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Social Determinants of Health Inequities and Human Development: Is there a role for mHealth in overcoming health inequities?

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Social Determinants of Health Inequities and Human Development: Is there a role for mHealth in overcoming health inequities?

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ABSTRACT

The spread of the pandemic in recent years has disproportionately affected people who are unable to access the basic resources needed to survive. Such resources include but are not limited to food, shelter, capital and the ability to find the information they need to stay healthy. These socio-economic factors influence the manner in which people and communities are able to recover. This paper investigates the relationship between social determinants of health and human development and the role of mHealth in overcoming health inequities. Data was collected for 27 variables from 189 countries through the United Nations, World Bank and the World Health Organization's databases. Following an analysis of a model comprising of indices created to test a set of hypotheses, this paper offers unique insight into the social determinants of health that can be overcome through mHealth. The contribution of this paper is in uncovering the social determinants of health that are related to human development and how mhealth access is related to social determinants of health and the Human Development Index. This has implications for how inequalities may be addressed through mobile health applications to bring about human development.

Keywords: Social determinants of health, health inequity, mhealth, and health equity.

INTRODUCTION

This research attempts to understand social determinants of health as they relate to health inequities. We know that socio-economic standing effects health inequities and the abilities of people to stay healthy (Clarke et al., 2021; Qureshi & Xiong, 2021). When it comes to human development, ones' social opportunities and ones' own participation in a healthy lifestyle have been considered as indicators for good outcomes. Patient-centered care focuses on the patient's participation in a healthy lifestyle. It is important because when people feel ownership over their own health then their health outcomes are better than people who are not as empowered (Clarke et al., 2016; Clarke et al., 2020). Research has also shown that people use mhealth applications to seek medical information and or lifestyle assistance (Clarke et al., 2021). There is a relationship between use of mhealth and human development where mortality rates are part of the Human Development Index (HDI) (Qureshi & Xiong, 2021).

While often mistaken as interchangeable terms, health inequality and health inequity are fundamentally different concepts. Health inequality exists when there are substantially different health outcomes between two or more populations, i.e., female and male health expectancies (Qureshi & Xiong, 2021). Health inequity, however, occurs when the opportunity to live a prosperous and healthy life varies substantially between two or more populations, i.e., the prevalence of fair or poor health among poverty-stricken populations. The demographic, geographic, and socioeconomic conditions that influence a population's health outcomes have come to be known as the social determinants of health; or, "the causes [of health inequity]" (Marmot 2007).

The role of social aspects, such as one's race, rural/urban lifestyle, or level of educational attainment in determining the health outcomes of a given population, has left many with the idea

that health inequity is solely a social justice issue. While the social justice aspect of health inequity is cause for concern on its own, health inequity also hinders socioeconomic development as ill and injured populations are limited in their ability to participate in the workforce (Marmot 2007). As such, neither one's quality of life, nor their socioeconomic opportunity, can be separated from their health.

When thoughtfully implemented, information technologies can bridge the financial, social, and distance gaps between patients and health professionals in underrepresented populations (Deitenbeck et al., 2018; Negash, 2018). Furthermore, when the behaviors, perceptions, desires, and needs of underrepresented populations are considered, these information technology interventions prove to be sustainable (Deitenbeck et al., 2018; Negash 2018). However, further information on the relationship between underrepresented populations and their demographic, geographic, socioeconomic, and other social determinants of health need to be explored. Social determinants of health are factors such as education level, economic assets, occupational class, demographic factors race, religious affiliations, gender, geographical location, age, disability, sexual orientation, and other factors relevant to the particular setting that can impact a person's health or access to health care (Healthy People 2030; Georgsson & Mattias, 2016; Marmot, 2007; Adler & Ostrove, 1999; Qureshi, 2021).

In this research the social determinants that affect the ability of people to stay healthy are investigated through the creation of indices. The social determinants that affect the ability of people to stay healthy are represented by the Inequality Index, the Gender Index, the Age Dependency Index, the Educational Index, and the Locational Index. Since these factors affect the ability of people to stay healthy, they are referred to as social determinants of health. The ability of people to lead healthy lives is measured by the human development index (HDI). This paper

investigates the relationship between social determinants of health and the ability of people to lead healthy lives; it also investigates the connection between mhealth and the social determinants of health. The questions this paper will address are, is what is the relationship between inequities in social determinants of health and human development? Additionally, is there a correlation between mHealth and addressing the social determinants of health? These questions are investigated in the following sections after the theoretical background section in which the indices are created.

THEORETICAL BACKGROUND

Health inequality

According to the UNDP Human Development index, in order to live a free and healthy life, health equity is needed. Health equity is a form of distributive data justice and a form of social opportunities (Sen, 2002; Taylor, 2017). Distributive data justice is when everyone has the access to the same resources regardless of their social circumstances (Taylor, 2017). Braveman and Gruskin state that "health disparity is inequitable if it is systematically associated with social disadvantage in a way that puts an already disadvantaged social group at further disadvantage" (Braveman & Gruskin, 2003, pg 256). The ability for people to take control of their own health leads to empowerment of those people (Marmot, 2007). Khan et al. note that it is a cycle where individual health will impact community health, which will grow the economy and better the community (Khan et al., 2010).

