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The Association Between Cardiovascular Health with Internet and Mobile Technology Use

Among Jackson Heart Study Participants

By

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Master of Public Health

Behavioral, Social, and Health Education Sciences

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An abstract of a thesis submitted to the Faculty of the

Rollins School of Public Health of Emory University

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2021

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By Shandria Sutton

Background: Cardiovascular disease (CVD) is a pervasive issue in the United States, as it is the leading cause of death in the country. African Americans are disproportionately impacted by this chronic disease, and they experience higher cardiovascular risk compared to other racial or ethnic groups. Current research has examined how effective technological interventions are in supporting CVD self-management and health information seeking. However, few of these studies have been conducted in populations of older, African Americans. Further research must be conducted to understand whether African Americans with or at risk for CVD use the internet and mobile technology, and if socioeconomic status affects this relationship, to understand if it is a feasible tool to help people obtain needed CVD-related information and utilize it to manage their cardiovascular risk.

Methods: The present study is a secondary data analysis using Jackson Heart Study data. Data were collected at three time points: Exam 1 (n=5,306), Exam 3 (n=3,819), and during the Digital Connectedness Survey (n=2,557). Participants completed measures of cardiovascular health (the American Heart Association's Life simple 7), internet and mobile technology use, and demographic characteristics via telephone interview. Both multivariable logistic and linear regression analyses were conducted to analyze the relationship between Life's Simple 7 composite scores (representing cardiovascular health) and internet and mobile technology use.

Results: Overall, 2, 255 (88%) of participants were IMT users. The association between LS7 composite scores and IMT use was non-significant ($p \leq 0.50$). When analyzing the association between individual LS7 component scores and IMT use, glucose yielded the only significant result ($p \leq 0.01$). Individuals in the ideal and intermediate categories for glucose control were more likely to be IMT users. In a model that included LS7 composite scores, socioeconomic status and the interaction between the two, the interaction did not have a significant effect on the relationship ($p \leq 0.83$). The relationship between LS7 composite scores and IMT use characteristics was also mostly non-significant. The only significant association was between LS7 composite scores and use of smart devices ($p \leq 0.01$). As LS7 scores increased (indicating better cardiovascular health), so did the odds of using smart devices such as smart phones, tablet computers, and smart watches.

Conclusions: The results failed to demonstrate an association between cardiovascular health and internet and mobile technology use. However, the study provided insight for areas of future research regarding cardiovascular health and internet and mobile technology use among older, African Americans.

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Chapter 1: Introduction

Cardiovascular Disease as a Public Health Issue

Over 100 million Americans are living with at least one chronic disease, an illness that lasts for a year or longer (American Public Health Association, 2012). Cardiovascular disease (CVD), in particular, is especially pervasive as it is one of the most common chronic diseases in the United States, affecting over 80 million people (Heron, 2019; Roger et al., 2011). Also known as heart disease, CVD is comprised of several conditions that affect the heart valves and blood vessels. It is the leading cause of death in the United States, killing nearly 650,000 Americans annually, which exceeds cancer (599,108) and deadly injuries from accidents (169,936) (Benjamin et al., 2019; Fryar, Chen, & Li, 2019; Heron, 2019). Cardiovascular disease also costs the United States billions of dollars each year in health care and lost production costs, making it the most expensive chronic disease as well (American Public Health Association, 2012; Heron, 2019).

Several risk factors are attributed to the development and progression of CVD. Some include age, gender, physical inactivity, diabetes, obesity, hyperlipidemia, hypertension, and smoking (Mozaffarian, Wilson, & Kannel, 2008; O'Donnell & Elousa, 2008). While CVD can be detrimental to one's health, it can be prevented by those at risk or managed by those who have already been diagnosed with it. This can be accomplished by targeting the risk factors. To assist people with this effort, the American Heart Association created Life's Simple 7 (LS7), a list of seven factors that people can focus on to achieve ideal cardiovascular health (CVH) (Lloyd-Jones, et al., 2010).

Life's Simple Seven and Lack of Information

The seven LS7 factors consist of four health metrics and three clinical factors. The four health metrics are smoking, physical activity, nutrition, and body mass index (BMI), and the three clinical factors are cholesterol, blood pressure, and glucose. Engaging in physical activity, consuming a healthier diet, monitoring glucose, and smoking cessation are just a few of the lifestyle changes related to these factors that have been shown to lower cardiovascular risk (Chidum et al., 2011; Ornish et al., 1998). By managing each of these LS7 factors, people can monitor and assess their heart health. After making these evaluations, they can talk with their doctor and make the necessary lifestyle and medicinal changes needed to avoid CVD or slow its progression.

Lack of awareness and a shortage of information also contribute to cardiovascular risk for some people. While knowledge alone is not sufficient to reduce cardiovascular risk, it is a necessary component. The general public is not adequately informed about CVD, its risk factors, and preventable measures (Gill & Chow, 2010; Koniak-Griffin & Brecht, 2015; Magnani et al., 2018). This can be a result of language or cultural barriers, poor communication, or inadequate health literacy (Gill & Chow, 2010; Koniak-Griffin & Brecht, 2015; Magnani et al., 2018). Ultimately, this is problematic because it can cause people to make misinformed behavioral decisions that may cause the onset of CVD or exacerbate its progression for those who already have it.

Cardiovascular Disease in African Americans

Cardiovascular disease affects thousands of African Americans living in the United States. As of 2011, 46% of African American men and about 48% of African American women (over 20 years of age) were living with some form of this chronic disease (Mozaffarian et al., 2015). In the same year, nearly 93,000 African Americans died as a result of CVD (Mozaffarian et al., 2015).

These numbers are even more concerning when compared to other racial groups. Black[1] people are also likely to experience the onset of heart disease at younger ages than Whites, partly due to some social conditions, such as high rates of poverty, unemployment, and the inability to access healthcare, that disproportionately affect them and detrimentally affect their health (Centers for Disease Control and Prevention, 2017). CVD rates are 20% higher in Blacks compared to non-Hispanic Whites (Mensah, 2018). This is partially because African Americans have higher burdens of associated risk factors. High blood pressure is more prevalent in African Americans than any other racial group, 69% of Black men and 82% of Black women are overweight or obese, and they also have higher rates of diabetes than Whites (American Heart Association, 2015). Additionally, African Americans face barriers acquiring CVD-related knowledge such as lower health literacy, lack of trust in healthcare professionals, and a shortage of culturally-specific health messaging (Bhattacharya, 2013; Kutner et al., 2006; Muvuka et al., 2020). From the 2003 National Assessment of Adult Literacy, findings indicated that 58% of African Americans had health literacy skills that were basic or below basic messaging (Kutner et al., 2006). This number was significantly lower than their White counterparts, of whom only 28% had low messaging health literacy skills (Kutner et al., 2006). Without adequate health literacy skills, one is unable to effectively understand health-related information, and apply it to their daily lives, often contributing to negative health outcomes and health disparities.

[1] The terms Black and African American will be used interchangeably throughout this paper.

Technology for CVD Prevention

Monitoring and assessing one's smoking habits, physical activity, diet, blood pressure, cholesterol, BMI, and glucose can be difficult for some. This is known as self-management or an individual's own daily efforts to manage an illness throughout the course of the disease (Grady & Gough, 2014). In addition to monitoring and assessing behavioral and clinical factors, it also includes the process of acquiring and understanding relevant health information and communicating concerns to healthcare providers. All of which can also be difficult to accomplish. For these reasons, researchers recently have begun exploring how technology can be used to aid people in efforts to improve their overall cardiovascular health (Afshin et al., 2016). Technology encompasses digital devices and tools such as mobile technologies, the internet, and social media. Over the years, these different forms of technology have been increasingly used in healthcare to diagnose patients, provide treatment, and conduct health-related research (Balogh, Miller, & Ball, 2015; Forum on Neuroscience and Nervous System Disorders, 2016).

Interventions centered around technology are currently being developed and researched to explore how they can enhance primary and secondary CVD efforts. These interventions have employed numerous types of digital technology including texting, mobile phones, mobile apps, and the internet. In these interventions, participants using the technology were able to self-manage their cardiovascular health by monitoring risk factors such as blood pressure and weight as well as engage in healthier behaviors such as exercising, making better food choices, and adhering to their medication (Burke et al., 2015; Park et al., 2016; Pfaeffli et al., 2015). This research demonstrates that technological applications' potential is useful in increasing uptake and adherence to the lifestyle changes essential in avoiding negative cardiovascular outcomes.

