Relationship Between Disease Rates and Demographic Factors in Independence, MO

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Abstract

Background: Health begins in one's home, neighborhood, and community. Health is determined by numerous factors. The social determinants of health (SDOH) account for up to 55% of health outcomes. They are responsible for the majority of health inequities seen globally. The purpose of this study was to understand the relationship between demographic factors and rates of disease. **Methods:** Rates of pertussis and varicella in Independence, Missouri (MO) children aged 0-5 in 2015-2019 were examined. Only eight of Independence's zip codes were included. These rates were then compared to the city's race, ethnicity, language, median income, and education level demographic factors. A linear regression and Kruskal-Wallis test were performed for each disease and list of factors using SPSS. **Results:** Individual demographic factors were not significant when compared to disease rates. The significance level was set at 0.05. In the linear regression, spoken language was the most significant factor for pertussis ($\beta = 1.439$, $p = 0.513$) and race for varicella ($\beta = -0.813$, $p = 0.496$). Education level was the most insignificant factor for pertussis ($\beta = -0.085$, $p = 0.940$) and median income for varicella ($\beta = -0174$, $p = 0.888$). In the Kruskal-Wallis test, education level was the most significant factor for pertussis ($p = 0.433$) and race for varicella ($p = 0.480$). Median income was the most insignificant factor for pertussis ($p = 0.856$) and education level for varicella ($p = 0.954$). **Conclusion:** No single demographic factor can increase an individual's susceptibility to disease. To effectively understand disease rates, all facets of one's SDOH must be considered. Implications of this work include interventions directed at improving the public's SDOH may, in turn, positively impact their overall health.

Introduction

Health is determined by numerous factors. It begins in places such as a person's home, neighborhood, and community (Healthy People, n.d.b.). Typical recommendations including eating healthy foods, exercising, getting enough sleep, not using tobacco or taking illegal drugs, regularly visiting a primary care physician and dentist, and getting recommended health screenings and vaccinations are all valid methods to improving one's health (Healthy People, n.d.b.). However, they do not completely alleviate all health concerns. The conditions in which an individual lives, learns, works, worships, and plays possess a powerful impact over health outcomes. These conditions can provide an explanation for why some people are healthier than others.

The mentioned conditions are the social determinants of health (SDOH). They are shown in figure 1. According to WHO (n.d.), the SDOH can impact one's health more significantly than their lifestyle choices or if they received regular health care visits. They are responsible for 30-55% of all health outcomes (WHO, n.d.). Diverse forces such as political systems, social norms, policies, economic systems, and development agendas shape the SDOH (WHO, n.d.). Power, money, and local, national, and global resources are also significant influencers (Centers for Disease Control and Prevention [CDC], 2021a).

Figure 1. The SDOH (Healthy People, n.d.b.).

In regards to the five domains of the SDOH, health and sickness follow a social gradient where the lower one's socioeconomic position (SEP), the worse their health typically is (WHO, n.d.). This holds true for all countries. Education is often associated with improved quality of life and longer life expectancy (Healthy People, n.d.b.). Discrimination negatively affects health. It increases stress and blood pressure. Socioeconomic disadvantageous neighborhoods can be located proximal to food deserts. Here, healthy foods can be very expensive or unavailable-leading people to consume foods with little to no nutritious value to survive (Healthy People, n.d.b.).

Having access to varying means is important. Having access to quality schools, safe housing and neighborhoods, affordable health insurance, clean water and air, green spaces, nutritious foods, and social and economic opportunities significantly impact one's life (Healthy People, n.d.b.). If any of these are absent then that increases an individual's risk for negative health outcomes (CDC, 2021a). It is understandable then that a person residing in a safe neighborhood with well-maintained sidewalks and parks that also has access to great schools, job security, plentiful grocery stores, and affordable health insurance is more likely to live a longer, fulfilled life than an individual residing in an impoverished, unsafe neighborhood with access to only substandard schools, unskilled jobs, groceries from convenience stores, and unaffordable health insurance.

Health Inequalities, Inequities, and Disparities

The SDOH are responsible for the majority of health inequities seen globally (CDC, 2021a). Health inequities are avoidable, unfair differences in people's health statuses (CDC, 2021a). Health inequalities are differences in health between individual people or groups (Arcaya et al., 2015). Regarding equality, resources are distributed equally whereas in equity, individual circumstances are considered when providing resources in order to attain an equal outcome (Arcaya et al., 2015). Figure 2 depicts this. Health disparities are preventable differences in disease burdens between socially advantageous and disadvantageous populations (Health People, n.d.a.).

