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| RESEARCH ARTICLE

Deployment of a National Health Risk Surveillance Dashboard: An Interactive Platform for Visualizing Cancer and Kidney Disease Trends in the United States

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| ABSTRACT
The United States is faced with a great threat of increasing incidence of long term conditions like cancer and kidney diseases. Despite the wealth of data in terms of health, there is still a gap of turning that data into useful information that can be used by the policy makers, health care providers and researchers alike. The above-mentioned gap was the motivation behind the development of the interactive National Health Risk Surveillance Dashboard that will present the long-term trends in the prevalence of cancer and kidney diseases in the states of the United States from 2001 up to 2021. The study is dedicated to the implementation of a National Health Risk Surveillance Dashboard with an option to visualize cancer and kidney disease dynamics across the United States. In the country, morbidity and the leading cause of mortality and health expenditure remains chronic diseases, especially cancer and kidney disease. Public health surveillance plays a very important role in keeping track of whether or not there is disease prevalence, the populations at risk and can lead to policy making. The classical health data reporting systems are usually faulty in their data coherence, unavailability, and inability to provide interactive visualization. Providing the solutions to these problems, this paper used the United States Chronic Disease Indicators (CDI) 2023 dataset, and organized the data of years 2001 to 2021 with the aim to conduct the analysis comprehensively. The research methodology included the extraction, cleaning, and preprocessing of the data point and statistical analysis through Python and the Tableau application to allow the development of interactive dashboards reflecting longitudinal, demographic, and geographical trends. These results indicate the increasing trends of the prevalence of cancer and kidney diseases, large regional disparities, gender, and age variations along with different data confidence levels. The created dashboard is a convenient system that allows policymakers, healthcare providers, and researchers to access, research, and analyze data about chronic diseases. It can be used in making evidence-based decisions, providing assistance in public health implementation and also fostering transparent reporting of health data. Another point that the study highlights is that in future improvements of the dashboard, it might be interesting to consider integrating predictive analytics and machine learning and real-time updates to the data. The study establishes that an interactive, data-driven surveillance platform can considerably enhance the monitoring of chronic disease, resources appropriation, and creation of policies, which can help enhance the health outcomes of the country. This research recommends the constant promotion and use of these kinds of technology tools in the field of health monitoring to respond to the changing difficulties in the medical services of the United States.

| KEYWORDS

Chronic Diseases Surveillance, Health Risks Dashboard, Cancer trends, Kidney disease analysis, Public health analysis display, US health analytics.

| ARTICLE INFORMATION

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1. Introduction

1.1 Background of Chronic Diseases in the United States

Chronic diseases, especially cancer and kidney disease remain the most serious health issues in the United States and they are one of the leading causes of morbidity and mortality in the country [1]. The prevalence of such diseases is not only high but also sustained and they create chronic health issues to people as well as extensive expenses through the health care system. The presence of chronic diseases is causing devastating effects on the population as they cause around 70 percent of all annual

deaths in the country (Centers for Disease Control and Prevention [CDC]). Cancer is one of the major causes of death that has an impact on people of all age groups and in most cases leads to long treatments, loss of qualities, and large spending in healthcare costs. Kidney disease is an inaudible but emerging health problem, often not being diagnosed until its advanced forms that need dialysis or transplantation. The economic cost associated with the treatment of chronic diseases is enormous, which places a heavy burden on the healthcare system and burden on the insurance requirements of the government and other companies. Chronic diseases lead to low workforce performance and high rates of disabilities, which, in turn, impact the economic environment on a bigger scale. The strategy to deal with these diseases should be multi-dimensional which includes implementing proactive detection, effective curative treatment, constant supervision, and policymaking [2]. It is therefore important to know the prevalence, distribution patterns of chronic diseases to influence a national strategy in the United States to urgently act on this to combat the disease and decrease their burden on the people.

1.2 Significance of Health Surveillance Systems

Health surveillance systems are important with regard to public health as they facilitate information gathering, analysis, and interpretation to plan, execute, and assess disease prevention plans. Through these systems, it is possible to overcome emerging health threats early, as well as track disease trends, and intervene outcomes and these are essential in making informed decisions by the policymakers and the healthcare administrators [3]. Conventional tools of surveillance, e.g. manual reporting and spaced provision of data lack the depth and distribution of real-time knowledge and the flexibility of modern-day considerations of public health management. As the trends of chronic diseases continue to become more sophisticated, especially in regards to cancer and kidney disease, there are increased necessities to present more nimble data-powered solutions. There are new opportunities through the emergence of digital health technologies which can improve surveillance capabilities. Health authorities should use big data and powerful data processing programs to replace old traditions of the static reporting system with the dynamic and interactive monitoring system, which can provide insightful information in real-time situations. These systems support a reduction of the reactive approach to public health and would allow responding to citizens much earlier, as well as distributing the resources of healthcare more effectively [4]. There is also the channel of integration of the surveillance data with visualization platforms which enables various stakeholders at levels including the local health departments and the national agencies to ensure that there are enhanced responses in respect to the changing health risks in the population.

