CREATING A HEALTH EQUITY DASHBOARD FOR THE WORCESTER AREA

TEAM MEMBERS

SRIKAR NEKKANTI
SAMUEL FURMAN
ZACHARY HARRIS
LOGAN O'DONNELL

DATE:
MAY 13, 2021

PROJECT ADVISORS
DR. COREY DEHNER. WPI
DR. GILLIAN SMITH, WPI

PROJECT SPONSORS
CASEY BURNS, DIRECTOR OF COALITION FOR A HEALTH GREATER WORCESTER

ABSTRACT

Disparities in public health present an urgent priority to both urban and rural areas in the state of Massachusetts. To address this, we worked with the Coalition for a Greater Healthy Worcester to identify an appropriate dashboard development tool, which we then used to design and prototype an online dashboard of public health data. Using semi-structured interviews, surveys, and on-line research, we identified the most important criteria for an effective public health dashboard. Our team also identified dashboard development tool options that were easy to use, update and accurately display data. Along with the dashboard prototype, we developed a set of recommendations for the Coalition to help them with the dashboard's upkeep and addition of new features.

ACKNOWLEDGEMENTS

HEALTHCARE DISPARITIES: AN OVERLOOKED OBSTACLE

The demographics of the United States are changing at an unprecedented level. From 2016 to 2060, the number of multiracial Americans will triple from approximately 8.5 million to over 25.3 million (APM Research Lab & Kassira Absar, 2018). The nation's public health system needs to address glaring disparities in healthcare that have become a significant cause for concern as the population experiences unprecedented change.

In 2010, Black children who have asthma, a relatively manageable medical condition, were 2.6 times more likely to visit the emergency department and 5 times more likely to die from the condition than their White counterparts across the nation.
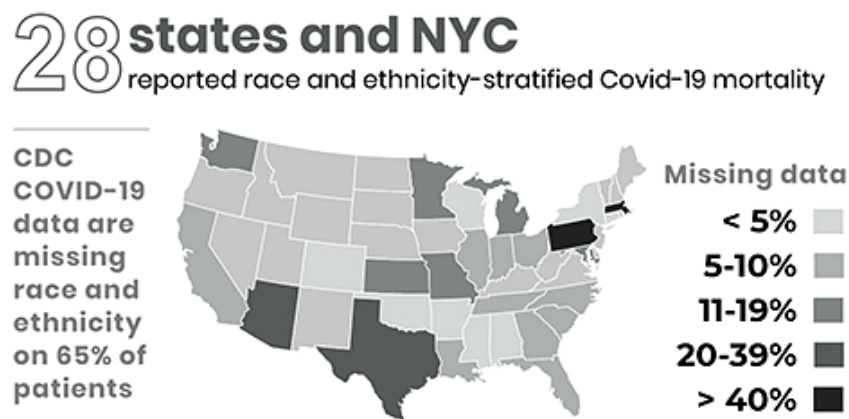
Figure 1 - A map of the United States showing percentages of missing Covid-19 data by race and ethnicity in the various states (Caprara,2020).

Statistics that can convey the extent of disparities between residents serve as the basis for data-guided decision-making by lawmakers to improve public health (Fact Sheet: Health Disparities by Race and Ethnicity, n.d.; Wu et al., 2020). While awareness of these disparities has increased in the past decade, the coronavirus pandemic that struck in 2020 is a recent example that there is much work to be done. Less than ten states reported complete and accurate statistics on how minorities were affected by the coronavirus, while 12 states aggregated less than 5% of their public health by race and ethnicity(Caprara, 2020).

HEALTH INADEQUACIES AND INEQUITIES
IN THE UNITED STATES.

Public health is the science of protecting and improving communities' health by combatting healthcare inadequacies, promoting healthy lifestyles, and disease research and response (CDC Foundation, 2021). Local departments of health work with private healthcare providers and nonprofit organizations in cities such as Worcester, Massachusetts. These local departments and their partners do crucial work to address the constantly changing healthcare landscape around them. Together, they form the foundation for the nationwide public health system as they are often the first to identify and react to public health problems that the population faces. (Hogg & Varda, 2016; Whitehead & Dahlgren, 2007).

To improve the health outcomes of its citizens, it is essential that governments fully understand and plan to overcome healthcare inadequacies. Health inequities and health inequalities are the two categories of healthcare inadequacies (Davis, 1991; Raphael, 2000). Health inequalities are variations in individuals' health, which can arise from differences in genetic factors, geographic location, age, and gender (Whitehead & Dahlgren, 2007). According to the World Health Organization, health inequities are distinguishable from inequalities when the differences that arise have three main characteristics: they are systematic, socially produced, and unfair, making them unnecessary and modifiable (Dickman et al., 2017; Whitehead & Dahlgren, 2007). For instance, children born into poverty have higher mortality rates than children born into wealthy families. These differences are not biological but caused by underlying socio-economic factors affecting health outcomes. The public health system can address these underlying factors, making their existence unnecessary by nature (American Public Health Association, 2018; Whitehead & Dahlgren, 2007).

Figure 2 - The Bay Area Regional Health Initiative's framework for reducing health inequities (Bay Area Equity Atlas, 2021).

Public health inequities arise due to a wide array of social and institutional inequities that work in tandem. Social and institutional inequities work to affect one's living conditions directly. To explain this concept fully, consider an example: a community that was once historically segregated along racial lines. During the city's planning and expansion, these racial differences meant that parts of the city made up of racial minorities did not receive adequate planning for hospitals, schools, green spaces, or sewage systems and were subject to racist policies that reinforced socio-economic separation. This, in turn, creates further disparities, shapes risk behaviours and ultimately influences disease, injury, and mortality rates to negatively affect health outcomes or contribute to significantly worse or unhealthy living conditions of an individual. The model in figure 3, widely adopted by health agencies and organizations across the United States, depicts how health outcomes are affected by inequities using an upstream/downstream analogy. (Bay Area Equity Atlas, 2021).

A FEW EXAMPLES OF SOCIO-ECONOMIC HEALTH INEQUITIES IN THE UNITED STATES:

IN THE UNITED STATES, THE WEALTHIEST AMERICANS' LIFE EXPECTANCY EXCEEDS THOSE WHO FACE POVERTY BY ALMOST 15 YEARS.
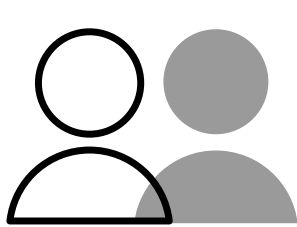
(DICKMAN ET AL., 2017).

African Americans/ Black Americans were

2x

likely to die from stroke compared to Whites in the country in 2010

(Weinstein et al., 2017).

American Indian/Native Alaskan women are

2x

likely to die from inflammatory bowel disease than White women
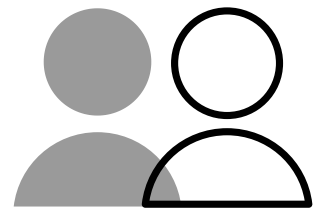
(Cancer and American Indians/Alaska Natives - The Office of Minority Health, n.d.)

Asian Americans face higher risks for cancer, heart disease and diabetes in comparison to Whites.

(Asian American - The Office of Minority Health, n.d.).