Technological interventions have also been created to lower cardiovascular risk through communication features. In these studies, text messaging, interactive voice response calls, and other mobile phone features are implemented to help participants adhere to healthier lifestyle changes through text reminders and voicemails (Franklin, Lavie, & Arena, 2015). They also allow study investigators to give educational messages to participants (Franklin, Lavie, & Arena, 2015). Furthermore, they help facilitate communication with participants by asking them questions about their health, giving them tasks, and sending them words of encouragement (Franklin, Lavie, & Arena, 2015).

While these technological interventions have been utilized to lower cardiovascular risk, they have not been tested equally among different racial groups. Technology use, particularly the use of computers, the internet, and smart devices, has increased among African Americans in recent years (Perrin & Turner, 2019). In 2019, 58% of African Americans living in the US reported having personal access to a desktop or laptop computer, 66% reported having home internet service, 80% reported having a smartphone, 58% reported having a tablet computer, and 33% reported having access to all of these digital devices (Perrin & Turner, 2019). However, technological interventions designed to help participants improve their heart health and find relevant health information have rarely been tailored specifically for African American populations. Because African Americans have a higher prevalence of CVD, they would arguably benefit greatly from interventions that use technology to communicate health-related information and assist with behavioral lifestyle changes without requiring high levels of health literacy.

Additionally, few technological interventions have been tested among different age groups, particularly with participants 65 years of age and older. For the ones that do exist, findings have demonstrated that technological interventions have not significantly impacted health outcomes among older participants experiencing heart failure (Son, Lee, & Lee, 2020). While older Americans have generally been more reluctant than younger individuals to adopt the use of technology, this has changed in recent years. A 2017 Pew Research Center report has found that about 40% of adults 65 years of age and older now personally own smartphones whereas only 18% reported this in 2013 (Pew Research Center, 2017). Furthermore, almost 70% of adults in this age group reported using the internet as well (Pew Research Center, 2017).

Socioeconomic Status, Technology, and CVD Prevention

As the years have progressed, more Americans have begun utilizing technology. A 2017 Pew Research Center report revealed that, as of 2016, nearly 80% of Americans had access to a smartphone (Smith, 2017). Only 35% of Americans reported this in 2011 demonstrating a vast increase in technology uptake (Smith, 2017). However, this rise in technology use and access was not possible for all Americans as access to digital technology differs based on various social factors.

These factors are known as social determinants of health (SDOH). They are defined by the World Health Organization as “the conditions in which people are born, grow, live, work and age” (World Health Organization, 2021). Socioeconomic status (SES) is one SDOH that influences technology access. Individuals with lower incomes have been found to be less digitally connected with those with higher incomes in America. About 30% of Americans with yearly household incomes less than $30,000 a year reported not having a smartphone (Pew Research Center, 2015). Additionally, 44% of individuals with this same yearly income reported not having home internet, 46% did not have a computer, and 64% did not have a tablet computer. Only 18% of these Americans had access to all of these devices (Pew Research Center, 2015). These numbers differ greatly from Americans with yearly household incomes between $30,000 and $99,000 a year. Of these Americans, 85% reported owning a smartphone, 83% owned a computer, 81% had home internet, 51% had a tablet computer, and 39% had access to all devices (Pew Research Center, 2015).

These differences demonstrate how SES can heavily influence access to digital devices, and in turn, prevent the use of technology to improve cardiovascular health. This is problematic when considering that SES is also closely related to cardiovascular outcomes. Individuals with lower SES have higher CVD risk and are more likely to engage in behaviors, such as eating an unhealthy diet and participating in little to no physical activity, related to the incidence of CVD (Pew Research Center, 2016). While there are interventions that aim to address CVD risk factors in populations with lower SES, there is a paucity of studies that do so with the utilization of technology.

This information is pertinent when considering that African Americans are overrepresented in low SES. No matter the level of educational attainment, African Americans are more likely to have lower income than Whites (Rosengren et al., 2019). Blacks are also more likely to face generational poverty and are 2.6 more times than Whites to be impoverished (Bloome, 2014). This inequality could be attributed to a number of social factors including discrimination and systemic racism (Williams, Priest, & Anderson, 2016).

Relevant Theories

The Wilson 1996 general model of information behavior may be used to explain how people seek and utilize information (Wilson, 1999), such as that related to CVD. This model suggests that a need or problem must first arise for a person. Once this occurs, it inspires or motivates them to seek out relevant information to satisfy that need or resolve that problem. It also outlines potential barriers and facilitators that may hinder or support a person’s attempts at seeking this information (Figure 1). While this model is not specific to health information, it is still applicable to the relationship between CVD and internet use. Those with or at risk for the disease (if they are aware of this risk) will experience a need to improve their heart health. Using the internet and mobile technology is one method in which they can seek out the information they need. Additionally, like the model suggests, intervening variables exist that may serve as barriers and can prevent some people from using technology in this way (Wilson, 1999). These variables can be characteristics of the source material, psychological, demographic, role-related, interpersonal, or environmental as all of which can influence an individual's financial or social standing and, in turn, can affect their access, understanding, and utilization of information (Wilson, 1999). Some specific examples include personally not having access to adequate information resources or the resources themselves being unreliable and inaccurate, therefore making them unable to use as an appropriate source of information.

While Wilson's (1996) general model of information behavior suggests that people search for information when a need or concern becomes apparent, Ayers and Kronenfeld's (2007) theory of health information-seeking proposes a similar idea but in a health context. The theory of health information-seeking is more specific to individuals with chronic disease. This theory posits that people who are more uncertain about their health and have more health concerns are more likely to find health-related information and use the internet to do so (Ayers & Kronenfeld, 2007). Those affected by CVD are likely to have a number of health concerns. Therefore, they are more likely to seek out health information. Moreover, those with access to technology may use these tools as vehicles to acquire the necessary information.

As previously mentioned, research exists that illustrates how technological approaches can be used to improve cardiovascular health, yet very few were conducted among older African

Americans, a population more likely to die from CVD than any other racial or ethnic group in America (Centers for Disease Control and Prevention, 2019). To understand whether such interventions can be effective among this group, it is first important to determine if and how this population uses digital technology. Therefore, the purpose of this study is to analyze how cardiovascular health relates to Internet and Mobile Technology (IMT) use among older African Americans in the Jackson Heart Study (JHS). For the purposes of this study, IMT use is defined as the internet, mobile phones, digital health technology, and smart devices. The JHS is a prospective cohort study established in 1998 to understand the incidence and progression of CVD in a target population of African Americans living in Mississippi. This study is significant because, by conducting this study with JHS data, we will better understand the use of the internet and cellphones among older, African Americans, a population not often studied when conducting research on digital technology. Additionally, understanding how cardiovascular health metrics relate to IMT use will help us to better understand if people at risk, or with CVD, use IMT and how. If used adequately, then technology could be used to design health information and educational interventions in the hopes of preventing or lessening the effects of CVD.

Study Aims and Hypotheses

This study seeks to answer the research question: What is the association between cardiovascular health with internet and mobile technology (IMT) use among Jackson Heart Study Participants? The study has two aims:

- Aim 1 is to determine whether the LS7 composite and component score are associated with IMT use among African Americans and if socioeconomic status (SES) modifies this association.

- Aim 2 is to restrict the data to those who indicated they were IMT users and analyze how LS7 composite scores relate to characteristics of IMT Use (i.e. average number of hours spent on the internet, usage of technology to track health, and usage of smart devices)

This study also has five hypotheses.

For Aim 1:

- 1a) Lower LS7 composite and component scores will be associated with greater IMT use
- 1b) SES will modify the association between LS7 scores and IMT use

For Aim 2:

- 2) Among IMT users, those with lower composite LS7 scores will be more likely to do the following compared to those with higher LS7 scores:
  a. spend more time on the internet
  b. use technology to track or manage their health
  c. use smart devices

Chapter 2: Literature Review

Prevalence of CVD

Cardiovascular disease incorporates several conditions that affect the heart. Some include heart failure, stroke, hypertensive heart disease, coronary artery disease, and congenital heart defects. According to data gathered from 2013-2016 by the National Health and Nutrition Examination Survey, 48% of American adults 20 years of age and older have been diagnosed with some form of heart disease (Benjamin et al., 2019). This accounts for over 120 million people (Benjamin et al., 2019). This number is projected to see a 10 million person increase by the year 2035 (Khavjou, Phelps, & Leib, 2016).