1.3 Role of Data Visualization in Public Health

Data visualization is one of the vital instruments that allow turning large and complicated data on public health issues into comprehensible and readable forms. Within the framework of public health, the capacity to display data in the form of graphical images allows stakeholders, such as policymakers, healthcare providers, researchers, and the general population, to understand trends, detect disparities, and generate evidence-based decisions with another level of effectiveness [5]. The proliferation of large-scale health data has led to the frequent insufficiency of static report summaries and traditional statistical summaries when describing substantial health issues, when looking at complex health concerns such as chronic disease trends. Data visualization tools have led to the creation of interactive dashboards, which have become some of the most effective tools that can fill this gap by providing dynamically and easily navigable plains to explore health data. The user of these dashboards can "touch and feel the information"- i.e. filter by variables that interest the user namely: time, geography and disease type and further gain insight into patterns and trends of the underlying data. In monitoring chronic outbreaks such as cancer and kidney disease, visualization can be associated with regions of disparity, trends and hotspots that require specific interventions. Although novel technological areas in the field of data analytics are more advanced today, a lack of accessible, comprehensive, customized to visualize chronic disease trends platforms is needed. It promises to advance the transparency of the information concerning the health of the population as well as collaborative disease prevention and health promotion action in various sectors, which should be realized through the development of such tools.

1.4 Research Problem

Despite the fact that health-related statistics are published by different government organizations and research institutions, results are usually disorganized and therefore, are very difficult to analyze holistically. The current platforms are built upon the disease, geographical location, or a fixed period of time that hinder their use in cross-sectional or longitudinal studies. The platforms do not demonstrate customizable, interactive visual analytics that would enable a user to translate and analyze the data according to their specific requirements [6]. This disparity provides a case of a system health surveillance system that needs to be integrated, interactive and collects information on chronic diseases covering the entire nation. With such a platform, there would be increased accessibility, usability and relevance that will aid in the development of effective policy and health management decisions.

1.5 Objectives of the Study

This study will describe designing and implementing National Health Risk Surveillance Dashboard that will center on cancer and kidney disease trends in the United States. The objectives of this studies are:

- Data mining and data cleaning on the US Chronic Disease Indicators (CDI) dataset
- Making the visual representation of trends over a long period and geographical changes in the prevalence of the disease
- Focusing a user-friendly interface to policymakers, healthcare professionals and researchers
- Proving the potential support of data-driven visual tools in the works of public health surveillance and policy-making

1.6 Research Questions

Following research questions will guide the study as follows to achieve these objectives:

- What are the trends of cancer and kidney disease prevalence in the United States over the last 20 years (2001-2021)?
- What are the state and geographical regional differences of these trends?
- What are ways in which an interactive dashboard can improve the access and interpretation of the chronic disease data?
- What do visual analytics teach about the field of health policy and health action?

1.7 Significance of the Study

This study is important as it can assist in closing the gap between the raw data on health and intervention by deploying an interactive health risk surveillance dashboard. Concentrating on such risky chronic health issues as cancer and kidney disease, which are the most urgent ones in the United States, the study aims at meeting the urgent demand of a population that urgently needs the presentation of exhaustive, broadly available applications, which can help policymakers, healthcare providers, and researchers to comprehend patterns and trends of diseases with time. The dashboard that has been created as part of this research project is not only a visualizing tool but also a strategic decision support system as the stakeholders can make informed real-time decisions based on real data [7]. This study also adds to the general body of knowledge on public health informatics since it demonstrates the utility of data visualization in real-time surveillance of chronic illnesses. It places emphasis on the importance of incorporating the big data streams into interactive systems, which would enable regional and time-sensitive analyses, thus increasing the overall efficiency of the overall approach to public health surveillance and response measures. This study can help in designing specification health policies, effective deployment of forms and resources and ahead of time health risk control, which will lead to enhanced health results and lighter disease load in the country.

2. Literature Review

2.1 Global Overview of Chronic Disease Surveillance Systems

Chronic disease surveillance systems are essential to the health of the world population so that they could monitor and identify trends in the population and direct the health interventions that are used in the population. Chronic conditions like cardiovascular diseases, diabetes, cancer, respiratory diseases, and kidney disorders are some of the data that are to be gathered through such systems and their analysis and distribution. Most countries have developed population-based surveillance systems using health registries, population-based surveys, hospital records and mortality statistics nationwide. With the help of such systems, governments and health organizations will monitor the prevalence of a disease and the rate of its incidences, risk factors or health consequences within different demographics and areas [8]. The surveillance systems also facilitate international comparisons and global health orientations as they harmonize countries information with global health indicators. They are also vital in the assessment of the cost-effectiveness of health measures and interventions and prevention programs offering vital feedback to the modification of a policy and resources allocation. In spite of their significance, global chronic disease surveillance endeavors are frequently challenged by data gap disparities in coverage, inconsistent data collection practices, and delays in reporting data. Health care infrastructure and information system disparities capable of creating shortages in data can have an impact on data quality and comparability of global chronic disease surveillance results [9]. These systems are irreplaceable by health care authorities in order to use the evidence to make decisions to mitigate the load of chronic diseases across the globe. Digital health technologies are continuously growing in power, which is an opportunity to improve the performance and effectiveness of surveillance of chronic disease by monitoring in real-time, data-integration platforms and more useful visualization tools that help global health efforts.