This points to the fact that health inequities limit development. Being able to find information about health would impact one's own ability to live healthier. This is also one of the freedoms discussed in Sen's Development of Freedom (Sen, 2010). Clarke et al. (2016) noted that there are many barriers when it comes to accessing this information. They found that "age,

education, and household income" effected one's ability to find relevant and credible information (Clarke et al., 2016). This lack of information could impact the capabilities of people who might already be affected by other social justice issues.

These researchers all point to different aspects of health equity as a multidimensional concept (Braveman & Gruskin, 2003; Sen, 2010; Marmot, 2007; Khan et al., 2010). They also point to the fact that health inequities limit development. In Sen's Development of Freedom, it was discussed how all freedoms impact one another. Indeed, if there is an unfreedom in economic facilities, this will impact health equity (Sen, 2010). We saw the effects of this most recently as more and more people from wealthy backgrounds encourage those of perhaps not so wealthy backgrounds to not get vaccinations and not take precautions in order to end the current pandemic. When the health of these two groups were impacted by the virus, the wealthier received hardcore treatment plans. Whereas many people who were not as well off did not receive similar treatment plans. In order to understand health inequities, we use the United Nations Human Development Index. It is defined as follows:

"The Human Development Index (HDI) is a summary measure of average achievement in key dimensions of human development: a long and healthy life, being knowledgeable and have a decent standard of living. The HDI is the geometric mean of normalized indices for each of the three dimensions.

The health dimension is assessed by life expectancy at birth, the education dimension is measured by mean of years of schooling for adults aged 25 years and more and expected years of schooling for children of school entering age. The standard of living dimension is measured by gross national income per capita." (UNDP p.1, 2021)

Mobile Health (mHealth)

mHealth is the use of mobile devices to promote healthier behaviors and self-education (Khan et al., 2010). While a standardized definition has yet to be established, mobile health (mHealth) is largely understood to be a "medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants (PDAs), and other wireless devices" (WHO, 2011). In order to understand the use of mobile devices for the provision of equitable provision of healthcare, Qureshi and Xiong (2019) created an mHealth index. They found a significant relationship between mHealth, social inequalities in life expectancy and in education on Human Development for all the countries of the world. Their analysis discovered a significant relationship between mHealth, social inequalities in the provision of healthcare and human development outcomes. In a subsequent study they found that there is a strong positive correlation between the social determinants of health on health equity in relation to mHealth use at the global level (Qureshi & Xiong, 2019).

According to Clarke et al. (2016) patients tend to look for information about "illness or medical conditions, nutrition, and alternative" treatment options. Clarke et al. (2021) listed other commonly mentioned information needs of patients from a review of literature, noting specifically young adult patients prefer mHealth as compared to older adults. mHealth is an important tool. It could help inform patients and therefore increase the speed of diagnosis (Clarke et al., 2016; Clarke et al. 2020). These tools could decrease the amount a patient has to pay. They help reinforce healthy behaviors such as sleeping, eating, and exercise. mHealth could provide a monitoring system to those afflicted by chronic health issues. Some mHealth educate patients about possible diagnoses and how to use or how to treat illnesses. Other types of mHealth act as a direct line of communication between healthcare workers and their patients.

Mobile healthcare applications are helping people become healthier and may bridge the gap among rural and remote communities. These apps ranged from chronic disease management, ability to access relevant health care information, exercise and food intake tracking, follow-up care and basic diagnostics for minor medical issues. The opportunity for users to monitor their own health is particularly useful for low income and rural populations who may be unable to visit a healthcare profession due to monetary or travel limitations as well as those who may, for whatever their reason may be, have hesitations in seeking medical services (Deitenbeck et al., 2018; Qureshi & Xiong, 2019). However, to be sustainable, developers of mHealth tools must observe how their tool is being used, monitor user behavior, and they must collect feedback from its users to ensure quality and relevancy (Negash, 2018).

In order to investigate the ability of people to stay healthy using mobile phones, an mhealth index is created. The United Nations Development Program's Human Development Index measures the ability of people to live healthy lives in terms of life expectancy. Since this is an established measure for health, we use it in our mobile health index. The mHealth variable is an Index of life expectancy (LE), total percent of population using the internet (Internet), and mobile phone subscriptions per 100 people (Mobile).

$$Mobile\ Health\ Index = \frac{LE + Internet + Mobile}{3}$$

Socio-economic inequalities

Socio-economic status is defined as a measure of the combined economic and social status of an individual and tends to be positively associated with better health where there is a causal relationship between socio-economic status and health (Adler & Ostrove, 1999; Baker, 2014; Marmot, 2007; Braveman & Gruskin, 2003). Adler and Ostrove (1999) suggest that there are many ways in which socio-economic status determines the human development. The pathways through

which health and socio-economic status interact include economic contexts, "social environments, individual psychological and behavioral factors, and biological predispositions" (Adler & Ostrove, 1999). Marmot (2007) further confirms that socioeconomic status may be a prominent predictor of health, "trends in life expectancies are directly related to educational attainment and annual income rates" (Marmot, 2007).