In the United States, CVD is more prevalent among males than females. From 2013-2016, men accounted for 61,500,000 CVD cases and 840,678 deaths (Benjamin et al., 2019). Women accounted for 60,000,000 cases and 412,244 deaths. It is the leading cause of death in both groups (Benjamin et al., 2019). The risk of CVD also increases with age. Approximately 90% of both men and women over 80 years of age have at least one type of CVD (Benjamin et al., 2019).

Cardiovascular risks and outcomes vary across races and ethnicities. African Americans, specifically, are disproportionately affected by CVD. The disease occurs in African Americans at earlier ages than in other racial groups (Carnethon et al., 2017). This is partially due to high rates of hypertension, obesity, and diabetes among this population (Carnethon et al., 2017). They are also 20% more likely to die from CVD than their White counterparts (Centers for Disease Control and Prevention, 2019). Furthermore, they also experience more negative CVD-related outcomes as they are more than twice as likely to experience sudden heart arrest, and more than

50% likely to experience strokes than Whites (Reinier et al., 2015; U.S. Department of Health and Human Services, 2020).

Social Determinants of CVD

Several SDOH contribute to this health disparity for African Americans, including racism. Racism is still an issue in America, and it can lead to bias and stereotypical thinking in healthcare, which impacts how patients are treated (Institute of Medicine Committee on Understanding and Eliminating Racial and Ethnic Disparities in Healthcare, 2003). These biases in healthcare are more likely to affect minority populations, such as African Americans and Hispanics, and can result in doctors making misguided decisions for their patients and people receiving lower quality treatment (Havranek et al., 2015). In studies analyzing bias and decision-making among healthcare professionals, some clinicians had negative perceptions about African Americans, deeming them untrustworthy, sicklier looking, having poor social support, and lacking ample finances. As a result, Blacks were less likely than White patients to be recommended for advanced cardiac care (Breathett et al., 2019, 2020). These racial biases can also undermine the relationship between the doctor and patient, which will affect the patients' comfortability to communicate, ask questions, and express concerns (Havranek et al., 2015). Specific to cardiovascular health, there is a gap in access to healthcare between African Americans and Whites, especially regarding advanced cardiac treatment and care. Some examples include that African Americans are more likely than Whites to experience delays in revascularization after experiencing a heart attack and to experience graft failure or die after receiving a heart transplant (Lui et al., 2019; Mody et al., 2012; Young, 2020). Furthermore, they are less likely to receive the same care after being hospitalized for a stroke (Mody et al., 2012).

The environment, consisting of the neighborhood and built environment, also contributes to health inequities. An individual's environment can determine exposure to crime and violence, access to healthy foods, and safety for physical activity. In turn, these elements shape an individual's ability to engage in physical activity, eat healthier foods, and visit a health care provider. In terms of cardiovascular disease, living in a disadvantaged or low-income neighborhood can result in higher cardiovascular risk (Havranek et al., 2015). A neighborhood's built environment is associated with cardiovascular health as well. Nutrition and physical activity are two key factors in maintaining ideal cardiovascular health. Therefore, those living in neighborhoods with access to stores that sell healthier foods and have characteristics that encourage exercise like sidewalks have been found to have lower rates of type two diabetes and obesity (Havranek et al., 2015).

Socioeconomic status is another SDOH that can greatly affect cardiovascular health. Socioeconomic status can have several indicators including income, education, occupation, and employment status. Lower educational attainment, lower income, and being unemployed, in particular, have been found to be associated with increased cardiovascular risk, and poorer cardiovascular events such as non-fatal heart attacks or sudden cardiac death (Clark et al., 2009; Shultz et al., 2018). Furthermore, lower educational attainment is associated with higher rates of CVD risk factors such as diabetes and high blood pressure (Clark et al., 2009; Rosengren et al., 2019).

The impact of SES on cardiovascular risk is strengthened by its association with access to health care, another SDOH. Some people with a lower SES are not able to receive the treatment that they need. This may be due to a lack of insurance, which is associated with higher CVD-related mortality, or an inability to afford health care costs (Havranek et al., 2015). Additionally, individuals with lower incomes or living in low-income areas are not always offered an expensive, yet needed procedure after experiencing a negative cardiac event, and experience delays receiving treatment after experiencing a heart attack (Schultz et al., 2018). In addition to SES, individuals may not have access to care because there may not be a health care facility close to where they live, or they may not have access to transportation.

American Heart Association's LS7

As an organization that strives to improve the nation's cardiovascular health, the American Heart Association created Life's Simple 7 to help people monitor risk factors associated with CVD, make necessary lifestyle changes, and achieve ideal cardiovascular health. LS7 consists of four health behaviors. They are smoking status, physical activity, nutrition, and maintain a healthy BMI (Lloyd-Jones et al., 2010). It also consists of three clinical metrics. They consist of blood pressure, cholesterol, and blood glucose (Lloyd-Jones et al., 2010). A review of each factor is presented below.

Health Behaviors. Smoking is one of the main contributors to the development and advancement of cardiovascular disease. In the United States, smoking is linked to 25% of CVD-related deaths (National Center for Chronic Disease Prevention and Health Promotion, 2014). This is because smoking increases the plaque buildup in blood vessels which can lead to clotting and prevent sufficient blood flow throughout the body. Smoking can also be detrimental to nonsmokers through secondhand smoke. Individuals who constantly breathe in secondhand smoke increase their risk of developing heart disease by up to 30% (Centers for Disease Control and Prevention, 2020a). African Americans smoke less than Whites, yet they are still more likely to die from smoke-related illnesses (Centers for Disease Control and Prevention, 2021; Kochanek et al., 2016; Tobacco Use among U.S. racial/ethnic minority groups, 1998). Compared to other racial groups, African Americans are also more likely to be exposed to secondhand smoke (Centers for Disease Control and Prevention, 2021; Tsai, Homa, & Gretzke, 2018).

Physical activity is another indicator for cardiovascular health as it can be a protective or a risk factor. The American Heart Association recommends that people get 150 minutes of moderate aerobic exercise or 70 minutes of vigorous aerobic exercise weekly (American Heart Association, 2016a). Meeting these guidelines and engaging in frequent and consistent physical activity can lower CVD mortality by increasing muscular function, one's ability to take in oxygen, and lessen the chances of developing other cardiovascular risk factors (Myers, 2003). Conversely, physical inactivity or living a sedentary lifestyle can negatively affect heart health. Adults who do not engage in physical activity, tend to be less fit and are 4.5 times more likely to die from CVD complications (Myers, 2003). Among African Americans, those who are older, unemployed, and have lower educational attainment and income, are less likely to engage in physical activity, making them more vulnerable to cardiovascular risk (Whitt-Glover et al., 2007; Williams et al., 2018).

An individual's diet or nutrition is another factor that influences cardiovascular health. Eating sodium, processed foods, added sugars, and unhealthy fats in excess can increase the likelihood of developing CVD. In 2012, about 45% of CVD-related deaths were attributed to unhealthy eating habits (Micha et al., 2017). On the contrary, a diet that consists of healthier, more balanced foods such as whole grains, vegetables, and fruit can lower cardiovascular risk by almost 33% (Anand et al., 2015). As a result of their culture and heritage, many African Americans consume a diet that includes high amounts of fat and sodium, contributing to their CVD risk (Airhihenbuwa et al., 1996; James, 2004).

Additionally, BMI can impact cardiovascular health as well. Nearly 70% of adults in the United States are either overweight or obese (Akil & Ahmad, 2011). This is problematic as being overweight or obese is linked to several negative cardiovascular outcomes including the incidence of heart failure and coronary artery disease (Csige et al., 2018). The American Heart Association recommends for individuals to maintain a healthy BMI to reduce stress on one's heart and blood vessels and in turn, reduce the likelihood of being diagnosed with CVD. Due to the dietary patterns of African Americans mentioned previously, they have the highest rates of being overweight or obese than any other racial group in America (U.S. Department of Health and Human Services Office of Minority Health, 2020).