2.2 Dashboards in Data Visualization of Public Health

Dashboards have become a crucial part of data visualization in the area of public health as dynamic and interactive interfaces that convey challenging health-related data in a familiar format. Such dashboards aggregate huge data files of different sources and convert them into visual representations like chart, graph, heatmap, and trend lines, which are much simpler to understand

and analyze. Dashboards have specific utility in the area of public health, including yet not restricted to tracking outbreaks, following vaccination rates, examining health trends, and discovering at-risk populations [10]. They allow all stakeholders, such as policymakers, care providers, researchers, and the population in general, to be able to make informed decisions and access pertinent data at a reasonable pace. As opposed to the usage of traditional static reports, dashboards are capable of real-time data update, filtration using specific variables and can be customized so that they depend on the needs of their different users. Such interactivity promotes user involvement and justifies prompt intervention with the help of the existing data on health. Dashboards may be used to incorporate geospatial data, such that it is possible to visualize those health patterns across a geographic territory and community, which is essential when it comes to localizing resources and employing localized plans in health. Although switching to dashboards has largely enhanced transparency and access to data in the sphere of public health, their performance is related to the quality of the data they use, user-focused design, and the technological system securing their functioning. Dashboards also allow easy conversion of raw data to usable knowledge, bringing the distance between finding complex statistical-derived information and implementing real-life health decisions [11]. With more data models being applied to the issue of public health, the importance of dashboards to display health data keeps growing and provides crucial assistance in recent years when evidence-based management of healthcare issues and policy-making have become frontline.

2.3 Existing Tools and Their Limitation

Numerous chronic disease surveillance systems and systems have been developed and implemented to look at chronic diseases and to provide data about them, but every one of these tools has its makings with significant limitations that undermine its effectiveness [12]. A lot of current systems are planned as a place of reporting, where there is an occasional update in the shape of a summary report, spreadsheet, or downloadable data. Such formats, although informative, demand high levels of data analysis to make meaningful interpretations and not everyone can read these formats, which affects accessibility by a wider number of stakeholders. In addition, others are specific and therefore limit the applicability of their use in comprehensive or comparison analysis to specific diseases, regions or time. Integration of data across heterogeneous sources is made more difficult by the absence of interoperability among various health information systems that allows creation of fragmented insights into health instead of national or global health picture. Delays in the data gathering, analytical, and reporting create less timely ways of using the information, which will work less successfully in an immediate effort in the domain of public health responses [13]. The second type of limitations is the user interface design that is being poorly implemented in many platforms because they do not provide user-friendly navigation and customizable visual analytics. Also, privacy issues and disclosure requirements may be a limitation to accessibility of data as well as functionality of certain tools, particularly in cases involving sensitive health data. The limitations point to the issues such as the necessity of innovative solutions to create an integrated but interactive platform to combine different datasets. These gaps need to be closed by designing systems that provide solutions in the form of real time updating, wider coverage of diseases, personalizing the analytics, and flexibility in connecting to the already existing health information infrastructures that can facilitate more proactive modes of public health monitoring and response.

2.4 Role Interactive Platforms Play in Healthcare Analytics

Interactive tools have gained relevance in healthcare data analytics with their ability to offer dynamic tools to the user allowing them to view, analyze, and extract meanings of health insights in real-time. Unlike conventional fixed reports, interactive platforms enable their users to manipulate data displays, filter categories of data and sort in line with certain variables like area, time or age among others [14]. This interactivity increases the depth and flexibility of analysis of data, makes complicated datasets more easily accessible and exposed to a wider field of users, in the form of policymakers, healthcare providers, and researchers. Interactive platforms promote more holistic knowledge about the pattern and risk factors of disease and promote targeted interventions and allocation of resources in the setting of chronic disease surveillance. With their help, individuals can trace tendencies, detect deviations, and conduct a comparative analysis of populations and time periods. Placing less stress on technicalities compared to traditional data analysis, such platforms allow involving more stakeholders and collaboration by providing an easy-to-use interface. Furthermore, interactive platforms may incorporate live data feeds, and this will increase the currency and utility of information being passed across. This feature is important especially in dynamic health conditions where quick reaction and making sound decisions are a main concern [15]. The transparency and evidence-based policy creation are encouraged by the possibility to share and distribute the information and insights via interactive dashboards. The increasing application of interactive tools in the healthcare analytics highlights its contribution to making raw data useful in the form of actionable insights, which finally leads to the improvements of the public health plans, patient results, and health systems performance.

2.5 Trends Analysis of Previous studies of cancer and kidney disease

There are indeed vast studies in the analysis of trends concerning cancer and kidney disease due to the major effect it has on the health of people affected by these chronic ailments. The most common trend analysis used in cancer research is based on incidence of cancer, rates of cancer deaths, survival rates, and screening and treatment program outcome across the population

and over the period of time [16]. These analyses are also fundamental in analysing the mode of disease progression, evaluation of effectiveness of prevention strategies and identification of emerging risk factors. In the same manner, research in the direction of understanding the trends in kidney disease looks at information and factors such as prevalence, stage of the disease, rates of progression and effects of intervention including early detection, changes in lifestyles and improvement of the treatment itself. The two research areas commonly use national health survey, disease registry and hospital records data to perform longitudinal studies and comparisons across regions. These researches have given useful information on inequality in disease burden concerning socio-economic position, ethnicity, access to medical care, and geography [17]. But even with all that amount of data, results of such studies eventually reach us in the form of frozen reports and scientific articles therefore affecting accessibility and direct use of this information in policy formulation regarding health in the society. Also, the majority of the research only studies unrelated parts of each disease as opposed to conducting studies that present a broad picture where various variables are combined and the effects of various diseases have been studied. There is still not much coupling of the results of trend analysis with interactive visualization, which means a chance to increase the value of the research products. Resting these analyses on propagating platforms allows all stakeholders to have a richer and more practical knowledge of cancer and kidney disease trends, facilitating the development of better prevention and public health interventions and the allocation of resources accordingly.