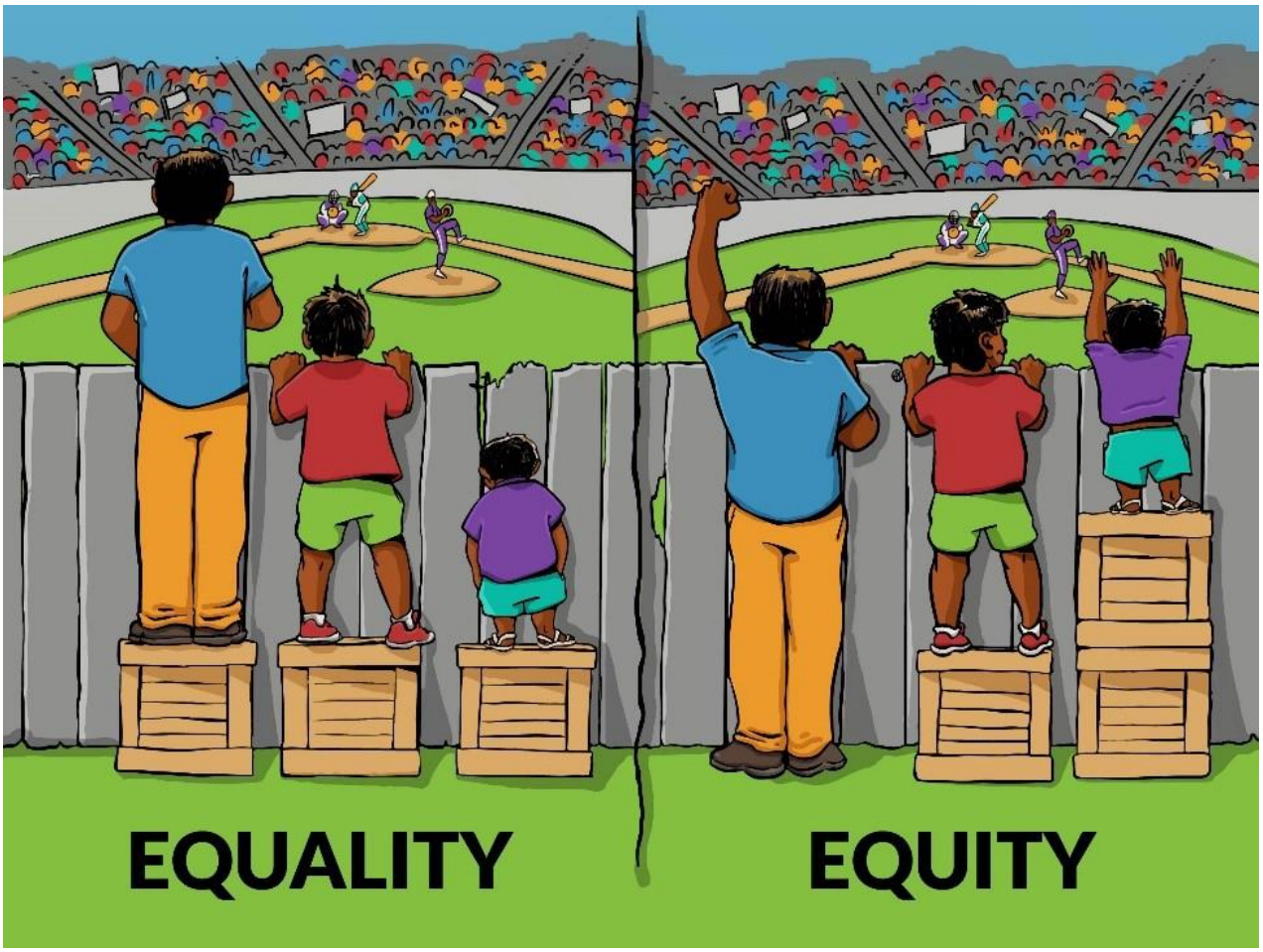

Figure 2. Health equality versus health equity (Interaction Institute for Social Chance [IISC], 2016).

It is a common phenomenon for minorities to experience health disparities (Healthy People, n.d.a.). Factors such as age, race, ethnicity, location, sexual orientation, and SEP all contribute to the likelihood a person will have great health (Healthy People, n.d.a.). This is especially apparent when considering African American women, preterm birth, and low birth weight. Non-Hispanic or Latinx African American women are 50% more likely to deliver preterm than all other races and ethnicities (CDC, 2020). From 2018-2019, the nationwide rate of preterm birth in non-Hispanic or Latinx African American women increased 14.13%-14.39% (Martin et al., 2021). However, the rate for non-Hispanic or Latinx white women only rose

9.09%-9.26% (Martin et al., 2021). The fact there is almost a 5% difference between these groups of women is significant.

There is a correlation between preterm birth and low birth weight since preterm infants and more likely to weigh less than infants born closer to 40 weeks gestation (Black Women's Health Imperative [BWHI], 2017). The likelihood of a non-Hispanic or Latinx African American woman with a high SEP to deliver preterm is still higher than a non-Hispanic or Latinx white woman that did not complete high school (BWHI, 2017). Between 2018-2019, of the infants born to non-Hispanic or Latinx African American women, 14.16% were considered low birth weight (weighing less than 5.5 pounds) (BWHI 2017; Martin et al., 2021). In contrast, 6.89% of infants born to non-Hispanic or Latinx white women were of low birth weight (Martin et al., 2021).

Heart disease also does not equally affect people. While there are some risk factors an individual can modify to reduce their likelihood of developing heart disease, certain factors simply cannot be changed such as one's age, race, ethnicity, and sex. For example, non-Hispanic or Latinx African Americans have greater chances dying of heart disease than all other races and ethnicities (American Heart Association [AHA], 2015). More women and younger populations are experiencing heart attacks (AHA, 2018). Considering the fact heart attacks were previously labeled an "old man's disease," it is typical for women and younger people arriving at hospitals with chest pain to not be promptly treated (AHA, 2018).