Clinical Factors. Blood pressure is a major clinical indicator for cardiovascular risk. Globally, almost 47% of coronary heart diseases are a result of hypertension. This is because the excess force of the blood on the arteries causes atherosclerosis and narrows those arteries (American Heart Association, 2016b). Similarly, cholesterol also affects heart health, and is a pervasive issue in America as approximately, 29 million American adults have high cholesterol (Virani, et al., 2020). Like high blood pressure, too much low-density lipoprotein (LDL) cholesterol in the blood can also lead to atherosclerosis through plaque buildup in the heart and can ultimately lead to CVD. Keeping one's blood pressure and cholesterol in healthy ranges decreases the chances of atherosclerosis and other forms of heart disease. In 2018, about 57% of African Americans over 20 years of age had high blood pressure, which was more than 10% higher than their White counterparts (43.6%) (U.S. Department of Health and Human Services Department of Minority Health, 2021). On the other hand, more White individuals had high cholesterol (32.7%), but a substantial number of African Americans had high cholesterol as well (24.1%) (U.S. Department of Health and Human Services Department of Minority Health, 2021).

Lastly, glucose, or blood sugar, can also increase cardiovascular risk, which is concerning as over 100 million Americans are diabetic or pre-diabetic (Centers for Disease Control and Prevention, 2020b). In 2018 alone, nearly 11% of adults in the United States had diabetes (Centers for Disease Control and Prevention, 2020b). Having high blood sugar, or diabetes, can harm several parts of the body, including blood vessels of the heart. Having diabetes is also linked to other risk factors for CVD, including high blood pressure and high levels of bad cholesterol (Centers for Disease Control and Prevention, 2020c). Compared to Whites, African Americans are 60% more likely to be diagnosed with diabetes, significantly increasing their risk of developing CVD (U.S. Department of Health and Human Services Office of Minority Health, 2019).

LS7 Composite. Each of these individual components can be added to create a LS7 composite score, a measure of overall heart health. Lower LS7 composite scores indicate greater risk for CVD, and higher scores demonstrate better cardiovascular health. One study found that a gradual increase in LS7 composite scores was associated with a 25% decrease in the occurrence of a stroke (Kulshreshtha et al., 2013). In another study analyzing the relationship between LS7 composite scores and atrial fibrillation, lower scores at midlife were associated with higher atrial fibrillation burden later in life (Wang et al., 2020).

Technology in Public Health

Internet and mobile technology have forever changed all aspects of public health. In research, technology is used to collect data, share information, and implement interventions (Rosa et al., 2015). In healthcare, digital devices now allow health facilities to better organize and store patient health information (Murero & Rice, 2006). Doctors and other health care providers can conduct more accurate, efficient health examinations that help them to better diagnose ailments and provide more effective treatment. Furthermore, use of technology allows people to have more agency over their own health by assisting them in monitoring and controlling their own health metrics such as blood pressure and glucose levels (Bhavnani, Narula, & Sengupta, 2016; Steinhubl, Muse, & Topol, 2015).

Furthermore, technology has altered health communication and the dissemination of health information. When people have health-related questions, they can easily and quickly find the information they need in an instant by accessing the internet with their phone, computer, or other mobile device (Murero & Rice, 2006). Patients can also communicate with their doctors without leaving their house. They can use mobile technology, the internet, telehealth, and the patient portals of their healthcare facilities to contact their healthcare providers, set up appointments, ask questions, find out test results, and even have virtual doctor appointments with their doctors (Murero & Rice, 2006).

While it is beneficial that the internet makes health information easily accessible, it can also be problematic. The internet can be used as a vehicle to spread false information, which can be harmful when seeking knowledge to make decisions about one's health (Mashiach, G. Seidman, & D. Seidman, 2002; Ostrom, 1999). People can find inaccurate information on health-related topics and integrate it into their lives without the knowledge of a medical professional (Wu & McCormick, 2018). This leaves individuals to be their own judge of which sources are accurate and reliable. However, this may be difficult to accomplish without the health literacy skills necessary to effectively decide which sources are dependable and how to safely utilize the information to the benefit of their health.

SDOH and Technology Access

While technology has many benefits and seems to be the future of healthcare, it is important to consider the "digital divide." This is the gap that exists between those with access to certain forms of technology and those who do not. Both SES and environment influence whether an individual has access to digital technologies such as internet, computers, mobile phones, and other mobile devices. It also determines the quality of the internet service. People with lower income may not be able to afford technology, those with lower educational attainment may avoid using technology because they feel that they lack the skills to use it efficiently, and those living in rural areas may experience difficulties getting reliable internet access due to the infrastructure's ability to support it (Baum, Newman, & Biedrzycki, 2014; Pew Research Center, 2018). These gaps in technology access have the potential to exacerbate health inequities because those with technology access will be able to reap its health-related benefits, while those without it will not. As aforementioned, this is important to consider because African Americans are overrepresented among those with lower SES.

Technology use among those with CVD

People with multiple chronic diseases are also less likely to have internet access, which further undermines its potential utility among those who suffer from chronic diseases (Fox & Purcell, 2010). However, individuals that do have a chronic illness and access to digital technology do tend to utilize technology for various purposes. Those with a chronic disease and internet access may use the internet to find health-related information and seek social support from people with similar conditions, which both positively impact aspects of their health (Burrows et al., 2000; Eng et al., 1998; Fox & Purcell, 2010). Specific to CVD, people use internet and mobile technologies to find new information related to their disease. Some of the most common searches include seeking information about cardiovascular-related vital signs and symptoms (Jadhav et al., 2014). Moreover, those with higher cardiovascular risk are more likely than those with lower CVD risk to share the information they find with their health care providers for further input and discussion (Shan et al., 2019). Interventions with cell phone applications and other forms of digital technology are being created to help people self-manage their heart health by tracking and monitoring risk factors. To aid in weight management, innovative mobile technologies have helped participants monitor their weight on a weekly basis, promote healthy eating and physical activity, and provide personalized feedback through apps, texting, and the internet (Coons et al., 2012; Thomas & Bond, 2014). Interventions involving text messaging, mobile apps, email, and the internet are also used to target other CVD risk factors like diabetes and high blood pressure (Liang et al., 2011; Orsama et al., 2013).

Technology use among African Americans

The "digital divide" is progressively closing between African Americans and Whites. As stated before, 82% of African Americans own either a desktop or laptop computer, 79% have home internet service, and 82% own a smartphone (Perrin & Turner, 2019). In 2014, 67% of African Americans with a smartphone reported using their smartphone device to look up information about a health condition (Pew Research Center, 2015). There is little research testing the use of internet, mobile technology, and other smart devices to improve cardiovascular health in primarily African American populations (Kiselev et al., 2012; Thiboutot et al., 2013). However, the studies that do exist demonstrate that technology can improve aspects of heart health and that there is some interest in use among participants (Brewer et al., 2019; Laken et al., 2004; Still et al., 2018). One study illustrated that internet and mobile technology use is prevalent among African Americans with type two diabetes and that there is a willingness to use technology for health information and self-management purposes (Laken et al., 2004). In a qualitative study of African Americans aged 60 and older, the authors found that not all participants were comfortable with using mobile technology for health purposes, but those who were, actively utilized their mobile phones to self-manage diabetes and hypertension (Still et al., 2018). These findings show that using technology is feasible for helping those diagnosed with or at risk for CVD by helping them stay informed and better manage their health.

Theoretical Frameworks

The original version of Wilson's general model of information behavior was created in 1981 (Wilson, 1981). The foundational idea of the model is that the presence of a personal need or issue will cause someone to seek out health information to meet the need or resolve the problem (Murero & Rice, 2006). This model outlines several stages that the person goes through in the process of seeking information (Figure 1). The first step is the context of need. The second step is the activating mechanism, which is the personal characteristic that triggers the act of information-seeking. Next is information-seeking behavior, which can have four modes: passive attention, passive search, active search, and ongoing search (Murero & Rice, 2006). The last step is information processing and use. During the activating mechanism stage, the model also presents the possibility of barriers and facilitators, which ultimately determine if people access the information they need and integrate it into their lives. These barriers and facilitators are referred to as intervening variables (Murero & Rice, 2006).