Social determinants of health are understood to be the social, political, and economic factors that contribute to one's state of health (Marmot, 2007; Castaneda, 2015). While the distribution of resources within a society that contributes to health varies along the social gradient, this unequal distribution does not necessarily indicate a health inequity (Sen, 2003; Marmot, 2007; Braveman, 2003; Braveman, 2011). Health inequity occurs "where inequalities in health are avoidable, yet are not avoided" (Marmot, 2007). Health equity, on the other hand, occurs when all persons along the social gradient share in the "equal opportunity to be healthy" (Braveman, 2003).

The opportunity to be healthy, as a concept, does not concern itself with factors such as pre-existing conditions or personal exercise and dietary habits. It is the opportunity to attain the highest possible level of physical and mental wellbeing that an individual's personal biological limitations will permit (Braveman, 2003). As such, the person who has the opportunity to attain health improvements but chooses not to either in their habits or in their failure to seek health services, is not a victim of health inequity. On the other hand, the person who is unable to develop healthy habits or seek medical services due to social, political, or economic conditions, and thus has not been afforded the opportunity to attain their highest possible level of physical and mental wellbeing, is a subject of health inequity.

While inequities are an important factor, the data currently available relate to inequality. In order to investigate inequality and gender inequality, the following indices are used:

The Inequality Index is the Inequality-adjusted Human Development Index (IHDI). In IHDI, the UN averages life expectancy, years of schooling, and income. See technical notes UNDP (2019) for formula (UNDP, 2019).

The Gender Inequality Index which the UN combines maternal mortality ratio (MMR), adolescent birth rate (ABR), female and male population with at least secondary education (SE), female and male shares of parliamentary seats (PR), and female and male labor force participation rates (LFPR). See technical notes UNDP (2019) for formula (UNDP, 2019).

In order to investigate the remaining socio-economic factors, the following indices are developed:

The Age Dependency Index is combination of the Dependency Ratios for both those younger than 14 years old and those over 65 years old. It is important to look at those who are older because they understand the healthcare system in their country better than younger generations that might not have the same level of experience with the health care system. Likewise, younger generations show a preference for ICTs (Clarke et al., 2020). Therefore, they most likely have an intrinsic motivation for learning new skills that can increase ICT usage (Qureshi, 2017).

$$Age\ Dependency\ Index = \frac{Dependency\ Ratio\ for\ Youth + Dependency\ Ratio\ for\ Elder}{2}$$

The Education Index is made by combining female expected schooling (FS), the female mean years of schooling (FMS), the male mean years of schooling (MMS) and the male expected schooling (MS).

$$Education\ Index = \frac{FS + FMS + MMS + MS}{4}$$

The Location Index combines multiple variables such as total percent of population using the internet (Internet), mobile phone subscriptions per 100 people (Mobile), average dietary energy

supply adequacy percentage (Food), rural population percent with access to electricity (Electricity), percent of population using safely managed drinking water service (Water), and percent of population using safely managed sanitation services (Sanitation).

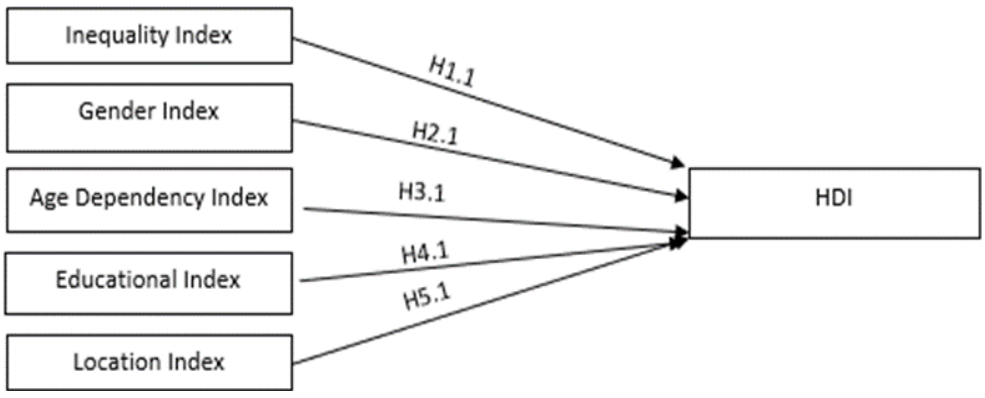
$$Location\ Index = \frac{Internet + Mobile + Food + Electricity + Water + Sanitation}{6}$$

This research posits that mobile health may potentially enable people lead better lives by helping them address their socio-economic inequities. In order to understand these relationships, we create a mobile health index. In an effort to understand which aspects of health inequities could be addressed with mhealth, we must evaluate each separately. Therefore, we created five different indices of health inequity based on the concept of social opportunities and social determinants of health. Social determinants of health could be separated into a few different categories: socioeconomic status, demographic information, and environmental factors.

