 360-540 minutes. Exercise intervention was a part of normal class activities during

children's free activity time and was offered to all children who were willing to join. At any time, a child displays signs of distress, the researcher was to escort them back to their classroom teacher.

✓		Task
☐	30 Sec.	Push-ups
☐	45 Sec	Jumping Jacks
☐	45 Sec.	Arm Circles
☐	30 Sec	Sky Touch (Squat Jumps)
☐		Giant Walk (Walking Lunges) - for a chosen distance
☐		Run - For a specified distance
☐	30 Sec.	Push-ups
☐	45 Sec	Jumping Jacks
☐	45 Sec.	Arm Circles
☐	30 Sec	Sky Touch (Squat Jumps)
☐		Giant Walk (Walking Lunges) - for a chosen distance
☐		Run - For a specified distance
☐		DANCE PARTY- Take requests for a couple songs and let the kids DANCE THEIR WIGGLES OUT!

(Figure 1)
Pictured is the exercise intervention that occurred for phases 2-4, this intervention occurred 3 times a week over the course of the 3 phase (3 weeks); during children's outdoor time.

The entire study lasted 4 weeks, split into 4 phases; each phase lasted 1 week. For the first phase of the research there was no intervention, to act as a control variable. For phase two, three and four there was an exercise intervention.

All data collection was completed by the researchers. Parent Surveys were completed at the school during the pick-up period every Friday (See Figure 2). The

researchers were present for the parent surveys, to assist the parents in completing the questionaries.

Phase: 3 Exercise Intervention

Child # 1313

Devereux Early Childhood Assessment for Preschoolers Second Edition (DECA-P2)

(for children ages 3 through 5 years)

Paul A. LeBuffe ■ Jack A. Naglieri

Child's Name: [redacted] Gender: Male Date of Birth: [redacted]

Program/Site: SJSU CDC Classroom/Group: Is your child in Dandelion or Splash? Dandelion

Person Completing this Form: [redacted] Relationship to Child: Father Date of Rating: 3/17/2023

This form describes a number of behaviors seen in some young children. Read the statements that follow the phrase: ***During the past ~~4~~ weeks, how often did the child...*** and place a check mark in the box underneath the word that tells how often you saw the behavior. Please answer each question carefully. There are no right or wrong answers. If you wish to change your answer, put an ✗ through it and fill in your new choice as shown to the right. Please do not skip any items.

	Never	Rarely	Occasionally	Frequently	Very Frequently
	✗	✓			

Item #	During the ~~past 4~~ weeks, how often did the child...	Never ✓	Rarely ✓	Occasionally ✓	Frequently ✓	Very Frequently ✓
1.	act in a way that made adults smile or show interest in him/her?					✓
2.	listen to or respect others?				✓	
3.	control his/her anger?				✓	
4.	seem sad or unemotional at a happy occasion?		✓			
5.	show confidence in his/her abilities (for instance, say "I can do it!")?				✓	
6.	have a temper tantrum?	✓				
7.	keep trying when unsuccessful (show persistence)?					✓
8.	seem uninterested in other children or adults?		✓			
9.	use obscene gestures or offensive language?	✓				
10.	try different ways to solve a problem?					✓
11.	seem happy or excited to see his/her parent or guardian?					✓
12.	destroy or damage property?	✓				
13.	try or ask to try new things or activities?			✓		
14.	show affection for familiar adults?				✓	
15.	start or organize play with other children?				✓	
16.	show patience?		✓			
17.	ask adults to play with or read to him/her?				✓	
18.	have a short attention span (difficulty concentrating)?		✓			
19.	share with other children?			✓		
20.	handle frustration well?				✓	
21.	fight with other children?	✓				
22.	become upset or cry easily?	✓				
23.	show an interest in learning new things?				✓	
24.	trust familiar adults and believe what they say?				✓	
25.	accept another choice when his/her first choice was not available?			✓		
26.	seek help from children/adults when necessary?				✓	
27.	hurt others with actions or words?		✓			
28.	cooperate with others?				✓	
29.	calm himself/herself down?				✓	
30.	get easily distracted?		✓			
31.	make decisions for himself/herself?				✓	
32.	appear happy when playing with others?					✓
33.	choose to do a task that was hard for him/her?				✓	
34.	look forward to activities at home or school (for instance, birthdays or trips)?				✓	
35.	touch children or adults in a way that you thought was inappropriate?	✓				
36.	show a preference for a certain adult, teacher, or parent?		✓			
37.	play well with others?				✓	
38.	remember important information?				✓	

Ask: Do you feel like your child enjoyed the exercise this week? (Based on the phases) Feedback? Then feel free to add any notes or important information.

Notes:

He enjoyed it. He had his first T-ball practice and was looking forward to the exercises. He remembered when the exercises were happening.

	INTIATIVE (IR)	SELF REGULATION (SR)	ATTACHMENT RELATIONSHIP (AR)
SCALE RAW SCORE:	27	21	28
T-SCORE:	50	42	41
PERCENTILE RANK :	50	21	18
DESCRIPTPION	Typical	Typical	Typical

TOTAL

133

=

SUM

TOTAL PROTECTIVE FACTORS (TPR)	BEHAVIOR CONCERNS (BC)
133	7
43	41
24	18
Typical	Typical

(Figure 2)

Pictured is the DECA-2 which was used to survey parents on their children's behavior and to track behavior impacts as the research and exercise interventions progressed. The calculations for the child in this phase are also pictured.

Child Mood Surveys were conducted at school during regular class times (See Figure 3). Kids were surveyed individually by the researchers, and upon completion the researcher walked the kids back to their classroom.

Phase [redacted]

Childs Name/ Number: 1111

Researchers Name: Reem Fahat

Assent and Instruction:
Hello [childs name], my name is [researcher's name].
I would like to ask you questions about how you feel about different things. Is that okay?
(proceed after receiving a verbal or nonvverbal yes)
Now I am going to ask you the questions and I want you to use these faces here to show me how you feel about my questions. And, you can let me know anytime if you don't want to answer or don't want to continue, ok? We can go back anytime, ok?
(proceed after receiving a verbal/nonverbal yes)

Ok. Here we go!

1. I felt like this today. (Script: Point.)

2. Did you feel like you had a lot of energy today? (Script: Point.)

3. Do you feel you are a good person today? (Script: Point.)

4. Did you cry a lot today? (Script: Point.)

5. Do you feel loved today? (Script: Point.)

6. Do you feel tired today?(Script: Point.)

7. Do you feel like you are able to make friends easily today? (Script: Point.)

8. Do you feel calm today? (Script: Point.)

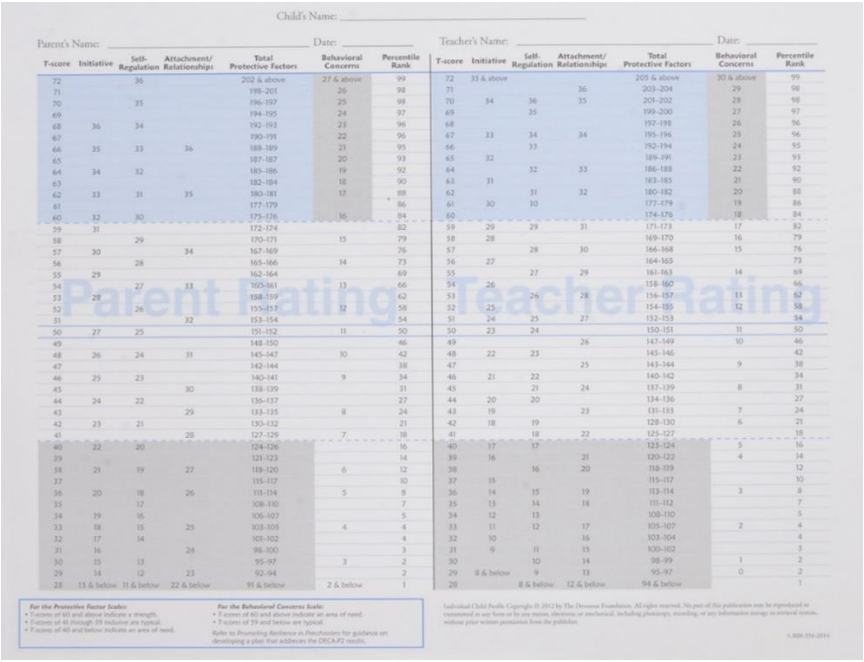
9. Did you feel excited when you woke up today? (Script: Point.)

10. Do you feel like you can tell others how you feel today? (Script: Point.)

(Figure 3)
Pictured is an example of Phase 1 Child Mood Survey, for child 1111. The questions were specifically made to track a child self-reported mood changes across the course of the research.

Data Analysis

After the two-week recruitment period we had a total of 17 participants. Parent surveys were calculated through DECA-P2 scale, through this scale we accounted for each participants IR (initiative), SR (self-regulation), AR (attachment relationship, TPF (total protective factors, and BR (behavior concerns). For each category we measured: scale raw score, t-score, percentile rank, and accounted for a description falling under; (typical, strength, and area of need). See (Figure 4) for scale reference. Each participants data was calculated for each phase that their parent completed the survey. In the end all the scored were added for each phase and averaged out to arrive to the collective data of the participants for each phase. This allows us to see the variable (exercise intervention) true effects across the phases.



Child's Name: _____

Parent's Name: _____ Date: _____

T-score	Initiative	Self-Regulation	Attachment/ Relationships	Total Protective Factors	Behavioral Concerns	Percentile Rank
72		36		202 & above	27 & above	99
71				198–201	26	98
70		35		196–197	25	98
69				194–195	24	97
68	36	34		192–193	23	96
67				190–191	22	96
66	35	33	36	188–189	21	95
65				187–187	20	93
64	34	32		185–186	19	92
63				182–184	18	90
62	33	31	35	180–181	17	88
61				177–179		86
60	32	30		175–176	16	84
59	31			172–174		82
58		29		170–171	15	79
57	30		34	167–169		76
56		28		165–166	14	73
55	29			162–164		69
54		27	33	160–161	13	66
53	28			158–159		62
52		26		155–157	12	58
51			32	153–154		54
50	27	25		151–152	11	50
49				148–150		46
48	26	24	31	145–147	10	42
47				142–144		38
46	25	23		140–141	9	34
45			30	138–139		31
44	24	22		136–137		27
43			29	133–135	8	24
42	23	21		130–132		21
41			28	127–129	7	18
40	22	20		124–126		16
39				121–123		14
38	21	19	27	118–120	6	12
37				115–117		10
36	20	18	26	113–114	5	8
35		17		108–110		7
34	19	16		106–107		5
33	18	15	25	103–105	4	4
32	17	14		101–102		4
31	16		24	98–100		3
30	15	13		95–97	3	2
29	14	12	23	92–94		2
28	13 & below	11 & below	22 & below	91 & below	2 & below	1

Teacher's Name: _____ Date: _____

T-score	Initiative	Self-Regulation	Attachment/ Relationships	Total Protective Factors	Behavioral Concerns	Percentile Rank
72	35 & above			205 & above	30 & above	99
71			36	203–204	29	98
70	34	36	35	201–202	28	98
69		35		199–200	27	97
68				197–198	26	96
67	33	34	34	195–196	25	96
66		33		192–194	24	95
65	32			189–191	23	93
64		32	33	186–188	22	92
63	31			183–185	21	90
62		31	32	180–182	20	88
61	30	30		177–179	19	86
60				174–176	18	84
59	29	29	31	171–173	17	82
58	28			169–170	16	79
57		28	30	166–168	15	76
56	27			164–165		73
55		27	29	161–163	14	69
54	26			158–160		66
53		26	28	156–157	13	62
52	25			154–155	12	58
51	24	25	27	152–153		54
50	23	24		150–151	11	50
49			26	147–149	10	46
48	22	23		145–146		42
47			25	143–144	9	38
46	21	22		140–142		34
45		21	24	137–139	8	31
44	20	20		134–136		27
43	19		23	131–133	7	24
42	18	19		128–130	6	21
41		18	22	125–127		18
40	17	17		123–124	5	16
39	16		21	120–122	4	14
38		16	20	118–119		12
37	15			115–117		10
36	14	15	19	113–114	3	8
35	13	14	18	111–112		7
34	12	13		108–110		5
33	11	12	17	105–107	2	4
32	10		16	103–104		4
31	9	11	15	100–102		3
30		10	14	98–99	1	2
29	8 & below	9	13	95–97	0	2
28		8 & below	12 & below	94 & below		1

For the Protective Factor Scales:
- T-scores of 60 and above indicate a strength.
- T-scores of 41 through 59 inclusive are typical.
- T-scores of 40 and below indicate an area of need.

For the Behavioral Concerns Scale:
- T-scores of 60 and above indicate an area of need.
- T-scores of 59 and below are typical.

Refer to *Promoting Resilience in Preschoolers* for guidance on developing a plan that addresses the DECA-P2 results.

(Figure 4)

Pictured is the DECA-2 scale that was used to calculate each child's individual scores, each week a calculation was completed and accounted for. To measure the scores, we used the Parent rating portion. Depending on each child's score we were able to calculate if they were portraying behaviors of: strength, typical, or an area of need.

Phase 1 Averages
Total Collected: 9

	INTIATIVE (IR)	SELF REGULATION (SR)	ATTACHMENT RELATIONSHIP (AR)
SCALE RAW SCORE:	25	24	31
T-SCORE:	46	48	48 =
PERCENTILE RANK :	34	42	42
DESCRIPTPION	Typical	Typical	Typical

TOTAL
142
SUM

TOTAL PROTECTIVE FACTORS (TPR)	BEHAVIOR CONCERNS (BC)
142	10
47	48
38	42
Typical	Typical

Participants: 1001,3003,4004,5005,8008,9009,1313,1414,1616

(Figure 5)
The first phase was no intervention, see for measurements averages for parent surveys.

Phase 2 Averages
Total Collected: 10

	INTIATIVE (IR)	SELF REGULATION (SR)	ATTACHMENT RELATIONSHIP (AR)
SCALE RAW SCORE:	26	23	30
T-SCORE:	48	46	45 =
PERCENTILE RANK :	42	34	31
DESCRIPTPION	Typical	Typical	Typical

TOTAL
139
SUM

TOTAL PROTECTIVE FACTORS (TPR)	BEHAVIOR CONCERNS (BC)
139	11
45	50
31	50
Typical	Typical

Participants: 1001,4004,5005,7007,8008,9009,1010,1313,1515,1616

(Figure 6)
The second phase was exercise intervention, see for measurement averages for parent surveys.

Phase 3 Averages
Total Collected: 9

	INTIATIVE (IR)	SELF REGULATION (SR)	ATTACHMENT RELATIONSHIP (AR)
SCALE RAW SCORE:	25	22	28
T-SCORE:	46	44	41 =
PERCENTILE RANK :	34	27	18
DESCRIPTPION	Typical	Typical	Typical

131

TOTAL PROTECTIVE FACTORS (TPR)	BEHAVIOR CONCERNS (BC)
131	12
42	52
21	58
Typical	Typical

Participants:1001,2002,4004,5005,8008,1313,1414,1515,1616

(Figure 7)
The third phase was exercise intervention, see for measurement averages for parent surveys.

Phase 4 Averages
Total Collected: 11

	INTIATIVE (IR)	SELF REGULATION (SR)	ATTACHMENT RELATIONSHIP (AR)
SCALE RAW SCORE:	27	24	31
T-SCORE:	50	48	48 =
PERCENTILE RANK :	50	42	42
DESCRIPTPION	Typical	Typical	Typical

146

TOTAL PROTECTIVE FACTORS (TPR)	BEHAVIOR CONCERNS (BC)
146	10
48	48
42	42
Typical	Typical

Participants: 1001,4004,5005,7007,8008,1010,1111,1212,1313,1515,1616

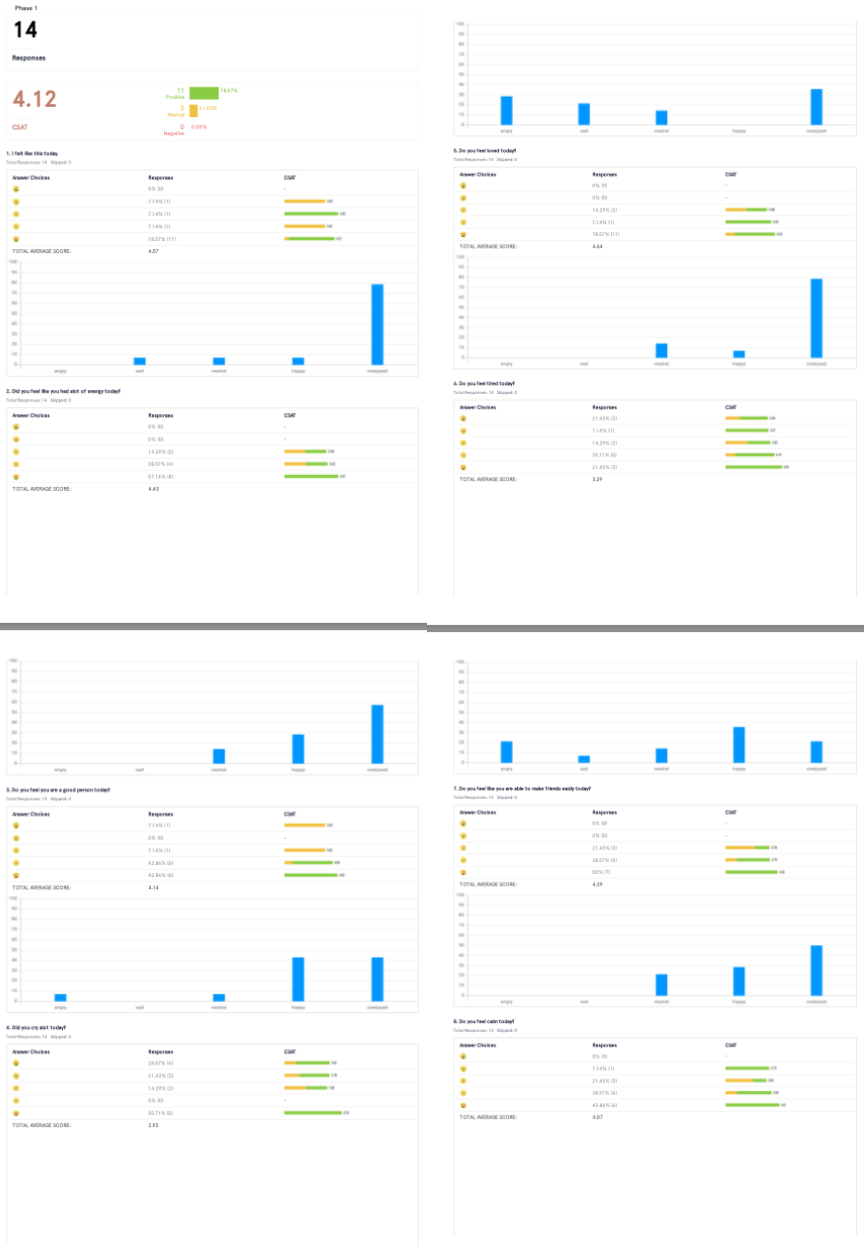
(Figure 8)
The fourth phase was exercise intervention, see for measurement averages for parent surveys.