PERCENTAGE OF HEALTH COVERAGE, BY RACE

Percentage of Health Coverage, by race

	Whites	Asian Americans	African Americans	Hispanics	American Indians or Alaskan Natives
	88%	82%	79%	68%	68%
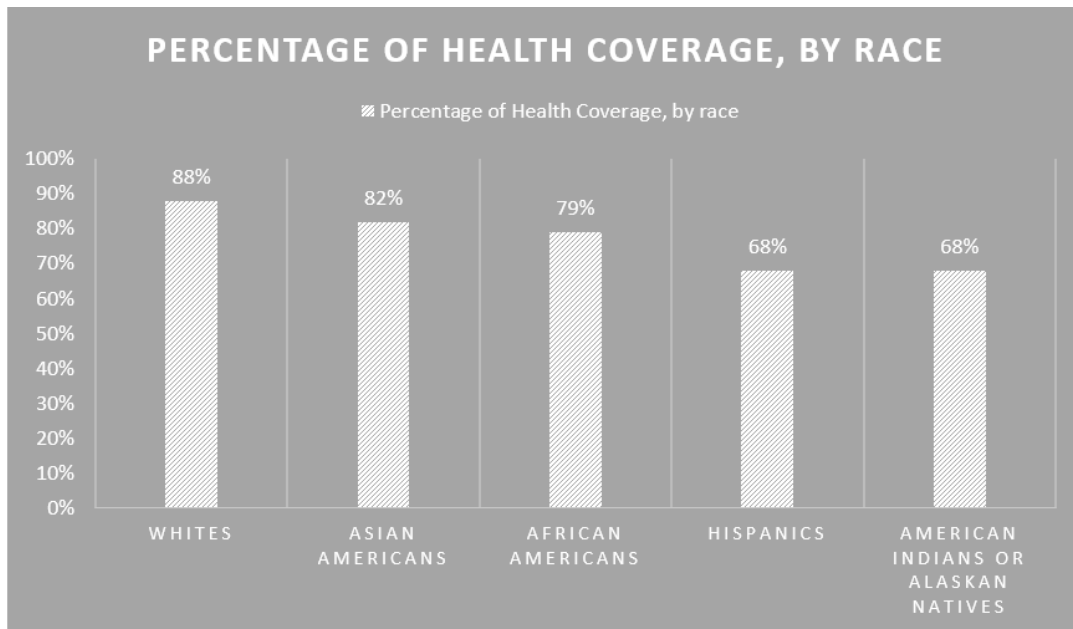
Figure 3 - - Percentage of Health Coverage by Race in the United States.

Health inequities present an urgent priority for all levels of government, requiring collaboration between the government, private and nonprofit organizations. In order for this collaboration to work, the organizations would need to share data, research, funding of educational and social outreach programs, and increase basic service coverage to all groups of people.

PUBLIC HEALTH AND DEMOGRAPHICS IN WORCESTER, MASSACHUSETTS.

Local government and health care organizations must identify gaps in their existing systems to protect the most vulnerable parts of their population. Worcester, located in central Massachusetts, is the second-largest city in New England and has a predominantly white population, making up 69.2% of all residents. However, members of marginalized communities disproportionately face socio-economic and public health issues even though they only represent less than a third of the total populatio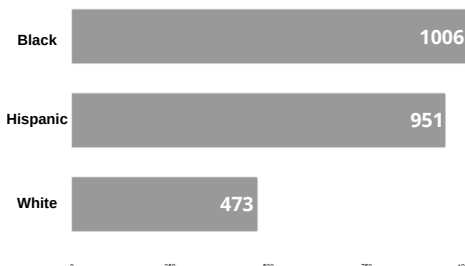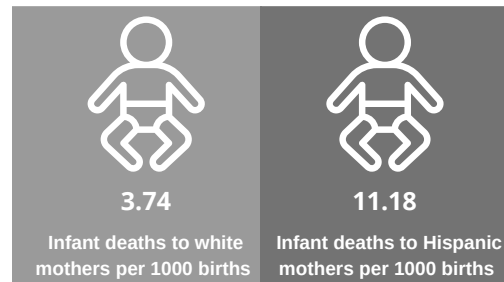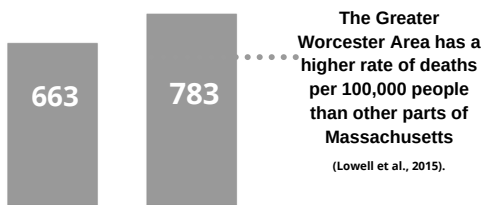n. Recent work done by local organizations, health care providers, and the city government to collect and report data demonstrates the extent to which disparities plague the health system in the area (Caprara, 2020; U.S. Census Bureau QuickFacts: Worcester City, Massachusetts, n.d.).

EXAMPLES OF DISPARITIES IN WORCESTER, BY THE NUMBERS

22.1%

Percentage of the Worcester population that relies upon food stamp/SNAP benefits
(Central MA Regional Public Health Alliance, 2018)
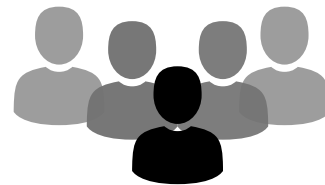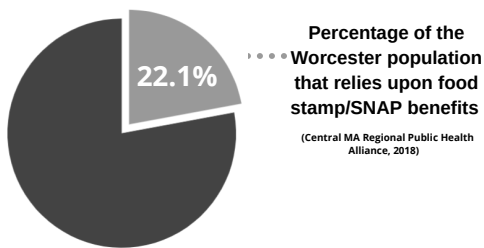
1 in 5 people in Worcester live below the poverty line.
(Central MA Regional Public Health Alliance, 2018)

663 **783**

The Greater Worcester Area has a higher rate of deaths per 100,000 people than other parts of Massachusetts
(Lowell et al., 2015).

3.74 **11.18**

Infant deaths to white mothers per 1000 births | **Infant deaths to Hispanic mothers per 1000 births**

Black **1006**
Hispanic **951**
White **473**

0   250   500   750   1000

Hispanic and Black populations also had significantly higher incidences of emergency department visits per 100,000 people for asthma in comparison to Whites.
(Central MA Regional Public Health Alliance, 2018; Lowell et al., 2015).

Almost half of Worcester city's available housing predates 1939. The lack of affordable and safe housing can directly contribute to many health outcomes such as respiratory diseases, substance abuse, lead poisoning, and infectious disease rates.
(Central MA Regional Public Health Alliance, 2018).

Lack of reliable and affordable transportation is another notable issue within the region, leading to decreased access to resources, education, health services, and other basic needs
(Central MA Regional Public Health Alliance, 2018; Lowell et al., 2015).

According to a 2012 survey conducted in the city of Worcester regarding healthcare access, approximately 7.2% of survey respondents mentioned experiences of discrimination from healthcare providers and staff in the city, along with 2.4% of respondents discussing language barriers as a primary reason affecting healthcare access (Balcewicz et al., n.d.)

THE COALITION FOR A HEALTHY GREATER WORCESTER

PREVIOUS EFFORTS TO IMPROVE HEALTH EQUITY USING DATA

Local health departments must work closely with health providers and nonprofits to identify and recognize inequities in the Worcester Area. Close collaboration and data sharing between stakeholders can serve as a basis for evidence-based decision-making to improve health equity and overall quality of life for the city's residents. Pilot programs in the D.C area and San Francisco Bay area have become full-fledged initiatives that provide data to both the general public and public health organizations that wish to identify areas of improvement to provide equitable health care. The data collected by the Washington D.C area initiative, for instance, helped guide planned-parenthood legislation to reduce maternal mortality rates for minority populations (Planned Parenthood Supports Bill That Targets DC's High Maternal Mortality Rate | WDVM25 & DCW50 | Washington, DC, n.d.).

THE COALITION'S MISSION AND PROJECT

The Coalition for a Healthy Greater Worcester, founded in 1992, serves the city of Worcester and surrounding towns by improving community decision-making, health, and wellbeing (Coalition for a Healthy Greater Worcester, n.d.). Since 2009, the Coalition has combined the efforts of, and data from, several major health organizations in the local area. The Coalition then uses this data to develop the Community Health Improvement Plan (CHIP) every three to five years. The CHIP is a collection of goals and strategies used to guide public health agencies and organizations' efforts (Central MA Regional Public Health Alliance, 2018; Coalition for a Healthy Greater Worcester, n.d.). The Coalition has recently unveiled its CHIP goals for the years 2021 - 2025.
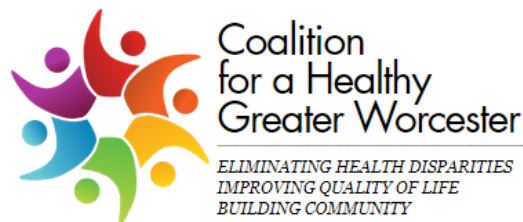
Figure 4 - - The Greater Worcester Area that the Coalition serves.

Coalition Director Casey Burns wanted to provide the Greater Worcester Area with a platform that can consolidate data on specific health indicators and present it in an appealing and user-friendly way. Similar programs across the United States, such as those in the previous section, have met notable success. The Coalition aims to replicate the impact these exemplary programs had on policy-making and the broader public by creating a centralized data consolidation platform for the City of Worcester.