African American children are less likely to get vaccinated than non-Hispanic or Latinx white children (Hill et al., 2017). Based on one's race and ethnicity, adults are less likely to get recommended vaccinations as well (Let's Vaccinate, n.d.). In children and adults that do not have health insurance and/or are living below the United States' poverty threshold, vaccination

rates are lower (Hill et al., 2017). Barriers to overall health care including vaccinations are experienced by individuals living in rural environments where resources and health care facilities are typically scarce (Let's Vaccinate, n.d.).

What is Pertussis?

Pertussis, or whooping cough, is a highly contagious illness caused by the *Bordetella pertussis* bacterium (Havers et al., 2020). It affects the respiratory system causing uncontrollable, violent coughing. It is commonly transmitted through droplets from the infected individual. While anyone can develop pertussis, it is typically deadly for children and infants (Havers et al., 2020). There are two vaccines to prevent pertussis: Tdap for older children recommended to be administered around 11-12 years of age and DTaP for younger children recommended to be administered before they are 1-years-old and again when they are 4-6 years of age (Missouri Department of Health and Senior Services [MDHSS], n.d.). Missouri's current immunization schedule is shown in figure 3. In the United States before these vaccines were available, pertussis was a significant cause of childhood death. It was also an extremely common childhood disease with over 200,000 reported cases each year (Havers et al., 2020). In contrast, in 2018 there were only seven reported deaths and 18,000 reported cases (Havers et al., 2020).

Figure 3. Missouri's current immunization schedule (MDHSS, n.d.).

What is Varicella?

Varicella, or chickenpox, is a highly contagious illness caused by the varicella-zoster virus (Lopez et al., 2020). Once an individual has developed varicella, this virus can also cause the viral infection shingles later in their life (Lopez et al., 2020). The hallmark symptom of varicella is an itchy bodily rash. However, people can also experience flu-like symptoms such as headache, loss of appetite, and fever. It is routinely transmitted through droplets from the infected individual or coming into contact with the fluid from their blisters (Lopez et al., 2020). It is recommended to administer the varicella vaccine when a child is 12-15 months of age and again at 4-6 years of age (MDHSS, n.d.). Before the vaccine became available, the disease was endemic in the United States with roughly 4 million reported cases each year (Lopez et al., 2020). Since the vaccine became available, varicella cases have decreased by 97% (Lopez et al., 2020).

Public Health Theory

The theory used in this study was the socio-ecological model. It was originally introduced by Urie Bronfenbrenner in the 1970s and later formalized as a theory in the 1980s (McKenzie et al., 2017). The socio-ecological model is composed of five different levels: intrapersonal, interpersonal, institutional, community, and public policy (McKenzie et al., 2017). The model is shown in figure 4.

The intrapersonal level deals with individual characteristics that impact one's behavior such as their beliefs, attitudes, and knowledge. Interpersonal involves people in the immediate surroundings of an individual, including family and friends. Health behaviors can be promoted or checked by varying rules, informal structures, and regulations at the institutional level. Community involves norms, social networks, as well as community contexts. Laws and policies can affect one's health at the policy level (McKenzie et al., 2017).

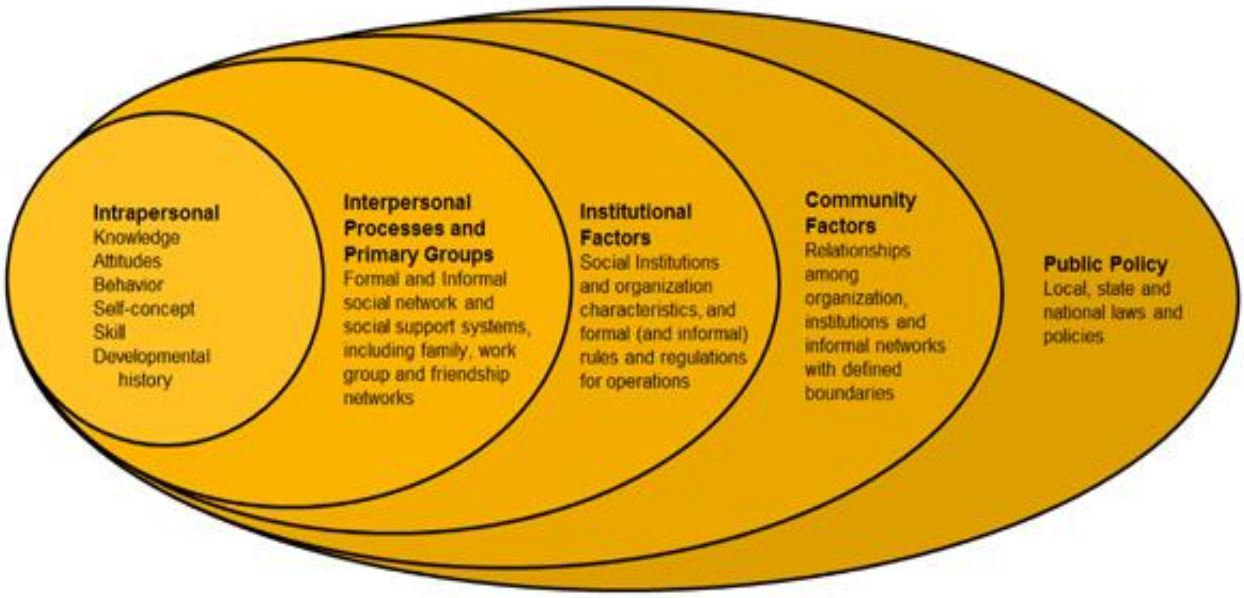

Figure 4. The socio-ecological model. (American College Health Association [ACHA], n.d.).