Although more research has been conducted on health communication in recent years, there are not many theories developed to focus on health information-seeking, specifically among those with CVD and other chronic diseases. Ayers and Kronenfeld (2007) use multiple constructs presented in health information-seeking to explain this relationship. The theory of health information posits that people with chronic diseases are more likely to seek out health information because they have more questions and concerns and need the information more than those without chronic diseases. Additionally, the information they seek is specific to their condition, making it easier to find potential solutions most helpful for managing their particular health needs (Ayers & Kronenfeld, 2007).

While this study is not poised to shed light on every step outlined by Wilson's 1996 general model of health information behavior, its overall notion, in conjunction with Ayers and Kronenfeld's (2007) theory of health information-seeking, is still applicable to African Americans, technology, and CVD. Wilson's 1996 model proposes that when people experience problems, they seek out the necessary information to help them address their concerns. Ayers and Kronenfeld (2007) posit that people with health problems are likely to use the internet to find this information. Based on these two theories, it is probable that people with greater CVD risk would use the internet to seek health information to better their CVH.

Limitations of Current Research

There are numerous studies analyzing the effects of different technological interventions for CVD prevention and management. However, very few are conducted in a population of older, African Americans. Ownership of smartphones, computers, and home internet access has increased significantly among this population in recent years. Furthermore, the few studies that do analyze these interventions in primarily African American populations demonstrate that internet and mobile technologies can be beneficial among this group to target CVD, but people must have the skills and comfortability to use them. Additionally, more information is needed on how this population uses the technology they own, and if they use it for health information purposes. Therefore, the present study seeks to analyze if and how a population of older African

Americans are using internet and mobile technology to determine if they are viable tools to aid in CVD self-management.

Chapter 3: Methods

Research Design

This research study was a descriptive, secondary analysis of the JHS using a longitudinal study design. It assessed the association between cardiovascular health and IMT use. The JHS is a prospective cohort study designed to analyze the development and advancement of CVD in African American adults that was established in 1998. (Fuqua et al., 2005; Payne et al., 2005; Taylor et al., 2005). Informed consent was obtained from all study participants and was approved by the Institutional Review Boards (IRB) of the University of Mississippi Medical Center, Jackson State University, and Tougaloo College (Fuqua et al., 2005; Payne et al., 2005; Taylor et al., 2005). The data used for this study were collected at Exam 1 (2000-2004), Exam 3 (2009-2013) and during Annual Follow-up (2017-2019) as shown in Table 1. The Emory University IRB deemed this secondary data analysis, not human subjects research and therefore, exempt from review.

Target Population

The target population for this study was JHS participants. The JHS consists of 5,306 African Americans living in the Jackson, Mississippi metropolitan statistical area (Fuqua et al., 2005; Payne et al., 2005; Taylor et al., 2005). Participants were recruited from three Mississippi Counties: Hinds, Madison, and Rankin. Four methods were used for recruitment. Of the 5,306 participants, 17% were from a random sampling of Jackson area residents, 22% were enrolled from the Jackson site of the Atherosclerosis Risk in Communities study, 30% were volunteers from the Jackson metropolitan statistical area, and 31% were recruited as family members of existing JHS participants (Taylor et al., 2005).

Outcomes

For Aim 1, the outcome was IMT use. This variable was used to measure if participants use the internet, cell phones, or both. The data for this variable were collected using the Digital Connectedness Survey, which was completed by JHS participants from 2017-2019 during the annual follow-up (N=2,564). A dichotomous yes/no variable represents IMT use whereas participants were categorized as IMT users if they responded yes to at least one of the following questions “Do you use the internet at least occasionally?” and “Do you use a cell phone?” Participants were indicated as non-users if they responded “no” to both questions.

For Aim 2, there were three outcome variables used, all of which were collected when participants completed the Digital Connectedness Survey during the annual follow-up from 2017-2019. The first outcome variable used for Aim 2 is the average number of hours spent on the internet. This is a continuous variable representing an estimate of the hours participants spend on the internet daily. The corresponding question used to measure this variable is “On average, how many hours per day do you use the internet?”

The second outcome for Aim 2 was usage of technology to track health. This is a dichotomous yes/no variable created to indicate if participants utilize apps on their cell phones or other forms of digital health technology to monitor their health. Participants were categorized as users if they responded yes to at least one of the following questions: “On your phone, do you have any software applications or "apps" that help you track or manage your health?” and “Do you use any digital health technology, which store health readings digitally? (Digital blood pressure cuff [e.g. Omron, Rite Aid, A&D Medical, etc.] Digital glucometer [e.g. FreeStyle, Bayer, True Metrix, Accu Check, etc.] Digital scale [e.g. Taylor, Tanita, Escali, Weight Watchers, etc.]". Participants were indicated as non-users if they responded "no" to both questions.

The third and final outcome for Aim 2 was use of smart devices. This is a dichotomous yes/ no variable used to measure if participants use smartphones or other smart devices such as computers and smartwatches. Participants were categorized as non-users if they responded "no" to both questions. They were indicated as users if they responded "yes" to at least one of the following questions: "Some cell phones are called "smartphones" because of certain features they have. Is your cell phone a smartphone, such as an iPhone, Android?" and "Do you use any of the following devices? (Computer, Tablet computer, Game console, E-book reader, Smartwatch [e.g. Apple, Motorola, Samsung, etc.], Physical activity tracker [e.g: FitBit, Garmin, Misfit, etc.]".

Exposures

For both Aim 1 and Aim 2, the primary exposure was LS7 composite scores, which were used to represent overall cardiovascular health. The LS7 composite scores are comprised of seven metrics (cigarette smoking status, physical activity, nutrition, BMI, cholesterol, blood pressure, and glucose) as outlined by the American Heart Association (Lloyd-Jones et al., 2010). Data for each LS7 measure were collected at Exam 1 or 3 depending on the variable, which took place from 2000-2004 and 2009-2013 respectively. Each variable has three categories: poor, intermediate, and ideal as defined by AHA guidelines (Lloyd-Jones et al., 2010). For each factor, participants were assigned 2 points for each ideal categorization, 1 point for each intermediate categorization, and 0 points for each poor categorization. All component points were added to form the total composite score ranging from 0-14 such that lower scores indicate greater cardiovascular risk.

For Aim 1, each individual metric was also utilized to assess how each LS7 metric independently relates to IMT use. Each metric has three categories: poor, intermediate, and ideal based on how much they engage in the health behavior. Criteria for each category were defined using American Heart Association guidelines (Lloyd-Jones et al., 2010).

Smoking

Data were collected at Exam 1 using a self-reported questionnaire. Participants were categorized as poor if they were a current smoker, intermediate if they were former smokers who quit within the past 12 months of completing the survey, and ideal if they had never smoked or quit smoking at least 12 months prior to the exam.

Physical Activity

Data were collected at Exam 3 using an interviewer-administered questionnaire that asked assessed the type of activity completed by the participants, as well as the duration and frequency (Dubbert et al., 2005). Participants were categorized as poor if they did 0 minutes of moderate physical activity and 0 minutes of vigorous physical activity weekly. Participants were categorized as intermediate of they did 0-150 minutes of moderate physical activity weekly or 0-75 minutes of vigorous physical activity weekly. Participants were also categorized as intermediate if they did 0-150 minutes of combined moderate and physical activity weekly. Participants were categorized as ideal if they completed 150 minutes or more of moderate physical activity a week or 75 minutes of more of vigorous physical activity a week. Participants were also categorized as ideal if they completed 150 minutes or more of combined moderate and vigorous physical activity a week.

Nutrition

Data were collected at Exam 1 using the Delta Nutrition Intervention Research Initiative food questionnaire. The American Heart Association score was computed using five dietary components. The components (based on 2000-kcal diet) were 4.5 cups a day or more of fruits and vegetables, more than 3.5 ounces of fish twice per week, less than 1500 mg per day of sodium, less than 450 kcal per week of sugary beverages, and 3 or more servings a day of whole grains. Participants were categorized as poor if their diet consisted of 0-1 components, intermediate if their diet consisted of 2-3 components, and ideal if their diet consisted of 4-5 components.

