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Introduction

In our previous round, we established that **location is a critical pain point** affecting health outcomes in low-access communities. Our expanded research utilizing data from the **Centers for Disease Control and Prevention (CDC)** has illuminated the multifaceted nature of **Social Determinants of Health (SDoH)** that contribute to these disparities. To visualize this, we have created a **radar graph** on the left that highlights the main criteria of SDoH.

Additionally, our findings indicate that **cost barriers** play a crucial role in limiting healthcare access, leading to delayed treatment and worsened health conditions.

According to the **Kaiser Family Foundation (KFF)**, disparities in healthcare access vary across U.S. states. **Southern states**, such as **Mississippi** and **New Mexico**, experience high uninsured rates and fewer healthcare providers, particularly in rural areas. In contrast, **high-access states** like **Massachusetts** and **Minnesota** benefit from comprehensive insurance coverage and strong healthcare infrastructure.

For our analysis, we have identified **Mississippi** and **New Mexico** as the **most low-access areas**, and **Minnesota** and **Massachusetts** as the **most high-access areas**. This selection ensures a balanced and unbiased study of SDoH and supports the **scalability of our Health Pods** through an algorithm that identifies low-access **ZIP codes**.

To further understand the specific pain points and challenges faced by individuals in these contexts, we have built **user personas** representing four people from these states. The next slide will introduce these personas and delve into their unique experiences related to healthcare access.

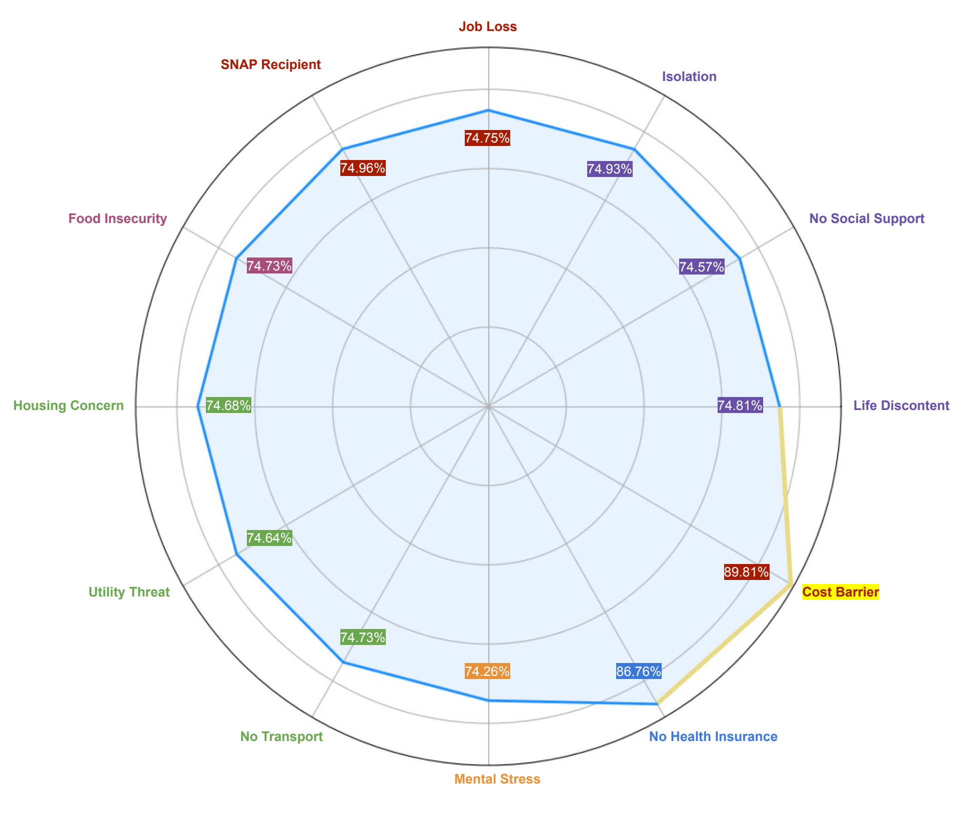

Figure 1: Radar Graph of Average Percentage Impact of SDoH Factors

User Personas

Person 1 - Low-Access State

Demographics: **Anaika**, **42**, lives in **rural Mississippi**. She's a **single mother of two**, working as a **part-time retail employee**.

Income: She earns **$28,000 per year** and is **uninsured**.

Pain Points:

- **Long travel distances** to access quality medical care.
- **High consultation fees**, especially without insurance coverage.
- **Limited access** to mental health services and preventive care.
- **Few community health resources** or educational programs available.

Person 2 - High-Access State

Demographics: **Soham**, **38**, is a **public school teacher** living in **Minneapolis**, **Minnesota**. He has **two young children**.