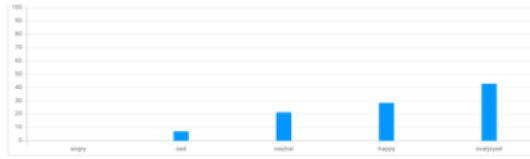
Number	3/6	3/8	3/10	3/13	3/15	3/17	3/20	3/22	3/24
1001	X	x	x		x	x		x	x
2002	X	x		x	x		x	x	x
3003									
4004	X	x	x	x		x			x
5005	X	x		x		x	x		x
6006	X	x			x				
7007	X	x	x		x	x	x	x	x
8008	X	x	x	x	x	x	x	x	x
9009		x			x			x	x
1010	X	x	x	x	x		x	x	x
1111		x		x	x	x	x	x	x
1212		x		x	x	x			
1313		x			x	x		x	x
1414	X	x		x			x		
1515	X	x	x	x	x	x	x	x	x
1616		x	x		x		x	x	x

(Figure 9)

For phases 2-4 each participant who was present was marked with an X, this allows us better understand the data accuracy in relation to the intervention variable in terms of participation.

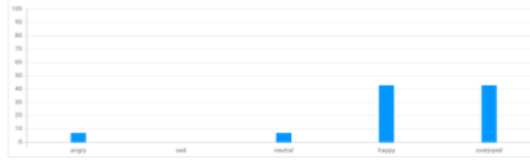
Throughout analyzing the data, it is clear to see that the description of each phase remains the same, as typical. While there is no difference in the descriptions from phase one to phase four it is worthwhile to notate that phase four total T scores was the highest. The total T score for phase one was 142, and for phase two ended being 146 for the average T scores of all of the participants. It is also important to note that this was the parents record of their children's behavior as they perceived their children's changes.


Phase 1
14
Responses
4.12
CSAT
11
Positive
78.57%
3
Neutral
21.43%
0
Negative
0.00%
1. I felt like this today.
Answer Choices
Responses
CSAT
TOTAL AVERAGE SCORE:
4.07
2. Did you feel like you had alot of energy today?
Answer Choices
Responses
CSAT
TOTAL AVERAGE SCORE:
4.43
6. Do you feel loved today?
Answer Choices
Responses
CSAT
TOTAL AVERAGE SCORE:
4.64
4. Do you feel tired today?
Answer Choices
Responses
CSAT
TOTAL AVERAGE SCORE:
3.29
3. Do you feel you are a good person today?
Answer Choices
Responses
CSAT
TOTAL AVERAGE SCORE:
4.14
4. Did you cry alot today?
Answer Choices
Responses
CSAT
TOTAL AVERAGE SCORE:
2.93
7. Do you feel like you are able to make friends easily today?
Answer Choices
Responses
CSAT
TOTAL AVERAGE SCORE:
4.29
8. Do you feel calm today?
Answer Choices
Responses
CSAT
TOTAL AVERAGE SCORE:
4.07



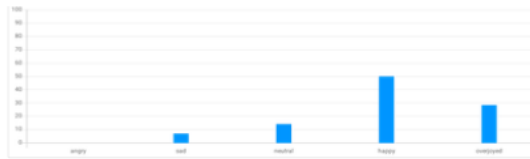
9. Did you feel excited when you woke up today?

Answer Choices	Responses	CSAT
	7.14% (1)	
	0% (0)	-
	7.14% (1)	
	42.86% (6)	
	42.86% (6)	
TOTAL AVERAGE SCORE:	4.14	



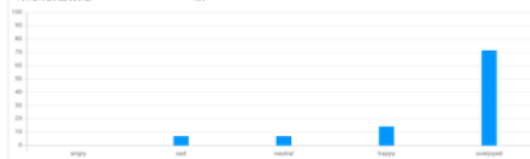
10. Do you feel you can tell others how you feel today?

Answer Choices	Responses	CSAT
	0% (0)	-
	7.14% (1)	
	14.29% (2)	
	50% (7)	
	28.57% (4)	
TOTAL AVERAGE SCORE:	4.00	



11. Do you feel like you are having fun today?

Answer Choices	Responses	CSAT
	0% (0)	-
	7.14% (1)	
	7.14% (1)	
	14.29% (2)	
	71.43% (10)	
TOTAL AVERAGE SCORE:	4.50	

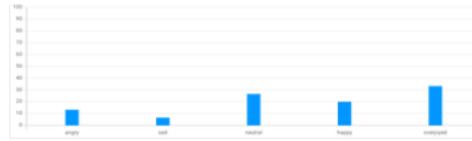


12. Do you feel safe today?

Answer Choices	Responses	CSAT
	0% (0)	-
	0% (0)	-
	0% (0)	-
	57.14% (8)	
TOTAL AVERAGE SCORE:	4.43	

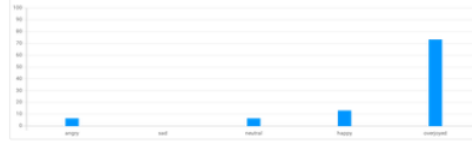
(Figure 10)
The first phase was no intervention, shown above is the averages of the children surveys.


Phase 2
15
Responses
3.87
CSAT
1. I felt like this today.
2. Did you feel like you had alot of energy today?
3. Do you feel you are a good person today?
4. Did you cry alot today?
5. Do you feel loved today?
6. Do you feel tired today?
7. Do you feel like you are able to make friends easily today?
8. Do you feel calm today?



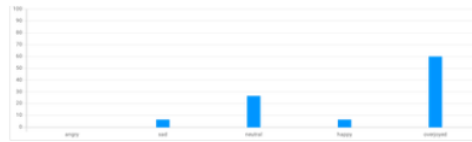
1. Did you feel excited when you woke up today?

Answer Choices	Responses	CSAT
	6.67% (1)	
	0% (0)	-
	6.67% (1)	
	13.33% (2)	
	73.33% (11)	
TOTAL AVERAGE SCORE:	4.47	



10. Do you feel you can tell others how you feel today?

Answer Choices	Responses	CSAT
	0% (0)	-
	6.67% (1)	
	26.67% (4)	
	6.67% (1)	
	60% (9)	
TOTAL AVERAGE SCORE:	4.20	

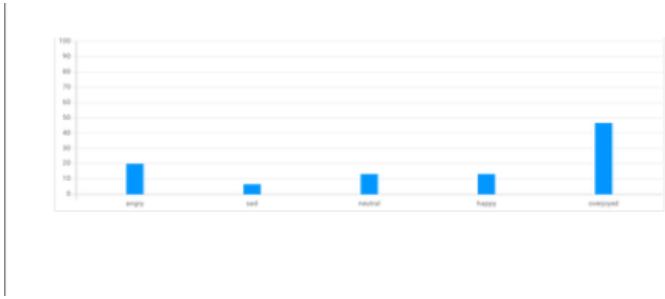


11. Do you feel like you are having fun today?

Answer Choices	Responses	CSAT
	6.67% (1)	
	6.67% (1)	
	0% (0)	-
	26.67% (4)	
	60% (9)	
TOTAL AVERAGE SCORE:	4.27	

12. Do you feel safe today?

Answer Choices	Responses	CSAT
	20% (3)	
	6.67% (1)	
	13.33% (2)	
	13.33% (2)	
	46.67% (7)	
TOTAL AVERAGE SCORE:	3.60	



(Figure 11)
The second phase was exercise intervention, shown above is the averages of the children surveys.


Phase 3
13
Responses
4.15
CSAT
1. I felt like this today.
2. Did you feel like you had alot of energy today?
3. Do you feel you are a good person today?
4. Did you cry alot today?
5. Do you feel loved today?
6. Do you feel tired today?
7. Do you feel like you are able to make friends easily today?
8. Do you feel calm today?

9. Did you feel excited when you woke up today?

Answer Choices	Responses	CSAT
	0% (0)	-
	7.69% (1)	
	7.69% (1)	
	7.69% (1)	
	76.92% (10)	
TOTAL AVERAGE SCORE:	4.54	

10. Do you feel you can tell others how you feel today?

Answer Choices	Responses	CSAT
	0% (0)	-
	0% (0)	-
	7.69% (1)	
	23.08% (3)	
	69.23% (9)	
TOTAL AVERAGE SCORE:	4.62	

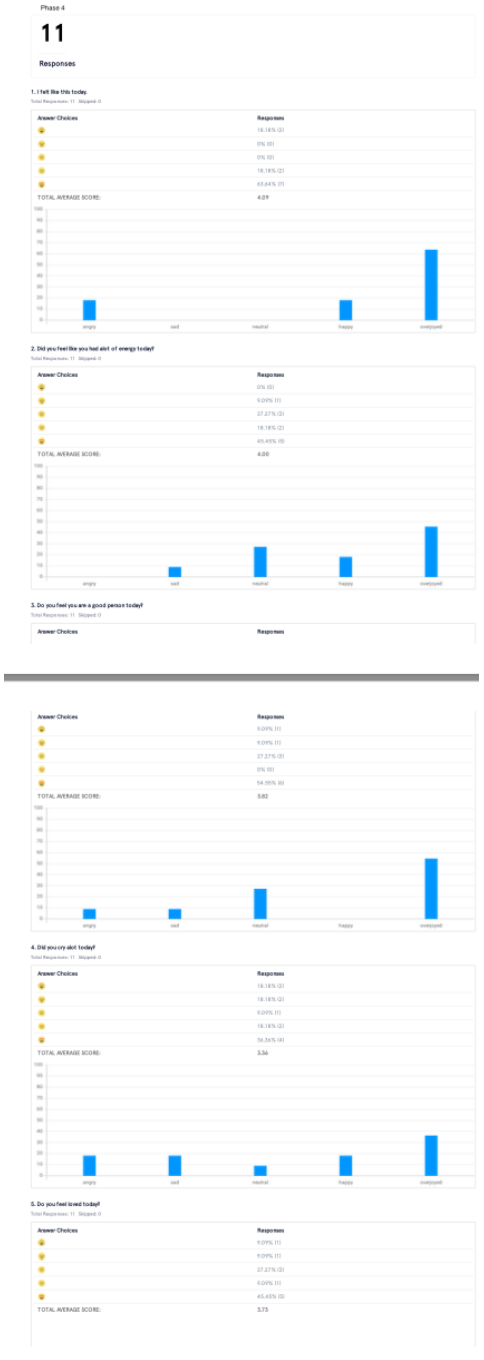
11. Do you feel like you are having fun today?

Answer Choices	Responses	CSAT
	15.38% (2)	
	7.69% (1)	
	7.69% (1)	
	0% (0)	-
	69.23% (9)	
TOTAL AVERAGE SCORE:	4.00	

12. Do you feel safe today?

Answer Choices	Responses	CSAT
	7.69% (1)	
	0% (0)	-
	15.38% (2)	
	30.77% (4)	
	46.15% (6)	
TOTAL AVERAGE SCORE:	4.08	

(Figure 12)
The third phase was exercise intervention, shown above is the averages of the children surveys.


Phase 4
11
Responses
1. I felt like this today.
Answer Choices
Responses
TOTAL AVERAGE SCORE:
4.09
angry
sad
neutral
happy
overjoyed
2. Did you feel like you had alot of energy today?
Answer Choices
Responses
TOTAL AVERAGE SCORE:
4.00
3. Do you feel you are a good person today?
Answer Choices
Responses
TOTAL AVERAGE SCORE:
3.82
4. Did you cry alot today?
Answer Choices
Responses
TOTAL AVERAGE SCORE:
3.36
5. Do you feel loved today?
Answer Choices
Responses
TOTAL AVERAGE SCORE:
3.73

6. Do you feel tired today?

Total Responses: 11 Skipped: 0

Answer Choices	Responses
	0% (0)
	18.18% (2)
	27.27% (3)
	18.18% (2)
	36.36% (4)
TOTAL AVERAGE SCORE:	3.73

7. Do you feel like you are able to make friends easily today?

Total Responses: 11 Skipped: 0

Answer Choices	Responses
	0% (0)
	18.18% (2)
	9.09% (1)
	36.36% (4)
	36.36% (4)
TOTAL AVERAGE SCORE:	3.91

8. Do you feel calm today?

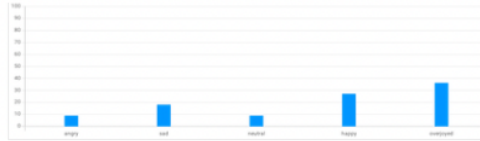
Total Responses: 11 Skipped: 0

Answer Choices	Responses
	0% (0)
	18.18% (2)
	45.45% (5)
	9.09% (1)
	27.27% (3)
TOTAL AVERAGE SCORE:	3.45

9. Did you feel excited when you woke up today?

Total Responses: 11 Skipped: 0

Answer Choices	Responses
	9.09% (1)
	18.18% (2)
	9.09% (1)
	27.27% (3)
	36.36% (4)
TOTAL AVERAGE SCORE:	3.64



10. Do you feel like you can tell others how you feel today?

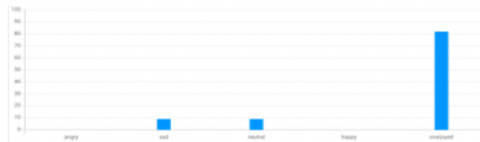
Total Responses: 11 Skipped: 0

Answer Choices	Responses
	18.18% (2)
	0% (0)
	9.09% (1)
	27.27% (3)
	45.45% (5)
TOTAL AVERAGE SCORE:	3.82

11. Do you feel like you are having fun today?

Total Responses: 11 Skipped: 0

Answer Choices	Responses
	0% (0)
	9.09% (1)
	9.09% (1)
	0% (0)
	81.82% (9)
TOTAL AVERAGE SCORE:	4.55



12. Do you feel safe today?

Total Responses: 11 Skipped: 0

Answer Choices	Responses
	9.09% (1)
	0% (0)
	18.18% (2)
	18.18% (2)
	54.55% (6)
TOTAL AVERAGE SCORE:	4.09

(Figure 13)
The fourth phase was exercise intervention, shown above is the averages of the children surveys.

As observed through (Figure 10) through (Figure 13) the children self-reported surveys proved that there was a positive increase in their moods as they progress through the exercise program. while the results aren't drastic, it is important to take into account that some children were absent and unable to complete their surveys therefore there was not a consistent amount of surveys completed through phase one through phase four.

Discussion

While there wasn't a tremendous difference in the children's self-report mood surveys and the parents' surveys in terms of mood improvement. There definitely was a overall positive improvement as the exercise intervention progress. An interesting finding in this research was in the second phase of the experiment, or the first exercise intervention there was a reported lower mood improvement then in the first phase with no intervention. This pattern occurred with both the parent reported surveys and the child's self-reported surveys, this is a discovery worth notating because breaking and building new habits can always be a disturbance to the routine of a child. While forming new habits that are positive one would assume that a child or participants experience would always be positive, this research shows us that when forming a new habit, a child may experience a mood fluctuation that might be perceived as negative, but as researchers it is important for us to dig deeper into this phenomenon.

It is important to consider what a child's normal routine includes, this research shows us that children who don't practice physical exercise regularly when introduced to it in the first week reacted with some resistance. While the children did express enjoying the exercises as they progressed, a healthy amount of physical exercise as recommended by physical medical professionals; may still be mentally daunting to a child who may not have a routine that includes a healthy dosage regularly or as practiced by the parental figures. From the results of this research, we hypothesize that if a child is used to a more sedentary lifestyle, or the

parental figures in their lives do not practice a physical lifestyle there is a direct correlation to the positive impact of the physical exercise. The healthy recommended dose may be seen by the child as and overexertion or unnecessary. This research teaches us that not only is it important to include physical exercise for its benefits and preventative factors in terms of mental health, it is very important that the participants are also educated on the importance of physical exercise; in relation to children, we hypothesized that parental figures leading by example/modeling; plays the largest role in mentally pruning the child and creating a more positive impact to their mood improvements. We hypothesize that this phenomenon works similarly to a placebo effect, if a child simply practices physical exercise, we hypothesize that that may not be enough. While it is still important to notate the positive impacts of physical exercise, we have found that it is also necessary that child is mentally able to understand and see the value in the exercise. It is important that children are taught exercise in a way that is appealing to them and excites them to participate.

We asked the children that we surveyed what they enjoyed most about the exercise, 95% of the children reported it was the dance portion of the exercise. This research also shows us that every child is unique, and it is important to find a form of exercise that works for each child and compels them to partake. It is not only important to practice the physical component of exercise but to also exercise the mental component and make sure that each child is engaged and enjoying the activities. In conclusion mental pruning is equally just as important as the physical movements.

Future Research

When it comes to future research endeavors, we are interested in creating research that develops an educational portion of the research prior to beginning the exercise interventions. It would be interesting to observe the impact if an equal amount of time is spent on educational and mental development as to the exercise interventions. We also hope to conduct research in the future that accounts for nutritional components in relation to the impact of a positive mental wellness in children.