RESEARCH MODELS

In order to investigate the two research questions, two research models are created in this section with the hypotheses that are tested. The social determinants that affect the ability of people to stay healthy are represented by the Inequality Index, the Gender Index, the Age Dependency Index, the Educational Index, and the Locational Index. The ability of people to lead healthy lives is measured by the human development index (HDI). This model is illustrated in the following:

Figure 1: Model of Social Determinants of Health and the Human Development Index



The hypotheses tested by this model are as follows:

H1.1: Inequality Index is positively related to HDI

H2.1: The Gender Index is negatively related to HDI

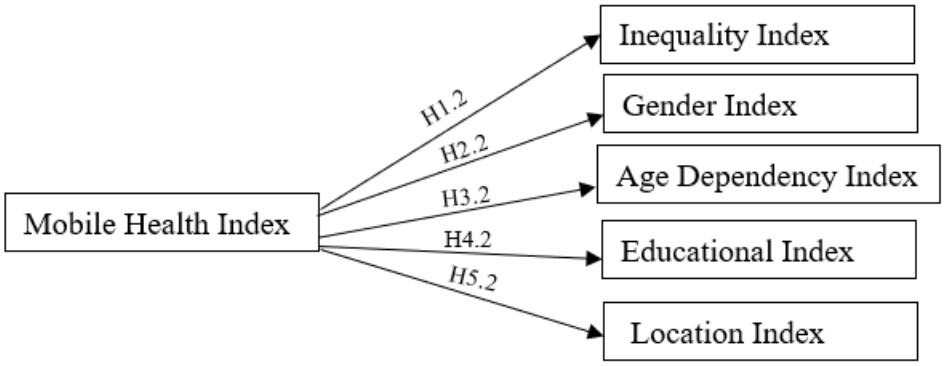
H3.1: The Age Dependency Index is negatively related to HDI.

H4.1: The Educational Index is positively related to HDI.

H5.1: The Location Index is positively related to HDI.

To address the second research question (is there a correlation between mHealth and addressing the unequal health outcomes?) we will take the same indexes and compare them to a Mobile Health Index. The Mobile Health Index is made by combining the percent of the total population using the internet, mobile subscriptions per 100 people, and life expectancy. The model for this research question is illustrated in figure 2 below:

Figure 2: Model of Mobile Health to Social Determinants of Health



In order to find out if the use of mobile phones to access health information can help overcome limitations brought about by the above social determinants, we investigate the following hypotheses as follows:

H1.2: The Mobile Health Index is positively related to the Inequality Index.

H2.2: The Mobile Health Index is negatively related to the Gender Index.

H3.2: The Mobile Health Index is negatively related to the Age Dependency Index.

H4.2: The Mobile Health Index is positively related to the Educational Index.

H5.2: The Mobile Health Index is positively related to the Location Index.

METHODOLOGY

Demographic information was a difficult category. No matter where you go there will be biases. But they might not always be the same biases. Since our data was limited, we decided to use two demographic indices: age and gender. As we could see from Clarke et al (2016), age is a variable that impacts ICTs usefulness (Clarke et al., 2016). Therefore, an age index was needed. Gender inequality is a concern that is impacted by health inequity and use of ICT (UNDP, 2019; Alder & Ostrove, 1999; Taylor, 2017; Baker, 2014; Castañeda et al., 2015, Kaba & Meso, 2021). Women in many parts of the world are not as equal to their male counterpart (UNDP, 2019). Education of women is especially low in some countries (UNDP, 2019). According to Sen's Development as Freedom, this is an unfreedom of social opportunities. Unfreedoms in social opportunities tend to effect other freedoms. According to the UN, this could affect health care and mortality rates (UNDP, 2019; Sen, 2001). Thus, a Gender inequality index will also be utilized when considering addressing health inequities with mhealth. The environmental factors were organized into infrastructure and potential future infrastructure. Infrastructure is operationalized by the location index which groups together many impacts to health. Future infrastructure is operationalized by education index. Those countries that have a more educated population will have more innovations. It contributes to the number of doctors a population has, the number of engineers a population has, and so on.