Income: He makes **$58,000 per year**, with **comprehensive state-provided insurance** for his family.

Pain Points:

- **High co-pays** for specialist visits, even with insurance.
- **Scheduling difficulties** for last-minute appointments due to demand.
- **Limited access** to holistic health services.
- **Overwhelmed** by numerous healthcare options, unsure of the best providers.

Person 3 - Low-Access State

Demographics: **Owais**, **55**, is a **farmer** in **rural New Mexico**, married with **grown children**.

Income: He and his wife have a **combined income of $34,000**. They have **minimal insurance coverage**, making specialized care expensive.

Pain Points:

- **Limited transportation options** to reach hospitals.
- **High cost of healthcare consultations** for chronic issues like diabetes.
- **Lack of community programs** addressing nutrition and wellness.
- **Difficulty in accessing timely health information**.

Person 4 - High-Access State

Demographics: **Akanksha**, **29**, is a **graphic designer** living in **Boston**, **Massachusetts**.

Income: She earns **$72,000 per year** and has **employer-sponsored health insurance**, covering most consultations.

Pain Points:

- **Even with good insurance**, some fees remain expensive.
- **Navigating complex insurance policies** to maximize coverage.
- **Frustration with long wait times** for non-urgent appointments.
- **Need for transparency** in pricing and quality of services offered.

Pain Point #1 - Cost Barrier

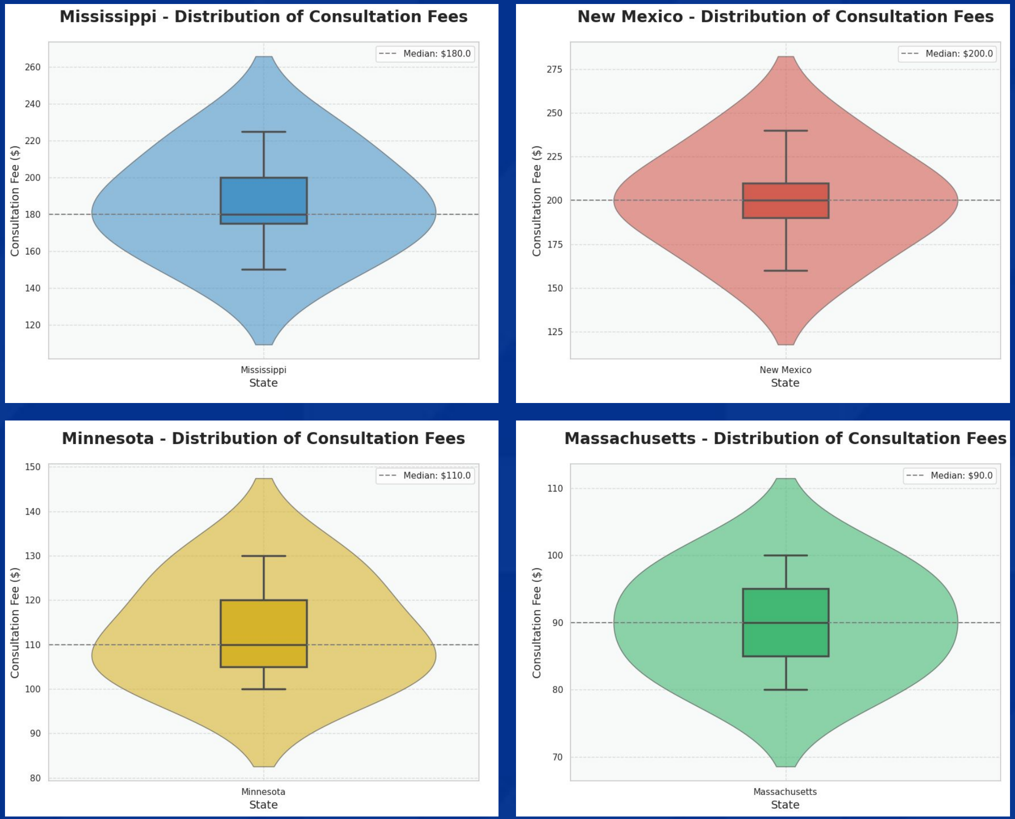

Figure 2: Box Plot and Violin Plot of the Distribution of Consultation Fees Across the Four States

Research indicates that a **significant portion of Americans finds medical care expensive**. According to a survey by the **Kaiser Family Foundation (KFF)**, **nearly 4 in 10 adults** report that they or a family member delayed or went without medical care due to costs. Specifically, **one-third of Americans** struggle to pay their medical bills, with approximately **25%** of those facing difficulties reporting that they have been contacted by a collections agency for unpaid medical debt.