Limitations

This study had limitations that had arisen in multiple portions of the research. the study was originally intended to be a two-month program with the two weeks to each phase. Due to the COVID-19 pandemic the child daycare center at San Jose State was unable to accommodate an 8-week research program. Another limitation was collecting A consistent number of surveys for both parents and children as some parents were absent on survey collection day, as were some of the children.

Acknowledgements

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Yeab Kebede

Major:
Art/Digital Media

Mentor:
Dr. Frank Ortega

#ExistenceisResistance: Black Spartans Exhibition

Biography

Yeab Kebede is a digital media artist with a focus on research and art as a tool of storytelling, documentary filmmaking, and experimental video production. Yeab is originally from Addis Ababa, Ethiopia and currently resides in San Jose, CA. With substantial experience working with departments, faculty, and staff at San José State University developing visual content, Kebede strives to maintain her playful, bold, and intricate style while promoting storytelling, individuality, and culture through her work and focus o9n research. In her recent work, "Black Spartans (1907-1948)," Kebede featured an exhibition that showcased a series of nineteen portraits that represented "ongoing research conducted by San José State University's Special Collection and Archives identifying documentation of Black experiences through San José State University history" (SJSU News Center).

Additionally, Kebede is a Graphic Designer for the MOSAIC Cross Cultural Center, a center that is dedicated to advocating for social justice issues. Furthermore, Kebede serves as an Administrative Coordinator for the Greene Scholars Program, a non-profit organization that focuses on helping youth of African ancestry in San Francisco Bay Area communities successfully complete their higher education in science, technology, engineering, and/or math (STEM).

Kebede plans to pursue her graduate studies to continue researching on how to come about real equality and how art and research can have a significant impact in achieving equality. She plans to one day open up her own not-for-profit school in Ethiopia that will encourage youth to immerse themselves in STEM and art.

#ExistenceisResistance: Black Spartans Exhibition

Abstract

This research paper explores the intersection of art and social justice, with a specific focus on the Black Spartans (1907-1948) Exhibit that showcased 19 Black students who attended San José State University from 1907 to 1948. The paper argues that art, in the form of visual representation, can serve as a powerful tool to address social injustices and provide a platform for underrepresented voices to be heard. By examining the Black Spartans exhibit, the paper highlights the significance of representation and how it can contribute to social justice movements. The paper also analyzes the impact of the exhibit on the local community and how it helped to reshape perceptions of local Bay Area history and how Black individuals during a time of systemic racism and oppression prevailed. Ultimately, the research highlights the importance of creating spaces for diverse narratives to be shared and the role of art in promoting social justice.

Introduction

The San José State University (SJSU) *Black Spartans (1907-1948)* (2022)[1] digital art collection presents the intersection of art and social justice. The exhibition, highlighting the portraits of previous Black students, represents history in contemporary physical and digital spaces. Living in the digital age, creating accessible art is necessary with accessibility being at the heart of social justice. Art as a form of social justice often introduces complicated ideas in a visual format that is open to interpretation while guiding the viewer toward the artist's intent. Although the content choice is key in art, its role in the emotional appeal of the subject is what sells the message. Social justice art differs from traditional art as it intends to uplift marginalized voices and build community while encouraging the audience to be involved in theirs. Arguably, the role of the artist could be to inform the audience, highlighting the fact that all of us can be agents of social change in our communities.

The contributions of previous African American/Black students at San José State University should be highlighted and celebrated. Many of these Black Spartans featured in the exhibition represent the manifestations of their educational aspirations and set a historical precedent. I started this research project through the creative process of digital media, symbolizing my desire to make art accessible, viable, long-lasting, and historically relevant. I connected my educational experiences to those depicted in the artwork. My art signifies the everyday person and those that are left out of popular discourse. Their stories have equal cultural wealth and importance and must be part of the institution's collective memory.

The 19 digital portraits I created for the *Black Spartans (1907-1948)* collection capture the nuances of Blackness and sets the tone for self-exploration. This self-analysis allows for a deeper understanding of what it means to be an African American/Black student in the Bay Area. This artwork stemmed from a collaboration with San José State University's Special Collections and Archives team to provide a visual component to their efforts to preserve the experiences of previous Black SJSU students. The featured alumni in the exhibit attended SJSU from the early 1900s to the 1950s at various times. The portraits highlight the individual's tenacity, perseverance, and ultimately puts a spotlight on their day-to-day lives. In

the developmental process, I was able to reinterpret and reflect on my path and place in the broader community and within the institution's historical traditions.

Research Questions

The existing research and literature on both physical and digital archives within African diasporic and Black studies, institutionalized White space and racism, Black autonomy, and the revival of Black history leads to the following research questions: What is the impact of digital art as a form of social justice expression in today's society? And, how does the San José State University's *Black Spartans (1907-1948)* (2022) digital archive showcase African American/Black intelligence, excellence, and art history? Lastly, how does documenting the average life of the Black person (at SJSU) disrupt the master narrative?

Literature Review

Storytelling

Researchers express the significance of storytelling through digital media and the importance of creativity in conveying messages. In, "You Better Recognize!: The Arts as Social Justice for African American Students,"[2] Mary Stone Hanley explores how middle school and high school students critically confront racism, classism, and internalized oppression through performance art. Hanley introduces a project, the Tubman Theatre Project (TTP), that researches the synergy between the "redistribution of resources and recognition of identity and culture" and the liberation of Black youth through art and education by being "...creative critical change agents who challenge demeaning perceptions and practices." The TTP was a "culturally relevant theatre program" that was modeled to encourage Black youth to channel their interactions and experiences with racism, inequality, and oppression into their performances to serve as a form of resistance. Theatre arts and digital media are related in this aspect because they both are being used as a vehicle to interpret ideas, emotions, and experiences of the Black narrative.

Making the fundamentals of social justice available is what makes digital art understandable, more palatable, and impactful to the masses.

Finding and isolating the key themes within social justice movements allows the artist to hone in on their medium and let it speak for itself. As stated in "Imagining Otherwise: Connecting the Arts and Social Justice to Envision and Act for Change"[3] by Lee Anne Bell and Dipti Desai, "perceiving the relationality of privilege and oppression requires that we be attentive to the kinds of stories that are given voice through history and those that are not." Both social and digital art is centered around passing down information to further enact change which is a pillar of social justice education. As Paul VanDeCarr says in "Storytelling and Social Change,"[4] stories should not be seen as discrete products, but instead as "... an essential part of how we think, feel, remember, imagine, relate – and create change." Digital art differs from traditional art as it incorporates 21st-century innovations with traditional creations ensuring that it is still art for the people and by the people.

Digital art is more accessible for both the artist and the audience due to its presentable nature. In the past, artists had to create their own paint using pigments, oils, and even egg yolk.[5] This adds to the notion that digital art is easier to create and distribute. Several software and programs exist for this very purpose with new and updated ones being released regularly. With the continuing technological explosion and growth, the settings available for creatives have only increased with no signs of slowing down. Digital art does not only have to be created digitally, which in turn allows thousand-year-old art to be seen on our devices. It addresses the same themes as traditional art while still pushing the boundaries of what modern art can be.

Social Justice & Institutional Space

In traditional and historically White institutional spaces, Blackness is often marginalized and erased. Therefore, the implementation of Black art remains a form of resistance and requires a social justice approach to creation and public installations. According to *Art and Social Justice Education: Culture as Commons*, art is a bridge between the ultimate transformation of communities through cross-cultural education and the solidarity of communities that are kept at the margins of society. At Boston College, a group of archivists and law professors launched an online archive and exhibit on the life of Robert Morris, the second Black lawyer in the

United States. During his time, Morris was widely known for his advocacy work on integrating "…schools, militias, and public spaces" and his support for "equal rights for women."[6] The purpose of the exhibit exploring Morris' life is to highlight the existence of a successful Black professional who advocated for equal rights amidst victimizing legislation such as the Fugitive Slave Act of 1850.[7] Emphasizing African American historical figures provides a deeper and more meaningful understanding of Black contributions.

Regarding San José State University's archive, it is tough to find excellence when existence is scarce. The digital archive is limited when it comes to documenting the lives of past Black students. *Black Spartans (1907-1948)* Exhibition is the biggest exhibition highlighting this time period. There were little to no entries focusing on Black art in the digital archives until now. This adds to the lack of Black history, representation, and legacy of the school throughout its incarnations. However, that does not mean Black people were not here. Although the university practiced integration since its inception, it fell victim to the "separate but equal" doctrine. Thirty years before the *Plessy v Ferguson* [8] court case, Black students in San Francisco were the first to be segregated in the state's public schools, as shown in *Mendez v Westminster: School Desegregation*.[9] Here, public education was viewed as a luxury that directly impacted literacy and creativity in colored communities.

Such was the case for San José State, where there were still little to no Black students enrolled. From sports teams to club pictures to beauty pageants, Black people were not seen nor represented. However, Lucy Turner Johnson, earning her teaching credential, graduated from what was then the Normal School Teacher's College in 1907, as stated in "African Americans of San José and Santa Clara County" by Jan Batiste Adkins.[10] Being the first Black graduate and Black teacher in the city, Johnson set an unspoken precedent of being Black at San José State. Also included in Adkins' work were the stories of the first Black fire chiefs, female firefighters, and volunteer leaders in San José. Some of the high-achieving students that followed in Johnson's footsteps at the school were successful teachers, athletes, and musicians. SJSU's Art Department, which was founded in 1911, "gained its reputation as one of the finest in the West."[11]

By the late 1950s, students and faculty of the department made up, "the largest group of artist-educators between San Francisco and Los Angeles."[12] The early stages of the department on campus were not headed by Black people and it is unknown when the first Black art student attended the university. However, their legacy continues with currently enrolled Black art students today.

Methodology

The *Black Spartans (1907-1948)* (see Table 1 below) project was created between December 2021 and January 2022. The images are an attempt to fill the void that exists at San José State University and the lack of knowledge and documentation of previous Black students attendees. This project further, "...represents ongoing research in San José State University Special Collections & Archives identifying documentation of Black experiences throughout SJSU history."[13] Nearly all of the information on past Black Spartans were written from the perspectives of White students as they were the ones working in the university's newspapers and yearbooks. My role as both a researcher and artist was to closely examine the findings of archivists to educate both the public and myself about these people and to share their stories in an accessible format. This research focuses on the intersection of history, race, education, art, and resistance. This analysis provides the researcher with a toolkit to examine culture in combination with multiple identities related to race, class, gender, and sexuality.

Discussion

Historical Contributions & Educational Achievement

Throughout American history, the Black experience often circulates around those who are revered. Whether it's those who worked for education reform, desegregated sports, or were Black on television, we're only taught about those who made a big change. However, what about those who were not in the spotlight? What about those who were not driven by systemic oppression and discrimination? This is the story of the average Black American, those who were not civil rights leaders, social reformers, or public figures. The overarching theme surrounding Black American history

has been of struggle, whether it was for equality in education, or public facilities where the "separate but equal" doctrine was implemented. This is demonstrated in Figure 1, Douglas Kinnard attended San José State College from 1934-35. His collegiate journey was marked by countless achievements in Greek life, athletics, and music. The African motif and vibrant color choice indicate elements from his academic journey and personal accomplishments.

Figure 1

Furthermore, Black art in America today has reached prominence due to movements such as the Harlem Renaissance. Because of the explosive and rapturous nature of this uniquely Black American culture, the art that was created would not have formed the way it did without the contributions of everyone. The creative part of Black history is often not included in the master narrative, which focuses on contributions by White artists. Black people tend to be mentioned throughout American history when convenient, which diverges attention from Black creatives and what they were regularly doing. Due to the Great Migration, Black people who moved North were very in tune with what their community was doing.

According to *Creating Their Own Image: The History of African-American Women Artists* by Lisa Farrington, Augusta Savage was a sculptor still conscious of equal rights, Pan-Africanism, and Black autonomy.[14] Although she included all of these concepts in her work, she is one of nearly all Black artists at the time who were creating content focusing on Black problems and identity. From the New Negro Movement to the artistic growth of Harlem, the Black community of New York City developed cultural consciousness, ideological liberation, and the understanding that Black art is not inferior to White art.

Figure 2

Lucy Turner Johnson attended SJSU (then known as California State Normal School) from 1905-1907 earning her teaching credential. As the first Black student that attended and graduated from SJSU, Johnson became the first African American public school teacher in the city of San José and later a Red Cross volunteer. This multi-media collage shows a variety of avant-garde symbols and slogans that contours her portrait. The dominant purple color located around the corners of the frame draws the audience's attention around the whole work.

The Black Spartans featured in this exhibit pursued their educational goals while combating institutionalized racism amidst the turbulent times featuring both World Wars, the Influenza Pandemic of 1918, and the Polio epidemic. On campus, blackface and minstrel shows were a regular part of student events. These national events also transpired at the local level, off-campus, "the deed to virtually every home in San José"[15] included restrictions against Black and Asian residents known as restrictive covenants.

From art to music and to literature, Black art has thrived in the nation for generations. The Harlem Renaissance ignited the flame of what it meant for Black people to be creative in a space that was not fostering that creativity. What they created was for them and by them. Although there were systemic and societal "glass ceilings" that tried to hinder the artistic creativity of Black and Brown people, each community's history has been unmistakably marked by perseverance.

Conclusion

The San José State University (SJSU) *Black Spartans (1907-1948)* (2022) digital art collection features portraits of previous Black students, representing their history in contemporary, physical, and digital spaces. The purpose of the exhibition was to highlight the lives of past Black students who attended San José State University. Black history oftentimes emphasizes public figures, which inadvertently shifts the focus from the average Black person. The contributions of past Black Spartans should not be told from the shadows of famous Black leaders. For Black history, the existence of its people can be seen as resistance because they were thriving in a system that was not built to include them. In a racially, physically, and politically turbulent time, these Spartans paved the way not only for future Black athletes, teachers, and more but for Black students altogether. Now, in this increasingly digital age, the field of digital and media arts capitalizes on the form's accessible nature. This allows artists to create art of their choice in a highly accessible manner.

Digital art is a form of social justice that introduces social critique in a visual format that is open to interpretation while still guiding the viewer toward the artist's intent. Creating this exhibition in a visual form allowed

the audience to not only see the past Black Spartans and what they were interested in, but what they stood for. They were more than faces in the yearbook, athletes on a court, and teachers in the city. They paved the way for generations of Black students to follow in their footsteps while still creating trails of their own for more to come. Being an African immigrant, creating this exhibition has helped me understand the African American experience all while helping me see previous Black existence and involvement on campus. The public display of 19 Black portraits offers a counter-narrative to the often-neglected educational history of African American students. Through the creation and exploration of the images of Black alumni, this research highlights the intersection of history, race, education, art, and resistance, to truly capture the spirit of #ExistenceisResistance.

Table 1: ***Black Spartans (1907-1948)***

Portraits #1-19	**Attended SJSU (then San José Normal School or San José State College)**
1. Aubrey Minter	1940-1944
2. Don Presley	1937-1940
3. Douglas Kinnard	1934-1935
4. Edward Homer Soulds	1934-1935
5. Ernie Allen	1940-1941
6. Faricita Hall	1932-1935
7. Hal Capers	1943

8. Henrietta Harris	1933, 1936-1940
9. Irving Smith	1942
10. John Allen	1939-1941
11. Lloyd Thomas	1936-1939
12. Lucy Turner	1905-1907
13. Mark Courts	1942-1943
14. Ralph Kaufamn	1941
15. Roger Romine	1941-1942
16. Thelno Knowles	1941-1943, 1946-1948
17. William Lewis	1934-1939
18. William Moulden	1935-1941
19. Willie Steele	1942-1943

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1."Black Spartans." *Dr. Martin Luther King Jr. Library*, https://library.sjsu.edu/black-spartans

2. Hanley, M. S. (2011). You Better Recognize!: The Arts as Social Justice for African American Students. *Equity & Excellence in Education*, 44:3, 420-444.

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The Red Ribbon and the Black Cross: A Qualitative Study of the Relationship between Social Activism and Contemporary Black Church Responses to HIV in Oakland, CA

Biography

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The Red Ribbon and the Black Cross: A Qualitative Study of the Relationship between Social Activism and Contemporary Black Church Responses to HIV in Oakland, CA

Abstract

The Black Church as a social institution has been a source of social activism during racial crises, but there is a lacking social activist response by Black churches to HIV's disparate impact on Black communities. Previous research does not adequately explore the influence of community-based organizations on Black church responses to HIV in the context of social activism. This study examines the relationship between social activism and contemporary Black church responses to HIV in Oakland. It considers community-based organizations (CBOs) as potential drivers of social activism. Semi-structured interviews with Black church leaders in Oakland were conducted and content analyzed along with associated church websites to thematize contemporary responses to HIV. Findings reveal that Black churches that have adequate resources, are committed to social justice, and welcome and affirm gender and sexual minorities are motivated to address HIV through social activism.

Keywords: AIDS; Black Church; community-based organizations; HIV; Oakland; social activism; social justice

INTRODUCTION

On the 35th anniversary of the HIV epidemic in 2016, former President Barack Obama released a press statement claiming that an AIDS free generation is possible.[1] This is a bold claim but has increasingly become more likely with the advent of new biomedical innovations that can treat and prevent HIV. He emphasized that a continued mobilization of testing, treatment, and education among the most impacted populations is necessary to realize this goal.[2] From the onset of the epidemic until now, African Americans have been disparately impacted. In 1981, the year of the first reported AIDS cases in the U.S., they represented 29% of HIV cases while being only 11.7% of the total U.S. population.[3] Similarly, in 2020, they accounted for 13.4% of the total U.S. population but are 37.4% of people living with HIV.[4] Racial disparities in HIV outcomes are associated with structural barriers to HIV care and prevention, like access to affordable

[1] Amy Lansky, "Statement by the President on the 35th Anniversary of HIV/AIDS in America," June 5, 2016, https://obamawhitehouse.archives.gov/blog/2016/06/05/statement-president-35th-anniversary-hivaids-america.

[2] Ibid.