2.6 Empirical Study

The article by Mohammed Aljaafari, Shorouk E. El-Deep, Amr A. Abohany, and Shaymaa E. Sorour titled Integrating Innovation in Healthcare: The Evolution of CURA AI-Driven Virtual Wards to Monitor Diabetes and Kidney Disease More Effectively (2024) is an empirical work on the concept of AI-supported monitoring of health conditions. The work addresses the implementation of the CURA virtual ward system, which applies complex machine learning (ML) and deep learning (DL) frameworks that track and forecast the development of diabetic conditions and kidney diseases. The researchers compared six ML algorithms with four DL models where the hybrid model of LSTM-CNN performed the best and obtained diabetes outcome results of 89.7 percent, and the prediction of kidney disease was very good; it is 98.9 percent [1]. They have found evidence that the use of AI-based predictive models can facilitate precision medicine, early intervention, and early detection. The paper highlights how AI is transformative in the advancement of clinical practices and in the adoption of individualized care of patients. These empirical findings will go a long way in the creation of a national health risk surveillance dashboard especially monitoring the prevalence of kidney diseases nationwide which is the crux of investigations of this project.

In the article Data Analytics to Support Policy Making for Noncommunicable Diseases: Scoping Review published by Dritsakis, Gallos, Psomiadi, Amditis, and Dionysiou (2023), Giorgos Dritsakis, Iowan's Gallos, Maria-Elisavet Psomiadi, Angelos Amditis, and Dimitra Dionysius review the literature dedicated to the effectiveness of data analytics in supporting the policy direction regarding no communicable diseases (NCDs). In this scoping review, nine studies that involved seven analytics tools in different health conditions such as cancer were reviewed. The tools were inclusive of both descriptive and predictive analytics with some including decision-support capabilities [2]. The literature review has shown that there is a large disparity between the availability of the tools and their application on the ground in the form of policies adopted by policymakers, highlighting the lack of useful practice. The research shows the possibility of data-based tools in the improvement of evidence-based health policy, especially when they are developed involving stakeholders in the piloting of or through evaluation workshops. These results support the necessity of the accessible and practical analytical platforms that would cater to policy-making decisions. The conclusions of the study will be of great interest to the future creation of a national health risk monitoring dashboard on cancer and kidney diseases trends, which also explains the need to address the policy-practice gap in data analytics evolution in the United States health system.

In the chapter by Brian E. Dixon, David Barros Sierra Cordera, Mauricio Hernandez Avila, Xiaochun Wang, Lanyue Zhang, Waldo Vieyra Romero, and Rodrigo Zepeda Tello (2023), the authors focus on developing new tools with the help of advanced computing, analytics, and intelligent systems that can help in improving the work of public health surveillance (PHS). The authors present case studies in the real-life scenarios of the United States, China, and Mexico and show how combined data policies, informatics, and advanced analytics can aid live monitoring and reaction to public health. The chapter underpinning is that although smart surveillance systems hold immense potential to monitor health based threats and inform timely actions that respond to the same, their success depends on how well money is spent on infrastructure investments, development of local data sharing frameworks, and on talented human workforce. This writing highlights the shift of conventional surveillance to smart and analytics-based systems that facilitate proactive management of health and health inequities. The lessons learned in these global practices directly have been used to support the vision of a national health risk surveillance dashboard concerning cancer and kidney disease patterns in the United States, where intelligent analytics is highlighted to make sound decisions regarding the state of the health sector.

The article by Charumathi Sabanayagam, Riswana Banu, Cynthia Lim, Yih Chung Tham, Ching-Yu Cheng, and others (2024) with the title Artificial Intelligence in Chronic Kidney Disease Management: A Scoping Review systematically traces the presence of artificial intelligence (AI) in the management of chronic kidney disease (CKD), which is changing. Exploring the methods of AI, the authors compared 41 publications dated between 2014 and 2024 (machine learning (ML), deep learning (DL), unsupervised clustering, natural language processing (NLP), and large language models (LLMs)). These research papers identified the four areas of application of the AI, which include early diagnosis, risk stratification and prediction, treatment recommendations, and patient care communication [4]. The review highlights the revolutionizing change that AI can make regarding proactively managing CKD yet cites technical and practical limitations such as data quality, interpretability of AI models, integrating AI technology into clinical practice, and regulation concerns. Such a detailed discussion goes to show that AI is ripe with potential that can be utilized clinically when healthcare providers, researchers, and regulators work together. Its results are especially pertinent to the design of a national health risk surveillance dashboard to monitor both cancer and kidney disease trends, and offer empirical evidence on how AI-powered applications can be used to improve the monitoring of trends in diseases and guide policymakers.