Obamacare, officially known as the **Affordable Care Act (ACA)**, was enacted to address some of these cost barriers by **expanding Medicaid** and **providing subsidies for health insurance premiums**. Despite these efforts, many individuals still face **high consultation fees** and out-of-pocket expenses. According to recent data, the **average consultation fee for specialists** can exceed **$200**, and costs can vary widely by state. For instance, patients in **Mississippi** may pay **25% more** for similar services compared to those in **Massachusetts**.

Additionally, **Medicaid plays a critical role** in **providing coverage to low-income individuals**, yet **many states have not expanded the program**, leaving **countless residents without affordable healthcare options**. In states that **have expanded Medicaid**, more residents are **eligible for coverage**, **reducing their out-of-pocket costs** and **improving access to essential care**. However, in states that **opted out of expansion**, **low-income individuals face higher financial barriers**, often leading to **delayed or skipped medical appointments** due to **cost concerns**.

To illustrate these **state-by-state disparities**, we used data from the **Kaiser Family Foundation (KFF)** to create **box plots and violin plots** that reveal **consultation fee variations** across **Mississippi**, **New Mexico**, **Massachusetts**, and **Minnesota**. These **visualizations highlight the financial challenges** faced by residents in **low-access areas** and demonstrate that, even in **high-access areas**, costs remains **huge**.

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Pain Point #2 - Location

In our **expanded study on geographic distance** in both **low- and high-access areas** identifies **location** as a **significant barrier** to healthcare access. Using data from the **Kaiser Family Foundation (KFF)**, the **bar graph** on the right illustrates **travel distance disparities** across these states, highlighting **rural regions with longer average travel distances** and **urban areas with generally shorter ranges**.

- Mississippi: Moderate travel distances highlight the need for closer healthcare options.
- Minnesota: Moderate distances persist, especially impacting residents without reliable transportation.
- New Mexico: Rural communities often face hours-long travel, emphasizing the challenges of healthcare access in these areas.
- Massachusetts: Generally shorter travel distances indicate better accessibility, though certain low-access zones still face significant travel demands.

Research from the American Hospital Association shows that **proximity to healthcare within 10 miles** significantly **improves preventive and emergency care use**, reducing **untreated health issues by 30%**. According to the **Commonwealth Fund**, **25% of uninsured or underinsured Americans** delay care due to **travel distance**, while **insured Americans** often face **in-network limitations**. For instance, **only 40% of rural hospitals accept Medicaid**, frequently requiring **residents to travel farther** for covered services.