In order to investigate social determinants of health and human development, social determinants of health attributes are Inequality Human Development Index, Gender Inequality

Index, Age Dependency Index, Education Index, and Location Index. HDI is used to show human development. The data were grouped into indexes specifically to social determinants of health, mhealth, and human development. The variables used in this paper are defined in table 1, as follows:

Table 1: Definition of Variables

Index	Variables	Definition
Human Development Index	income, education attainment, and life expectancy at birth	HDI is a measurement of people's capabilities to live a "long and healthy life, being knowledgeable and have a decent standard of living." (UNDP 2021).
	Life Expectancy at Birth	In the HDI the health dimension is assessed by life expectancy at birth (UNDP 2021)
	Income	HDI uses the logarithm of income in order to reflect the diminishing importance of income with increasing Gross National Income (GNI). (UNDP, 2021 see technical notes) (UNDP, 2021).
	Education Attainment	Education attainment is measured by expected years and mean years of schooling.
Mobile Index	Life Expectancy at Birth	In the HDI the health dimension is assessed by life expectancy at birth (UNDP, 2021)
	Internet	Total percent of population using the internet (Internet) (ITU 2021)
	Mobile	Mobile phone subscriptions per 100 people (Mobile) (ITU 2021)
The Inequality Index	Average life expectancy	In the inequality index for life expectancy shows lower achievement is emphasized with a geometric mean, based off the Atkinson index. (UNDP, 2021).
	Years of schooling	In the inequality index for years of schooling shows lower achievement is emphasized with a geometric mean, based off the Atkinson index. (UNDP, 2021).
	Income	In the inequality index for income shows lower achievement is emphasized with a geometric mean, based off the Atkinson index. (UNDP, 2021).
The Gender Inequality Index	Maternal mortality ratio (MMR)	The MMR and the ABR are used in order to show disadvantages women have in reproductive health. See technical notes UNDP (2019) for formula (UNDP, 2019).
	Adolescent birth rate (ABR),	
	Female and male population with at least secondary education (SE)	The SE and PR measure empowerment of women. The ability to be in high positions and to have role models in high positions leads to more empowerment. See technical notes UNDP (2019) for formula (UNDP, 2019).
	female and male shares of parliamentary seats (PR)	
	female and male labor force participation rates (LFPR)	The LFPR measures equality in the workplace. It shows whether women can participate in the work force of specific countries. See technical notes UNDP (2019) for formula (UNDP, 2019).

The Age Dependency Index	0-15 years old – Young Age Dependency Ratio	The age dependency ratio for younger populations was created by the UN. It was made to investigate how much the working population was depended on by the younger population. It shows the percent of younger people to the working population (UNDP, 2019)
	65+ years old- Older Age Dependency Ratio	The age dependency ratio for older populations was created by the UN. It was made to investigate how much the working population was depended on by the older population. It shows the percent of older people to the working population (UNDP, 2019).
The Education Index	Female Expected Years of Schooling	The female expected years of schooling is the amount years a female is expected to be in school. It sums up primary, secondary, post-secondary, and so on (UNDP, 2019).
	Female Mean Years of Schooling	The female mean years of schooling is the average years of schooling for women within a country (UNDP, 2019).
	Male Expected Years of Schooling	The male expected years of schooling is the amount years a male is expected to be in school. It sums up primary, secondary, post-secondary, and so on (UNDP, 2019).
	Male Mean Years of Schooling	The male mean years of schooling is the average years of schooling for men within a country (UNDP, 2019).
The Location Index	Internet	Total percent of population using the internet (Internet) (ITU 2021)
	Mobile	Mobile phone subscriptions per 100 people (Mobile) (ITU 2021)
	Food	Food access was evaluated using the average dietary energy supply adequacy percentage. The average dietary energy supply adequacy percentage is a measure to investigate food deserts or food insecurity (World Bank, 2020).
	Electricity	Electricity access was measured with rural population percentage with access to electricity (ITU, 2021).
	Water	Water access was measured with percent of population using safely manage drinking water service (World Bank, 2020).
	Sanitation	Sanitation access was measured with percent of population using safely managed sanitation services (World Bank, 2020).

Data

Data from 189 countries was collected for all of the above variables. To investigate the relationship between social determinants of health and health outcomes and the role of mHealth in addressing the health inequity, data is an aggregated set of data from the UN. The mobile phone and internet variables were sourced from the International Telecommunication Union (ITU, 2020). The health-related variables were sources from the World Health Organizations Global Health Observatory (WHO 2020). The food access, water access, and sanitation service access variables were collected from

the World Bank's (2020) World Development Indicators database. Inequality measures were collected from the World Inequality Database (2020). These are all included in the HDI measures described above.