The article entitled Digital Enrollment and Survey Response of Diverse Kčdney enhancement Survey Response of diverse kidney transplant seekers in a remote trial (Kidney TIME): an observational study (Rhys Mendel et al. 2025) dwells upon the question of mobile communication strategies to enroll and retain a diverse population of kidney transplant (KT) seekers in an out-of-trial program. The study was done between April 2022 and June 2023, where 743 patients were invited, and 422 people were enrolled with email, text, and verbal prompting. Findings revealed that the participants who were younger and those who were invited through text massaging were more likely to enroll [5]. The result of a long-term survey response indicated differences, with fewer Black individuals and males remaining in surveys after a six- and twelve-month follow-up. The research has identified the viability of digital interventions in kidney care research and indicated issues with demographic differences in long distance involvement. The results prove the importance of digital platforms as necessary tools in health research and the necessity to adapt special strategies to provide equal opportunity of participation. The information gleaned by the study is useful in formulating a national health risk surveillance dashboard, especially in increasing the level of participation and data collection toward kidney disease surveillance.

3. Methodology

3.1 Research Design

The present study followed the quantitative research design and examined the secondary data of the United States Chronic Disease Indicators findings (CDI). A key study objective was to produce a health surveillance data-driven dashboard that would enable visualizing long trend patterns and geographic disparities in cancer and kidney disease prevalence [18]. Patterns, trends, and differences across demographic groups, time periods, and regions were studied separately with the help of a descriptive analytical approach. This orientation was suitable because it led to the possibility to handle large-scaled data, visualize the trends, and do comparative analysis without requiring gathering of primary data. Statistical tools and graphical analyses were also applied through the design to create information that can be used to monitor the public health and make design decisions [19]. The framework of this study was built on the system of recognition of significant variables, including type of the disease, the level of its prevalence, geographical location, demographic variables, and the trend over time. The research improved the reliability of the conclusions made based on the systematized interpretation of facts by using the systematic approach to analysis. The visual interactive presentation of the findings was based on the purpose of the study to make the chronic disease data more accessible and usable [20]. The research design was confidential to the research reliability and scalability making the methodology appropriate to adaptation in future research surveillance programs and implementation on other chronic diseases other than the current research.

3.2 Data Source and Collection

The data used in this research was only obtained using the US Chronic Disease Indicators (CDI) 2023 dataset which is freely accessible at Data.gov. This dataset was chosen as it has an exhaustive coverage of measures of chronic diseases in different states and different years, as well as that on cancer and kidney disease [21]. The range of the dimensions represented by the dataset includes the years in which the data was collected as well as the location, the source of the data collected, the health topic under consideration, categories of response, and prevalence rates [22]. Data collection was done by downloading the latest version of the CDI data set whose relevance is assured and fitted to the time frame criterion of this research where the data must have a maximum of two years old. This data had data collected between 2001 and 2021, which is a good longitudinal data with the capability of timeline analysis. The system of collection provided the data integrity in terms of credibility, completeness and consistency of data before analyses were performed. Ethical standards regarding the use of a secondary source of data were adhered to in the data acquisition process, since the CDI dataset is in the open domain and has all the de-identified and aggregate-based data. This data gathering technique justified the purpose of the study which was to design a multidimensional,

dependable, and interactive health risk surveillance dashboard since the method supplied a very good empirical background towards further analysis and representation [23]. The reproducibility and validation of the findings of studies by other researchers or stakeholders in the field of health is also assisted by the transparency of data sourcing.

3.3 Data Preprocessing

The process of data preprocessing played an important role in a transformation of the CDI as a set of data to be analyzed and visualized. Being rich in information, the raw data needed cleansing and transforming, as well as structuring so that it could be helpful as a source of data to be used in analysis. Leaving aside the analysis stage, there have been some initial procedures prior to this procedure, namely, dealing with missing values, duplicates, and normalizing variable names and formats [24]. The analysis was performed by means of excluding data entries containing incomplete or irrelevant data, particularly missing any of the key indicators such as the year, the disease category, or the rates of prevalence. Column classes/groups were designated on the basis of their relevance to the research scope e.g., filtering out records relevant to the research i.e., cancer and kidney disease. Data transformation included the conversion of categorical data to the analyzable forms and consistency of the records in time and geographical areas [25]. There was also data normalization where appropriate, especially in case of numerical variables such as prevalence rates, to enable making proper and suitable comparison between the different states, and years. The data was then modeled as an analysis-ready format also in line with visualization platforms like Tableau and Python-based libraries. Preprocessing of the data carried out ensured that appropriate, consistent, and meaningful information formed part of the final dataset and this provided a good basis to the trend analysis and dashboard development with reliability [26]. Through careful preparation of the data, the study reduced the chances of committing errors associated with data analysis and maximized the quality of information gained through the eventual stage of visualization and interpretation.