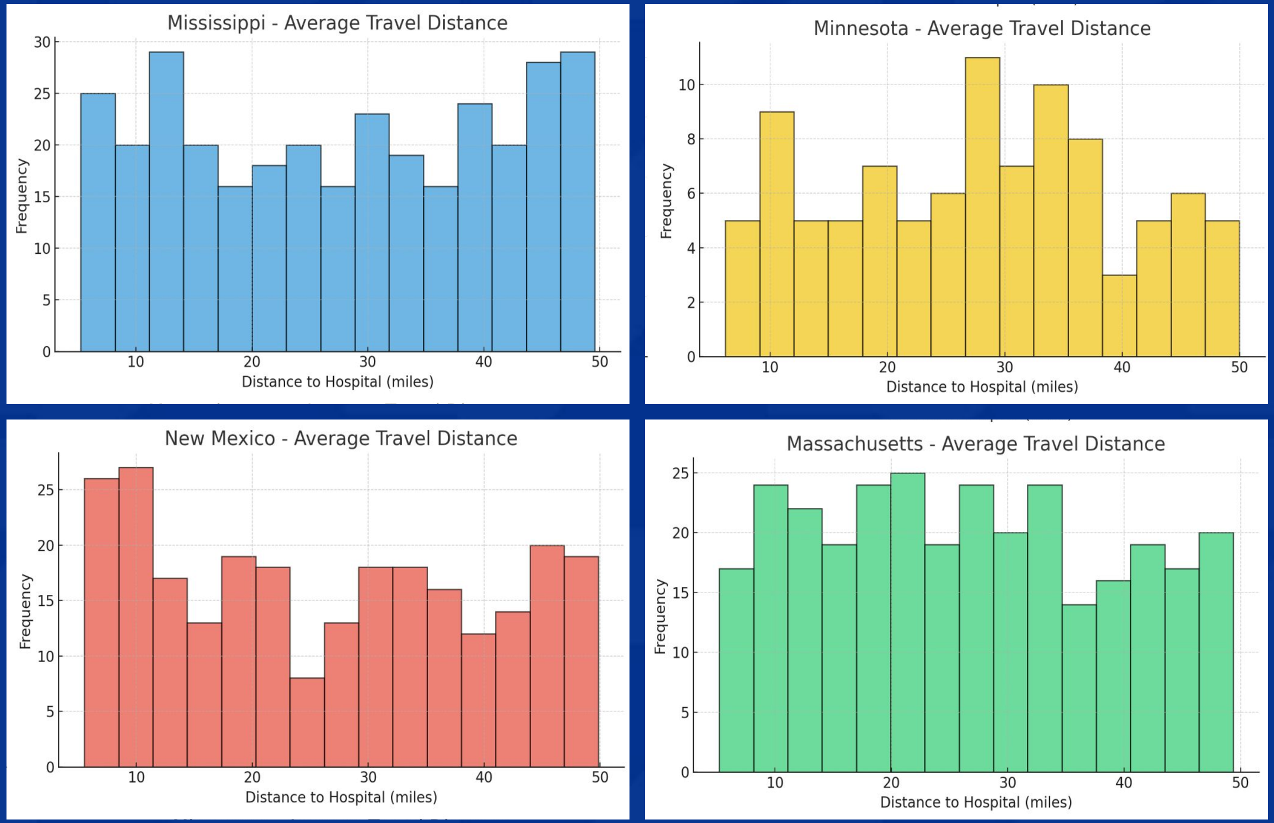

Figure 3: Bar Graph of the Average Travel Distance to the Hospital Across the Four States

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Source code for our algorithm can be accessed here

Identifying the Low-Access Areas

To enhance the **scalability** of our **Health Pods** and ensure their successful deployment in **low-access areas**, **a data-driven approach** is paramount. Identifying **ZIP codes** in regions with limited healthcare access allows us to strategically position our pods, maximizing their potential impact on community health, thereby enhancing **healthcare accessibility** and promoting **equity**.

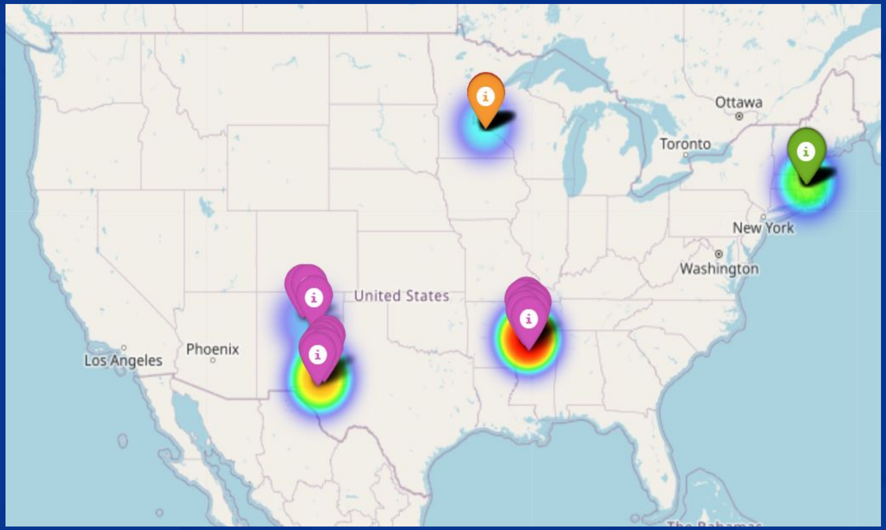

Figure 4: Heat Map Layer of the Low-Access Areas in the Four States

Our **algorithm** is a structured approach for **identifying low-access ZIP codes** and visualizing them effectively. It begins by loading sample data from four states—**Mississippi**, **New Mexico**, **Massachusetts**, and **Minnesota**—where each ZIP code entry includes its **average distance to the nearest hospital**, state, latitude, and longitude. This data is then filtered to ensure we're targeting areas known for **low healthcare access**, allowing us to focus our resource allocation in the most **underserved communities**.

A **heat map layer** is created using the filtered data, which visually highlights low-access areas based on hospital distance. Areas with greater distances appear "**hotter**," making them easy to spot as potential sites for Health Pod deployment. This heat map is also **scalable**; as the dataset grows, new points will adapt dynamically, making it suitable for larger-scale analysis across broader regions.

To improve this identification approach and increase scalability, we can leverage advanced **machine learning techniques**, particularly **K-means clustering** and **regression analysis**. K-means clustering would enable us to group ZIP codes with similar access limitations—based on average distance to healthcare facilities, income, and other demographic factors—prioritizing these clusters for intervention. Regression analysis could also help predict ZIP codes at risk of low access by correlating additional **social determinants**, like **household income** and **car ownership**, to access distances. Incorporating these elements enables a **robust identification method** that learns from existing data trends to address emerging low-access areas.

To further enhance the **accuracy** and **scope**, integrating additional datasets from source like the **U.S. Census Bureau** can bring deeper insights. For example, data on **income levels**, **population density**, and **vehicle availability** can improve our ability to identify underserved areas. This **multidimensional approach** helps us pinpoint **healthcare gaps** across urban and rural areas and assess where Health Pods can make the **greatest impact**.