The socio-ecological model notes that a person's health is affected by interactions at each level (McKenzie et al., 2017). Health is routinely impacted by both internal and external factors. In other words, people influence as well as become influenced by structures and others around them. The social context in which individuals live, shape their health behaviors (McKenzie et al., 2017). Factors that impact one's health become entangled and difficult to isolate. As a result, multiple levels of the model should be considered when formulating effective interventions (ACHA, n.d.).

In the context of this study, the SDOH can affect one's health at each level of the socio-ecological model. The conditions in which an individual lives, learns, works, worships, and plays can affect their attitudes towards health and their subsequent health behaviors. A person's family, friends, and social networks along with the informal structures and public policies where they are located are all influential factors as well.

Independence, Missouri (MO)

Independence, MO has a population of roughly 117, 207, the median age being 41, with a $48,331 median household income compared to the United States' national average of $61,937 (Data USA, n.d.). As of 2018, Independence's five most notable ethnic groups are non-Hispanic or Latinx white (77.2%), non-Hispanic or Latinx African American (7.08%), Other race (5.25%), Hispanic or Latinx white (3.84%), and two or more races (2.09%) (Data USA, n.d.). Independence has ten zip codes: 64050, 64052, 64053, 64054, 64055, 64056, 64057, 64058, 64015, and 64016 (ArcGIS, n.d.). A map of the city's zip codes is displayed in figure 5. In this study, zip codes 64015 and 64016 were excluded due to the fact the majority 64015 is the City of Blue Springs, MO and most of 64016 is the City of Buckner, MO.

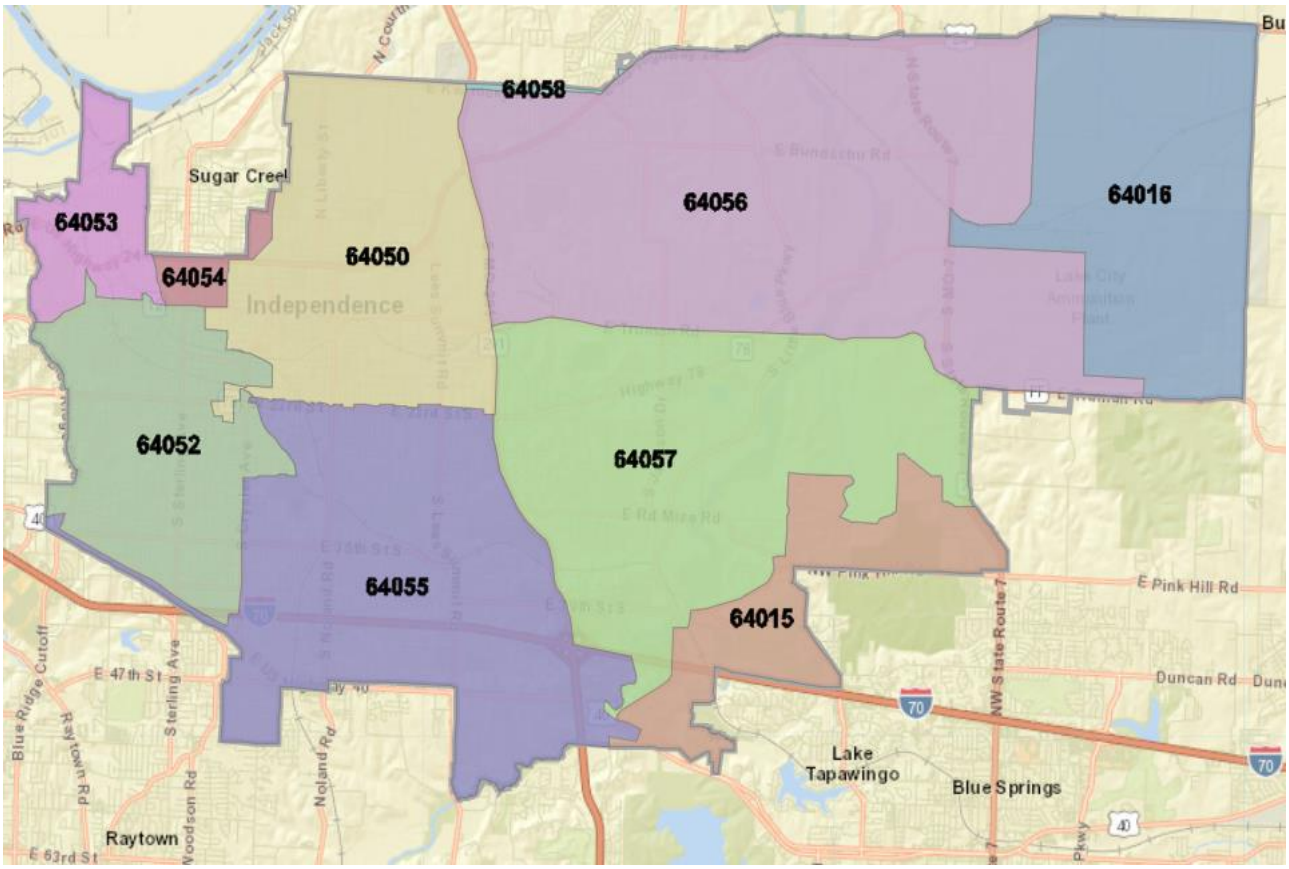

Figure 5. Map of Independence, MO zip codes (ArcGIS, n.d.).