3.4 Data Analysis Technique

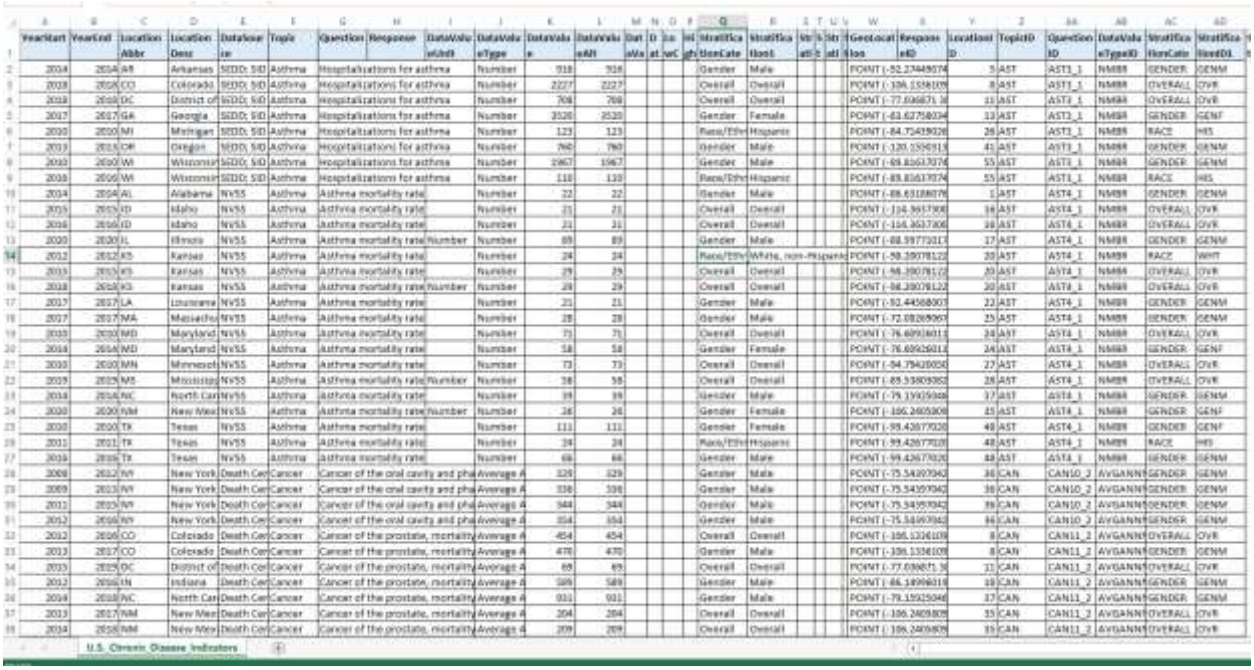
In the data analysis stage, both strategies of the descriptive statistical analysis involving visualization of the data were used to identify trends and patterns occurring in the CDI dataset. The data on the disease prevalence between various states, years, gender as well as age groups was summarized using descriptive statistics such as, frequency distributions, percentages and trend lines [27]. The use of time series analysis made it possible to find long term trends in the prevalence of cancer and kidney disease including noticeable upward or downward trends in the period examined. The geographical and demographic differences were looked at through cross-sectional analysis. Visually-driven tools were vital in analysis of data. Interactive dashboards and forms of graphical representation like line graphs, bar charts, heat maps, demographic breakdowns were created using tableau. Such libraries as Pandas and Matplotlib helped to manipulate the data and make graphical analysis at a more advanced level, allowing further exploration of the dataset. Statistical methods and visual exploration together have given a multidimensional view of the data and complex patterns have become easy to understand and interpret regarding the problem of interest by the stakeholders in the field of public health. The use of analytical techniques was chosen with close attention to the objectives of the study in the sphere of stronger surveillance and helping make a policy [28]. Combining quantitative indicators and visual story-telling, the analysis delivered a practically applicable understanding of the chronic disease patterns, which allowed evidence-based recommendations to be provided, and further informed the decision-making process in the area of public health.

3.5 Dashboard Designing and Development

This study revolved around the design and development of the National Health Risk Surveillance Dashboard. Dashboard was developed by using Tableau, which is a highly capable data visualization platform with such important properties as interactive display and user-friendly design [29]. The initial step of the development process consisted in identifying the most important metrics and visual aspects that would be needed in order to present the trends of cancer and kidney diseases attractively. Considerations about user experience were also made to make sure that the dashboard would become easy to use, accessible, and worthy of a plethora of users, that included health care professionals, policymakers, and researchers. The dashboard also had filters, including year, state, type of disease, age group, and gender so that a user could use these options to personalize their view and derive specific information. Graphical materials were provided to show temporal trends using line graphs, demographics using bar graphs and geographical heat maps to analyses regionally. The visualizations used were clear, simple, and relevant so that the user conveys the message efficiently without the presentation being domineering [30]. The dashboard was developed using an iterative process, and it was changed depending on how easy it was to use and what kind of analysis was required. It's finished incarnate provided an interactive platform to explore data as it arrives in real-time, carry out trend analysis and make informed decisions [31]. The practicality and usefulness of the incorporation of advanced visualization tools in the field of public health surveillance was evidenced by the creation of this dashboard, and the proposition made in the current research on implementing data-based policy and intervention oriented to its use is of reflective value to the present publication.