Body Mass Index

Data were collected at Exam 3. Participants' height and weight were measured by trained study staff. Then, BMI was calculated by dividing weight (kilograms) by the square of height (meters). Participants were categorized as poor if their BMI was 30 or higher (obese), intermediate if their BMI was from 25-30 (overweight), and ideal if their BMI was less than 25 (normal).

Blood Pressure

Data were collected at Exam 3. Two blood pressure readings were measured by trained study staff in the sitting position and then averaged after 5 minutes of rest using random zero sphygmomanometers. Participants were categorized as poor if their systolic blood pressure was ≥ 140 mmHg, or their diastolic blood pressure was ≥ 90 mmHg. Participants were categorized as intermediate if their systolic blood pressure was from 120–139 mmHg or their diastolic blood pressure was 80–89 mmHg. Participants were also categorized as intermediate if their systolic blood pressure was <120 mmHg (if treated) and diastolic blood pressure was < 80 mmHg (if treated). Participants were categorized as ideal if their untreated systolic blood pressure was < 120 mmHg, and their untreated diastolic blood pressure was < 80 mmHg.

Total Cholesterol

Data were collected at Exam 3. Participants were categorized as poor if their total cholesterol was ≥ 240 mg/dL. Participants were categorized as intermediate if their total cholesterol was between 200-239 mg/dL, or their treated total cholesterol was < 200 mg/dL. Participants were categorized as ideal if their untreated total cholesterol was < 200.

Glucose

Data were collected at Exam 3 using glucose oxidase colorimetric methods. Participants were categorized as poor if their fasting plasma glucose was ≥ 126 mg/dL. Participants were categorized as intermediate if their fasting plasma glucose was between 100-125 mg/dL untreated. Participants were categorized as ideal if their fasting plasma glucose was < 100 mg/dL.

Covariates

Income, age, sex, and educational attainment were included in all models as covariates. For income, which was also measured as a moderator in the Hypothesis 1b analysis, data were collected at Exam 1 and was derived from family income and family size and adjusted for inflation by the interview year that the data were collected. This variable has 4 categories: poor, lower-middle, upper-middle, and affluent. Age and gender were collected at Exam 3. Age is a continuous variable measured in years. Gender was assessed as a dichotomous yes/no variable that represents whether the participant is male or female. Educational attainment was also measured at Exam 1. This variable has four categories: less than high school, high school diploma or GED, and attended vocational school, trade school, or college.

Data Analysis Procedures

Statistical analyses were performed using the Statistical Analysis System (SAS). Descriptive statistics were performed to summarize all study variables and detect outliers and missing values. For hypothesis 1a, a multivariable logistic regression was conducted with LS7 composite scores as the exposure and IMT use as the outcome. Additionally, multivariable logistic regressions were conducted with each LS7 component as the exposures and IMT use as the outcome. Age, sex, income, and education were included in these models as covariates. For Hypothesis 1b, a multivariable logistic regression was also conducted with the LS7 composite scores and IMT use. This model included an interaction term with LS7 composite scores as the exposure and income as the effect modifier. For Hypothesis 2a-c, the data were restricted to the 2,262 people who indicated they were IMT users. Logistic and linear regression analyses were conducted to examine relationships between Life's Simple 7 composite scores and characteristics of IMT use (i.e., average number of hours spent on the internet, usage of technology to track health, and usage of smart devices). The covariates age, sex, income, and education were included in each of these models. The level of significance for all tests was $p<0.05$.

Chapter 4: Results

Descriptive Analysis

Of the 2,557 participants who completed the Digital Connectedness Survey, 2,255 (88.19%) met the criteria for being IMT users, and 302 (11.81%) were classified as Non-IMT users (Table 2). Of the IMT users, 1,211 (53.70%) participants were over 60 years of age (range 20-100; SD 12.1), 1,421 (63.02%) were female, and 1,631 (72.49%) attended vocational school, trade school, or college. For income, 773 (39.93%) of IMT users were classified as affluent, 632 (32.63%) were classified as upper-middle class, 355 (18.24%) were classified as lower-middle class, and 176 (9.09%) were classified as poor.

For each of the LS7 components, participants were placed in either the poor, intermediate, or ideal category based on their engagement in healthy behaviors as outlined by the American Heart Association. Descriptive data for each of the seven components can be found in Table 2. For smoking, a majority of participants were classified in the ideal category (88%). Alternatively, for physical activity, the least number of participants (26%) were categorized as ideal, while most participants (43%) were categorized into the poor category. Nutrition was similar with 68% of participants being assigned to the poor category. For BMI, a majority of participants were also categorized in the poor category (56%). Most participants were in the intermediate categories for both cholesterol (59%) and blood pressure (66%). Lastly, more participants were also in the intermediate category for glucose (55%) followed by poor (24%), then ideal (21%).

Aim 1 Results

Aim 1 explored two hypotheses. The first hypothesis was that lower LS7 composite and component scores (indicating greater CVD risk) would be associated with greater IMT use. The results of the multivariable logistic regression demonstrated that the association between LS7 composite scores and IMT use was not statistically significant ($p \leq 0.50$). The relationships between each of the LS7 metrics (smoking, physical activity, nutrition, BMI, cholesterol, blood pressure, and glucose) and IMT use were also analyzed. The bivariate results indicated that IMT users and non-users differ on four different LS7 components. They are physical activity, cholesterol, blood pressure, and glucose (Table 2). Seven multivariable logistic regressions were conducted with each of the metrics as the independent variables and IMT use as the dependent variable (Table 3). The association between IMT use and glucose was the only significant relationship ($p = 0.01$). Compared to those with poorer glucose control, those in the intermediate category had 1.59 times the odds of using IMT (95% CI= 1.10, 2.29; Table 2). Compared to those in the poor category for glucose, those in the ideal category had 1.89 times the odds for using IMT (95% CI= 1.14, 3.14; Table 3).

The second hypothesis explored in Aim 1 was that SES would modify the association between LS7 scores and IMT use. In a model that included SES, LS7 composite scores, and their interaction, the interaction term was not significant ($p=0.83$).

Aim 2 Results

The purpose of Aim 2 was to explore three hypotheses: people with lower LS7 scores would be more likely to do 2a) spend time on the internet, 2b) use technology to track or manage health, and 2c) use smart devices compared to those with higher LS7 composite scores. The data were restricted to the 2,255 people who indicated that they were IMT users. Of these participants, 519 (31.92%) used apps to manage their health, 1,553 (69.18%) used digital health technology to track their health, 1,586 (72.82%) specifically used smartphones, and 1,366 (60.85%) used other smart devices such as tablet computers and physical activity trackers. The average amount of hours spent on the internet was 2.5 (SD 2.42).

A linear regression analysis was conducted for hypothesis 2a. Logistic regression analyses were conducted for hypotheses 2b and 2c (Table 4). The relationship between LS7 composite scores and use of other smart devices was the only association that was statistically significant ($p=0.01$). For every 1 unit increase in LS7 composite scores, the odds of using smart devices increased by 1.11 (95% CI= 1.02, 1.20) indicating that better cardiovascular health was associated with using smart devices such as smart phones, tablet computers, and smartwatches.

Chapter 5: Discussion

Findings and Implications

The purpose of the present study was to analyze the association between cardiovascular health and IMT use among Jackson Heart Study Participants. More specifically, this study sought to explore whether LS7 composite and component scores were related to IMT use and specific IMT use characteristics including frequency of internet use, use of smart devices, and use of technology to track or manage health.

Overall, a majority of participants (88%) reported utilizing internet and/or cellphone devices. However, there were no significant associations between CVH and IMT use. Non-significant p-values were yielded when testing the association between LS7 composite scores and IMT use. Furthermore, SES did not significantly change this relationship. However, this may have occurred because there was not much variability in SES among study participants. A majority of participants were categorized as either affluent (37%) or upper-middle class (32%).

Generally, there were also no significant associations when testing the association between individual LS7 component scores and IMT use. When testing the association between LS7 composite scores and IMT use characteristics (i.e. time spent on the internet, use of technology to track health, and use of other smart devices) there was also generally no significance. These findings coincided with the limited literature already in existence about technological interventions for older populations where mobile interventions had no effect on participants' health outcomes (Son, Lee, &, Lee, 2020).