[3] Centers for Disease Control, "HIV Surveillance Report, 2020," May 2022, https://www.cdc.gov/hiv/pdf/library/reports/surveillance/cdc-hiv-surveillance-report-2020-updated-vol-33.pdf. This report notes that the reduction of HIV diagnoses in 2020 is likely "due to disruptions in clinical care services, patient hesitancy in accessing clinical services, and shortages in HIV testing reagents/materials, which causes concern regarding underdiagnosis."; Reinhold, Robert, and Special to the New York Times. "1980 Census Shows 17% Growth of Blacks Surpassed Rise for U.S.," *The New York Times*, February 24, 1981, sec. U.S., https://www.nytimes.com/1981/02/24/us/1980-census-shows-17-growth-of-blacks-surpassed-rise-for-us.html.

[4] "Impact on Racial and Ethnic Minorities," HIV.gov, January 26, 2022, https://www.hiv.gov/hiv-basics/overview/data-and-trends/impact-on-racial-and-ethnic-minorities.

healthcare, incarceration, and poverty.[5] Community-based interventions (CBIs) are health programs designed to improve health outcomes in certain communities.[6] They are an effective evidence-based solution to address social and structural barriers because they "allow increased access and ease the availability of medical care to populations at risk, or already with HIV."[7] Churches and other faith-based organizations (FBOs) are ideal conduits for CBIs due to their trusted position in vulnerable communities.[8] Given the historical role of Black churches in addressing pressing issues in Black communities in the U.S., Black churches are well-situated to be efficient mediums for implementing community-based interventions.

The Black Church & HIV

Historically, the Black Church has held a central role within the Black community.[9] Its prominence is largely due to its function as a source

[5] Matthew E. Levy et al., "Understanding Structural Barriers to Accessing HIV Testing and Prevention Services among Black Men Who Have Sex with Men (BMSM) in the United States," *AIDS and Behavior* 18, no. 5 (2014): 972-996, https://doi.org/10.1007/s10461-014-0719-x.

[6] Kenneth R. McLeroy, Barbara L. Norton, Michelle C. Kegler, James N. Burdine, and Ciro V. Sumaya. "Community-Based Interventions." *American Journal of Public Health* 93, no. 4 (April 2003): 529–33. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1447783/.

[7] Rehana A Salam et al., "Impact of Community-Based Interventions on HIV Knowledge, Attitudes, and Transmission," *Infectious Diseases of Poverty* 3, no. 1 (2014): n.p., https://doi.org/10.1186/2049-9957-3-26.

[8] Karen R. Flórez, Denise D Payán, Kartika Palar, Malcolm V Williams, Bozena Katic, and Kathryn P. Derose. "Church-Based Interventions to Address Obesity among African Americans and Latinos in the United States: A Systematic Review." *Nutrition Reviews* 78, no. 4 (April 1, 2020): 304–22. https://doi.org/10.1093/nutrit/nuz046.

[9] Richard I. McKinney, "The Black Church: Its Development and Present Impact." *The Harvard Theological Review* 64, no. 4 (1971): 452–81. http://www.jstor.org/stable/1509098.

of resiliency and social justice to rectify racially discriminatory conditions. Sociologist Sandra Barnes (2004) describes the Black Church as an agent for "civil, political, and economic involvement" and as a "refuge in a hostile, white world."[10] By appropriating Christian tenants of hope and salvation to the Black American experience, many Black Americans use the Christian faith as a source of "moral and spiritual strength" against racial injustices.[11] The Black Church facilitates the creation of groups and networks in which resources are distributed and exchanged. Sociologist Daniel C. Thompson states that the Black Church acts as a parent to many organizations in the Black community who seek to compensate for insufficient access to resources by providing services.[12] An example of this is the burial-aids societies which assisted families with funeral funds. Furthermore, Black churches create socially cohesive communities due to mass participation in worship and other church activities where messages of resistance and social justice are shared. As a result, congregants can find the motivation to create social change by being immersed in church culture. The Black Church has historically given members the tools to stay resilient to past injustices, but its participation in some contemporary racial issues, namely HIV, is lacking compared to previous efforts.

In 1981, the Centers for Disease Control and Prevention (CDC) declared the onset of the HIV epidemic. It paralyzed some Black congregations due to its high prevalence in socially ostracized groups, e.g., men who have sex with men, people who use drugs, and commercial sex workers.[13] At that time, the dominant Christian theological interpretation of

[10]Sandra L. Barnes, "Priestly and Prophetic Influences on Black Church Social Services." *Social Problems* 51, no. 2 (2004): 203, https://doi.org/10.1525/sp.2004.51.2.202.

[11] Ibid.

[12] Daniel C. Thompson, *The Negro Leadership Class,* (Englewood Cliffs, NJ: Prentice-Hall-Spectrum Books, 1963).

[13] Nikita Viswasam, Sheree Schwartz, and Stefan Baral, "Characterizing the Role of Intersecting Stigmas and Sustained Inequities in Driving HIV Syndemics across Low-to-Middle-Income Settings," *Current Opinion in*

homosexuality condemned same-gender love and stigmatized premarital sex, and construed HIV/AIDS as God's punishment for disobeying his commandments.[14] Church leaders also did not think it was worthy of being addressed due to media portrayals of HIV being a "white, gay man's disease."[15] The taboo of sexuality and the lack of awareness of its prevalence within Black communities prevented Black churches from mobilizing resources at the beginning of the epidemic. Unfortunately, studies note that this lack of early response among Black churches is partly responsible for the virus's disproportionate impact on Black communities.[16]

By the mid-1990s, the impact of HIV became apparent within congregations and the broader community, catalyzing the creation of church ministries and programs to help those living with HIV thrive and to educate the wider community on prevention. For example, the African Methodist Episcopal (AME) Church—the first Black Church denomination in the U.S.—instituted guidelines to increase HIV literacy among its clergy. Requirements mandate that clergy at all levels are expected to 1) have a basic scientific understanding of HIV and 2) be recertified every four years.[17] Similarly, activist Parnessa C. Seele organized the Harlem Week of Prayer to educate Black religious leaders and to help them develop

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HIV and AIDS Publish Ahead of Print (January 2020): n.p., https://doi.org/10.1097/coh.0000000000000630.

[14] Horace L. Griffin, *Their Own Receive Them Not: African American Lesbians and Gays in Black Churches* (Eugene, OR: Wipf & Stock, 2010).

[15] Angelique C. Harris, "Sex, Stigma, and the Holy Ghost: The Black Church and the Construction of AIDS in New York City." *Journal of African American Studies* 14, no. 1 (2010): 31. https://doi.org/10.1007/s12111-009-9105-6.

[16] For a representative sample, see Cohen, Cathy J. *The Boundaries of Blackness: AIDS and the Breakdown of Black Politics*. Chicago: University of Chicago Press, 1999.

[17] Robin G. Lanzi et al., "Love with No Exceptions: A Statewide Faith-Based, University–Community Partnership for Faith-Based HIV Training and Assessment of Needs in the Deep South," *AIDS and Behavior* 23, no. 11 (2019): 2936-2945, https://doi.org/10.1007/s10461-019-02604-7.

progressive responses to HIV.[18] Her efforts later expanded to the creation of the Balm of Gilead, a non-profit organization that coordinates religious institutions worldwide to address HIV and other health disparities. The cumulative work of activists like Seele resulted in Black clergy addressing homophobia and misinformation within their congregations. Furthermore, the Ryan White CARE Act of 1990 and other government-funded initiatives enabled churches to apply for capacity development grants to increase their ability to develop community-based interventions.[19] Churches could use grant money to establish in-house primary care services to increase access to essential services for those living with or at risk of contracting HIV. Despite increased support, congregations are still battling stigma, lack of awareness, and insufficient funding for the mobilization needed to improve HIV outcomes in Black communities.

Social Activism, Social Justice, and Social Services

Addressing health issues is neither new nor uncommon among Black churches. They utilize education, community building, and alliances within a social-activist framework to mitigate health disparities and their effects on other social inequities. In a study that seeks to understand the relationship between social activism and gender inclusivity in Black churches, Barnes (2006) defines social activism as "community involvement designed to address social problems such as poverty, discrimination, and other forms of unequal treatment."[20] Social activism is

[18]Dan Royles, *To Make the Wounded Whole: The African American Struggle against HIV/AIDS* (Chapel Hill: *University of North Carolina Press*, 2020).

[19] "Part C: Early Intervention Services and Capacity Development Program Grants," Ryan White HIV/AIDS Program, (February 4, 2022), https://ryanwhite.hrsa.gov/about/parts-and-initiatives/part-c-early-intervention.

[20] Sandra L. Barnes, "Whosoever Will Let Her Come: Social Activism and Gender Inclusivity in the Black Church." *Journal for the Scientific Study of Religion* 45, no. 3 (2006): 383, note 2. https://doi.org/10.1111/j.1468-5906.2006.00312.x.

rooted in the prophetic role of the Black Church. Religious scholars Eric C. Lincoln and Lawrence H. Mamiya (1990) contend that the Black Church has the priestly and prophetic function. The priestly function deals with the spiritual concerns of congregants, while the prophetic role is concerned with "political involvement and activities."[21] This prophetic role allows churches to work "in the world to improve political, social, and economic conditions."[22] Ultimately, social activism in the Black Church tradition can be useful in addressing the social and structural drivers of health disparities.

Churches often establish health ministries to address health issues within their respective communities. Health ministries are formal and informal church programming that holistically— spiritually, physically, and psychologically—addresses health.[23] They refer clients to medical care and social services to compensate for social and healthcare disparities within their own communities. These services are meant to act as the collective's provision of resources and support for its own members and are offered in the example of the Christian emphasis on helping the less fortunate.[24] Some examples of services are counseling, food services, housing assistance, and financial aid.

Social services and social activism are different due to their intended beneficiaries. Social services within churches are meant to address the individual needs of clients. Social activism addresses issues that collectively impact the public. Social activism addresses structural drivers of disparity, which affects multiple populations. Social services mitigate outcomes of structural inequities, which are often unique to the place, time, and

[21] Eric C. Lincoln, and Lawrence H. Mamiya. *The Black Church in the African American Experience*. Durham: Duke University Press, 1990, 12.
[22] Sandra L. Barnes, "Priestly and Prophetic Influences on Black Church Social Services," 209.
[23]Diane Dean, Karen T. Jorgensen, David S. Loose, and Mary E. Duffy. "Local Health Planning: A Report of a Collaborative Process between a University and a Church." *Family and Community Health* 10, no. 4 (1988): 13–22. http://www.jstor.org/stable/44952918.
[24] Sandra L. Barnes "Priestly and Prophetic Influences on Black Church Social Services."

population they manifest in. Nevertheless, both participate in the project of social justice. Social justice is a process and an outcome in which resources and social benefits are distributed fairly.[25] Within the Black Church tradition, social justice advances the welfare of marginalized populations through theological principles of equality, justice, and inclusiveness and is used for the socio-political deliverance from racial oppression.[26]

HIV in Oakland and Local CBOs

Oakland's Black residents account for approximately 24% of its population, making it the city with the largest Black population in the San Francisco Bay Area.[27] In Alameda County, where Oakland is located, roughly 6,300 people are currently living with HIV.[28] Most of these cases are in Oakland.[29] From 2018–2020, Black people made up 40.2% of new HIV diagnoses while only being 10% of the population in Alameda

[25] Colin R. Bonnycastle, "Social Justice along a Continuum: A Relational Illustrative Model." *Social Service Review* 85, no. 2 (2011): 267–95. https://doi.org/10.1086/660703.

[26] Sandra L. Barnes, "Black Church Culture and Community Action," *Social Forces* 84, no. 2 (December 1, 2005): 967–94. https://doi.org/10.1353/sof.2006.0003; James I. Clark, "Social Justice and Black Church Leadership: A Phenomenological Study." *ProQuest Dissertations Publishing*, 2014. https://www.proquest.com/docview/1691842963.

[27] Stephen Menendian and Samir Gambir, "Racial Segregation in the San Francisco Bay Area, Part 2," *Other and Belonging Institute,* (2019), n.p., https://belonging.berkeley.edu/racial-segregation-san-francisco-bay-area-part-2.

[28] "2022 Demographics," Healthy Alameda County, accessed July 10, 2022, https://www.healthyalamedacounty.org/demographicdata; Alameda County Department of Health, "HIV in Alameda County, 2018-2020," n.d., https://oaklandtga.org/wp-content/uploads/2022/01/hiv-ac-2018-20.pdf.

[29] Ibid.

County.[30] There is a diverse denominational landscape of Black churches to accommodate Oakland's large Black population that includes the African Methodist Episcopal Church, the Baptist Church, the Church of God in Christ, and the United Church of Christ, among others.[31]

Previous studies suggest there is a connection between faith-based responses to HIV and social activism, but scholars have not given sufficient attention to the relationship between the two.[32] Research on faith-based responses to HIV within the Black Church primarily examines the influence of spirituality, cultural stigmas, and clergy demographics on the church's responsiveness to HIV.[33] While such studies are informative, they fail to

[30] Ibid.

[31] Churches were found through web search and inquiry on denomination websites. Please refer to these sites, "American Baptist Churches USA," Accessed January 27, 2023. https://www.abc-usa.org/; United Church of Christ, "Home," Accessed January 27, 2023, https://www.ucc.org/; "Fifth Episcopal District African Methodist Episcopal Church," Accessed April 29, 2023. https://www.ame5.org.; "Church Locator - Church of God in Christ," December 17, 2014. https://www.cogic.org/church-locator/.

[32] For representative samples, see Connie Musolino et al., "Global Health Activists' Lessons on Building Social Movements for Health for All," *International Journal for Equity in Health* 19, no. 1 (June 2020): n.p., https://doi.org/10.1186/s12939-020-01232-1; "Home," The Black Church and HIV (August 21, 2018) https://theblackchurchandhiv.org/; Shelley A. Francis, and Joan Liverpool, "A Review of Faith-Based HIV Prevention Programs," *Journal of Religion and Health* 48, no. 1 (2009): 6–15. https://doi.org/10.1007/s10943-008-9171-4.

[33] For representative samples, see Madeline Y. Sutton and Carolyn P. Parks, "HIV/AIDS Prevention, Faith, and Spirituality among Black/African American and Latino Communities in the United States: Strengthening Scientific Faith-Based Efforts to Shift the Course of the Epidemic and Reduce HIV-Related Health Disparities," *Journal of Religion and Health* 52, no. 2 (2011): 514-530, https://doi.org/10.1007/s10943-011-9499-z and Patrick A. Wilson et al., "Ideologies of Black Churches in New York City and the Public Health

give attention to the external factors, namely other organizations, which also shape Black churches' willingness to address HIV in a social-activist manner. Sociologist Brad R. Fulton (2011) states that a Black church's responsiveness to HIV is associated with its commitment to "external engagement," meaning the level of community involvement determines the presence of HIV programming in a congregation.[34] Sociologists Paul J. Dimaggio and Walter W. Powell (1991) emphasize the social environment "sets standards of legitimacy and pressures" the organization to adopt its interests.[35] There are several CBOs in Oakland that are addressing the HIV epidemic that may influence Black churches' responses, including the AIDS Project of the East Bay (APEB), Women Organized to Respond to Life-Threatening Disease, and the Oakland LGBTQ Center.

Research Questions

This study examines the relationship between social activism and contemporary responses of Black churches to HIV in Oakland. In doing so, it explores if CBOs are potential drivers of social activism within Black churches and investigates if they influence contemporary responses to HIV within Oakland Black churches.

The following research questions guide this study:

Crisis of HIV among Black Men Who Have Sex with Men," *Global Public Health* 6, no. sup2 (2011), https://doi.org/10.1080/17441692.2011.605068.

[34] Brad R. Fulton, "Black Churches and HIV/AIDS: Factors Influencing Congregations' Responsiveness to Social Issues," *Journal for the Scientific Study of Religion* 50, no. 3 (2011): 617-630, https://doi.org/10.1111/j.1468-5906.2011.01579.x.

[35] Paul J. DiMaggio and Walter W. Powell, "The Iron Cage Revisited: Institutional Isomorphism and Collective Rationality in Organizational Fields," *American Sociological Review* 48, no. 2 (1983): 147, https://doi.org/10.2307/2095101.

1. Is there a relationship between social activism and contemporary Black Church responses to HIV in Oakland?
2. Does engagement with HIV CBOs make Black churches more likely to respond to HIV with social activism?
3. If so, how do these relationships shape Black churches' responses to HIV? What do these responses look like?
4. If not, what other factors encourage Black churches to respond to HIV with social activism?
    a. In what ways do Black Churches respond to HIV, which is not social activism?

METHODS

Semi-structured interviews up to one hour in duration were conducted to collect primary source data. Interview participants were identified through a web search of Black churches in Oakland. The criterion for participation included holding a leadership position in a local Black church that currently or recently had an active HIV ministry/initiative. Participants represented their respective churches. A total of four interviews were conducted with five participants on the web-conference platform, Zoom, and in person. Three Black churches were represented in the sample. Secondary source data was collected from the internet and included websites of churches represented in the study and previously conducted interviews with affiliated clergy available on archival sites. Content analysis was used to analyze interview transcripts, website content, and archival data to identify dominant themes relevant to the study.

The following is an anonymized chart of participant churches and their respective respondents.

Table 1: Participant Churches and Respondents

Black Church 1	Respondent 1 Respondent 2 Respondent 3
Black Church 2	Respondent 4

Black Church 3	Respondent 5

RESULTS

1. Is there a relationship between social activism and contemporary Black church responses to HIV in Oakland?

Yes, there is a relationship between social activism and contemporary Black church responses to HIV in Oakland. All three participant churches indicate responses to HIV that adheres to definition of social activism in this study. These activities included housing development, encouraging other churches to respond to HIV, and the use of client-based services. Additionally, they are informed by a commitment to social justice.

Theme #1- Housing Development

> **Respondent 4, Black Church 2**:
> But I think our biggest claim of fame is we were the first African American church west of the Mississippi to build housing for people who are living with HIV, that housing and federal housing program called 811.
>
> **Respondent 1, Black Church 1**:
> It was horrifying for black men at that time, in the early eighties. And so, [Anonymous Church Leader Name] sprang into action with this, supportive housing program, and she got and rented a house. There [were] some beds in there, made sure there was food, got people, no funding.