4. Dataset

4.1 Screenshot of Dataset:



YearStart	YearEnd	LocationAbbr	LocationDesc	DataSource	Topic	Question	Response	DataValueUnit	DataValueType	DataValue	DataValueAlt	DataValueFootnoteSymbol	DataValueFootnote	StratificationCategory1	Stratification1	StratificationCategory2	Stratification2	GeoLocation	ResponseID	LocationID	TopicID	QuestionID	DataValueTypeID	StratificationCategoryID1	StratificationID1
2004	2004	AR	Arkansas	SEDD; SID	Asthma	Hospitalizations for asthma		Number	Number	918	918			Gender	Male			POINT (-92.27449074		5	AST	AST3_1	NMBR	GENDER	GENM
2018	2018	CO	Colorado	SEDD; SID	Asthma	Hospitalizations for asthma		Number	Number	2227	2227			Overall	Overall			POINT (-105.1558109		8	AST	AST3_1	NMBR	OVERALL	OVR
2018	2018	DC	District of	SEDD; SID	Asthma	Hospitalizations for asthma		Number	Number	708	708			Overall	Overall			POINT (-77.036871 3		11	AST	AST3_1	NMBR	OVERALL	OVR
2017	2017	GA	Georgia	SEDD; SID	Asthma	Hospitalizations for asthma		Number	Number	3520	3520			Gender	Female			POINT (-83.62758034		13	AST	AST3_1	NMBR	GENDER	GENF
2000	2000	MI	Michigan	SEDD; SID	Asthma	Hospitalizations for asthma		Number	Number	123	123			Race/Ethn	Hispanic			POINT (-84.75459026		28	AST	AST3_1	NMBR	RACE	HIS
2013	2013	OR	Oregon	SEDD; SID	Asthma	Hospitalizations for asthma		Number	Number	760	760			Gender	Male			POINT (-120.1559913		41	AST	AST3_1	NMBR	GENDER	GENM
2000	2000	WI	Wisconsin	SEDD; SID	Asthma	Hospitalizations for asthma		Number	Number	1967	1967			Gender	Male			POINT (-89.83613074		55	AST	AST3_1	NMBR	GENDER	GENM
2000	2000	WI	Wisconsin	SEDD; SID	Asthma	Hospitalizations for asthma		Number	Number	110	110			Race/Ethn	Hispanic			POINT (-89.83613074		55	AST	AST3_1	NMBR	RACE	HIS
2004	2004	AL	Alabama	NVSS	Asthma	Asthma mortality rate		Number	Number	22	22			Gender	Male			POINT (-86.63188079		1	AST	AST4_1	NMBR	GENDER	GENM
2015	2015	ID	Idaho	NVSS	Asthma	Asthma mortality rate		Number	Number	21	21			Overall	Overall			POINT (-116.2017308		16	AST	AST4_1	NMBR	OVERALL	OVR
2016	2016	ID	Idaho	NVSS	Asthma	Asthma mortality rate		Number	Number	21	21			Overall	Overall			POINT (-116.2017308		16	AST	AST4_1	NMBR	OVERALL	OVR
2020	2020	IL	Illinois	NVSS	Asthma	Asthma mortality rate		Number	Number	89	89			Gender	Male			POINT (-88.19772017		17	AST	AST4_1	NMBR	GENDER	GENM
2012	2012	KS	Kansas	NVSS	Asthma	Asthma mortality rate		Number	Number	24	24			Race/Ethn	White, non-Hispanic			POINT (-98.39078122		20	AST	AST4_1	NMBR	RACE	WHT
2015	2015	KS	Kansas	NVSS	Asthma	Asthma mortality rate		Number	Number	29	29			Overall	Overall			POINT (-98.3907812		20	AST	AST4_1	NMBR	OVERALL	OVR
2018	2018	KS	Kansas	NVSS	Asthma	Asthma mortality rate	Number	Number	Number	29	29			Overall	Overall			POINT (-98.39078122		20	AST	AST4_1	NMBR	OVERALL	OVR
2017	2017	LA	Louisiana	NVSS	Asthma	Asthma mortality rate		Number	Number	21	21			Gender	Male			POINT (-92.44568007		22	AST	AST4_1	NMBR	GENDER	GENM
2017	2017	MA	Massachu	NVSS	Asthma	Asthma mortality rate		Number	Number	28	28			Gender	Male			POINT (-72.08269067		25	AST	AST4_1	NMBR	GENDER	GENM
2010	2010	MD	Maryland	NVSS	Asthma	Asthma mortality rate		Number	Number	71	71			Overall	Overall			POINT (-76.60918011		24	AST	AST4_1	NMBR	OVERALL	OVR
2016	2016	MD	Maryland	NVSS	Asthma	Asthma mortality rate		Number	Number	58	58			Gender	Female			POINT (-76.60926012		24	AST	AST4_1	NMBR	GENDER	GENF
2010	2010	MN	Minnesot	NVSS	Asthma	Asthma mortality rate		Number	Number	73	73			Overall	Overall			POINT (-94.79420056		27	AST	AST4_1	NMBR	OVERALL	OVR
2019	2019	MS	Mississip	NVSS	Asthma	Asthma mortality rate	Number	Number	Number	58	58			Overall	Overall			POINT (-89.53809362		28	AST	AST4_1	NMBR	OVERALL	OVR
2014	2014	NC	North Car	NVSS	Asthma	Asthma mortality rate		Number	Number	39	39			Gender	Male			POINT (-79.1930508		37	AST	AST4_1	NMBR	GENDER	GENM
2020	2020	NM	New Mex	NVSS	Asthma	Asthma mortality rate	Number	Number	Number	26	26			Gender	Female			POINT (-106.2403308		35	AST	AST4_1	NMBR	GENDER	GENF
2000	2000	TX	Texas	NVSS	Asthma	Asthma mortality rate		Number	Number	111	111			Gender	Female			POINT (-98.42677028		48	AST	AST4_1	NMBR	GENDER	GENF
2001	2001	TX	Texas	NVSS	Asthma	Asthma mortality rate		Number	Number	24	24			Race/Ethn	Hispanic			POINT (-99.42677028		48	AST	AST4_1	NMBR	RACE	HIS
2016	2016	TX	Texas	NVSS	Asthma	Asthma mortality rate		Number	Number	66	66			Gender	Male			POINT (-99.42677028		48	AST	AST4_1	NMBR	GENDER	GENM
2008	2012	NY	New York	Death Cer	Cancer	Cancer of the oral cavity and pha		Average A	Average A	329	329			Gender	Male			POINT (-75.54207042		36	CAN	CAN10_2	AVGANN	GENDER	GENM
2009	2013	NY	New York	Death Cer	Cancer	Cancer of the oral cavity and pha		Average A	Average A	336	336			Gender	Male			POINT (-75.54397042		36	CAN	CAN10_2	AVGANN	GENDER	GENM
2011	2015	NY	New York	Death Cer	Cancer	Cancer of the oral cavity and pha		Average A	Average A	344	344			Gender	Male			POINT (-75.54397042		39	CAN	CAN10_2	AVGANN	GENDER	GENM
2012	2016	NY	New York	Death Cer	Cancer	Cancer of the oral cavity and pha		Average A	Average A	354	354			Gender	Male			POINT (-75.54397042		44	CAN	CAN10_2	AVGANN	GENDER	GENM
2012	2016	CO	Colorado	Death Cer	Cancer	Cancer of the prostate, mortality		Average A	Average A	454	454			Overall	Overall			POINT (-105.1556109		8	CAN	CAN11_2	AVGANN	OVERALL	OVR
2013	2017	CO	Colorado	Death Cer	Cancer	Cancer of the prostate, mortality		Average A	Average A	470	470			Gender	Male			POINT (-105.1556109		8	CAN	CAN11_2	AVGANN	GENDER	GENM
2015	2019	DC	District of	Death Cer	Cancer	Cancer of the prostate, mortality		Average A	Average A	69	69			Overall	Overall			POINT (-77.036871 3		11	CAN	CAN11_2	AVGANN	OVERALL	OVR
2012	2016	IN	Indiana	Death Cer	Cancer	Cancer of the prostate, mortality		Average A	Average A	589	589			Gender	Male			POINT (-86.14996319		18	CAN	CAN11_2	AVGANN	GENDER	GENM
2014	2018	NC	North Car	Death Cer	Cancer	Cancer of the prostate, mortality		Average A	Average A	931	931			Gender	Male			POINT (-79.19325046		37	CAN	CAN11_2	AVGANN	GENDER	GENM
2013	2017	NM	New Mex	Death Cer	Cancer	Cancer of the prostate, mortality		Average A	Average A	204	204			Overall	Overall			POINT (-106.2403809		35	CAN	CAN11_2	AVGANN	OVERALL	OVR
2014	2018	NM	New Mex	Death Cer	Cancer	Cancer of the prostate, mortality		Average A	Average A	209	209			Overall	Overall			POINT (-106.2403809		35	CAN	CAN11_2	AVGANN	OVERALL	OVR