Only two associations were the exception. Glucose component scores and IMT use were significantly associated. Individuals in the intermediate and ideal categories for glucose were more likely to be IMT users than those in the poor category. The association between LS7 composite scores and use of other smart devices was also significant. As LS7 composite scores increased, indicating better CVH, so did the odds of using smart devices, such as smartphones, tablet computers, and activity trackers. In both exceptions, people with better heart health were the ones more likely to use technological devices. These findings were contrary to the ideas proposed by the two theories utilized in this study. Wilson (1996) posits that individuals with more health problems seek more health information. Ayers and Kronenfeld (2007) propose that these same people are more likely to use the internet to find the health information that they need. Instead, the two significant findings from this study exhibit the possibility that people with better CVH are actually more likely to use technology as a tool to seek health information and maintain their CVH.

There are several possible explanations for these findings. One is that this study design was not poised to capture the nuanced relationship between CVH and IMT use. How well an individual manages the different LS7 components can vary over time depending on factors such as the individual's lifestyle choices or age (Khanji et al., 2018; North & Sinclair, 2012). An individual's use of the internet and mobile devices to find health information can also fluctuate (Kumar et al., 2018). Therefore, the relationship between the two can change and influence each other over time as well. It is possible that study participants may have already used health information, including that found on the internet, to improve their CVH. Even for a longitudinal study design, such as the one used for this study, it may be difficult to capture this complicated, complex relationship.

Age may be another explanation for these findings. Nearly 90% of study participants (of whom more than half were 60 years of age or older) reported being IMT users. This is consistent with the literature in that technology is increasing among older populations (Pew Research Center, 2017). However, while this study supports these findings and demonstrates that older African Americans use the internet and cell phone devices, it is still unclear how they use this technology. Having access to and utilizing these devices is not a direct indicator that they use them specifically to seek health information, especially to target and improve cardiovascular outcomes.

Moreover, just because older individuals have access to technology does not mean that they know how to effectively find and utilize relevant information to help them improve their cardiovascular health. It also does not mean they are comfortable doing so on their own. Previous studies have shown that older participants think themselves less capable of using technology for health information-seeking than younger individuals (Khanji et al., 2018; North & Sinclair, 2012). Due to being unfamiliar with technology, fears of privacy, and mistrust in online information, older populations are less likely to feel comfortable seeking health information on their own and using it in their daily lives (Fischer et al., 2014; Gordon & Hornbrook, 2018; Still et al., 2018). Instead, they may be more comfortable using more traditional forms of health-information-seeking like talking with a trusted health care provider.

It is also important to consider that health information-seeking on the internet may only be necessary for certain health problems. The relationship between glucose and IMT use was one of the only significant associations. This may be because managing blood sugar, requires continuous effort and vigilance on behalf of the individual. Several lifestyle changes are necessary, and people must also constantly monitor their blood sugar in order to see improvements in their health. To successfully do so, they need an abundance of information to be fully aware of their health and the appropriate changes they need to implement (Ahmad &

Tsang, 2013; Kuske et al., 2017). This information could come from multiple sources, and as a result, people with high glucose may be the ones most likely to use the internet as a tool to seek CVD-related health information (Kuske et al., 2017).

Usage of smart devices was the only other factor significantly associated with LS7 composite scores. This aligns with the literature as well. In recent years, there has been increased use of tablet computers and smartphones among older populations (Pew Research Center, 2017). It is probable that if healthier people are more likely to use the internet and mobile devices, that they would also utilize smart devices such as the computer and physical activity trackers as they provide additional means for individuals to monitor and maintain their health (Anderson, Langstrup, & Lomborg, 2020; Melin et al., 2018).

Strengths and Limitations

This study is characterized by notable strengths. It explored IMT use among older African Americans, a population rarely included in research about technological interventions. Additionally, this study was conducted utilizing Jackson Heart Study data, one of the largest cohorts of African Americans with or at risk for CVD. The findings from this study can be used to spur future research that delves more deeply into these issues.

There were also some limitations with the current study. One limitation was that the LS7 metrics used were measured at two different time periods. Data for smoking and nutrition were measured at Exam 1 (2000-2004) while data for physical activity, BMI, cholesterol, blood pressure, and glucose were measured at Exam 3 (2009-2013). As a result, data used for the LS7 composite scores could have been missing for certain individuals due to attrition. Another limitation was that there was a great number of missing data for some of the statistical tests, meaning a number of participants were excluded from some of the analyses thereby increasing the selectivity of the sample. Lastly, participants in the Jackson Heart Study are from three urban areas of Mississippi. Therefore, these results may not be generalizable to older African Americans living in more rural areas or other parts of the country, indicating the need for further research.

Public Health Implications and Directions for Future Research

The present study still has several public health implications. This study provides further evidence that older African Americans are using the internet and mobile phones given the high level of IMT use in the study sample. Additionally, among this population, a minority of participants were in the ideal categories for physical activity, nutrition, BMI, cholesterol, blood pressure, and glucose. This indicates that these specific LS7 components may benefit most from health education strategies. Furthermore, previous studies show that some African American participants have expressed an interest and willingness to use mobile technology to manage their health (Brewer et al., 2019; Laken et al., 2004; Still et al., 2018). For these tools to be successfully utilized as effective methods for health communication and education purposes, this population would benefit from instruction on how to use these devices for health information-seeking, decide which sources are reliable, and build confidence and comfortability with doing so.

Future research should be conducted to further strengthen and explore these possible implications. Qualitative studies can be conducted to learn more about how exactly Black older adults are using the internet, mobile phones, and other smart devices. More research should also be conducted to better understand specifically what smart devices and forms of digital health technology this population is using. Understanding this could determine which forms of technology are most viable for health communication and information-seeking purposes. Further research is also needed to better understand this population's perceptions about technology use for health information-seeking and which health problems are most appropriate to search on the internet. Lastly, research can also be conducted to determine what supports they would need if they attempted to use IMT for CVD self-management. Specifically, it would be beneficial to determine what training they need, where and how they should receive this training, what types of training would be most effective, and which types of software applications would be most useful.

Conclusion

Technology is increasingly being utilized more both by members of the public and in healthcare. Therefore, it is important to consider how the internet and smartphones can be used to help people, especially minorities like African Americans, improve their cardiovascular health. While no association was found between LS7 composite scores and IMT use, there were positive associations between glucose component scores and IMT use and LS7 composite scores and the use of other smart devices. These findings demonstrate a need for further research to continue to assess the feasibility of using technology to manage heart health among older Black adults.

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Tables

Table 1: Each Study Variable and Time of Measurement

Variables	Exam 1 (2000-2004) n=5306	Exam 3 (2009-2013) and sample size n=3819	Digital Connectedness Survey at Annual Follow-up (2017-2019) N=2557
Outcome Variables			
Internet Use			
Cell Phone Use			
Internet and Mobile Technology Use			
Usage of Apps to Track Health			
Use of Digital Health Technology			
Average Number of Hours Spent on the Internet			
Smartphone Use			
Usage of Other Smart Devices			
Exposure Variables			
AHA Smoking			
AHA Physical Activity			
AHA Nutrition			
AHA BMI			
AHA Cholesterol			
AHA Blood Pressure			
AHA Glucose			
Covariates			
Income			
Age			
Sex			
Educational Attainment			

Table 2: Demographic Characteristics of Jackson Heart Study Participants by Internet and Mobile Technology (IMT) Use (N=2557)