This theme reflects efforts to address housing discrimination faced by individuals living with HIV. Participants recognized that the advent of HIV exacerbated housing inequalities in Black communities. Individuals who were living with HIV were restricted from housing. This prompted these churches to create housing projects that would accept individuals living with HIV. Housing is a structural-level determinant of health, and the

lack of it has been identified as a major predictor for HIV seroconversion.[36] The theme is significant because it shows that participant churches have the capacity and understanding to engage with HIV on a structural level.

Theme #2- Encouraging Other Churches

> **Respondent 4, Black Church 2**:
> And then we got a book that we wrote, the CDC adopted for, you know, targeting African American people through the church, through the churches, because that's where we, where it's assumed that most of us will be found.
>
> And then we finally did write a grant, got some change in order to do some education, specifically to African American churches.

Participant churches had multiple efforts to make more Black churches open to addressing HIV progressively. Participants understand their HIV efforts within the context of church-based discrimination of LGBTQ individuals. Participants noted that many Black churches held interpretations of Christianity that excluded sexual and gender minorities. According to participants, discriminatory attitudes towards LGBTQ people make it harder to organize social activism around HIV. Therefore, participant churches assist other congregations in curating social activist responses by providing tools to navigate HIV stigma and homophobia. This theme is significant because it shows that participants are invested in organizational change within denominations and individual congregations. Participant churches acknowledge the impact Black churches have on their communities, so increased HIV literacy in other congregations is intended

[36] "Issue Brief: The Role of Housing in Ending the HIV Epidemic | Policy and Law | HIV/AIDS | CDC," December 1, 2022, https://www.cdc.gov/hiv/policies/data/role-of-housing-in-ending-the-hiv-epidemic.html.

to increase HIV social activism in churches and the diffusion of preventative resources within Black communities.

Theme #3- Client-Based Services

> **Website, Black Church 2**:
> We provide local HIV medical and social services and prevention awareness to educate those at-risk for contracting the virus.
>
> [Black Church 2's] AIDS Ministry seeks to address the fear and lack of knowledge surrounding HIV by providing medical and social services.
>
> **Respondent 5, Black Church 3**:
> So, we did "test for a ticket" where everybody that got a test got a ticket to the Raiders game that weekend. And so that was popular among some of the church guys. And we also kind of combine HIV testing with HEP C testing.

Client-based services for this study refer to social and medical services. They are used to meet the specific needs of individuals and to create a community impact, thus cohering with the definition of social activism in this study. Churches recognize the lack of access to certain resources on an individual and population level. These churches use client-based services as social activism. Client-based services are not regarded as social activism in this study, but when utilizing them to address community health disparities for a broader population, such action coheres with the definition of social activism in this study. This is significant because it shows that social activism is defined by the context in which an activity is being done. For this sample of participant churches, the context is unequal treatment that drives racial HIV disparities.

Theme #4- Social Justice

> **Respondent 3, Black Church 1**:

> So, the first thing I would say to you is that the history of the Black church has been one of social justice. From the time of enslavement till today, the church has been one of the main vehicles for the African American community to address social justice issues.

> **Respondent 4, Black Church 2**:
> And [Black Church 2] is a church based on the foundation of social justice. And so, when you take a look at our foundation, it's about doing what needs to be done in the community.

This theme makes clear that HIV social activism within participant churches is informed by a commitment to social justice. Participants identify that social justice is embedded in church history and theology and that it is operationalized to meet the goals of HIV ministry. This signifies that a social justice orientation facilitates HIV social activism.

2. Does engagement with HIV CBOs make Black churches more likely to respond to HIV with social activism?

It cannot be determined if engagement with CBOs solely makes Black churches more likely to respond to HIV because churches engage equally in collaborations with government agencies and other churches. Participant churches' HIV ministries established partnerships with government agencies, other churches, and local CBOs. Furthermore, collaboration with government agencies and other churches had more influence compared to CBOs. These collaborations had a more discernable effect. For example, with government funding, some churches were able to establish housing. While partnerships with CBOs were limited in number and resulted in the exchange of resources rather than realized programming and activities. All collaborations led to resources being exchanged, and some resulted in the creation of coalitional partnerships.

Theme #5- Coalitional Partnerships

> **Respondent 5, Black Church 3**:
> Black AIDS Institute, I went to [a training] that they host at [another national HIV organization]. And that was when I was starting the ministry at the Church. And, so my problem was, really, how do I mobilize churches in Oakland around HIV with the Black AIDS Institute? And through that year fellowship program, I met everybody I need[ed] to meet in Oakland, just talking about HIV. I kind of got an idea of what everybody was doing, and you know, a few years later, we ended up starting a faith-based organization to encourage other churches to be active against HIV.

> **Respondent 3, Black Church 1**:
> It's a fellowship of African American churches that [is] doing work in HIV, that [is] doing work on homophobia, that is doing work and getting more clergy involved in politics and getting those people elected to keep rows throughout the country. So, our [fellowship] is an organization that's in many states across the country.

Participant Churches engaged in coalitional partnerships to address the needs of local and global communities impacted by HIV. Most of these organizations are faith-based, but some have other orientations. For example, there is an organization created by Black Church 3 that seeks to unite Black churches and secular medical HIV healthcare providers. The purpose of these organizations is to synergize the resources and missions of multiple churches in one entity. This leads to a wider and more profound impact compared to work done by a single congregation. Respondent 3 indicated that coalitional partnerships facilitated an impact across multiple states and demonstrates that social activism within participant churches has a wider impact through collaboration.

Theme #6- Exchange of Resources

> **Respondent 5, Black Church 3**:
> So, [an international organization], has, you know, resources. So, I used to put it together, you know, prayers for every day of the week, for the National Week of Prayer. I would use to work with another local organization to kind of publicize those things widely throughout the Bay Area and kind of make that week a big deal for churches.
>
> **Respondent 3, Black Church 1**:
> And so, it has been the grassroots organizations working in tandem with the Black churches that feel called to do this work, to actually get these messages and to get the resources to the community.

This theme indicates that one of the results of collaboration is the flow of resources between organizations. Resources can be material (e.g., money), immaterial (e.g., information), or both. They are created to execute the mutual goals of partnering organizations. These collaborations give churches the necessary resources to address HIV in a social-activist manner.

3. If so, how do these relationships shape Black churches' responses to HIV? What do these responses look like?

This question cannot be answered because CBOs were not determined to be the only outside entity that influences participant churches' social activism. Their effect cannot be isolated, therefore rendering these questions unanswerable.

4. If not, what other factors encourage Black churches to respond to HIV with Social Activism?

Theological beliefs, congregational autonomy, and lived experiences of clergy and congregants were other factors that encouraged Black churches to respond progressively to HIV. The presence of these factors is rooted in the characteristics of a congregation. For this study,

participants identified how racial identity and sexual orientation in the congregation allowed life experiences to be translated into church activity, how their respective church reflects congregational autonomy, and how their chosen theological framework influences beliefs about Christianity and activism.

Theme #7- The Lived Experiences of Church Leaders and Congregants

> **Respondent 5, Black Church 3**:
> And I think, you know, most congregations focus on what they know is impacting their members, right? So, I think when I first joined [Black Church 3], breast cancer was a big deal because a few members were dealing with that publicly. So, you know, they formed a team. They did the breast cancer walk two years in a row. And so…when it's obvious that somebody's dealing with something in the congregation, it's easy for them to kind of rally around that issue. If you don't know that HIV is living in the congregation, then you can turn a blind eye and pretend like, "Well, that doesn't affect us. We don't have anybody dealing with that." So, it normally takes some personal connection.

> **Respondent 1, Black Church 1**:
> "…When they first started, people were still calling it GRID when I started writing, you know, [Pastor] had this idea that we had in, in one, in one year, in one congregation, ten men, ten black men passed away with HIV.

Participant churches addressed issues that were relevant to the lives of congregants and clergy. All participant churches have a connection to HIV that is based on their experience of being within Black and gay communities. Comments from participants show that integration with these communities promotes awareness within the congregation and provides knowledge on navigating HIV in a manner that is culturally appropriate.

Theme #8- Theological Beliefs

Respondent 3, Black Church 1:

I thought that I was alone, and that it was a punishment, and that God didn't love me because that is the messages I heard as a gay man coming up in the Black church. And it wasn't until I came to San Francisco, met [Pastor X], She did a ten-week course on what the Bible really says about homosexuality that just blew my mind. It was the first that I heard that God made you, God knows who you are, God loves you, and God can do anything but fail.

But those who know God know that God doesn't operate this way. This is not a punishment of God. This is an opportunity that God has given us to come together in community.

All participant churches had views of Christianity that were inclusive of sexual minorities and promoted action on issues impacting the community. These beliefs are a reaction to the discrimination that Black LGBTQ folks have experienced within the Black church and inaction regarding HIV by the Black church in the early years of the epidemic. This theme illustrates that participants have integrated their religion into their HIV social activism. This is important because, with these beliefs, congregations have navigated around the stigma of sex and sexuality that has historically prevented other congregations from addressing HIV.

Theme #9- Congregational Autonomy

Respondent 1, Black Church 1:

So [my denomination], by birth, is a progressive Christian denomination that leaves room for individual congregational autonomy, which means any congregation can pretty much do pretty much what it wants to, as long as it doesn't violate certain dearly held norms.

Some participant churches are not constrained by denominational polity. This means that participant churches could do what they would like with little to no denominational oversight. With congregational autonomy, these churches can organize against HIV despite oppositional views that may be promoted by the denomination. These churches do not have to worry about denominational interference, particularly in cases where there is a misalignment of theological beliefs on HIV. This theme demonstrates that church polity influences the type of social activism in which participant churches partake.

4a. In what ways do Black Churches respond to HIV, which is not social activism?

> **Respondent 5, Black Church 3**:
> I promoted [an initiative] to all the church ladies, so everybody came to church in their red shoes for National Women's and Girls' HIV awareness day. And they were talking about HIV. You know, World Aids Day, National HIV Testing Day, and National Black HIV Awareness Day, they would, they would hear from me about HIV... I was always going to conferences, so I would come back and be like, "Hey, this is what I heard. This is coming down the pipeline.

Church programming is not a form of social activism because although it potentially addresses social issues, it is primarily instituted at the congregational level and not the larger community. As seen in the example, the awareness event a participant church held was mainly attended by church members. Events like these may directly improve social conditions regarding HIV within participant churches but not necessarily for non-affiliated communities and individuals.

DISCUSSION

Participants based the relationship between social activism and Black church responses to HIV on a commitment to social justice that is inclusive of groups ostracized in Black Christian communities, namely LGBTQ individuals. The specific influence of CBOs is still unknown because participant churches reported fruitful partnership with government

agencies and other churches. Partnerships with other organizations tend to facilitate an exchange of resources that allows participant churches to engage in HIV social activism. Findings suggest Black churches can be effective mediums for CBIs targeting HIV if resource needs are met and churches have a commitment to social justice and inclusion of sexual and gender minorities.

Previous research on HIV responses in the Black church examine theological interpretations and political orientation as predictors for responding to HIV in a social activist manner. This study's findings indicate that there are additional motivating factors that inform Black churches' responses to HIV. They capture the interplay of congregational characteristics and external factors. Congregational autonomy, a social-justice orientation, and the racial and sexual identity of churchgoers give churches tools and knowledge to do social activism, and the resources gained from external influences such as CBOs allow churches to mobilize. For example, the lived experience of congregants and clergy will inform leaders that there are barriers to accessing HIV care. Churches typically do not have the resources to provide medical services, so they may partner with government agencies and hospitals to establish in-house services. This study's findings suggest that Black churches may not engage in social activism to address HIV without external partnerships. This may explain the lack of mobilization among Black churches for HIV. It is also important to note that churches motivate other congregations to engage in social activism. In the sample, Black Church 1 partnered with Black Church 2 in one of Black Church 2's early HIV programs. Additionally, Black Church 3 started a community organization to motivate Oakland faith communities to address HIV. Black churches, therefore, may be more motivated to address HIV if they are able to partner with other local congregations.

The churches represented in this study understand HIV as a social, religious, and medical issue, thereby allowing for a multi-faceted approach to addressing the disease. First, they use social and medical services as social activism. These services are not typically understood as social activism because they are used to meet an individual client's needs. Instead, participant churches used these services to create a community-wide impact to redress discrimination due to sexuality, race, and HIV status.

Furthermore, participant churches built housing for people living with HIV and trained clergy to be more inclusive of LGBTQ congregants. The diversity of social activism shows that participant churches are addressing HIV on multiple fronts to improve both individual and population outcomes. Interview participants made it clear that their commitment to social justice inspires their social activism. The Black Church is a source of resiliency and social justice within the Black community. Although, when it comes to HIV, many churches did not live up to that legacy, by engaging in HIV social activism, participant churches in this study illustrated how Black churches remain agents of social change.

This study is meant to contribute to efforts to create an AIDS-free generation. As former President Barack Obama stated, the participation of churches is fundamental. These findings may be useful to encourage more Black churches to address HIV and may inspire public health practitioners to navigate barriers of stigma and lack of resources.[37] For example, knowing that collaborations with other churches are more effective, practitioners can utilize other Black churches to spearhead stigma-reducing programming. Additionally, findings highlight how church activities are determined by their environment, which is important to understanding why and how Black churches respond to specific social issues. Future research should test the strength of the specific external and internal factors stated in the study on church activism.

One limitation of the study is that findings are not generalizable because of the small sample size. The study had a 33% response rate with only three Black churches represented in the sample. A criterion for participation is active or recently active HIV ministry thus excluding many churches from participating due to HIV ministries being uncommon within many Black congregations. Despite the low response rate and small sample size, this study usefully highlights the facilitators and barriers to social

[37] Sarita K Davis, "Understanding Barriers and Solutions to the Black Church Providing HIV Services in a Southern Urban City," *Fire!!!* 3, no. 1 (2017): 116–30, https://doi.org/10.5323/fire.3.1.0116.

activist responses to HIV within participant congregations and may inspire innovative ways to encourage more churches to address HIV.

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A Cost-Effective and Smart Sensing Tissue-like Testbed for Surgical Training

Biography

Lysette is a senior graduating during Spring 2023 with a Bachelor of Science in mechanical engineering and a minor in robotics. She will be the first person in her family to become an engineer. Through her undergraduate career, she has had three research internships at the University of Missouri, Florida A&M University, and Contra Costa College as well as one industry internship at Lockheed Martin. This engineering experience has spanned diverse fields with a focus on manufacturing and robotics in both the biomedical and aerospace areas. Beyond academics, she is passionate about uplifting others who are underrepresented in engineering such as through her current role as the professional development director in the SJSU Society of Women Engineers. She aims to continue contributing to this cause after graduating and entering the field.

Abstract

A low-cost tissue-like testbed with six nodes of varying stiffness was developed for surgical training to provide pressure and force feedback data through image reception to human operators. Using SolidWorks, a 3D model of the box trainer housing was created. A pad for the distribution of smartsensing nodes and microcontroller connections was designed with open spaces for the respective components. The pad was 3D-printed with PLA filament. Flat piezoelectric pressure sensors were fabricated with conductive materials and velostat sensor material. Using static and dynamic analyses, three top sensors were chosen to be used in three pressure sensing nodes. A calibration process was performed on the pressure sensors to find the linear relationship between voltage and pressure, which was then used to create a conversion equation for each sensor. These equations were used to collect data at the three pressure sensing nodes on the silicone testbed pad. Conductive TPU filament was used to 3D-print vertical force sensors, which were designed using SolidWorks. The force sensors were calibrated with a squeezing mechanism to find a relationship between voltage and force and to subsequently develop a conversion equation for each sensor. We used these equations to collect force data from the three force sensing nodes on the testbed pad. Through static and dynamic analyses, the force sensors were found to be functional, but to need improvements in accuracy. The mechatronic system was designed and developed to integrate all six sensors and to collect data from the testbed pad using an Arduino microcontroller. The flat pressure and vertical force sensors were embedded in each node to measure the pressure and force that occurs during the deformation of the six nodes. Data was collected and imported into MATLAB. This data was used in displaying pressure and force mapping of the nodes over a live video of the silicone pad. Pressure and force mapping was realized by drawing color-coded circles on each of the six nodes that correspond to a range of force or pressure values. From this development, the surgical testbed provides multi-stiffness tissue training with live pressure and force mapping overlaid on a live video of the emulated surgical field.

1 Introduction

1.1 Significance of advancing technologies in Minimal Invasive Surgery (MIS)

Minimally invasive surgery (MIS) aims to perform operations through only a few small incisions rather than large incisions typical of traditional, open surgery [1]. This results in reduced pain after the surgery and shorter recovery time for the patient. Most importantly, MIS significantly reduces medical risks such as blood loss, post-operative bleeding, internal organ exposure to contaminants, and post-operative infections [2]. Therefore, over the last three decades, minimally invasive surgery has been universally accepted for a wide range of surgical applications. The acceptance of MIS has led to significant reductions in morbidity, readmission, as well as reoperation [3]. For example, in the case of endometrial cancer treatment, minimally invasive surgery was compared with open surgery and it was found that MIS had decreased odds in several areas such as n=247 versus n=347 in major complications, n=238 versus n=269 in readmission, n=80 versus n=93 in reoperation, and n=20 versus n=41 in death. In the application of small bowel resections, MIS is underutilized as it is only applied to 9% of patients receiving the procedure [4]. However, when compared to open surgery in this application, MIS had a mortality rate of 2.9% versus 8.2% and a morbidity rate of 1.7% versus 4.3%. Therefore, the utilization of minimally invasive surgery has proven to make a significant impact on surgical success and outcomes in a wide span of surgical specialties.

The primary setup of minimally invasive surgery procedures consists of contact with the surgical field through small incisions, a laparoscope with a light and camera to get video imaging of the surgical field, a 2D video monitor to view the surgical field, and other long surgical instruments to perform the procedure, as shown in Figure 1. Compared to open surgery, MIS requires a unique set of technical skills that form steep learning curves that doctors must train through [5]. During MIS procedures, surgeons must utilize a 2D video screen to visualize the surgical field, which creates impairments in depth perception. Additionally, switching from

direct hand contact with the surgical field to contact using rigid laparoscopic instruments leads to a lack of tactile feedback. Lastly, using the long laparoscopic surgery instruments creates an effect called the fulcrum effect that amplifies tremors in the surgeon's hands. Therefore, the most important component for the successful implementation of minimally invasive procedures in the medical field is MIS training to account for the adaptation of these new skills.