EVIDENCE-BASED PUBLIC HEALTH

In health epidemiology, large-scale data-gathering and analysis act as the foundation for governments or organizations to take evidence-based steps to protect the public's health (Hedberg & Maher, n.d.).The CDC describes the integration of data and analysis as a "critical asset" to the agency, forming the basis for its programs (William K. Sieber et al., 2006). This process of data-gathering, analysis, and its subsequent use in decision-making is known as evidence-based public health (EBPH) (Evidence-Based - Evidence-Based Public Health Benefits Communities, n.d.).There are many benefits to the EBPH approach. The use of EBPH in Los Angeles county in its fight against HIV involved close analysis and data-driven decision-making. This helped the county identify areas of improvement and allowed health departments to allocate resources and funding to where it was urgently needed (Ryan et al., 2014).

EBPH approaches have been successful in the past. The Australian government incorporated EBPH into its Indigenous Tobacco Control Initiative to reduce the usage of tobacco in Indigenous communities. Through the EBPH approach, evidence collected by the initiative heavily influenced government decision-making and overcame political and social barriers, leading to the implementation of stricter Tobacco Control laws (Vujcich, 2017).

This concept can also be applied to address healthcare inadequacies. According to the World Health Organization, appropriately disaggregated data can serve as a basis for equity-oriented policies and programs to address health inadequacies (World Health Organization, 2021).

DATA GATHERING FROM VARIOUS SOURCES

ANALYSIS AND AGGREGATION OF GATHERED DATA

CENTRALIZED CONSOLIDATION OF AGGREGATED AND POST-ANALYSIS DATA

CHANGES TO PUBLIC HEALTH POLICY, FUNDING AND URGENCY OF PRIORITIES

EVIDENCE BASED DECISION MAKING BY LOCAL/STATE/FEDERAL GOVT
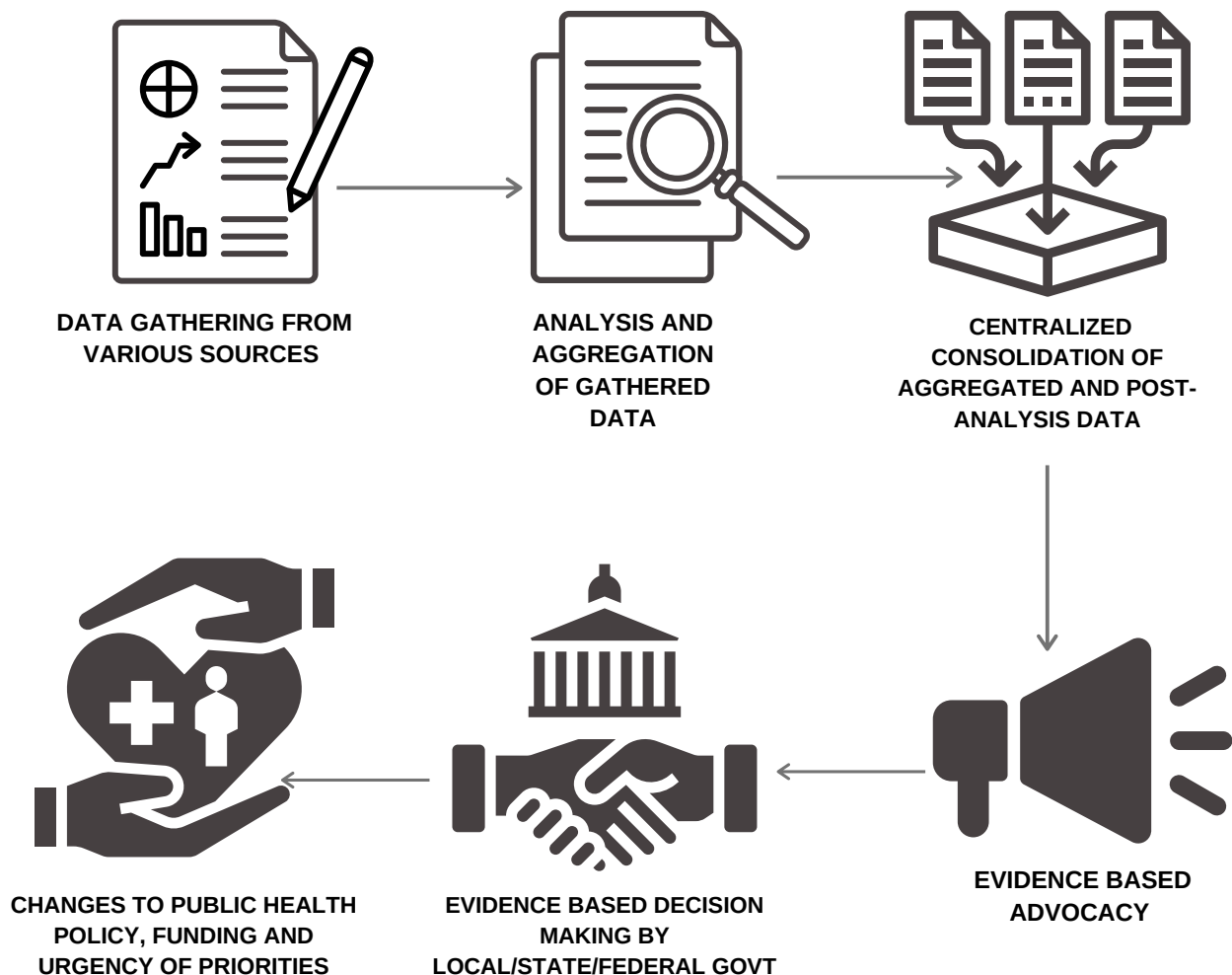
EVIDENCE BASED ADVOCACY

Figure 5 - How an evidence-based approach in public health functions.

WHAT IS A DATA CONSOLIDATION PLATFORM?

A data consolidation platform (DCP) is a medium through which raw public health data can be disaggregated, organized, and visualized for an audience. Through interaction with the DCP, a user can learn about public health by using the data presented.Various DCPs have unique characteristics that serve specific purposes. Figure 6 portrays the advantages and disadvantages of three types of DCPs: spreadsheets, reports, and dashboards.

TYPE OF DATA CONSOLIDATION PLATFORM	ADVANTAGES	DISADVANTAGES
Spreadsheet	• Intuitive • Quick updates/uploads • Interactive data models	• Struggles to engage audience • Lacks context about data • Struggles to work with large data sets
Report	• Provides background info • Presents findings to those with no prior knowledge of subject	• Cannot be updated • Difficult to distribute
Dashboard	• Archives real time data • Enables complex analysis • Displays trends • Intuitive • Wide reach • Provides background info and data	• Can mislead the audience • Complicated development process • Difficult to upkeep

Figure 6 - - Advantages and disadvantages of various Data consolidation platforms (Stehle & Kitchin, 2020; Amozurrutia & Marcuello Servos, 2011; Bendre et al, 2015; Li & Li, 2020; Ilenia Fronza et al., 2013).

It is crucial to understand where to use these types of DCPs: for instance, a spreadsheet might be the quickest way to add, update and organize data. However, it might not provide the background information about the data like a report or a dashboard. It is ideal for an audience with prior knowledge or expertise about the data, but not for those entirely new to the subject and trying to learn from it.

THE NEED FOR A CENTRALIZED PUBLIC HEALTH DASHBOARD IN WORCESTER, MASSACHUSETTS.

The Coalition for a Healthy Greater Worcester faces various obstacles when trying to achieve its goal of promoting evidence-based decision-making or awareness of inequities in public health. Despite having codified a massive strategy to combat the community's health issues, the Coalition wanted to expand and refine its capabilities, specifically in the realm of data consolidation. Without a centralized location for data, a disconnect develops between the community, lawmakers, and the Coalition. In such cases, it is often difficult for the public to find what health information they need and for the Coalition to assess their current initiatives' success. It also makes developing new community health assessments or health improvement plans more cumbersome for the Coalition. There is not just one or even a handful of locations to gather the data necessary, but many. Facing this situation, our team worked with the Coalition to develop a user-friendly online dashboard to consolidate community health information in an engaging format to serve the greater Worcester area.