RESULTS AND ANALYSIS

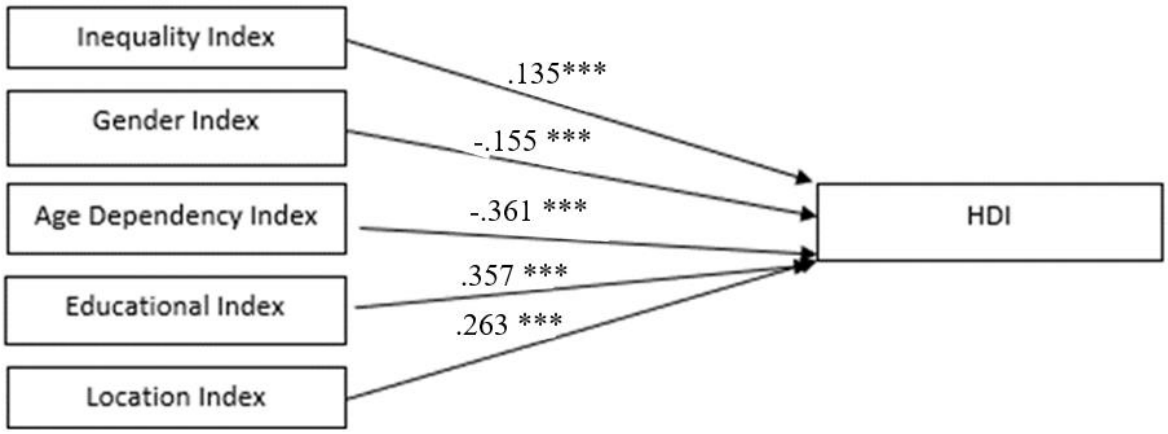
Regression analysis was carried out to discover any correlations that may exist to test the hypotheses described above to discover a relation between the social determinants of health and HDI. Where there are significant results, there is a relation between social determinants of health. Then we looked at the beta score in order to evaluate whether the hypotheses were correct or not.

Social Determinants of Health relation to Human Development (HDI)

The hypotheses predicts that the inequality index, the educational index, and the location index have positive beta scores and significant regression analyses when compared to HDI. For education and location, a positive relation would show infrastructure levels effect human development. The reason Inequality Index is predicted to relate positively is due to the way the index was calculated. The UN calculated this index in a way that it would be comparable to HDI. The less inequality there is, the higher the inequality index will be. Our prediction is the higher the index is, the higher the human development will be.

Similarly, when comparing the beta scores, for the gender inequality index and the age dependency index, these should have negative beta scores. For the gender inequality index this is because the more inequality there is, the higher this index will be. Our hypothesis is that when there is less gender inequality in a system, there will be better human development. Our hypothesis for the age dependency index is similar. The less dependency there is in terms of age, the better the human development will be.

Figure 3: Tested Model of Health Inequities and Human Development Index



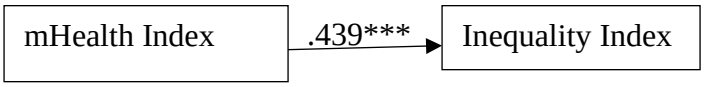
As illustrated in figure 3 above, all the hypotheses for this model are confirmed (p-value = 0.000, significant when p-value < 0.005). The R squared value is 0.878. Social determinants relate to human development. Socioeconomic status has a positive relation to human development. Educational and location indices have a higher beta score. Therefore, the investments in infrastructure is an investment in the health and well-being of a society. Gender inequality index and age dependency index are both negatively related. Thus, the demographic variables are related to human development. These variables are made by biases of the different countries. While ICTs might not be able to alleviate these biases, it can give resources and tools for those who are most affected by these biases. The following section investigates the role of mHealth in addressing the social determinants of health.

Mobile Health Relation to Social Determinants of Health

With the Mobile Health Index each variable was compared separately due to the model arrangement and our hypotheses that predicted mobile health would have an impact on social determinants of health. Once again, we did a regression analysis to see if the indices were related. Then we compared the beta scores in order to test our hypotheses. The hypotheses predict that the

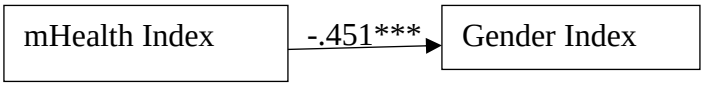
inequality index, educational index, and location index will all have positive beta scores. For gender inequality index and age dependency index, we predicted negative beta scores.

Figure 4.1: Mhealth Index relation to Inequality Index



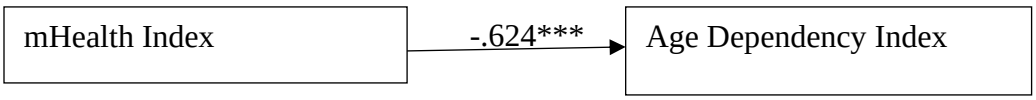
The figure above is the comparison between mHealth and Inequality. The relationship between these two indexes is significant (p-value = 0.000, significant when p-value < 0.005). As it was predicted mHealth is positively related to the Inequality Index. This means that as there is less inequality the life expectancy, use of mobile phones, and the access to mobile phones increases. Qureshi and Najjar (2017) showed this same result that use of information and communication technology (ICT) increased GDP of very small island states (Qureshi & Najjar, 2017). Since IHDI is HDI adjusted by the inequality of the state, we can see the impact of ICT in a worldwide perspective. The more people who have access to ICT, the better the HDI is and the less inequality there is likely to be in a given population.