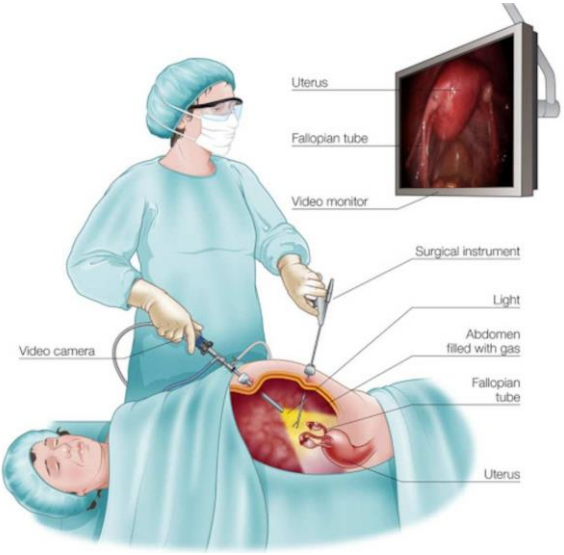


Fig. 1: Minimally invasive surgery setup. [6]

1.2 Current Surgical Training Solutions

Physical Box Trainers Because minimally invasive surgery requires the acquisition of niche technical skills, adequate training is necessary for skill development under the circumstances of impaired depth perception, the lack of tactile feedback, and the long instruments that are required to be used [5]. Therefore, it is important that training is grounded in surgical simulation, rather than the traditional apprentice training model, and that the simulation emulates the MIS circumstances as much as possible. The

foundational method of MIS training is the box trainer. The box trainer typically consists of a box containing holes where the trocar instrument can be inserted with the goal of simulating the surgical environment such as the abdominal cavity [2]. They can be used with the laparoscopic instruments and contain a camera to replicate the endoscopic camera that provides visual access via a 2D video. Typically, these box trainers allow for practicing the manipulation of objects like pegs or the practice of simple cutting and suturing tasks.

In an effort to standardize the training and evaluation of laparoscopic training, the Fundamentals of Laparoscopic Surgery (FLS) program was created. It trains for both cognitive and psychomotor skills. The psychomotor skills are trained through a box trainer that allows for the practice of tying knots, picking, precise cutting, suturing, and transferring between hands. The box trainer itself serves as a traditional box trainer that includes an opening on one end of the box and a white color to allow for light to enter the simulated training area [7]. The components utilized as emulation of the surgical field for the trainee to practice on are a peg board with several triangles for picking and placing, gauze pads with drawn shapes to practice precise cutting, a block to practice suturing with knot tying, and fake organs made from foam to practice creating a ligating loop. All of these tools are used in a strict evaluation of the trainee's ability to perform these tasks. Therefore, this FLS box trainer provides an established foundation of motor skills that need to be tested for laparoscopic surgery. However, it does not provide any further advanced feedback such as the interactions with replicas of human tissue and the amount of force or pressure that is being applied. Therefore, there is a clinical need for surgical trainers that emulate the variation that exists in tissue stiffnesses within the human body and that provide force and pressure feedback to train in control for delicate tasks.

Fig. 2: Fundamentals of Laparoscopic Surgery (FLS) Trainer [8]

The traditional box trainer is a common training method due to its widespread implementation under the Fundamentals of Laparoscopic Surgery (FLS) program [2]. Their benefit is that they are on the cheap side of MIS trainers, coming out to as low as $180 for off-brand box trainers [9] and as high as $1,199 for the official FLS program box trainer [10]. On the other end of the spectrum, the most expensive box trainers such as the Lap-X Box Laparoscopy Trainer [11] and the Lap-X VR Simulator [12] provide more advanced skills training in areas such as suturing and more advanced visual feedback as well as more information such as the amount of mistakes and the duration of the skills task. However, they are very expensive at $2,950 and $8,950, respectively, which affects their accessibility for surgical training. Most importantly, all of these surgical trainers presented from the market lack a key component of MIS training: pressure and force feedback, which is necessary for the adaptation of indirect surgical contact via laparoscopic instruments. Overall, current box trainer solutions only allow for the practice of generic skills without pressure or force feedback while the more adequate virtual reality simulation methods are expensive, making adequate laparoscopic training relatively inaccessible.

The inclusion of sensor-based feedback in surgical box trainers is a novel feature, for which the current research has performed varying design

configurations [13]. These studies have explored the added feature of integrating sensors into the box trainer apparatus as well as replicating the abdomen instead of relying on generic skills accessories. Sensors are directly integrated into the emulated surgical field such as a tissue pad. One study aimed to build a box trainer that is capable of measuring the forces of interactions between the replica tissue and the instrument along with visual feedback regarding the forces in the camera imaging. The platform to measure these forces, or the Force Platform, was created with the Optoelectronic 6D mouse that is on the market and an added 3-spring mechanical platform to increase the range of forces [14]. Coding in C++ was used to set up and calibrate the mouse for captivating vectors in 6 degrees of freedom: rotation in the x, y, and z directions as well as translation in the x, y, and z directions. In the overall apparatus, artificial tissue was attached to the top of the force sensor and had two markings for the incision point and the direction of the incision [13]. A laparoscopic camera was also fixed to the inside of the box. Adequate lighting was acquired through placing 8 white LED lights near the lens of the camera to create a beam of white light. Additionally, MATLAB was used to create the user interface that displayed the camera images and to record the data in real time. In this interface, an arrow is overlaid into the image to represent the magnitude and direction given by the exerted force of the user. Its color also changes depending on if it is approaching the maximum force allowed for that particular task. This system serves as a model that can objectively assess trainees through force sensing and visualization in laparoscopic box trainers. From this study, we want to further implement the idea of sensor integration by embedding force and pressure sensors within silicone tissue that the trainee interacts with. However, due to our goal of cost-effectiveness, we aim to utilize cheaper options than purchasing advanced platforms, including fabricating our own pressure and force sensors, using 3D-printing, and using silicone materials. Another aspect we want to take forward from this study is the concept of visual feedback for the trainee based on how much pressure or force they are applying. However, instead of utilizing an arrow to show the amount of force, we want to use a color-based format of pressure and force mapping to show how the pressure or force is changing within specific ranges at each node. This gives a more in-

depth understanding through two different sets of sensor data that come from sensors and sensing nodes that are specifically fabricated to provide feedback on tissue-based interaction.

1.3 Clinical Needs for Surgical Training

During minimally invasive surgery training, the current training assessments focus primarily on movement efficiency and completion time of tasks involving grasping and positioning [14]. However, there is a need for assessing performance when it comes to one of the most important skills in surgery: performing delicate tasks. The assessment requires the measurement of parameters involving the interaction forces that occur when the tool makes contact with the tissue. With force and pressure feedback missing from current training solutions, it is shown that MIS has a clinical need for the training of adequate force and pressure control in order to prevent surgical damages or complications.

In addition to the lack of force and pressure feedback in current surgical trainers, accessibility to MIS training is a significant clinical need that exists in the medical community [15]. Although it is known that skills developed from a simulated environment lead to improving performance within operating rooms, access to MIS training equipment is limited. In fact, most surgeons in training end up developing their surgical skills for MIS through practice from live patient procedures. In a global study of MIS training accessibility over a wide range of surgical areas, it was found that out of 292 survey responses, 34% had access to a surgical simulation trainer during their working hours and only 20% had access outside of working time. Within the previous 12 months, 46% did not use a surgical simulator at all while 19% reported use for more than 6 hours in that year. This shows a severe lack of training in minimally invasive surgery, which stems from high stress working time limiting training time and cost as a barrier to obtaining surgical simulators. Beyond the lack of usage, there is agreement amongst medical professionals where 79% agreed that competency should be shown on a simulator prior to performing procedures. Moreover, 75% believe that take-home simulation trainers for MIS can play an important role in training and 86% support the usage of simulators for warm-up while only 26% are doing this. Therefore, the clinical need for accessibility is

prevalent in the medical community and points towards a solution via cost and home-accessible surgical trainers.

1.4 Application of the Test bed for Robotic MIS

A robot with human intervention is called teleoperation [16]. Teleoperation provides a bidirectional interaction between humans and robots via enhanced perception and motion by integrating human intelligence with the robot's advantages over the constraint of distance [17–23]. Studies on bidirectional teleoperation system manipulation have largely focused on how to drive the follower robot more efficiently and robustly with various control method, such as adaptive control [20], predictive control [19], sliding mode control [17], and combinations thereof. In large part, the aims are on simplifying the workspace and adding predefined constraints.

Improving the bilateral human-robot interaction in real-time is a necessary, yet challenging, aspect of teleoperated surgical training, especially in a complex workspace environment. The goal of this work is to design and develop a smart testbed for surgical training and simulation that will provide sensing feedback, pressure and force mapping and live image information for better evaluating task performance in a future application of telesurgical operation.

The introduction of robotics into minimally invasive surgery has made the procedures more precise and efficient [1]. For instance, by moving the surgeon's control of operating tools to a remote station, specially designed robotic tool arms with greater articulation and flexibility allow for a broader range of tool motion. Further, sensing of the surgeon's fine hand movements is used to stabilize the output motion of the robot and eliminate transmission of tremors from a surgeon's hand to the surgical tool [24]. Additionally, robotic implementation opens the door for haptics, or the simulation of touch interactions, to return direct force feedback back to the hands of surgeons that must interact with indirect surgical instruments [25].

Therefore, robotics plays a vital role in improving MIS procedures. With the introduction of new technology, comes the need for adaptive training. Many hospitals and medical schools have inanimate physical laparoscopy simulators for medical students and staff to practice their skills

[26]. However, these simulators are intended for traditional laparoscopy with manual tools. Given that the traditional laparoscopic experience does not translate into the different skill sets required for robotic-assisted surgery [27], traditional simulators are insufficient for adequate training in robotic laparoscopy. Furthermore, most medical students do not receive any sort of structured simulator training until postgraduate residency or later in their career. A lack of teaching of the unique skills necessary for robotic assisted surgery, in combination with the increased ability of younger people to improve their skills via robotic surgical training compared with older students further in their education or career [27], presents a convincing case for integrating a robotic-specific training program earlier in medical school. This warrants consideration of the robotic space by integrating the testbed into an overall robotic system after the development of the standalone smart-sensing testbed.

1.5 Research Objectives

To address the issue of a lack of accessible and adequate MIS training, our project aimed to create a Minimally Invasive Surgery (MIS) training bed that is both cost-effective and smart. This training bed consists of a traditional testbed box trainer that contains housing and lighting for a tissue pad as well as slots for trocar insertion and the MIS tooling. We designed and developed a smart artificial tissue pad with integrated pressure and force sensors. A USB camera was placed in a camera holder on the box trainer for live imaging of the emulated surgical field within the testbed. Fabricated pressure sensors allowed for the measurement of pressure upon interaction between the surgical instrument and three pressure sensing nodes while the force sensors did the same for three force sensing nodes. The setup also included a live video display of the tissue pad within the testbed housing. The live imaging was overlaid with pressure and force mapping of the tissue pad nodes by gathering pressure and force data from the integrated sensors. This created a surgical testbed that is portable, relatively cheap, and effective through live visual feedback.

In addition to this primary focus for improving upon what is currently on the market for box trainers, the smart-sensing test bed will play a larger role within the development of robotic laparoscopic surgery. More specifically, it will be integrated into a teleoperated MIS robotic training system. The testbed will be the device practiced on by the surgeon in training and will also allow for the incorporation of various sensing feedback. Therefore, the designed testbed will be uniquely capable of playing two roles: 1) as a training bed that can be used on its own for more accessible and effective MIS training practices with pressure and force feedback via live imaging; and 2) as a testbed that can be integrated into a larger system of a telesurgical robotic training apparatus.

2 Methodology

The realization of the cost-effective, smart MIS training bed required 3 phases of design and development, which are a) mechanical design and fabrication of the testbed, b) sensor fabrication and calibration, and c) software development of the live image processing with force and pressure mapping.

Overview of the surgical training apparatus The apparatus for the cost-effective, smart-sensing surgical testbed consists of four main components:

1. Box trainer housing.
2. Pad for the distribution of nodes with integrated sensors.
3. Sensors to obtain force and pressure feedback data.

4. Live image processing with force and pressure mapping

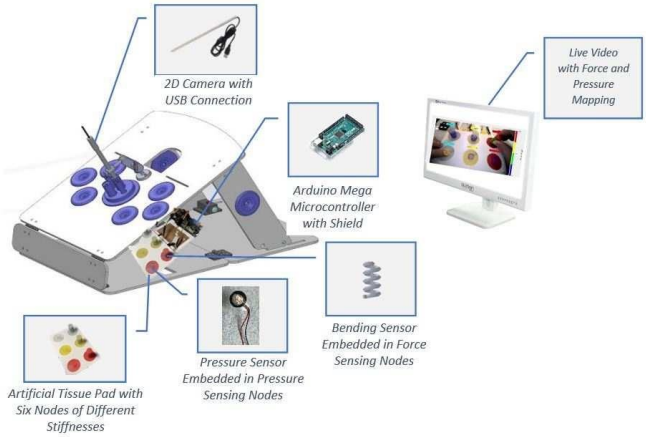
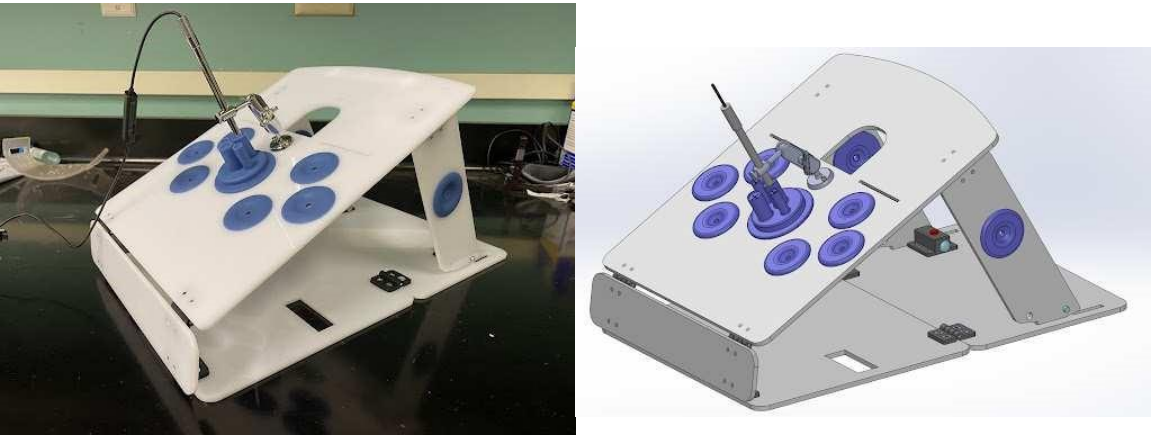


Fig. 3: Smart-sensing surgical training apparatus.



(a) (b)

Fig. 4: Box trainer (a) and 3D-modeled box trainer housing (b).

The purchased box trainer serves as the foundation of the apparatus that establishes the physical space within which the apparatus resides. The pad that represents the primary surgical field consists of three multi-stiffness nodes for force sensing and three multi-stiffness nodes for pressure sensing. To practice the performance of MIS with the view of the surgical field through a video, live image processing is used to create the live video and it is overlaid with visual mapping of the force and pressure feedback data.

2.1 Mechanical design of the testbed

Box trainer housing A standard surgical box trainer was purchased from the cheapest end of the commercially available spectrum to serve as the primary housing for the surgical training bed. The box trainer was hand-measured to obtain dimensions and modeled using SolidWorks. This model allowed us to establish the dimensions of the overall testbed apparatus and the parameters within which we designed the pad as well as the surgical field inside. It also provides the feature of trocar holes for instrument insertion and a camera holder for placement of the camera that obtains the live video imaging as well as additional lighting for the pad.

Nodes for pressure sensing Pressure sensing nodes were designed with a flat circular shape consisting of an elevated buttonlike rise in the center. This shape is ideal for the primary functionality of the pressure sensing node where the user will press directly down on the node with an MIS instrument to be provided with pressure feedback. Additionally, the circular shape was designed to correspond to a circular placement section in the primary pad that holds the sensors in the surgical field.

To provide MIS training for various tissue stiffnesses in the human body, three pressure sensing nodes were fabricated with silicone materials of different stiffness. The materials, as shown in table 1, emulate fat, glandular, and vascular tissue based on their corresponding Young's Modulus. For the user to easily distinguish between the materials and their variation in pressure feedback behavior, the nodes were dyed with no color, yellow coloring, and red coloring, respectively.

Table 1: Durometer Levels, Young's Modulus, and Elastic Modulus in various types of Human Tissues for Nodes with Assigned Colors.

Durometer	Young's Modulus	Human Tissue	Assigned Color
Shoreness 00-10	10 kPa	Fat [28]	White
Shoreness 00-30	25 kPa	Glandular [29]	Yellow
Shoreness 2A	36 kPa	Vascular [30]	Red

Fabrication of the pressure sensing nodes was performed through a silicone molding process that utilized 3D-printed molds. The molds consisted of two pieces: one piece to provide a flat, circular shape with a rise in the center and another piece to provide a thin and completely flat circular shape. Both pieces were 3D-printed with PLA filament and were designed to be open on top and to have an outline of the desired shape within the mold, as shown in figure 5. A consistent process was maintained to uphold quality during the silicone molding process. This included spraying the mold with a mold release spray prior to pouring silicone into it, placing the silicone in a vacuum chamber to remove gaps in the material, pouring the silicone into the mold with a pipette to accurately fill the mold level to its height, and placing the filled mold onto the hot plate at 65 degrees to enact the curing process with a faster, more efficient time frame. Once cured, the silicone was easily removed through pulling out from the mold of both pieces.