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Our Solution - Health Pods

Based on our **research** and **user personas**, we've crafted a strategy for implementing our **Health Pods** that directly addresses critical **pain points** in **underserved communities**. We identified two main challenges: **cost barrier** and **location**. These insights have shaped our Health Pods to effectively meet these needs.

Our Health Pods will be **simple**, **modular 3D-printed units**, equipped with a **tablet** and **specialized software for AI-driven health diagnostics**, allowing for **one-click telemedicine consultations**. **Basic health check-up equipment** will keep costs low while improving **scalability** across wider low-access areas. These Pods will be strategically placed indoors in **high-traffic public areas**, such as **local libraries**, **pharmacies**, or **strip malls**, ensuring easy access for residents. By leveraging innovative **3D printing technology**, we can produce these units more efficiently and at a lower cost, enhancing our ability to deploy them rapidly in **underserved regions**.

To enhance our **funding approach**, we will emphasize the potential impact of these Pods on **community health**. By integrating AI-driven insights, the Pods will provide **personalized health assessments** based on critical metrics like **BMI** and **blood pressure**. This capability aids in **early detection of health issues** and aligns with funding priorities that support **preventive care initiatives**. Incorporating **telemedicine features** will facilitate timely consultations for users in low-access areas, creating a **robust healthcare model** adaptable to community needs.

To secure funding, we plan to engage with **public and private organizations** that prioritize **health equity** and **wellness**. Our data-driven approach will highlight the Pods' potential to reduce **emergency room visits by 25%** and improve overall **health outcomes**. By addressing the pressing healthcare challenges identified in our research, we aim to build a strong case for **investment**, ensuring the scalability and sustainability of our Health Pods in the most **underserved areas**.

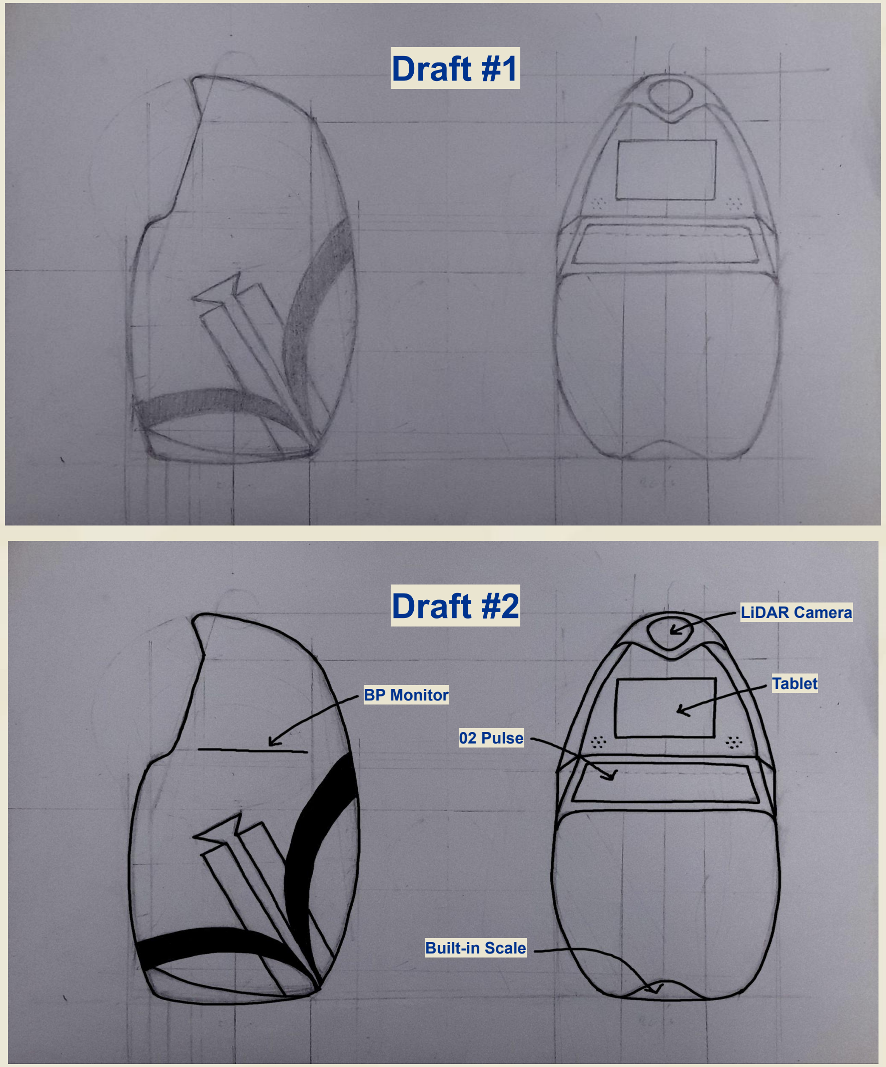

Figure 5: Prototype of our Health Pods

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Full UI Interface for our Software can be accessed here