Figure 4.2: Mhealth Index relation to Gender Index



The R-squared value for mHealth and Gender is 0.199. Therefore, the data fits 19.9% of the model and according to the regression table it is a significant relationship (p-value = 0.000, significant when p-value < 0.005). The relation shows a negative relation, as predicted. This means that if there is more mhealth access there is less gender inequality.

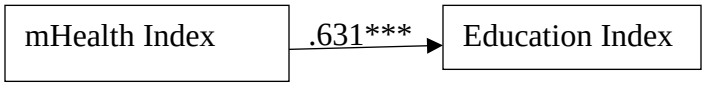
Figure 4.3: Mhealth Index relation to Age Dependency Index



The figure above shows the relation between mHealth and Age Dependency. The model is a 38.7% fit (r-square value= 0.387, p-value = 0.000, significant when p-value < 0.005) and the relation are a negative one, as predicted in the hypothesis. Surprisingly, it is a more negative correlation than the gender index. It is surprising, because in most areas of the world women are considered to be caregivers. Therefore, we believed they might be more negative or similar to age dependency. This relation shows that as mhealth access increases, age dependency decreases. So, potentially, this could show that the access to mhealth decreases those that are suffering from chronic diseases that makes them more dependent on others.

The next comparison we did was mHealth Index to the Education Index. The results show that there is a 39.5% relation between these two indexes. The beta coefficient is .631 which shows there is a steep positive slope when plotting this correlation. This correlation shows that as there is more access to mobile devices, the population in question is more educated. Qureshi (2017) showed this connection that the skill one has to use ICT impacts the usability of ICT (Qureshi, 2017).

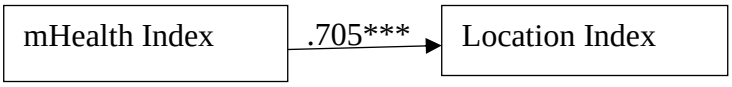
Figure 4.4: Mhealth Index relation to Education Index



Finally, we compare the mHealth index to the Location index. The model fits 49.5% of the data (r-squared value is 0.495) and is significantly related (p-value = 0.000, significant when p-value < 0.005). The relation is positive, as predicted. When looking at the model below the relation between mhealth access and location infrastructure is significant and has a high beta score. This

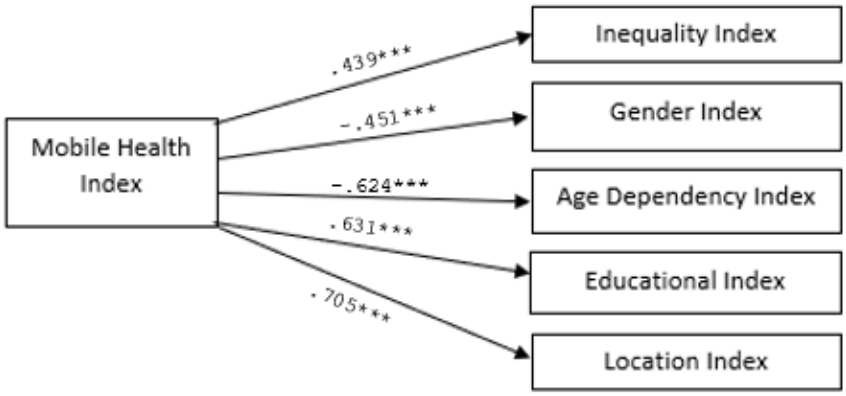
makes sense because to use mobile devices you need to have access to electricity and internet, which requires infrastructure to be in place.

Figure 4.5: Mhealth Index relation to Location Index



Below we can see the results together in one model. The hypotheses are confirmed. This shows that mHealth applications, while being available for all, will be more developmentally impactful. Since age dependency and gender showed a correlation to mhealth access, mhealth application might enable people to access health care and navigate healthcare more effectively. The tested model of mHealth to health inequities is illustrated below in figure 4.6.

Figure 4.6: Tested model of mHealth to Health Inequities

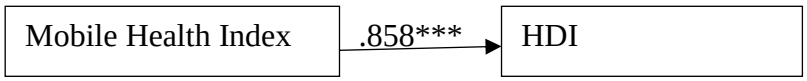


mHealth Relation to HDI

Another interesting result was that the mobile health index compared to the HDI. Of course, they should be related based on the fact that the mobile health index was correlated to the social determinants of health and the social determinants of health were related to the HDI (p-value = 0.000, significant when p-value < 0.005). But when testing the correlation, the R-squared value

and the beta coefficient were higher than expected. It shows that when mhealth is more accessible, the HDI is higher.