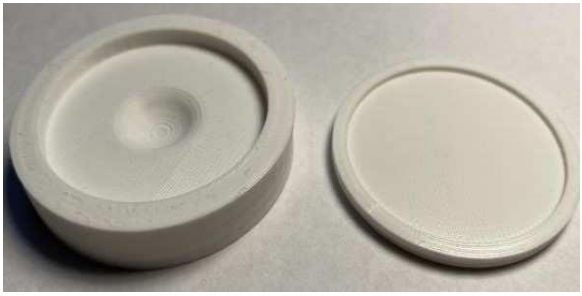


Fig. 5: Silicone molds for pressure sensing nodes.

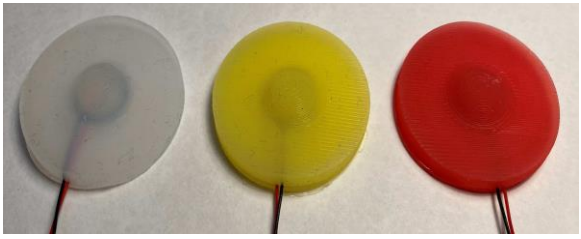


Fig. 6: Pressure sensing nodes.

The final goal of the pressure sensing node was to integrate a flat, piezoelectric pressure sensor directly below the buttonlike rise to create the node with capabilities for pressure feedback. This was achieved by sandwiching the pressure sensor between the silicone piece with the rise and the completely flat silicone piece and securing the layout with glue, producing the final pressure sensing nodes in figure 6.

Nodes for force sensing Force sensing nodes were designed with a vertical cylindrical shape and a flat circular bottom that fans out from the cylinder. This shape is compatible with the force sensing node's primary usage of being squeezed and bent by the trainee via an MIS strument to provide force feedback. The circular bottom was incorporated into the design so that the node can be placed in the corresponding circular placement within the pad for node distribution. Three force sensing nodes were fabricated with the same multi-stiffness silicone materials as the

pressure sensor nodes and were also color-coded in the same way, as shown in figure 7.

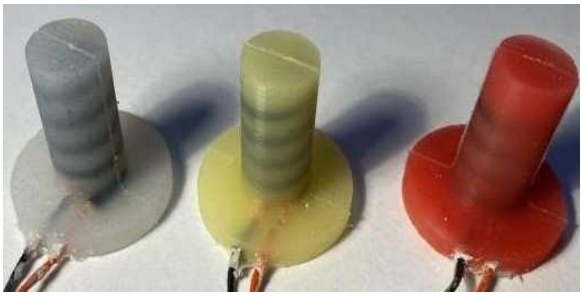


Fig. 7: Force sensing nodes.

Force sensing nodes were fabricated through close to the same silicone molding process as the pressure sensing nodes, but with a different design for the 3D-printed molds and additional steps for the integration of the vertical sensor. The mold for the force sensing node consists of two halves that create the vertical cylindrical shape with the circular bottom. The radius of the half-cylinder in each mold component was determined in order to give the slightest thickness possible past the diameter of the sensor. Prior to pouring the silicone into the mold, the two halves are screwed together and tape is placed on the flat surface of the two halves to prevent leaking. Additionally, to center and keep the vertical force sensor in place, particularly with its attached wiring, trenches were incorporated to the top of the node mold to allow for a resting placement of the wires that aligned with the extensions designed into the sensor. Clay was then used to hold the wires in place within the trenches in order to keep the sensor upright and centered during the silicone pouring and curing process.

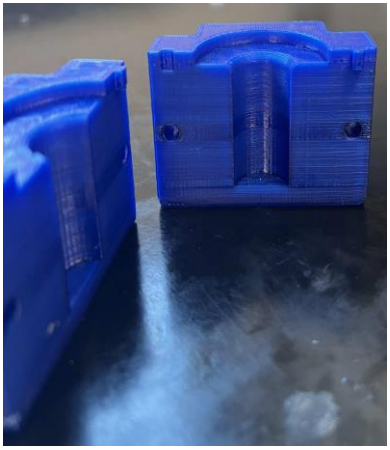


Fig. 8: Silicone molds for force sensing nodes.

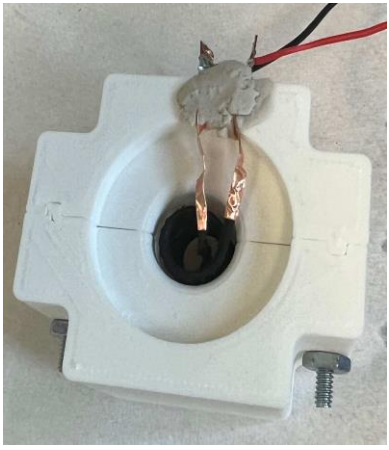


Fig. 9: Force sensor placed using clay before pouring silicone.

Pad for the distribution of pressure and force sensing nodes

To create the primary surgical field that is placed inside of the box trainer, we designed a pad in SolidWorks with a layout for the six sensors and with placements for the mechatronic components. The pad, as shown in

figure 10, was designed with a placement for the Arduino MEGA microcontroller in the back of the pad, including screw holes to hold the Arduino in place. In the front of the pad, placements were designed to hold each of the six nodes with the three pressure sensing nodes being held in the first row and the three force sensing nodes being held in the second row. The sizing of the circular placement cut-outs was designed to match the radius and height of the circular pressure nodes and the circular base of the force sensing nodes for a level fit. The pad was 3D-printed with PLA filament.

Piezoelectric pressure sensors

Piezoelectric pressure sensors were fabricated by hand through a layering technique consisting of five total materials as shown in figure 11: velostat, conductive fabric, copper tape, clear tape, and a soft elastomer material.

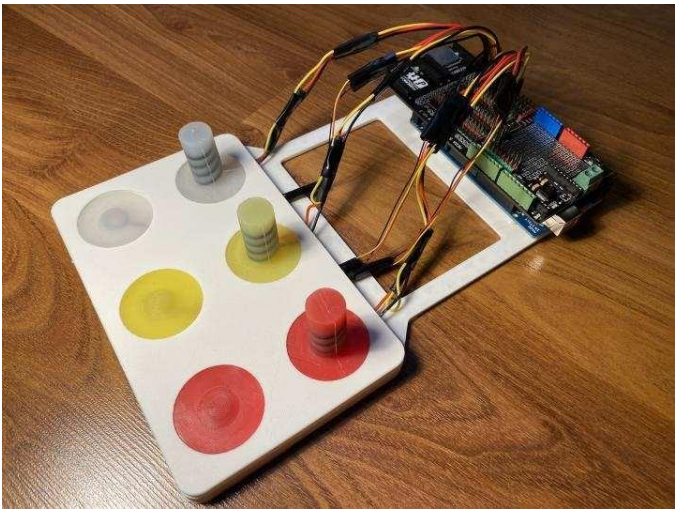


Fig. 10: Testbed pad for node distribution connected to the mechatronic set-up.

The flat design of the pressure sensors was enacted due to their desired position of being placed below the pressure nodes to gather pressure feedback data as the user presses directly on them with an MIS surgical instrument.

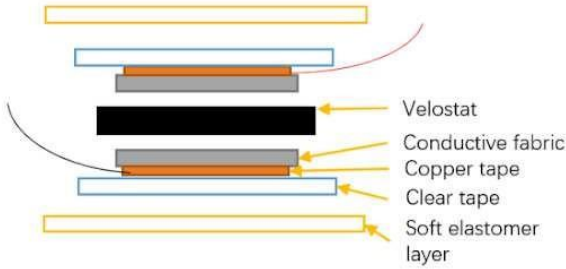


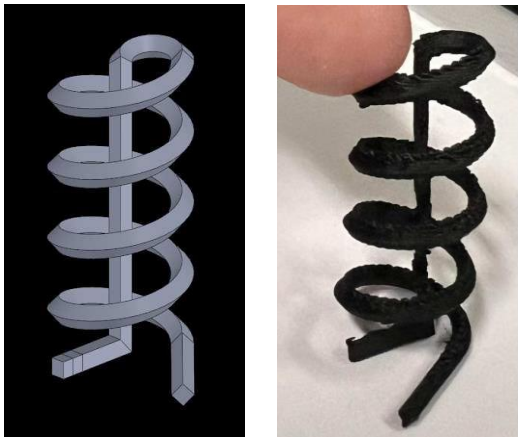
Fig. 11: Diagram of layered materials for the fabrication of piezoelectric pressure sensors.

Fig. 12: Piezoelectric pressure sensor.

Force sensors

The force sensors were designed in SolidWorks to have a vertical, cylindrical shape to match the primary use of bending and squeezing. Spirals were utilized along the vertical design to amplify the bending capability and the corresponding conductive behavior. Two ends were

designed for attaching wires as the power and ground connections. One end was designed



(a) (b)

Fig. 13: 3D model of force sensor (a) and 3D-printed force sensor (b).

(a) (b)

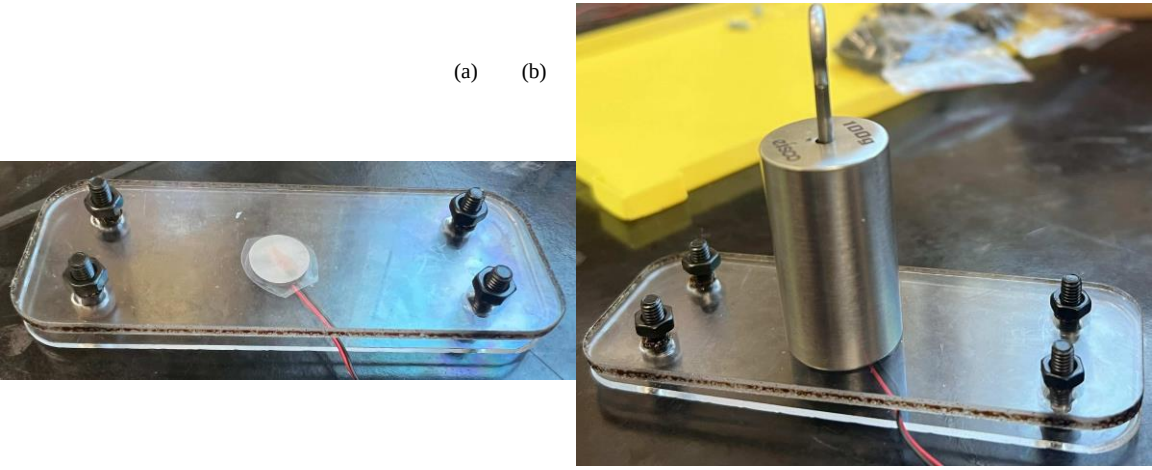


Fig. 14: Pressure sensor calibration apparatus (a) and apparatus with weight (b).

to follow a path vertically down the middle of the cylindrical-shaped sensor while the other end extends from the angular path of the spiral shape. The force sensor was 3D-printed with a conductive TPU filament called the NinjaTek Eel 3D printer filament to provide the conductive properties for force sensing. The sensor was printed with tree supports to realize the vertical spiral geometry when using the TPU filament.

Apparatus for pressure sensor calibration

An apparatus was designed to perform the pressure sensor calibration by placing various weights onto the pressure sensor. To stabilize the sensor in place and ensure control of the direct placement of the weight over the center of the pressure sensor, the sensor was placed between two acrylic plates. The plates were screwed to establish placement while being careful to minimize any excess pressure on the sensor from sandwiching the sensor between the two plates.

Apparatus for force sensor calibration

The apparatus for calibrating the force sensor was designed to perform testing that squeezes the vertical, cylindrical node at varying

weights. In this four-part design, the foundational piece has a notch for the circular part of the node to sit and allow the force sensor to sit horizontally. It also has a half-notch in a cylindrical shape for the stem of the node to sit in. The part that performs the squeezing has a top platform with another half-notch in a cylindrical shape and two cylindrical poles to sink down into two corresponding holes on the foundational component. Each pole also has a small hole to fit a toothpick through so that it can serve as a bar for hanging weights, causing the squeezing mechanism.

2.2 Mechatronic system for force and pressure feedback data

The mechatronic system to collect force and pressure data utilizes an Arduino MEGA microcontroller with the Arduino MEGA Sensor Shield v2.3 as displayed in figure 10 to collect voltage values through a serial data protocol. Each sensor is

Fig. 15: Apparatus for force sensor calibration.

wired to a resistor to add a voltage divider to the system, with a resistance of 100 ohms used for the pressure sensor and 22 kilo-ohms for the force sensor. For each sensor, one end is connected to the black ground wire with copper tape and the other end is connected to the red power wire with copper tape as well. The red power wire is soldered to the resistor and to the yellow data wire before the resistor. The power supply is at 5 volts.

2.3 Sensor calibration

Pressure sensor calibration and analysis

Calibration was performed on six fabricated pressure sensors to analyze the static and dynamic response behavior, of which three would be chosen as the sensors for three pressure sensing nodes.

Using the calibration apparatus, weights were placed directly centered on top of the sensor within the acrylic plates to analyze the response to variations in pressure. The weights utilized were 100 g, 200 g, 300 g, 400 g, and 500 g. The process to perform the calibration included placing all five weights in order during one pass of calibration. Each weight was placed twice in a row before moving onto the next. The weight was placed on the sensor for 45 seconds and was removed to be left off of the sensor for 15 seconds before placing the next weight. As each weight was placed on and off of the sensor, the corresponding voltage values were collected through the Arduino IDE's serial monitor. Values were copied from the monitor and imported as a numeric matrix to MATLAB.

The first step of analyzing the data was to plot the raw voltage data versus time. The static analysis of the voltage data was performed by taking the average of the stable region for each weight's voltage readings. Then, the mass of each weight as the y-axis was plotted versus the average voltage as the x-axis for each weight. This plot was fit to a linear equation with an R^2 regression value. To obtain a final relation that converts voltage to pressure, an equation was developed from the linear-fit equation that demonstrates the relation between voltage and mass. The linear equation was written with 'y' as the mass and to account for the base voltage value, the input 'x', or the voltage, was subtracted by the base voltage. Using the standard pressure equation, shown in figure 16, the equation for mass

replaced the mass component to give a final conversion equation from voltage to pressure that is utilized in the live data processing method.

The dynamic analysis began with finding the rise time, or the time it took for the voltage value to increase back to the base voltage value after removing the weight. This was done by subtracting the corresponding times for the voltage value to go from 100% at the maximum voltage value to 0% at the base value. The drop time was calculated, which is the time it takes the voltage to drop to the final value after adding a weight. Of the values from the base voltage of the sensor to the maximum voltage value reached when a weight is placed, the drop time was calculated by subtracting the corresponding times from 10% to 90% of the range. By estimating from the plot of the raw voltage data, the initial drop time was calculated by subtracting the time at the base voltage from the time where the initial rapid drop in voltage after adding the weight begins to slow down. Using the voltage values at these two parts of the range, the corresponding percent of voltage drop out of the maximum voltage reached when placing the weight on the sensor was calculated.

The analyses of the six calibrated sensors were then compared to choose the final three sensors that would be used for the pressure sensing nodes. There were two primary factors considered in the comparison. One was the R^2 regression values and how close they were to a value of 1. The second factor was the dynamic time response data to see how quickly the sensors responded to adding and removing weights. This allowed for determining three sensors with the top performance.

$$P = \frac{m \times g}{A}$$

Fig. 16: Standard pressure equation where m = mass, g = gravitational constant, and A = cross-sectional area.

Force sensor calibration and analysis

A calibration method was developed to determine the static and dynamic behavior of the vertical force sensors while they are integrated into the silicone materials of various stiffnesses. The calibration process was

performed twice on each of the three vertical sensors at two different orientations: one with the wiring attached to the sensor in the rightward horizontal direction and another with the wiring in the upright vertical direction to account for the asymmetry of the vertical sensor design. With the force sensor calibration apparatus, weights of 500 g, 750 g, 1000 g, 1250 g, and 1500 g were hung to provide various amounts of force through a squeezing mechanism. In a single pass of the calibration process, each weight was hung once in order from lowest to highest weight at 30 seconds hanging and 30 seconds for the node to recover after the weight is removed. Additionally, after all the weights were hung, data continued to be collected for an extra five minutes with no weight to collect data on the drop in voltage over time as it headed back toward the base voltage value. The voltage data was collected from the Arduino IDE and imported as a numeric matrix into MATLAB.

Analyzing the data began with plotting the raw voltage data against time for both the vertical and horizontal orientations. For static analysis, the average voltage was taken over the stable region for each weight. Then, the average voltages at each weight for the vertical and horizontal orientations were averaged to get one average value at each weight that takes into account the asymmetrical characteristic of the sensor design. These averaged voltage values were then plotted against mass, with mass on the y-axis and voltage on the x-axis. The plot was fit to a linear equation with an R^2 regression value. To get a final equation that converts voltage to force, the process begins by developing an equation from the linear-fit equation that relates mass to voltage. The linear equation was used to replace the ‘y’ component as the mass since it is located on the y-axis and to replace the ‘x’ component as the voltage that is on the x-axis. The voltage was also subtracted by the base voltage value of the force sensor. This equation for mass was then used to replace the mass component in the standard force equation in figure 18, which gives the final equation for the relationship between voltage and force that is used to calculate force in the live data processing.

Dynamic analysis of the force sensors was performed by analyzing two types of data. The first was calculating the average rise time, or the

average time it takes the voltage to increase to steady state once a weight is added. The second was the average drop percentage, which was the average percentage that the voltage drops relative to the base voltage during the 30-second period after a weight is removed.