Purpose

The purpose of this study was to understand the relationship between disease rates and demographic factors. To achieve this, the rates of pertussis and varicella in Independence, MO children aged 0-5 in 2015-2019 along with the city's demographic was examined. Included demographic factors were race, ethnicity, spoken language, median income, and education level. It was hypothesized that each individual factor would be significant when considering disease rates. The null hypothesis was there would be no correlation between individual demographic factors and disease rates.

Methods

Institutional Review Board (IRB) Exemption

This study did not go through the IRB due to the fact it meets National Institutes of Health (NIH) criteria for exemptions one and five (NIH, 2020). Figure 6 shows NIH's eight exemptions in human subjects research. This study was conducted in an educational setting. Employees of MDHSS were utilized in gathering public service data in the form of pertussis and varicella disease cases.

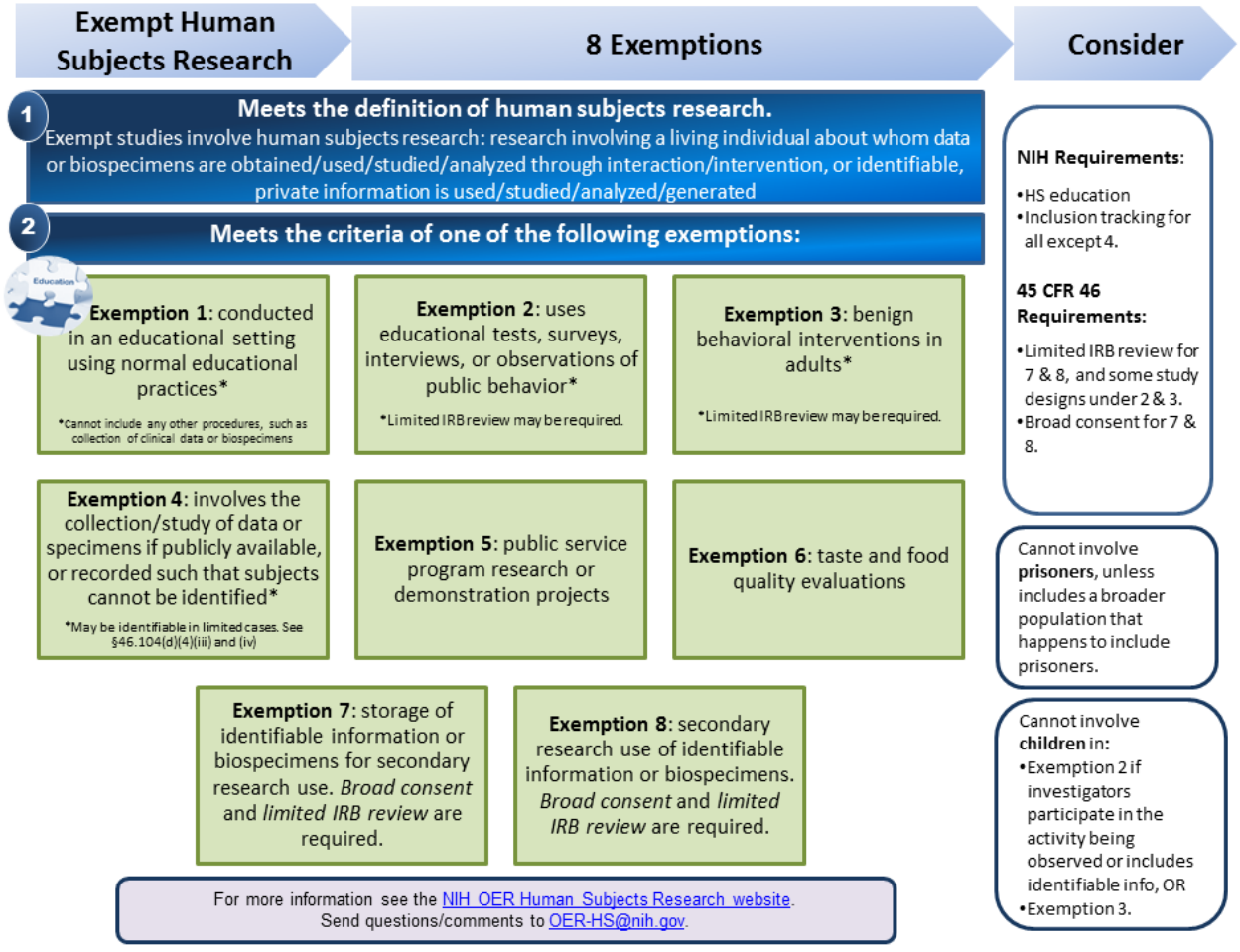

Figure 6. NIH's eight exemptions to human subjects research. (NIH, 2020).

Data Collection, Measures, and Data Analysis

In this study, incidences of pertussis and varicella in children aged 0-5 in the years 2015-2019 in the eight included Independence, MO zip codes were examined. The data were requested through MDHSS. Demographic data of each zip code's race, ethnicity, spoken language, median income, and education level were obtained from the 2019 American Community Survey (ACS) (United States Census Bureau, 2019). A five-year estimate from 2014-2019 was used in the ACS.