Figure 5: mHealth Relation to HDI



As shown in the analysis, mhealth has the ability to impact social determinants of health, which will improve the human development of a country. This offers unique insight into the inequities such as socio-economic, environmental, and demographic that can be overcome through mHealth. People who are unable to obtain basic necessities such as food, shelter, capital, and the capability to acquire the information they need to stay healthy are disadvantaged. These socioeconomic factors impact people's and communities' ability to recover from the most recent pandemic. mHealth has a role to play in the future to making sure that people have access to information and access to resources.

SUMMARY, CONCLUSIONS AND LIMITATIONS OF THIS RESEARCH

HDI is the human development index, it is the measure of being able to "live a long and healthy life, being knowledgeable, and [having] a decent standard of living." (Human Development Index). Social determinants of health are highly correlated to HDI. This means that the ability to have an ideal "healthy lifestyle" is correlated to social determinants of health. The analysis in this paper illustrated that people who live in a country where there are many inequalities, it will impact the population's development. Gender inequality, educational inequality, age inequality, location inequality, and income inequality are all determinants that impact one's ability to access an ideal healthy lifestyle.

In order to investigate social determinants of health and human development, social determinants of health are investigated through the following indices created for this study: Inequality Human Development Index, Gender Inequality Index, Age Dependency Index, Education Index, and Location Index. HDI is the dependent variable used to study the relationship between human development and the social determinants of health. The findings suggest that in the mhealth relation to health inequities was highly correlated to mhealth.

The analysis illustrates that as access to mobiles and internet improves, the gender inequality of a population decreases and the age dependency of a population decreases. This shows that mhealth can be a tool used to bridge the gender and age gaps in order to enable communities to have healthier lives. Mhealth if accessible could increase this relation by giving people of lower socioeconomic status opportunities and information about healthcare. Investing in access for ICTs and mhealth, impact one's health. It also gives people a way to learn about health resources via mhealth.

Further research is needed to understand how the use of mobile health applications can be used to address the socio-economic determinants that affect the ability of people from low socio-economic communities to stay healthy. Ultimately any intervention through mobile health applications can only be undertaking in communities where people have access to mobile and broadband internet. In communities that do not have mobile broadband internet access, such interventions may not be possible.

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APPENDIX

R squared Model Summary and ANOVA for Figure 3:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics		
					R Square Change	F Change	df1
1	.939[a]	.882	.878	.052263	.882	272.268	5

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.718	5	.744	272.268	.000[b]
	Residual	.500	183	.003		
	Total	4.218	188			

a. Dependent Variable: HDI 2019

b. Predictors: (Constant), Education Index, Age Dependency Index, Gender Inequality Index, IHDI 2019, Location Index

R squared model summary and ANOVA for Figure 4.1:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.439[a]	.193	.189	.262729	.193	44.718	1	187	.000

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.087	1	3.087	44.718	.000[b]

	Residual	12.908	187	.069		
	Total	15.995	188			

a. Dependent Variable: IHDI 2019

b. Predictors: (Constant), Mobile Health Index

R squared model su

Figure 1

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.451[a]	.203	.199	.191523	.203	47.747	1	187	.000

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1.751	1	1.751	47.747	.000[b]
	Residual	6.859	187	.037		
	Total	8.611	188			

a. Dependent Variable: Gender Inequality Index
b. Predictors: (Constant), Mobile Health Index

R squared model summary and ANOVA for Figure 4.3:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.624[a]	.390	.387	7.441229851677945	.390	119.520	1	187	.000

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6618.047	1	6618.047	119.520	.000[b]
	Residual	10354.546	187	55.372		
	Total	16972.592	188			

a. Dependent Variable: Age Dependency Index
b. Predictors: (Constant), Mobile Health Index

R squared model summary and ANOVA for Figure 4.4:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.631[a]	.398	.395	3.172960004606312	.398	123.877	1	187	.000

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	1247.155	1	1247.155	123.877	.000[b]
	Residual	1882.655	187	10.068		
	Total	3129.810	188			

a. Dependent Variable: Education Index
b. Predictors: (Constant), Mobile Health Index

R squared model summary and ANOVA for Figure 4.5:

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.705[a]	.497	.495	23.192088328444797	.497	184.912	1	187	.000

ANOVA[a]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	99459.111	1	99459.111	184.912	.000[b]
	Residual	100582.244	187	537.873		
	Total	200041.354	188			

a. Dependent Variable: Location Index
b. Predictors: (Constant), Mobile Health Index

R squared model summary and ANOVA for Figure 5:

Model Summary

R	R Square	Adjusted R Square	Std. Error of the Estimate
.858	.736	.735	11.043

The independent variable is HDI 2019.

ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Regression	63559.227	1	63559.227	521.221	.000
Residual	22803.327	187	121.943		
Total	86362.553	188			

The independent variable is HDI 2019.