WHAT MAKES A GOOD DASHBOARD ?

There are three crucial aspects to consider when designing a dashboard: data selection, source verification, and data visualization.

Data-selection - When designing a dashboard, it is important to conceptualize the dashboard's goal fully; then draft relevant and concise questions to be answered to achieve that goal. The developer must select the most pertinent data set to answer the drafted questions, thus achieving the dashboard's overall goal. Well-selected and relevant data is incredibly crucial so that it does not confuse or mislead the users on the information that the dashboard is trying to present to them (Ilenia Fronza et al., 2013).

Source verification - It is also important to correctly identify data sources and verify and inconsistencies or context surrounding the data that one may use in a dashboard. This is especially important when the designer needs to aggregate and compile data from multiple sources. Raw data can reach the designer in various formats with varying levels of context. The designer needs to consider the reliability and validity of the data sources, the amount of context provided with the raw data, and inconsistencies in the sourced data that could mar the data visualization process for the end-user. Inconsistent formats from various sources, for instance, can pose significant obstacles in the form of migrating and aggregating the data or make it difficult to update the dashboard regularly. One example could be that a medical center can utilize older methods of recording data, such as physical records, while some organizations or providers might use newer technologies or conventions for the same purpose. (Bendre et al., 2015; Li & Li, 2020; Ilenia Fronza et al., 2013).

Data visualization - It is important to tailor the end user's data visualization process so that it aids in achieving the dashboard's overall goal. If the dashboard's purpose is to act as a tool to find detailed and specific information, the dashboard must be easy to navigate. It must be easy to find the context surrounding the data/information presented to the user. If the dashboard's primary goal is to bring attention to a particular issue that the user might not know about, it is important to consider the visual appeal and minimize the interaction required to access the information. The dashboard must also take advantage of its users' perception when trying to convey information. For example, the use of universally accepted indicator colors such as red, yellow, and green can utilize the user's perception to draw attention to information of varying levels of importance, drawing them in to interact with the dashboard (Li & Li, 2020; Ilenia Fronza et al., 2013; Ghazisaeidi et al., 2015). The image below shows how a dashboard can use indicator colors to draw attention to specific data, with the color red used to display data of high importance.
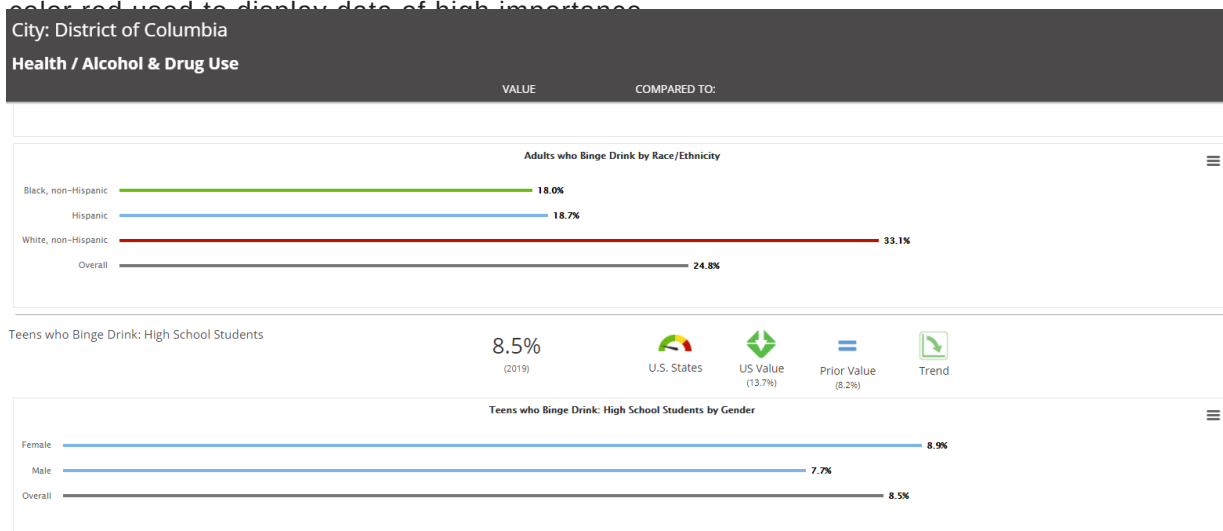

Figure 7 - - An example of what indicators on a public health dashboard look like from the D.C Health Matters pilot program (DC Health Matters, n.d.)

METHODOLOGY

We identified six objectives for our project, which we completed sequentially.

1	**IDENTIFY COALITION GOALS AND CURRENT DATA COLLECTION METHODS**
2	**ESTABLISH TARGET AUDIENCE**
3	**IDENTIFY DASHBOARD DEVELOPMENT TOOL REQUIREMENTS**
4	**SELECT DASHBOARD DEVELOPMENT TOOL**
5	**PROTOTYPE THE DASHBOARD AND MAKE REVISIONS**
6	**DEVELOP RECOMMENDATIONS FOR THE COALITION**

OBJECTIVE 1 : IDENTIFY COALITION GOALS AND CURRENT DATA COLLECTION METHODS USED BY COALITION

To identify Coalition goals and current data collection methods, we interviewed our sponsors. We generated a list of sources for public health data and the Coalition's desired categories for data disaggregation. This helped us clarify details about the size, type of data, the variety of sources, and the estimated timeframes for data updates.

Our team also conducted an in-depth analysis of previous Community Health Assessments, Community Health improvement plans, and the Greater Worcester Area Population framework by the University of Massachusetts Memorial Medical Center. This helped our team understand the region's demographics, prevalent health issues, the Coalition's priorities, and their progress in the last 10-12 years regarding public health.

OBJECTIVE 2 : ESTABLISH TARGET AUDIENCE FOR COALITION DASHBOARD

To establish the target audience for the Coalition's dashboard, we conducted interviews with our sponsors and Tom Quinn, an employee at the Worcester Regional Research Bureau. This gave our team-specific guidelines regarding accessibility, level of literacy, and technical ability that a typical dashboard user might have. It also allowed us to ensure that users do not face obstacles in obtaining the desired information.

Mr.Quinn has extensive experience working with the Worcester Regional Research Bureau. He has been a part of various data consolidation and distribution initiatives to educate the public and provide data for evidence-based decision-making. As a result, in our interview with Mr. Quinn, we asked him his experience on projects that aimed to educate the public using data in the Worcester region and the importance of presenting information and avoiding misinterpretation.

METHODOLOGY

OBJECTIVE 3 : IDENTIFY REQUIREMENTS FOR DASHBOARD DEVELOPMENT TOOL

Before our team moved to select a dashboard development tool, we wanted a robust method of evaluation that took our sponsor's requirements and priorities into account. Our team first conducted a content analysis on Professor Ilenia Fronza, Professor Richard Qi Li, and Prof. Ghazisaeidi's research about performance and managerial dashboards (Ghazisaeidi et al., 2015; Ilenia Fronza et al., 2013; Li & Li, 2020).

We then conducted interviews with our sponsors, Tom Quinn (Research Associate at Worcester Regional Research Bureau), Prof. Lane Harrison (Professor of Computer Science at WPI), Patricia Patria (Vice President for information technology and chief information officer at WPI), Monelle Verdolino (Associate Director of Institutional Research at WPI), and Eric Batista (Director of Urban Innovation at Worcester City). These interviews gave us further insight into dashboard development tool requirements that the Coalition prioritized or required. Lastly, we consulted the Coalition's quality data committee, consisting of members from the Worcester Regional Research Bureau, city government epidemiologists, and members of health organizations such as the University of Massachusetts Memorial Medical Center and Saint Vincent Hospital . We used the quality data committee meeting discussion to gauge their priorities and requirements for an ideal dashboard development tool. Through this process, we generated a robust method of evaluation for potential dashboard development tools that met the criterion supported by research and took our sponsor's priorities into account.