Demographic and IMT Use Characteristics	Overall n=2257 (100%)	IMT Users n=2255 (88.19%)	Non-IMT Users n=302 (11.81%)	P-Value
Age				<.0001
20-39	94 (3.68%)	93 (4.12%)	1 (0.33%)	
40-59	980 (38.33%)	951 (42.17%)	29 (9.60%)	
60+	1483 (58%)	1211 (53.70%)	272 (90.07%)	
Sex				0.0008
Male	916 (35.82%)	834 (36.98%)	82 (27.15%)	
Female	1641 (64.18%)	1421 (63.02%)	220 (72.85%)	
Educational Attainment				<.0001
Less than high school	360 (14.11%)	231 (10.27%)	129 (42.72%)	
High school diploma or GED	476 (18.65%)	388 (17.24%)	88 (29.14%)	
Attended vocational school, trade school, or college	1716 (67.24%)	1631 (72.49%)	85 (28.15%)	
Income				<.0001
Poor	231 (10.55%)	176 (9.09%)	55 (21.65%)	
Lower-middle	451 (20.59%)	355 (18.34%)	96 (37.80%)	
Upper-middle	696 (31.78%)	632 (32.64%)	64 (25.20%)	
Affluent	812 (37.08%)	773 (39.93%)	39 (15.35%)	
Life's Simple 7 Components*				
Smoking				0.9612
Poor	266 (10.56%)	235 (10.56%)	31 (10.58%)	
Intermediate	30 (1.19%)	27 (1.21%)	3 (0.12%)	
Ideal	2222 (88.24%)	1963 (88.22%)	259 (88.40%)	
Physical Activity				<.0001
Poor	989 (42.85%)	832 (40.53%)	157 (61.57%)	
Intermediate	709 (30.72%)	650 (31.66%)	59 (23.14%)	
Ideal	610 (26.43%)	571 (27.81%)	39 (15.29%)	
Nutrition				0.1251
Poor	1611 (68.41%)	1431 (68.90%)	180 (64.75%)	
Intermediate	717 (30.45%)	625 (30.09%)	92 (33.09%)	
Ideal	27 (1.15%)	21 (1.01%)	6 (2.16%)	
BMI				0.0657

Poor	1292 (56.25%)	1164 (56.75%)	128 (52.03%)	
Intermediate	749 (32.61%)	669 (32.62%)	80 (32.52%)	
Ideal	256 (11.14%)	218 (10.63%)	38 (15.45%)	
Cholesterol				0.0017
Poor	283 (13.36%)	250 (13.24%)	33 (14.35%)	
Intermediate	1248 (58.92%)	1092 (57.84%)	156 (67.83%)	
Ideal	587 (27.71%)	546 (93.02%)	41 (17.83%)	
Blood Pressure				0.0006
Poor	539 (23.57%)	459 (22.61%)	80 (31.13%)	
Intermediate	1515 (66.24%)	1351 (66.55%)	164 (63.81%)	
Ideal	233 (10.19%)	220 (10.84%)	13 (5.06%)	
Glucose				<.0001
Poor	530 (23.67%)	443 (22.25%)	87 (35.08%)	
Intermediate	1236 (55.20%)	1116 (56.05%)	120 (48.39%)	
Ideal	473 (21.13%)	432 (21.70%)	41 (16.53%)	
IMT Use Characteristics	**Overall (IMT users only) n= 2255 (100%)**	**Characteristic Users**	**Characteristic Non-Users**	**P-value**
Use of Technology to Track Health				0.8311
Use of Apps to Track Health		519 (31.92)	1107 (68.08)	
Use of Digital Health Technology		1553 (69.18)	692 (30.82)	
Use of Smart Devices				<.0001
Use of Smartphones		1586 (72.82)	592 (27.18)	
Use of Other Smart Devices		1366 (60.85)	879 (39.15)	

p-values ≤ .05 were considered statistically significant.

*Poor= 0-4 points; Intermediate= 5-9 points; Ideal=10-14 points

Table 3: Adjusted Odds Ratios for the Association Between each Life's Simple 7 Component and IMT Use (N=2,557)

	OR	**95% CI**	**P-Value**
Life's Simple 7 Components*			
Smoking			0.58
Intermediate vs. Poor	0.48	(0.12, 1.94)	
Ideal vs. Poor	0.87	(0.52, 1.47)	
Physical Activity			0.16
Intermediate vs. Poor	1.30	(0.89, 1.90)	
Ideal vs. Poor	1.48	(0.94, 2.35)	
Nutrition			0.94
Intermediate vs. Poor	1.04	(0.74, 1.45)	
Ideal vs. Poor	0.84	(0.24, 2.91)	
Body Mass Index			0.84
Intermediate vs. Poor	0.90	(0.62, 1.30)	
Ideal vs. Poor	0.92	(0.55, 1.53)	
Cholesterol			0.23
Intermediate vs. Poor	1.24	(0.77, 2.01)	
Ideal vs. Poor	1.66	(0.92, 2.98)	
Blood Pressure			0.72
Intermediate vs. Poor	0.98	(0.69, 1.40)	
Ideal vs. Poor	0.74	(0.35, 1.56)	
Glucose			0.01
Intermediate vs. Poor	1.59	(1.10, 2.29)	
Ideal vs. Poor	1.89	(1.14, 3.14)	

p-values $\leq$ .05 were considered statistically significant.

*Poor= 0-4 points; Intermediate= 5-9 points; Ideal=10-14 points

Each model was adjusted for income, age, sex, and educational attainment.

Table 4: Adjusted Odds Ratios for the Association Between Life's Simple 7 Composite Scores and IMT Use Characteristics (N=2,255)

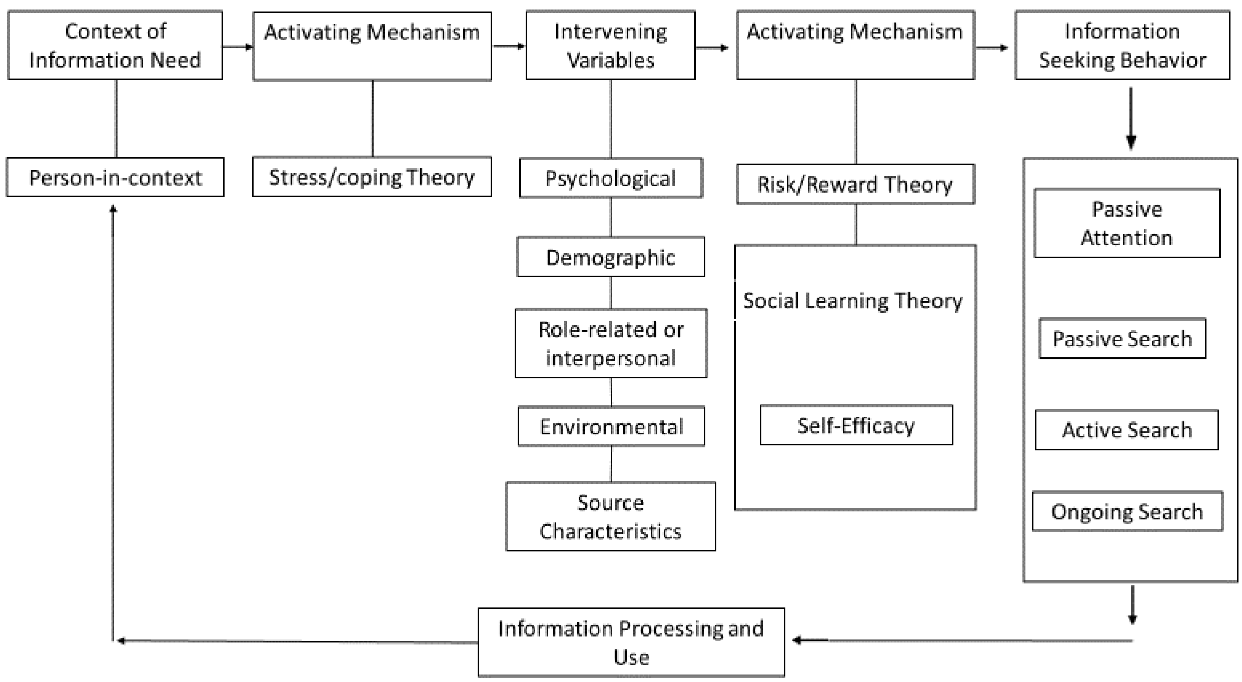
IMT Use Characteristics	OR	95% CI	P-Value
Use of Technology to Track Health	0.97	(0.91, 1.04)	0.38
Use of Other Smart devices	1.11	(1.02, 1.20)	0.01

p-values $\leq$ .05 were considered statistically significant.

Each model was adjusted for income, age, sex, and educational attainment.

Appendix

Figure 1: Wilson's 1996 General Model of Information Behavior



Note. This figure outlines the stages of Wilson's (1996) General Model of Information Behavior. Models of Information Behaviour Research, by T. Wilson, 1999, *Journal of Documentation*, 55 (3).