In Microsoft Excel, the number of white residents in a zip code was subtracted from the number of those not white. The number of Hispanic or Latinx residents in a zip code was subtracted from those not Hispanic or Latinx. This process was continued for each demographic factor and zip code. The data were organized in an Excel table by cases of pertussis and varicella and the demographic factors separated by zip code. These figures were then entered into SPSS in order to gather a statistical description of the population and perform the data analyses.

In SPSS, all cases of varicella in the zip codes were combined. The same was then done for pertussis cases. Means and standard deviations were found for each demographic factor to better understand the studied population. A linear regression and Kruskal-Wallis test were conducted for each disease and demographic factor to determine the significance between disease rates and the demographic factors. In the Kruskal-Wallis test, it was also calculated if the null hypothesis should be rejected or retained.

Results

Table 1 displays Independence, MO's demographic data in accordance to zip code. In each zip code, the total population as well as the population under 5-years-old was found.

Residents' median age, race, ethnicity, marital status, education level, spoken language, and median income were also gathered.

Table 1. Independence, MO demographic data by zip code.

	64050	64052	64053	64054	64055	64056	64057	64058
Population								
Population Total	22,614	20,854	5,985	3,055	33,350	16,718	14,323	6,852
Median Age	36.3	40.5	31.6	38.9	46.1	32	44.8	38.4
Percent of Population Under Age Five	6.8%	6%	7.2%	8.7%	4.5%	9%	5%	6.3%
Race								
White	79.8%	72%	75%	93.1%	82.9%	78.6%	82.7%	89.8%
African American	7.9%	8.6%	8.1%	1.4%	8.4%	8.7%	6.2%	5.1%
American Indian and Alaskan Native	0.2%	0.7%	1.1%	2.2%	0.1%	0.6%	1.3%	0%
Asian	1.2%	1.5%	0.8%	0.5%	1.8%	0.6%	2.2%	1.3%
Native Hawaiian or Pacific Islander	2.7%	0%	0%	0%	0%	4.5%	1.1%	1.5%
Other Race	4.5%	13.5%	12.8%	1.3%	3.2%	5.4%	3.3%	0.6%
Two or More Races	3.8%	3.7%	2.2%	1.6%	6.4%	1.6%	3.3%	1.8%
Ethnicity								
Hispanic or Latinx	8.1%	16.1%	20%	7.5%	6.4%	7.9%	7.1%	2.6%
Not Hispanic or Latinx	75.3%	67.9%	67.8%	87.6%	80.3%	74.7%	79.8%	87.3%
Marital Status								
Never Married	34.5%	30.2%	41.6%	36.5%	27.5%	30.1%	26.6%	24.4%

Married or Separated	37.9%	42.3%	35.1%	33.3%	47.8%	51%	47.5%	54.3%
Divorced	19.2%	21.4%	16.2%	25.5%	16.9%	13.7%	16.1%	13.3%
Widowed	8.4%	6.1%	7%	4.7%	7.8%	5.3%	9.8%	8%
Education Level								
Less than high school graduate	13.3%	14.2%	23.6%	15.8%	7.9%	8.5%	5.6%	9.7%
High school graduate	43.7%	37.3%	35.1%	42.2%	34.6%	39.1%	33.6%	43.3%
Some college or associate degree	32.9%	32.1%	30.2%	32.7%	32.8%	37.6%	33.1%	28.6%
Bachelor's degree	7.2%	12.3%	5.6%	8.7%	16.2%	10.2%	16.8%	13.7%
Graduate or professional degree	3%	4.1%	5.6%	0.6%	8.4%	4.6%	10.9%	4.7%
Language								
Speak language other than English	5.7%	12.3%	17.2%	3.5%	6.3%	4.4%	6.6%	4.2%
Household Income								
Median household income	$23,531	$28,843	$21,443	$24,107	$31,074	$32,692	$36,368	$32,239

Note. Demographic data were obtained from the 2019 ACS (United States Census Bureau, 2019). A five-year estimate from 2014-2019 was used in the survey.

For all Independence residents in the eight zip codes, (see *Table 2*), 81.7% was the mean of whites while 18.3% was the mean of those that are not white. 9.5% was the mean of those Hispanic or Latinx while 77.6% was the mean of those not Hispanic or Latinx. The mean of those that spoke English was 92.5% while 7.5% was the mean of those that did not speak English. The mean median income was $28,787.13. The mean of high school graduates was

38.6% while 61.4% was the mean of those that either did not graduate high school or did have some form of post-secondary education.

The standard deviation of those white and not white was 7%. The standard deviation of Hispanic or Latinx was 6% while non-Hispanic or Latinx was 8%. Those that spoke English and those that did not had the same standard deviation of 5%. $5,255.27 was the standard deviation of median income. The standard deviation of those that graduated high school and either did not graduate or had some form of post-secondary education was 4%.