OBJECTIVE 4 : SELECT A DASHBOARD DEVELOPMENT TOOL

Our team used the evaluation methods that we created from the last objective to select a dashboard development tool. By doing so, our team was able to narrow down ten potential tools to three promising options. Our team presented our evaluation of the three tools and sought feedback from the quality data committee and our sponsors. After the presentation, we asked the attendees to fill out a Qualtrics survey on the three tools' various aspects and features . It included open-ended questions about any features they felt were missing or could be improved. We also observed a discussion group conducted by our sponsors afterward where the subcommittee members stated their preferences on the tools we presented.

Using the feedback from verbal discussions, Qualtrics survey, meetings with our sponsor, and our evaluation method, we selected a dashboard development tool that we found most applicable to the Coalition's goals.

OBJECTIVE 5: PROTOTYPE THE COALITION DASHBOARD AND MAKE REVISIONS BASED ON FEEDBACK RECEIVED.

Once our sponsors agreed on the development tool, we conducted discussions with those who had prior experience using it. This included Prof. Harrison (WPI), Eric Kneeland (Worcester Regional Research Bureau), and Tom Quinn (Worcester Regional Research Bureau) (Supplemental material, App D) . Our team received specific guidance on data interpretation, disaggregation, and visualization for the selected tool through these interviews.

Our team then prototyped the dashboard. Once we made progress, we presented our progress tour sponsors, who provided us with feedback on data visualization, desired features, and aesthetic changes. Our team then returned to make changes and incorporate the received input into the prototype. We repeated this process twice.

OBJECTIVE 6: DEVELOP RECOMMENDATIONS ON UPKEEP AND FUTURE ADDITIONS TO THE COALITION DASHBOARD.

For the final objective of this project, our team developed a set of recommendations for the Coalition. The recommendations aimed to ensure that the management of the dashboard remained simple for the Coalition in the future. To do this, we met with the WPI library team, Prof.Lane Harrison (WPI), Eric Kneeland (Director of Program and Operations at the Worcester Regional Research Bureau, and Tom Quinn (Worcester Regional Research Bureau). In our discussions, we presented the prototype that our team created and received input on what our sponsors could add to the dashboard in the future and how they could avoid possible difficulties with data management. In addition to this, our team made additional recommendations on the upkeep of the dashboard itself. We made these using notes we took during development, compiling information from the tool's manuals, and adding visual instructions.

PUBLIC HEALTH IN THE WORCESTER AREA AND COALITION GOALS.

The Coalition would like to bring awareness to public health inequities in the Worcester area and use data on key indicators to promote equity-based public health practices. The Coalition has outlined several key data-sources who they wish to collaborate with for the dashboard project. Furthermore, the Coalition would like data for each health indicator to be disaggregated by race, gender, and age (Supplemental material, App A). According to Mr. Tom Quinn of the Worcester Regional Research Bureau, through clear disaggregation of data on these indicators, our sponsors can bring attention to how certain groups of people are disparately affected by some health issues while others are not (Supp. material, App A,B).

Therefore, data disaggregation is vital to the Coalition's dashboard as it will help them achieve their goal to communicate and bring awareness to public health disparities showing what groups are affected in some indicators more than others. In doing so, the dashboard can prove to become an important tool to support evidence-based decision making for local departments of health. Figure 8 depicts the current or future availability of data for each health indicator and states if the data shared is disaggregated.

PUBLIC HEALTH INDICATORS	AVAILABILITY OF DATA	IS THE DATA DISAGGREGATED?
Hypertension	Yes (Edward M Kennedy Health Centre)	Yes
Asthma	No (Future Source outlined)	No
Opiod Fatalities	No (Future Source outlined)	No
Diabetes	Yes (Edward M Kennedy Health Centre)	Yes
Mental Health	No (Future Source outlined)	No
Immunizations	No (Future Source outlined)	No
Infant Mortality	No (Future Source outlined)	No
Teen Pregnancy	No (Future Source outlined)	No
STI's	No (Future Source outlined)	No
Senior Falls	No (Future Source outlined)	No
Delivery/Birthweight	No (Future Source outlined)	No

Figure 8 - Table for the Coalition's outlined health indicators with data availability and disaggregation.

TARGET AUDIENCE FOR THE DASHBOARD

Our interviews and discussions with the Coalition revealed that they would like this dashboard to be accessible to two types of potential users. According to Casey Burns, the dashboard should allow members of the general public with some or no prior knowledge about health inequities in the Worcester area to educate themselves using the dashboard. Concurrently, they want local departments of health in the greater Worcester to use the dashboard as part of their data-driven decision-making while considering health problems in their community (Supp. material, App. A,B). Hence, the target audience for this dashboard is aimed towards the general public in the Worcester area who wish to learn more about public health, but also for elected officials in the area who can use data to plan and make decisions to improve community well-being. Our team decided to focus on the public primarily. We did this because we believed that while a dashboard primarily geared towards the elected officials and experts might prove too complicated for the public to understand, a simple dashboard that does not compromise on the data itself can be used by anyone – including experts.

DASHBOARD DEVELOPMENT TOOL REQUIREMENTS

Through the interviews with stakeholders, we identified the following requirements for a dashboard development tool. These requirements helped us evaluate the three competitors and select the most viable option for the Coalition.

DASHBOARD DEVELOPMENT TOOL REQUIREMENTS

1.The dashboard development tool must allow developers to upload data.
The tool must allow users to upload their own data that they deem relevant for the dashboard and the Coalition's goals. This was a high priority for the Coalition, according to Casey Burns and Tempe Staples. The right tool should allow them to upload data collected from a variety of sources in any format – either through built-in upload features or manual entry. This requirement aligns with the scientific literature on dashboard development, which emphasizes the importance of the developer's freedom to upload and choose the correct data for their goals (Li & Li, 2020; Ilenia Fronza et al., 2013).

2.The dashboard developed using the tool must appeal to a broad target audience with visual appeal.
55% of the quality data committee discussion group with a public health background prioritized the need for the tool's ability to design and variety of designs and aesthetic options. They wanted the design and visualization tools to enable easy, user-friendly, and interactive navigation to the dashboard's users. We found this to be in agreement with the literature our team analysed in the earlier objectives. Specifically, our team found that with regards to user perception and design choices, it is recommended to use color-palettes and a variety of data visualization techniques to create a visually appealing dashboard. (Ghazisaeidi et al., 2015).

3.   The dashboard development tool must have built-in features applicable to public health. Although only 37.5% of the quality data committee discussion group prioritized the need for the tool to have features specific to public health, the Coalition believes this requirement is a high priority for our dashboard. This would require the tool to provide features that support easy disaggregation, built-in access to public health data, and helpful visualization tools that specifically apply to community health. For instance, the tool could look at multiple databases and recognize data specific to one indicator, grouping it without the user taking any action. It could also then make relevant suggestions based on the type of the health data about how to best visualize this.

4.   The dashboard development tool must be easy to use and operate.
Casey Burns and Temperance Staples wanted an uncomplicated tool that would make it easy for them to manage, consolidate and display data. In addition to this, Prof. Harrison and Patricia Patria emphasized that requiring the Coalition to use development tools without prior experience can lead to confusion and inaccurate data visualization.

5.The dashboard development tool must be affordable for a nonprofit such as the Coalition in the long term.
The development tool must be affordable for the Coalition, even in the long term. Both Casey Burns and Temperance Staples prioritized this requirement due to the Coalition being a nonprofit with limited financial resources.

SELECTING THE DASHBOARD DEVELOPMENT TOOL: BROADSTREET, TABLEAU & SISENSE

Our team analyzed eight potential dashboard development tools in order to identify the best options for the Coalition: Power BI, Tableau, Redcap, Oracle Business Intelligence tool, Sisense, MicroStrategy, Broadstreet, and QlikSense. We found the three most viable options and presented them to the Coalition. These options were Sisense, BroadStreet and Tableau. These options are the best tools for the Coalition because of their ability to allows for easy development of dashboards obtaining the necessary requirements to be effective. To select these three tools, our team performed a generic evaluation using a basic rubric. This rubric was developed using online resources and literature, and contained criterion regarding the various basic aspects of dashboard development tools (Supplemental material, App C,D   ).