Our Features

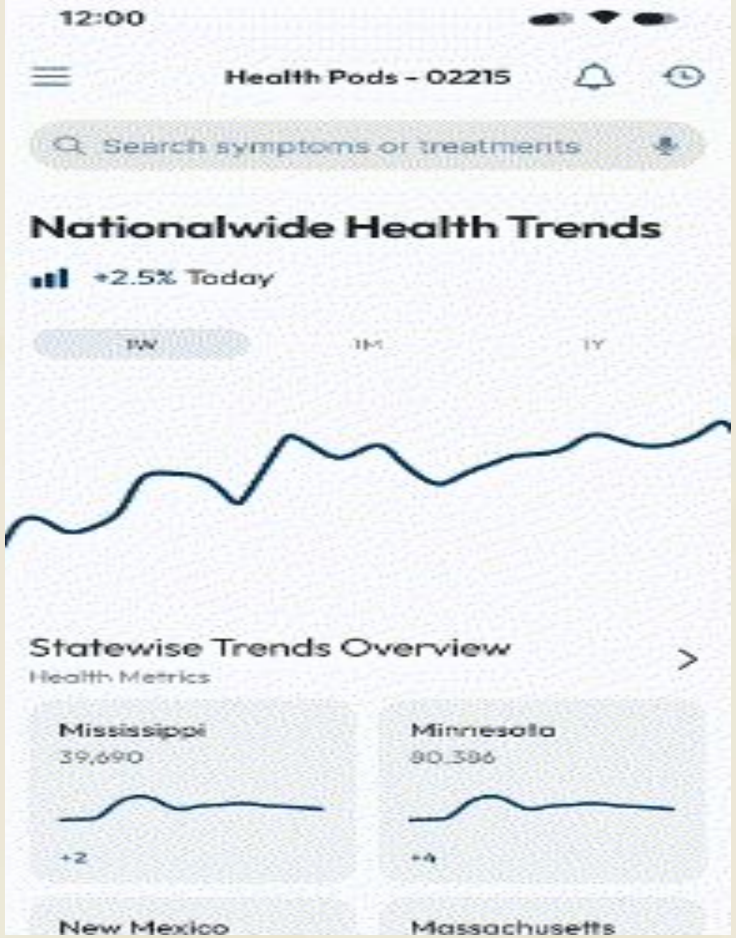

Figure 6: UI Interface of our Software

Our **Health Pods prioritize accessibility** and **community integration**, designed with features that simplify healthcare for **underserved areas**. Each Pod prominently displays its own **ZIP code** at the top, instantly confirming proximity (e.g., "Health Pods – 02215") and enhancing **personalization**. The **intuitive search function** helps users look up symptoms or treatments, providing easy access to **health information** on demand.

Each Health Pod also incorporates **AI-Driven Health Insights**, ensuring that visitors receive **personalized assessments** based on metrics like **BMI**, **blood pressure**, and **glucose levels**. This feature allows for **early warnings** about potential health issues, reducing the need for **emergency interventions** by an estimated **25%**. Additionally, **Telemedicine Integration** facilitates virtual consultations, which are crucial for individuals unable to travel. Approximately **40% of residents** in low-access areas rely on telemedicine as an essential link to healthcare professionals, enabling verified early diagnosis and personalized medication recommendations.

To keep users informed, each Pod displays both **national and state-level health trends**, including insights for specific states like **Mississippi**, **Minnesota**, **New Mexico**, and **Massachusetts**. With **graphs** available in **weekly**, **monthly**, and **yearly views**, users can track shifts in health metrics over time, gaining insights into both local and broader health trends. This **interactive data** promotes health awareness within the community and aligns with our commitment to creating **inclusive**, **equitable health solutions** for all.

Located in **accessible**, **high-traffic public areas** like **libraries**, **pharmacies**, and **strip malls**, Health Pods are designed to be easy to locate without needing a separate app. Users can simply perform a **Google search** ("Health Pods near me") to find nearby Pods. This approach is particularly relevant given that approximately **14% of Americans** do not use the internet, and **22% of rural residents** lack access to broadband, as reported by the **Pew Research Center**. By embedding these Pods into community spaces, we minimize both **digital and physical barriers** to healthcare access, making reliable health support a more immediate part of daily life. Ultimately, our goal is to promote **community engagement** and make **quality healthcare accessible for everyone**, reinforcing our commitment to **inclusive**, **equitable health solutions**.