Table 2. Description of Independence, MO demographic

	Mean	Standard Deviation
White	81.7%	7%
Non-White	18.3%	7%
Hispanic or Latinx	9.5%	6%
Non-Hispanic or Latinx	77.6%	8%
English speaking	92.5%	5%
Non-English Speaking	7.5%	5%
Median Income	$28,787.13	$5,255.37
High School Graduate	38.6%	4%
Not High School Graduate or Have Post-Secondary Education	61.4%	4%

Note. Demographic data were obtained from the 2019 ACS (United States Census Bureau, 2019). A five-year estimate from 2014-2019 was used in the survey. The number of white residents in a zip code was subtracted from those not white. The number of Hispanic or Latinx residents in a zip code was subtracted from those not Hispanic or Latinx. This process was continued for each demographic factor. This data were then entered into SPSS to gather means and standard deviations.

There were very few cases of pertussis and varicella in the years 2015-2019 (see *Table 3*). Zip code 64052 had the highest total number of pertussis cases at 5 while 64053, 64057, and 64058 had none. 64052 also had the highest total number of varicella cases at 4 while 64054, 64056, and 64057 had none.

Table 3. Pertussis and varicella disease cases in Independence, MO 2015-2019 by zip code

	Pertussis					**Varicella**				
	2015	2016	2017	2018	2019	2015	2016	2017	2018	2019
64050	0	0	1	0	0	1	0	0	1	0
64052	1	1	2	0	1	0	2	1	1	0
64053	0	0	0	0	0	0	0	1	0	0
64054	0	2	0	0	0	0	0	0	0	0
64055	0	0	1	0	2	1	1	0	0	0
64056	2	0	0	0	0	0	0	0	0	0
64057	0	0	0	0	0	0	0	0	0	0
64058	0	0	0	0	0	0	0	1	0	0

Note. A request was made to MDHSS for cases of pertussis and varicella in those aged 0-5 from 2014-2019 in the eight Independence, MO zip codes.

None of the demographic factors were found to be significant in the linear regression and Kruskal-Wallis test (see *Table 4* and *Table 5*). The significance level for both was set at 0.05. None of the demographic factors came close to reaching that significance level in either test. Regarding the linear regression (see *Table 4*), spoken language was the most significant factor

for pertussis (β = 1.439, p = 0.513) and race for varicella (β = -0.813, p = 0.496). Education level was the most insignificant factor for pertussis (β = -0.085, p = 0.940) and median income for varicella (β = -0174, p = 0.888).

Table 4. Linear regression output for noted demographic factors and pertussis and varicella cases

	Pertussis			**Varicella**		
	Standardized Coefficients Beta	t	*p*	Standardized Coefficients Beta	t	*p*
Race	-0.398	-0.372	0.746	-0.813	-0.826	0.496
Ethnicity	1.307	0.577	0.622	-0.853	-0.410	0.722
Spoken Language	1.439	0.789	0.513	-0.694	-0.414	0.719
Median Income	0.127	0.107	0.924	-0.174	-0.159	0.888
Education Level	-0.085	-0.085	0.940	0.280	0.307	0.788

Note. The total number of pertussis cases for the zip codes were added together in SPSS. A linear regression was then conducted to determine significance between disease rates and noted demographic factors. The same was done for varicella cases. The significance level is 0.05.

In the Kruskal-Wallis test, education level was the most significant factor for pertussis (p = 0.433) and race for varicella (p = 0.480). Median income was the most insignificant factor for pertussis (p = 0.856) and education level for varicella (p = 0.954). There was no difference in distribution between each factor and disease. The null hypothesis was retained.

Table 5. Kruskal-Wallis test output for noted demographic factors and pertussis and varicella cases

	Pertussis cases (*p*)	Varicella cases (*p*)
Race	0.591	0.480
Ethnicity	0.630	0.741
Spoken Language	0.469	0.614
Median Income	0.856	0.608
Education Level	0.433	0.954

Note. The total number of pertussis cases for the zip codes were added together in SPSS. A Kruskal-Wallis test was then conducted to determine if the null hypothesis should be rejected. The significance level is 0.05.

Discussion

The purpose of this study was to understand the relationship between disease rates and demographic factors. To achieve this, a linear regression and Kruskal-Wallis test were performed using SPSS. The results of this study were expected to indicate that each individual demographic factor was significant when examining disease rates. However, it was found that none of the factors were significant. The significance level was set at 0.05 for each test and none of the factors came close to reaching this. There was no difference in distribution between each factor and disease.

In the linear regression, spoken language was the most significant factor for pertussis (β = 1.439, p = 0.513) and race for varicella (β = -0.813, p = 0.496). Education level was the most insignificant factor for pertussis (β = -0.085, p = 0.940) and median income for varicella (β = -0174, p = 0.888). In the Kruskal-Wallis test, education level was the most significant factor for pertussis (p = 0.433) and race for varicella (p = 0.480). Median income was the most insignificant factor for pertussis (p = 0.856) and education level for varicella (p = 0.954).

Keeping this in mind, the null hypothesis that there would be no correlation between individual demographic factors and disease rates was retained.

The results were consistent with existing literature, which suggest that the SDOH possess a powerful influence over health outcomes. The conditions in which people live, learn, work, worship, and play shape their health behaviors. Over half of all deaths in the United States are caused by modifiable risk factors such as health behaviors (Braveman & Gottlieb, 2014). The ten leading causes of death in the United States are heart disease, cancer, unintentional injuries, chronic lower respiratory disease (CLRD), stroke, Alzheimer's disease, diabetes, influenza and pneumonia, kidney disease, and suicide (Nichols, 2019). They cause nearly 75% of all deaths in the country each year (Nichols, 2019). Several of these causes are preventable through initiating behavioral lifestyle changes. For example, modifiable risk factors for heart disease, cancer, stroke, and diabetes include tobacco use, lack of exercise, being overweight, and poor diet (CDC, 2014).