We then used the stated preferences from the various interviewees, survey respondents, and our evaluations of the three tools to recommend one tool for the Coalition out of the shortlisted three. Figure 8 displays the dashboard development tool preferences stated by the various interviewees/discussion group members upon presenting the three development tool options. In addition to a presentation, our team also provided the interviewees and discussion group with examples of dashboards developed using each tool. This was done before their preferences were noted.

GROUP/INDIVIDUAL	PREFERENCES	JUSTIFICATION/OTHER REASONS
COALITION DATA SUBQUALITY COMMITTEE	Qualtrics Survey - (7 participants) 71% BroadStreet 14% Tableau, 14% No preference Discussion Consensus - (19 members) 63% BroadStreet, 5% Tableau, 5% unsure, 26% absent	Based on Coalition high priority feature scores BroadStreet already in use by University of Massachusetts Memorial Medical center, potential for collaboration and data sharing
ERIC KNEELAND (Worcester Regional Bureau)	Tableau (Interview)	Prior experience, data integration and developer friendly aspects
TOM QUINN (Worcester Regional Bureau)	Tableau (Interview)	Third party-support and developer friendly - coding languages
PATRICIA PATRIA (WPI)	Tableau (Interview)	Prior experience
PROF. LANE HARRISON (WPI)	Tableau (Interview)	Prior experience, third party-app support and developer friendly coding languages
MONELLE VERDOLINO (WPI)	Tableau (Interview)	Prior experience, consider Tableau as the "gold standard for academic institutions"

Figure 9 - Table for the Coalition's outlined health indicators with data availability and disaggregation

The findings outlined in the table above highlight the contrast in preferences between those affiliated with the Coalition and interviewees who are experts in computer science and data management. This is a direct result of the fact that both groups prioritize development tool features very differently. The interviewees all had experience using or researching Tableau and were unaware of what Broadstreet was when we asked them. The Coalition quality data committee members were bought the idea of a dashboard from the UMass COVID dashboard which was made on Broadstreet, which is why we believe they selected the program they did.

SELECTING THE DASHBOARD DEVELOPMENT TOOL: BROADSTREET, TABLEAU & SISENSE

Our team initially suggested that the tool that best fits the Coalition's priorities would be BroadStreet, based on our initial score of the tools, but otherwise recommended Tableau as the tool with the most flexibility and the healthiest balance for available features and pricing. Figure 9 shows how we scored the three tools using the criterion specified in the previous objective. It is important to note that the first feature, the capability to upload data, was not factored accurately into our team's initial score because we assumed that every dashboard tool had this capability. Based on this initial score, our sponsors suggested our team create an account for BroadStreet and explore it further to confirm our analysis. Furthermore, UMass Memorial uses BroadStreet, which would potentially make collaboration for future data sharing initiatives seamless for the Coalition since it is a major healthcare provider in the area.

FEATURE/ASPECT	PRIORITY	SISENSE (scored from 0 – 5)	TABLEAU (scored from 0 – 5)	BROADSTREET (scored from 0 – 5)
CAPABILITY TO UPLOAD DATA**	CRITICAL	5	5	0
EASE OF USE	HIGH	4	4	3
PRICE	HIGH	1	1	4
PUBLIC HEALTH	HIGH	0	2	4
VISUAL APPEAL	LOW	4	3	3
INITIAL SCORE		9	10	14
FINAL SCORE		14	15	14

** not factored into initial score

COLOR	CORRESPONDING SCORE
(green)	4 – 5
(yellow)	3
(red)	0 - 2

Figure 10- - A comparative analysis of the three dashboard development tools for each criteria.

However, we soon found a glaring shortcoming that would hinder the Coalition's goals for the dashboard after we paid and created an account for BroadStreet. Contrary to the simple assumption, BroadStreet does not allow developers to upload their own data. BroadStreet only allows developers to use data already in their "data dictionary," which is scarce for the Worcester area in particular. This could be due to a lack of in-depth data collection initiatives in the area, or that the data was no fully added to BroadStreet's dictionary yet. Out of the nine health indicators the Coalition wanted to display, BroadStreet only offered data for three of them. This would severely restrict the Coalition's goals since they would not be able to use or upload any data from their local partners and sources. This led us to re-evaluate our initial score and factor in the capability to upload data for the process, leading to the final scores in figure 9.

Upon presenting this major shortcoming in discussions with our sponsor, they decided that it would be best to use Tableau as their preferred tool to develop their prototype dashboard. As per our analysis and first-hand usage, Tableau allows developers to upload any data format and thus provides complete flexibility over data visualization choices. We then proceeded to start dashboard development using Tableau.

CHALLENGES IN DASHBOARD DEVELOPMENT

The lack of access to public health data was the first challenge that we encountered. Local health centers and hospitals may be hesitant to share public health data due to privacy concerns. This is especially relevant when our sponsors want data on deaths in the Worcester region, as death records are identifiable and violate privacy guidelines. Health providers might also be hesitant to share data since they might have only recorded data in a physical form, which can be difficult to retrieve, organize, disaggregate, and share. Additionally, the owners of private health providers might not agree to share data because of a fear that it might lead to a negative image of their business. To surpass this challenge the Coalition identified community-focused health centers to be the most likely to share data in the future. Additionally, we developed a dashboard with place holders for specific indicators that can be replaced with actual data once it is received.

Another challenge within dashboard development that we discovered was the inconsistent formatting and definitions between different sources. Our sponsors identified various sources that range from community health centers, nonprofits, government organizations, and private healthcare providers for their dashboard. These sources lack a uniform format needed for data records. Specifically, we found that different sources have varying definitions and specifications for indicators during their data collection. For instance, one healthcare provider might collect data for Hypertension, but will exclude data if other underlying problems are part of the diagnosis, while others might include it in their data. Sources for data can be electronic or physical and can range from patient records, death records, incident reports, surveys, or medical questionnaires. Some sources might change how they choose to record data soon, too, creating further inconsistencies. This complicates the disaggregation and compilation process of data for health indicators.

PROJECT DELIVERABLES: DASHBOARD PROTOTYPE AND FUTURE GUIDANCE

Using Tableau, our team successfully created a dashboard prototype for the Coalition. This dashboard uses the data collected by the Coalition. The prototype displays data on the total number of patients in Worcester, collected by the Edward M Kennedy Health Centre. Users can adjust the dashboard to show data on the number of patients by two of the Coalition's indicators: Hypertension and Diabetes. Users can also apply additional filters to obtain information on the number of patients aggregated by race/ethnicity and gender for each health indicator. In addition to this, we also created a dashboard "shell." This shell sets the Coalition up for the future so that they can easily upload their data manually for any indicator into Tableau and have the tool perform the rest of the visualization for them. We also set up disaggregation filters so that any data uploaded undergoes automatic organization so that data about a particular health indicator can be compiled easily from various sources without requiring any input from the Coalition. To ensure that these features would work appropriately, we tested them using mock data values. Figure 10 shows a screenshot of the prototype, displaying patient count in Worcester by race/ethnicity in 2019.