How it works?

The **Data Flow Diagram (DFD)** above outlines a seamless system through which **patients interact with our Health Pods**, **enabling streamlined healthcare access** and efficient communication with **remote healthcare providers** and **public health authorities**.

In this model, **patients input their health data** into the Health Pod, which then **processes** and **provides personalized health insights** back to them. These insights, including **vital statistics** and **basic diagnostics**, **empower patients** to monitor their health directly. This system is designed to facilitate **self-care and early detection of health issues**.

Data Storage and Analysis occurs in the **Health Records Database**, where patient information is securely stored and sent to an **AI Processing Unit for deeper analysis**. The AI generates actionable insights, which are then returned to the Health Pod, supporting patients with additional health assessments. **This real-time feedback loop ensures that patients have access to relevant health data** tailored to their individual needs

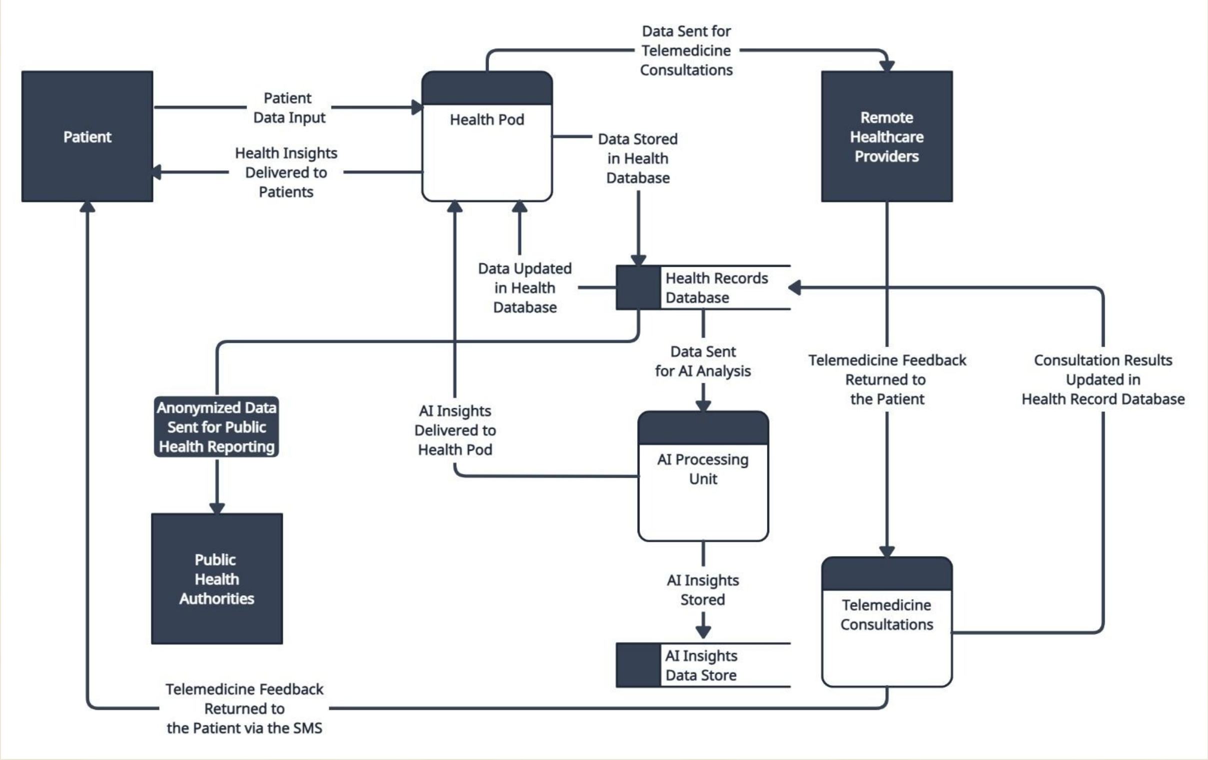

Figure 7: Data Flow Diagram of our Software

When a **telemedicine consultation** is needed, the patient's data is routed to remote healthcare providers for review. These providers **deliver feedback**, which is returned to the patient and **securely updated** in the **Health Records Database**. This feature makes healthcare more accessible for those in **remote or low-access areas**, offering **real-time support** and **reducing the need for travel**.

Our ultimate goal is to establish a **centralized health record system** accessible to **hospitals** and **federal health authorities**, supporting our mission to make healthcare **more accessible** and **equitable**. This integrated data access allows patients to **retrieve their records at any hospital**, **ensuring continuity of care** and facilitating thorough medical evaluations. Healthcare providers benefit from a **comprehensive view** of patients' histories, enabling **timely** and **informed treatments**, while public health authorities can use this data to **track trends** and **raise awareness of critical health issues**.