However, some causes of death result from disparities present in the social, environmental, geographic, and economic attributes of the environments in which people reside in (CDC, 2014). For example, illegal drug and alcohol use, lack of safety equipment use such as seatbelts and helmets, and residing in unsafe environments are all risks for unintentional injuries and suicides (CDC, 2014; Nichols, 2019). Exposure to violence increases the possibility an individual will commit gun violence in the future and die of an unintentional injury (Braveman & Gottlieb, 2014). Lack of educational resources in certain neighborhoods that cover the importance of safety equipment in addition to the negative effects of illegal drug use and alcohol consumption can lead to an increase in unintentional injuries and suicides in comparison to a neighborhood with better resources (Braveman & Gottlieb, 2014).

Social factors including employment, income, and education also shape health behaviors (Braveman & Gottlieb, 2014). While medical care generally positively impacts health outcomes, it is limited in terms of providing an explanation for why some people are healthier than others. The SDOH can be utilized in this respect since they take into account an entire person and their environment rather than focusing simply on health status.

Implications of this work include interventions directed at improving the public's SDOH may, in turn, positively impact their overall health. There is currently a health disparity regarding health insurance and Hispanic or Latinx adults in Independence, MO. The rate of non-Hispanic or Latinx white adults with health insurance in 2019 was 84.7% while the rate for Hispanic or Latinx adults was 50.3% that same year (KCHealthMatters, 2019). This is concerning given the fact medical costs in the United States are egregious. It is unlikely then that these people will seek needed medical treatment in a timely manner or regularly visit a physician or dentist. These actions negatively affect health outcomes.

This study examined pertussis and varicella. The fee for these vaccines without health insurance can be expensive especially to those that already have a low SEP (CDC, 2021b). This is disadvantageous since it is vital the public get vaccinated for many reasons. First, Havers et al. (2020) note that humans are reservoirs for both the virus that causes varicella and shingles (varicella-zoster virus) and the bacterium causing pertussis (*B. pertussis*). Both microorganisms only infect and cause disease in humans. Regarding pertussis, adults and older children act as reservoirs for *B. pertussis*. These populations are commonly the source of pertussis in infants (Havers et al., 2020). Adults and children that have never had varicella can develop it from coming in contact with someone with shingles or a child with varicella (Lopez et al., 2020).

Second, children are a vulnerable population as a result of their immature immune systems. Infants attain passive immunity by receiving antibodies from their mothers while in the womb (CDC, 2017). This immunity is only short-lasting, however. As a result, it is crucial for children to get vaccinated so they can commence production of their own antibodies for varying diseases (CDC, 2017).

Lastly, if childhood vaccination rates decline then so does herd immunity. According to Gostin (2019), 95% of the public must be vaccinated in order to maintain herd immunity. When this has been achieved, it becomes increasingly difficult for disease to be spread. This immunity also offers protection to a diverse range of people that would otherwise be negatively affected. These include individuals that do not wish to be vaccinated, those that cannot for varying reasons such as an allergy, as well as vulnerable populations including infants, immunocompromised persons, and the elderly (Oxford Vaccine Group, 2019).

Through becoming immunized, the lives of future generations and vulnerable populations can be saved (CDC, 2019). Opting against vaccines or not being able to afford them increases the chances of illness, disability, and death for both the individual as well as those around them (Perrone & Meissner, 2020). In the United States, for every one child that follows the recommended vaccine schedule (see figure 3), over 40,000 deaths and roughly 20 million illnesses are prevented and over $70 billion is consequently saved (Ventola, 2016).

Strengths and Limitations

Overall, this study is strong due to the fact the data being analyzed is primary data. As a result, the data is current and authentic. The data were gathered from MDHSS so study outcomes could be generalized to other Midwestern regions. The Midwest is understudied especially in

comparison to other regions of the country such as the South, the Northeast, and the West (Hendee, 2018). Adding research to this area would assist in the overarching goal of effectively understanding the relationship between disease rates and demographic factors.

There are limitations of this study. These include its sample size and the fact there were very few cases of pertussis and varicella in Independence, MO children aged 0-5 in 2015-2019. Only eight zip codes were examined in this study, making the sample size small. This in conjunction with the fact the highest number of pertussis cases was five and varicella cases was four, makes the study's results less powerful.

Conclusion

No single demographic factor can increase an individual's susceptibility to disease. To effectively understand disease rates, all facets of one's SDOH must be considered. This notion supports the socio-ecological model, which was the guiding framework for this study. The social context in which people live, shape health behaviors (McKenzie et al., 2017). This study and the SDOH can be utilized in creating more upstream care policies. This is beneficial considering the SDOH can impact one's health more significantly than their lifestyle choices or if they received regular health care visits (WHO, n.d.). Rather than the majority of efforts be directed at attempting to better the health of people once they are already in the hospital, more policies can be implemented to improve the conditions in which people live, learn, work, worship, and play. Doing so can lead to changed individual health behaviors, a decrease in the number of hospital visits, and result in improved health outcomes for greater numbers of people.

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