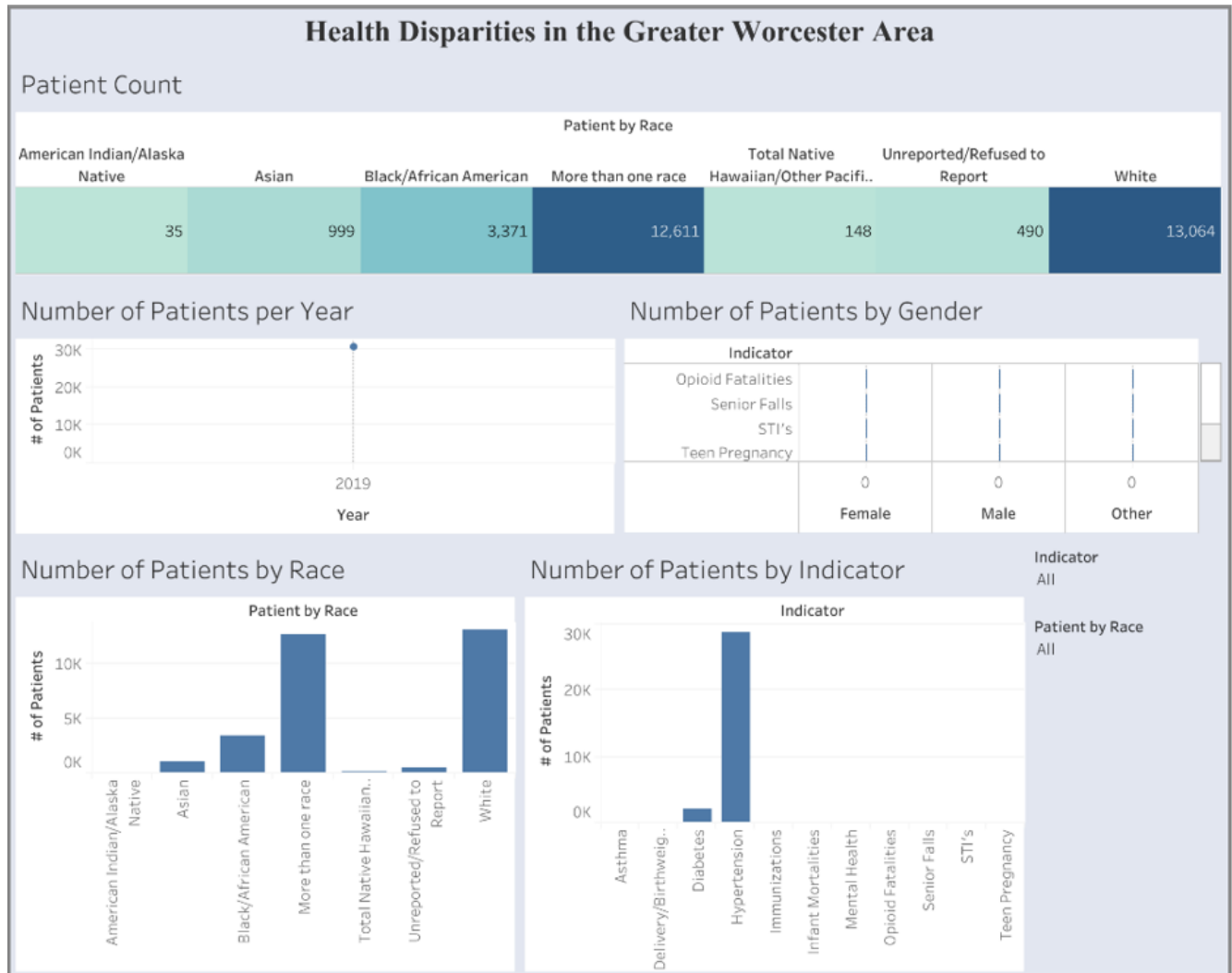## PROJECT DELIVERABLES: DASHBOARD PROTOTYPE AND FUTURE GUIDANCE

Figure 11 - The Coalition's dashboard prototype displaying patient count in the Greater Worcester area by race.

In addition to this, our team also compiled a list of resources for the Coalition for the future upkeep of the dashboard. This includes online resources, guides, and video tutorials about the various aspects of using Tableau, such as uploading data, data organization, adding features to the dashboard, and routine tasks. We also provide guidance in our Supplemental Materials ((Supplemental material, App E) that applies to specific aspects of their dashboard. The current setup of the dashboard is explained in this document so that it may serve as a starting point for anyone assigned to the development of the dashboard in the future.

RECOMMENDATIONS

On the basis of our dashboard development tool analysis, we recommend the Coalition continue to use Tableau. Tableau is a dashboard development tool that requires a minimal amount of technical knowledge. Its drag-and-drop features allow for the user to develop a dashboard as complex or simple as necessary to fit the requirements at hand. Additionally, Tableau's advanced capabilities make the development of interactive dashboards a much easier process than some of its competitors. Furthermore, the tool was the most preferred by the five professionals with experience in data visualization (Supplemental material, App D), making it a reputable development tool for the Coalition. It was also entirely free for the Coalition to use Tableau since the Worcester City government was able to provide a non-profit license for the dashboard project.

To meet the requirements in developing a sustainable dashboard for our sponsor, **we recommend connecting with local organizations to create a streamlined method of data collection.** By forming connections with the local health organizations collecting data in the Greater Worcester area, the Coalition would have access to a continuous data source. This would help alleviate the issue of obtaining public health data specific to the Worcester area. Furthermore, it would result in a more significant amount of data for the Coalition to use, producing more accurate information on the observed indicators. In turn, this would allow for greater transparency with the general public and policymakers in the Greater Worcester area.

To mitigate any potential issues that might occur during the maintenance and updates for the dashboard, **we recommend that the Coalition develop a uniform format for all of the collected data.** When working with data from multiple sources, it is common for problems to occur while preparing the data for analysis. When the data is not formatted identically throughout, there will be a significant amount of time wasted on reformatting data each time a new dataset is received. This also poses a much higher risk for human error, which could ultimately affect the process of importing new a dataset. A lack of a uniform format is likely to result in misinterpretation or inaccurate visualization of the data. It could also cause an internal problem within the dashboard that may not be immediately apparent at a surface level. A clean and concise format would mitigate the risk for all of these issues and reduce wasted time when maintaining and updating the dashboard. Our team could not develop a specific format that we could recommend to the Coalition. This was because we were unable to accurately confirm the various data types and formats potential sources might use in the future.

Maintaining and further developing collected data and dashboards require much time, so **we recommend creating a small team that is knowledgeable about dashboard development to focus on the needs of the dashboard.** For the dashboard to be sustainable and accurate in the long term for the Coalition's use on their website, it will need to be monitored and maintained very often. Since a dashboard is a technological way of displaying data, it is almost certain that technical issues or malfunctions beyond the surface level will occur. Based on our interviews with professionals in data visualization and dashboard design, we learned that when a dashboard is not adequately maintained, it poses a high risk of encountering technical issues. An alternative to creating a small team would be to have a current Coalition employee receive training for dashboard development through available programs that vary in length and can be priced between $200-$800. This would mitigate the risk of funding a new salary and enable current employees to dedicate their time towards the dashboard more efficiently. In either case, the dashboard would need at least one employee to maintain the influx of data to keep the dashboard working properly each time new data is shared. Our team predicts that when there is an influx of data in the future, the Coalition employee/team would most likely need to dedicate between two to three weeks to fully update and maintain the dashboard.

CONCLUSION

PAGE 114

CONCLUSION

 Similar to many communities, the Greater Worcester area has struggled with communicating their public health statistics and disparities to the general public in an effective and visual format. The development of the Coalition's dashboard will counteract this and create an environment of transparency around community public health, allowing local citizens to see the common disparities within their locale. Additionally, it displays the needed information for policy makers to make educated decisions regarding public health policies. Over the course of this project, we identified the required characteristics and features of dashboards and dashboard development tools to fit the needs of the Coalition. Once the dashboard shell is filled with data and fully implemented it will greatly increase the clarity of the current state of community health in the Greater Worcester area. Furthermore, we hope that our project will provide relief to local health organizations, allow the Coalition to monitor their goals, and provide a baseline for effectively displaying public health information to the general public and necessary stakeholders.

REFERENCES

Alvidrez, J., Castille, D., Laude-Sharp, M., Rosario, A., & Tabor, D. (2019). The National Institute on Minority Health and Health Disparities Research Framework. American Journal of Public Health, 109(S1), S16–S20. https://doi.org/10.2105/AJPH.2018.304883

American Public Health Association. (2018, November 13). Achieving Health Equity in the United States. https://www.apha.org/policies-and-advocacy/public-health-policy-statements/policy-database/2019/01/29/achieving-health-equity.

Amozurrutia, J. A., & Marcuello Servós, C. (2011). Excel spreadsheet as a tool for social narrative analysis. Quality and Quantity, 45(4), 953–967. https://doi.org/10.1007/s11135-010-9406-9

APM Research Lab, & Kassira Absar. (2018, July 2). The United States will soon be bigger, older, and more diverse . https://www.apmresearchlab.org/blog/the-united-states-will-soon-be-bigger-older-and-more-diverse

Asian American - The Office of Minority Health. (n.d.). Retrieved March 5, 2021, from https://minorityhealth.hhs.gov/omh/browse.aspx?lvl=3&lvlid=63

Balcewicz, J., Creedon, V., Noujaim, M., Smith, M., Spring, M., & Okwara, C. (n.d.). Population Health Framework Population Health DPH .