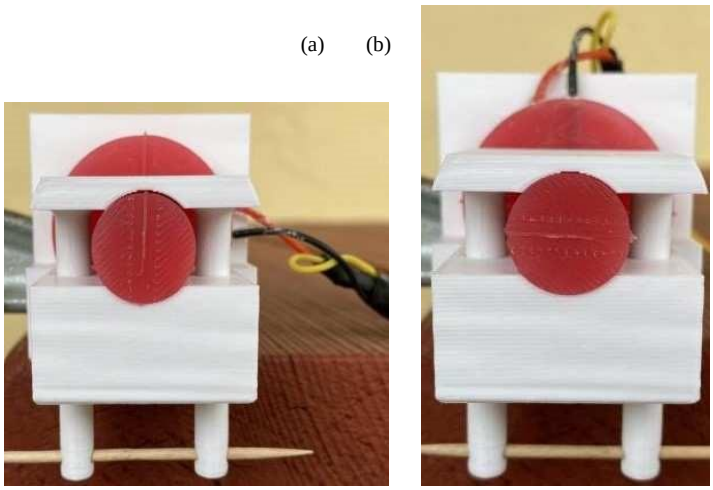


Fig. 17: Horizontal orientation of force sensor calibration apparatus (a) vertical orientation of apparatus (b).

$$F = mg$$

Fig. 18: Standard force equation where m = mass and g = gravitational constant.

2.4 Live image processing with force and pressure mapping

The user interface within the surgical testbed apparatus encompasses a live video of the surgical pad with nodes overlaid with force and pressure mapping. This interface was developed in MATLAB. The live video feed was achieved through the looping of screenshots taken by a USB laparoscopic camera. Functions were created for each node in the video to be overlaid with a circle that changes color based on the range of force and pressure that the current value falls in. A colorbar was added to show the correspondence between the ranges of the force and pressure data values and their assigned colors. A box was added above each node that is color-coded to the dyed color of the node and provides the current force or pressure value.

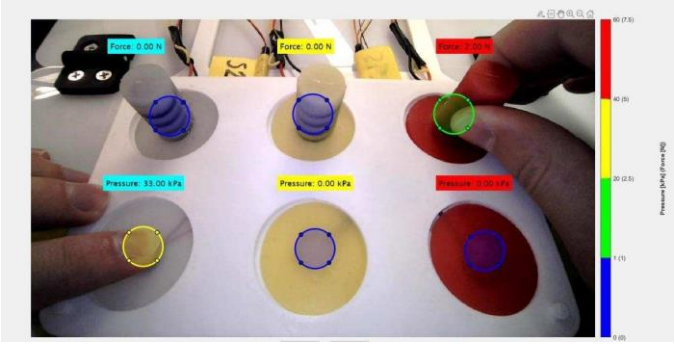


Fig. 19: User interface: live video overlaid with force and pressure mapping.

3 Results

3.1Pressure sensor calibration and analysis

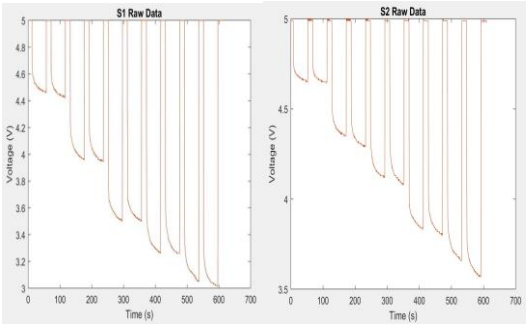
Figure 20 shows the raw data of voltage plotted against time for all six sensors throughout the calibration process. The base voltage for sensors 1-4 and sensor 6 are all around 5 V while the base voltage for sensor 5 is slightly lower at around 4.92 V. The addition of weight causes the drop in voltage and therefore, with increasing weight from 100 g to 500 g, the voltage progressively decreases. The pattern of decreasing in voltage

remained relatively consistent for the same weight amongst all six sensors with only slight variance, particularly in sensors 2, 3, and 5.

In figure 21, the plots contain the linearly fitted line and corresponding equation where y represents the mass and x represents the voltage. Each plot also has an R^2 regression value. The plots for all 6 sensors exhibited a common pattern where the average voltage values at each mass followed a generally linear trend. This is shown not only by the linearly fit line, but by the R^2 values, which are all very close to 1.

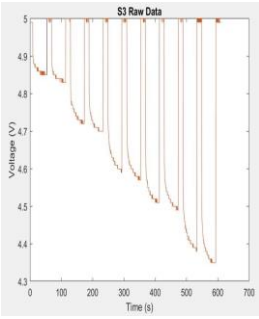
Table 2 shows the dynamic response data of all six sensors. The rise in voltage when the weight was removed occurred the fastest, particularly in comparison to the drop time when the weight was added, which was much slower. Although the drop time was relatively longer, the drop in voltage reached between 72% and 84% of its final value within a very short time that is comparable to the rise time. Amongst the six sensors, sensors 1, 2, and 6 had the fastest responses, but all six sensors were fairly consistent and within a similar range to each other.

In comparing the linear trends of the six sensors and their dynamic time responses, the sensors that showed the best balance of these characteristics were sensors 2, 4, and 5. They all had a linear fit with an R^2 value of at least 0.98 while maintaining relatively fast dynamic responses. For instance, the rise times for sensors 2, 4 and 5 were around 0.16 seconds, 0.25 seconds, and 0.22 seconds, respectively. Sensor 4 had a reasonable drop time of around 3.4 seconds and second-largest initial drop of 82.84%. Therefore, sensors 2, 4 and 5 were the sensors chosen out of the six calibrated sensors to be utilized in the pressure sensing nodes. The equations developed to convert voltage to pressure by using the methodology previously described are shown in figure 22.

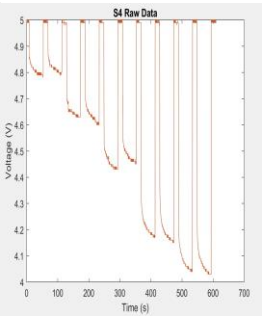


(a)

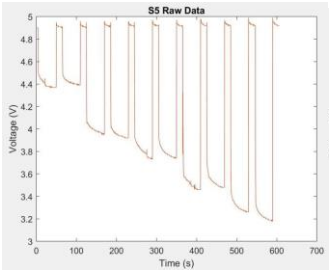
(b)



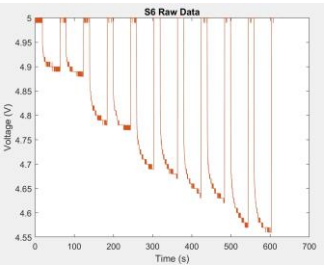
(c)



(d)



(e)



(f)

Fig. 20: Raw voltage data plotted against time for sensor 1 (a), sensor 2 (b), sensor 3 (c), sensor 4 (d), sensor 5 (e), and sensor 6 (f).

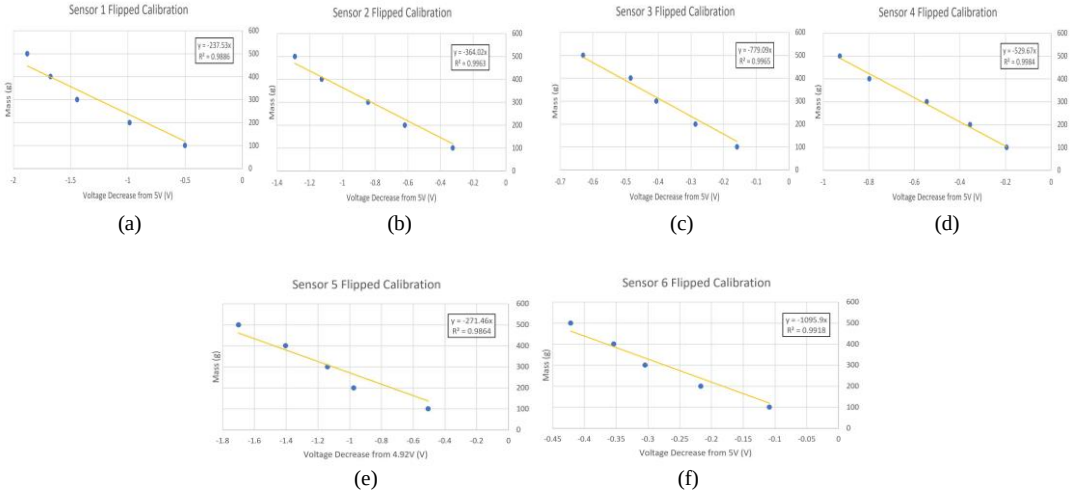


Fig. 21: Linearly fitted plots of mass versus voltage for sensor 1 (a), sensor 2 (b), sensor 3 (c), sensor 4 (d), sensor 5 (e), and sensor 6 (f).

3.2 Force sensor calibration and analysis

Raw data of the changes in voltage over time in both the vertical and horizontal orientations is shown in figure 23. Unlike the pressure sensors, as weight is added to squeeze the force sensor, the voltage increases rather than decreases. Another distinction is that each time a new weight was added, which is shown by each peak on the plots, the sensors were not able to return all the way back to the base voltage value during the rest period before the next weight was added. Even after waiting five minutes with no weight at the end of the calibration process, the voltage greatly reduced, but was not able to fully return to the base voltage value.

Between the calibration tests performed at the vertical and horizontal orientations, the average voltage values at each weight were averaged and plotted as the x-axis against the mass on the y-axis. While all three force sensors at various silicone stiffnesses had a linear trend for the change in voltage at different weights, the sensors in the fat-like and glandular-like silicone tissues showed the best fit, including the highest R^2 values that are over 0.99. Even so, the sensor embedded in the vascular-like

Table 2: Dynamic Time Response Data for Pressure Sensors.

Sensor	Rise Time (Weight Removed) [s]	Drop Time (Weight Added) [s]	Initial Drop Time [s]	Initial Drop [%]
S1	0.1968	3.2016	0.6556	78.21
S2	0.1638	3.0248	0.5420	78.56
S3	0.2046	4.0948	0.6650	77.64
S4	0.2516	3.4038	0.8236	82.84
S5	0.2188	1.6470	0.8208	84.02
S6	0.1580	4.8556	0.7458	72.94

$$P = (v - 5) \times -28.19 \quad \text{(a)}$$

$$P = (v - 5) \times -41.02 \quad \text{(b)}$$

$$P = (v - 4.92) \times -21.02 \quad \text{(c)}$$

Fig. 22: Equations to convert voltage to pressure for sensor 2 (a), sensor 4 (b), and sensor 5 (c) where v = voltage [V] and P = pressure [kPa].

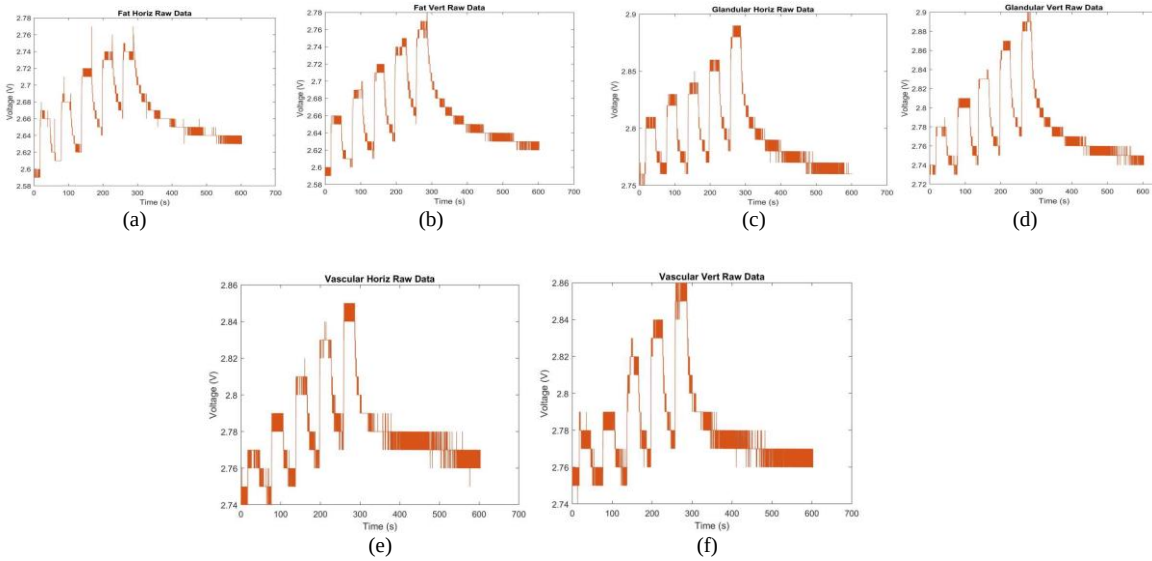


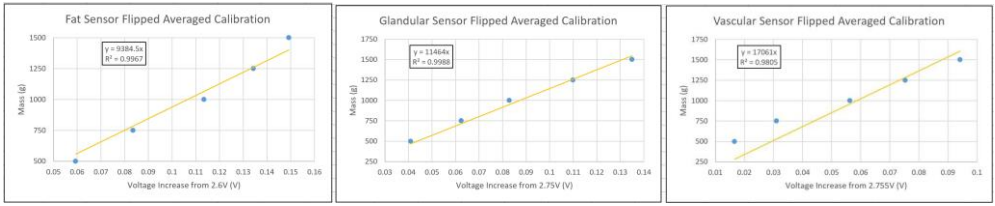
Fig. 23: Plots of raw voltage data versus time for the horizontal orientation of sensor 1 (a), sensor 2 (b), and sensor 3 (c), and for the vertical orientation of sensor 1 (d), sensor 2 (e), and sensor 3 (f).

tissue gave a linear fit with a high R^2 value of at least 0.98. The slight variation between the three force sensors is acceptable since a separate equation for converting voltage to force is made for each one.

In table 3, the average rise time and average drop percentages are compared amongst the three sensors embedded in varying tissue stiffnesses. The sensor in vascular-like tissue took only about around 0.5 seconds to reach the steady state after adding a weight while the sensors in the fat-like and glandular-like tissue took almost double that time. In terms of the average drop percentage, the sensor in fat-like tissue had the lowest drop at 64.73% of the base voltage value after 30 seconds of the weight being removed, while the sensors in glandular-like and vascular-like tissue were more improved at drops of around 76% of the base voltage value.

In the case of the force sensors, three sensors were fabricated and embedded in the three different stiffnesses of silicone tissue. With no

selection process, all three sensors are used in the three force sensing nodes. The static and dynamic character-



(a) (b) (c)

Fig. 24: Linearly-fitted plots of mass versus voltage for the sensors embedded in fat-like (a), glandular-Like (b), and vascularlike (c) silicone tissue.

Table 3: Dynamic Time Response Data for Force Sensors Embedded in Silicone.

Tissue	Average Rise Time [s]	Average Drop [%]
Fat	0.9707	64.73
Glandular	0.9672	76.45
Vascular	0.4972	76.95

$$F = (v - 2.46) \times 140.14 \quad F = (v - 2.65) \times 99.09$$

(a) (b)

$$F = (v - 2.65) \times 169.14$$

(c)

Fig. 25: Equations to convert voltage to force for sensors embedded in fat-like (a), glandular-Like (b), and vascular-like (c) silicone tissue where v = voltage [V] and F = force [N].

istics of each sensor were reasonably accepted and the methodology previously described was used to develop an equation that converts voltage to force for each sensor, as shown in the equations in figure 25. However, accuracy in returning to the base voltage value and improving response characteristics exhibits room for improvement.

4 Discussion

4.1 Pressure sensors

For each pressure sensor, the changes in voltage at each weight progressed consistently so that if the same weight was applied twice in a row, it reached just about the same drop in voltage. While this was consistent with the patterns of each individual sensor, comparing the sensors' raw data to each other shows some variance in the drop in voltage associated with each weight. This is acceptable in our application because each weight is calibrated separately to obtain an equation for each sensor that will be used to convert voltage to pressure.

In determining the top three pressure sensors to be used in the pressure sensing nodes, both the static and dynamic results were utilized. Sensors 2, 4, and 5 were selected because they exhibited the highest R^2 values that are over 0.98 while also maintaining relatively fast dynamic responses and large initial drop percentages. Any variations in data amongst the pressure sensors are evidence of some variation in the fabrication that took place by-hand despite following an identical process. This reflection does not hold a significant negative impact on the final equation that is utilized to convert voltage to pressure and more specifically, on the sensors' usage in the testbed apparatus. This is because all of the sensors are within the same relative range to where the slight variance does not hold weight in the overall performance of the testbed as long as there is an equation for each sensor rather than one equation that can apply to all of the sensors.

4.2 Force sensors

During the calibration process, the force sensors exhibited a unique behavior where the voltage was not able to reach the base voltage even after 30 seconds with no weight. Further, after five minutes with no weight at the end of the tests, the voltage was still not able to be reduced all the way down

to the base voltage. This could mean that it would take even more time to reach the base voltage than allotted in the current methodology, but longer time between interactions is not efficient for the real-time interactions necessary in the MIS training processes. The behavior seems to result from multiple factors. Since the force sensors are embedded in the silicone tissue, this may be slowing down the response after removing weight from the sensor. Additionally, the conductive filament used to print the force sensor may be experiencing effects of slight permanent deformation throughout the calibration process. In general, the material properties and behavior of the silicone and especially the conductive filament may require more advanced materials studies to fully understand this behavior. For the purposes of the surgical testbed, the prototype is reasonably functional with the equations developed through the current methodology. However, the accuracy and reliability of the force sensors is needed to be improved through further testing of material properties and further improvements to the calibration process based on these results.

5 Conclusion

The cost-effective, smart-sensing surgical testbed fulfills a clinical need for accessible and effective training in minimally invasive surgery. The pressure and force feedback during testbed interaction is a novel feature that is not yet commercially available, but is important to the motor skills and intuitive sensing practiced by surgeons in training. Additionally, the interaction with various tissue stiffnesses such as tissue comparable to fat, glandular, and vascular tissue, is vital to providing MIS trainees with experience in interacting with various levels of tissue stiffnesses in the human body. While providing these features is a leap forward amongst the box trainers currently on the market, modified pressure sensor fabrication techniques can improve the consistency amongst the pressure sensors and further material experimentation as well as calibration process adjustment is needed to improve the accuracy of the force sensors.

6 Future work

Following the development of the smart-sensing surgical testbed, this apparatus is planned to be integrated into a telesurgical robotic training system. In conjunction with a robotic gripper added to a robot, the goal of this future work is to characterize the human-centric metrics and model the human operator's behavior. More specifically, this study aims to evaluate the operator's ability to control the moving end effector and manipulate tools to grasp tissue from a laparoscopic surgical training module using Fitts' Law.

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