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Partnership Development

As outlined in the previous slide, establishing a **centralized health record system** is a core component of our vision to make healthcare more accessible and equitable. Currently, fully centralized health databases with unified access across all healthcare providers, public health agencies, and patient-facing devices (like our Health Pods) do not widely exist in most countries, including the U.S. Although **regional health information exchanges (HIEs)** and **state-level databases** enable some level of data sharing, systems like **Electronic Health Records (EHRs) often lack interoperability**, creating barriers to seamless data sharing across platforms. This gap offers both a challenge and an opportunity for advancing a **more integrated health system**.

To make this vision a reality, **strategic partnerships** will be essential for fostering the adoption and expansion of Health Pods. The centralized health record would act as a critical foundation for developing these partnerships in the following key areas:

1. <u>Interoperability Advocacy with Health Systems</u>: We aim to partner with **hospitals**, **clinics**, and **healthcare networks** to pilot Health Pods in underserved regions. By advocating for a **centralized**, **interoperable health database**, we can demonstrate the value of integrating Health Pods with existing EHRs to enhance **data accessibility** for healthcare providers. This integration would help participating health systems improve **care continuity** and support **holistic patient evaluations**, creating a compelling case for collaboration, especially in areas focused on increasing healthcare accessibility.

2. <u>Collaborations with Public Health Authorities</u>: Engaging with public health agencies will be critical for gaining support and expanding Health Pods. By sharing **anonymized health data** from Health Pods, public health authorities can gain insights into **community health trends** and address issues proactively. Our partnerships with these organizations will underscore how Health Pods contribute to **public health monitoring** and **community-level health planning**, directly supporting their mission to improve health outcomes in underserved areas.

3. <u>Technology Partnerships for Secure Data Handling and Compliance</u>: Ensuring **secure** and **compliant data handling** is a cornerstone of our approach. We would collaborate with technology providers specializing in **health data storage**, **encryption**, and **compliance solutions** (e.g., HIPAA, GDPR) to build a secure infrastructure that enables real-time data exchange. By partnering with experts in **secure cloud solutions**, we can strengthen trust among healthcare providers and public health authorities, positioning Health Pods as a **reliable** and **compliant** element of the healthcare ecosystem.

These partnerships would offer clear, mutually beneficial outcomes: **Hospitals** gain access to more comprehensive patient histories, **public health agencies** receive actionable data for **community health initiatives**, and **technology providers** get the opportunity to innovate in **secure health data management**.

Ultimately, these partnerships, anchored by our **centralized health record system**, would make Health Pods more **effective**, **scalable**, and **seamlessly integrated** with existing health infrastructure. This approach not only furthers our goal of **making healthcare accessible** to underserved communities but also aligns with the broader objectives of healthcare providers, public health authorities, and technology partners.

Conclusion & Future Scope

Conclusion

Scaling our product nationwide will provide a **powerful**, **data-driven way** to tackle healthcare disparities by identifying and **prioritizing underserved areas** through **K-means clustering** and **regression analysis**. As the model learns from a broad range of **data inputs**, it will become increasingly effective at pinpointing **ZIP codes with the greatest need**, allowing healthcare providers and policymakers to **allocate resources more strategically**. In addition to K-means clustering, **Gradient Boosting** and **Random Forest algorithms** will add predictive strength, helping us forecast emerging low-access areas based on household income, transportation access, and other **SDoH factors**.

Future Scope

1. Algorithm Refinement: With each phase, we'll **fine-tune our models for scalability**, incorporating larger datasets across ZIP codes and **integrating real-time SDoH inputs** to increase precision.
2. Data Partnerships: Expanding partnerships with **Census Bureau data sources** and healthcare agencies will **enhance the model's accuracy** and enable **cross-referencing of our predictions** with actual health outcomes to optimize our intervention strategies.
3. Cost-Effective Manufacturing: For cost-efficiency, **building the Health Pods in India** aligns with the **"Make for the World" initiative**, creating opportunities for high-quality, affordable manufacturing and supporting the global expansion of our product. By leveraging **India's extensive tech ecosystem**, we can **reduce production costs significantly**, ensuring that Health Pods remain **accessible without compromising on quality**.
4. National Impact Analysis and Continuous Improvement: After national deployment, we'll conduct **A/B testing** to evaluate **improvements in patient outcomes** and **healthcare access rates**. By assessing data trends and outcome metrics, we can **continually refine our approach** and measure the impact in real-time, establishing a **robust framework for scalable**, **cost-effective**, and **impactful healthcare solutions**.

Through these strategies, our roadmap not only **advances healthcare accessibility** but also lays the foundation for a **globally replicable model** that can adapt to the needs of diverse communities and ensure **equitable healthcare access** across the nation.