Bay Area Equity Atlas. (2021). https://bayareaequityatlas.org/about

Bendre, M., Sun, B., Zhang, D., Zhou, X., Chang, K. C. C., & Parameswaran, A. (2015). DATASPREAD: Unifying databases and spreadsheets. In Proceedings of the VLDB Endowment (Vol. 8, Issue 12, pp. 2000–2003). Association for Computing Machinery. https://doi.org/10.14778/2824032.2824121

Brath, R., & Michael, P. (2004). Dashboard Design: Why Design is Important. http://cs.furman.edu/~pbatchelor/csc105/articles/TUN_DM_ONLINE.pdf

Caprara, C. (2020, August 11). COVID-19 Health Disparities Reporting - Center for Health Equity Research and Promotion. https://www.cherp.research.va.gov/features/COVID_19_Health_Disparities_Reporting.asp

Cancer and American Indians/Alaska Natives - The Office of Minority Health. (n.d.). Retrieved March 5, 2021, from https://minorityhealth.hhs.gov/omh/browse.aspx?lvl=4&lvlid=31

CDC Foundation. (2021). What is Public Health? https://www.cdcfoundation.org/what-public-health

Central MA Regional Public Health Alliance. (2016). 2016 CHIP. www.healthycentralma.com

Central MA Regional Public Health Alliance. (2018). Greater Worcester Community Health Assessment 2018 CHA.

Coalition for a Healthy Greater Worcester. (n.d.). Retrieved March 6, 2021, from https://www.healthygreaterworcester.org/
Coalition for a Healthy Greater Worcester. (2016). What We Do | chgw.

Davis, K. (1991). Inequality and Access to Health Care. The Milbank Quarterly, 69(2), 253. https://doi.org/10.2307/3350204
DC Health Matters. (n.d.). Retrieved March 5, 2021, from https://www.dchealthmatters.org/

Dickman, S. L., Himmelstein, D. U., & Woolhandler, S. (2017). Inequality and the health-care system in the USA. In The Lancet (Vol. 389, Issue 10077, pp. 1431–1441). Lancet Publishing Group. https://doi.org/10.1016/S0140-6736(17)30398-7

Dixon, B. E., Grannis, S. J., McAndrews, C., Broyles, A. A., Mikels-Carrasco, W., Wiensch, A., Williams, J. L., Tachinardi, U., & Embi, P. J. (2021). Leveraging data visualization and a statewide health information exchange to support COVID-19 surveillance and response: Application of public health informatics. Journal of the American Medical Informatics Association, 2021(0), 1–11. https://doi.org/10.1093/jamia/ocab004

Fact Sheet: Health Disparities by Race and Ethnicity. (n.d.). Retrieved March 5, 2021, from https://www.americanprogress.org/issues/healthcare/news/2010/12/16/8762/fact-sheet-health-disparities-by-race-and-ethnicity/

Frey, W. H., & Brookings Institution. (2020, July 1). The nation is diversifying even faster than predicted, according to new census data. https://www.brookings.edu/research/new-census-data-shows-the-nation-is-diversifying-even-faster-than-predicted/

Ghazisaeidi, M., Safdari, R., Torabi, M., Mirzaee, M., Farzi, J., & Goodini, A. (2015). Development of performance dashboards in healthcare sector: Key practical issues. Acta Informatica Medica, 23(5), 317–321. https://doi.org/10.5455/aim.2015.23.317-321

Grossman, T. A., Özlük, Ö., & Gustavson, J. (2009). The Lookup Technique to Replace Nested-IF Formulas in Spreadsheet Programming.

Hedberg, K., & Maher, J. (n.d.). Epidemic Intelligence Service - Collecting Data . Retrieved March 14, 2021, from https://www.cdc.gov/eis/field-epi-manual/chapters/collecting-data.html

HIV/AIDS and Hispanic Americans - The Office of Minority Health. (n.d.). Retrieved March 5, 2021, from https://minorityhealth.hhs.gov/omh/browse.aspx?lvl=4&lvlid=66

Hogg, R. A., & Varda, D. (2016). Insights Into Collaborative Networks Of Nonprofit, Private, And Public Organizations That Address Complex Health Issues. Health Affairs, 35(11), 2014–2019. https://doi.org/10.1377/hlthaff.2016.0725

REFERENCES

Ilenia Fronza, by, Paul Clermont, by, Robert Charette, by N., Andrea Janes, by, Sillitti, A., Succi, G., David Parmenter, by, Ravi Tej Kanteti, by, & Lawrence Fitzpatrick, by. (2013). Making Managerial Dashboards Meaningful . In The Journal of Information Technology Management Cutter IT Journal (Vol. 26, Issue 1). www.cutter.com

Institute of Medicine. (2012). Federal Perspectives on Reducing Health Disparities. https://www.ncbi.nlm.nih.gov/books/NBK114229/

Institute of Medicine (US). (1988). Summary of the Public Health System in the United States. https://www.ncbi.nlm.nih.gov/books/NBK218212/

Li, Q., & Li, Q. (2020). Overview of Data Visualization. In Embodying Data (pp. 17–47). Springer Singapore. https://doi.org/10.1007/978-981-15-5069-0_2

Lowell, M. E., Salmon, K., Health, F., Clark, K., Reckert, K., Esparza, K., Cianciola, A., Johnson-Smith, N., Haley, H.-L., Cashman, S., Remillard, M., Koeman, J., Castro, L. S., Goins, K. V., Worcester, W., Burns, C., Yost, J., Seward, R., Frisard, C., … Dyer, Z. (2015). UMass Memorial Community Benefits Impace Measures. www.healthycentralma.com

Office of Research Integrity. (n.d.). Data Collection. Retrieved March 14, 2021, from https://ori.hhs.gov/education/products/n_illinois_u/datamanagement/dctopic.html

Planned Parenthood supports bill that targets DC's high maternal mortality rate | WDVM25 & DCW50 | Washington, DC. (n.d.). Retrieved March 31, 2021, from https://www.localdvm.com/news/washington-dc/planned-parenthood-supports-bill-that-targets-dcs-high-maternal-mortality-rate/

Ryan, G. W., Bloom, E. W., Lowsky, D. J., Linthicum, M. T., Juday, T., Rosenblatt, L., Kulkarni, S., Goldman, D. P., & Sayles, J. N. (2014). Data-Driven Decision-Making Tools To Improve Public Resource Allocation For Care And Prevention Of HIV/AIDS. Health Affairs, 33(3), 410–417. https://doi.org/10.1377/hlthaff.2013.1155

Racial Disparities Among COVID-19 Patients. (n.d.). Retrieved March 10, 2021, from https://spectrumnews1.com/ma/worcester/news/2020/04/26/covid-19-race-worcester

Raphael, D. (2000). Health inequities in the united states: Prospects and solutions. Journal of Public Health Policy, 21(4), 394–427. https://doi.org/10.2307/3343281

Social Determinants of Health - Let's Get Healthy California. (n.d.). Retrieved March 13, 2021, from https://letsgethealthy.ca.gov/sdoh/

Stehle, S., & Kitchin, R. (2020). Real-time and archival data visualisation techniques in city dashboards. International Journal of Geographical Information Science, 34(2), 344–366. https://doi.org/10.1080/13658816.2019.1594823

Whitehead, M., & Dahlgren, G. (2007). Concepts and principles for tackling social inequities in health: Levelling up Part 1. www.euro.who.int

William K. Sieber, T. Green, & G.D Williamson. (2006). Statistics and Public Health at CDC. https://www.cdc.gov/mmwr/preview/mmwrhtml/su5502a9.htm#fig1

World Health Organization. (2021). Social determinants of health. https://www.who.int/health-topics/social-determinants-of-health#tab=tab_1

Vujcich, D. (2017). Editorial: Evidence-Based Public Health: Why, What and How. Frontiers in Public Health, 5, 22. https://doi.org/10.3389/fpubh.2017.00253

Year In Review: Democratizing Data for Equitable Recovery | Bay Area Equity Atlas. (n.d.). Retrieved March 31, 2021, from https://bayareaequityatlas.org/node/62096