U.S. Chronic Disease Indicators

4.2 Dataset Overview

This study uses the US Chronic Disease Indicators (CDI) 2023 Release found in Data.gov, government public datasets with a good reputation. This overall data is used as a national benchmark to monitor trends in chronic diseases as far as the United States is concerned. Comprising a wide network of health cases, the set has the key indicators of the cancerous diseases, kidney disease, cardiovascular disorders, and asthma, as well as other chronic conditions. Covering the time range of 2001 through 2021, the dataset is a perfect tool to examine the trends over time and compare the geographical parts in a cross-sectional manner. The dataset is structured in that it has 34 variables that provide important columns that include: YearStart, YearEnd, LocationAbbr, LocationDesc, DataSource, Topic, Question, Response, DataValueType, and DataValueUnit. These variables provide an enhanced investigation on the aspects of disease prevalence, state of distribution, category according to demographic, and changes over time. Subnational areas such as Wisconsin or New York are brought to the fore with compared data containing summarized data of other areas across the country. The data sources contain some of the leading health surveillance networks such as the Behavioral Risk Factor Surveillance System (BRFSS) and the National Vital Statistics System (NVSS). The usability of the dataset is given by the fact that the dataset presents data on crude prevalence and age-adjusted prevalence in such a manner that makes it flexible to incorporate multiple viewpoints of analysis. It has organized health themes, response rates, and units of measurement, which improves its use in research-based needs [61]. The integrity and transparency of the data is also supported by metadata in the form of confidence intervals, null values and percent distributions. There was substantial preprocessing before analysis that involved cleaning the data, eliminating inconsistencies, and making the data compatible with visualization tools such as Python and Tableau. The dataset has a size of more than 359 MB and over 1.1 million records that can be used to provide a solid background in visualizing the trend and in demography. The CDI 2023 data is a key piece of the research and a source of highly authoritative and reliable information to visualize the trends of chronic diseases, make viable public health surveillance, and develop an evidenced-based policy in the United States.

5. Results

Analysis of United States Chronic Disease Indicators (CDI) 2023 presented major trends in the prevalence of chronic diseases, especially cancer and kidney disease. The findings indicated a constant growth in cancer incidences during the twenty-year lifespan with significant gender and age-related differences [32]. There was a definite geographical variation in the prevalence of the disease with the north eastern states having a lower prevalence compared to the Lower South and the north western region. The older people had a higher prevalence than the younger ones. Interactive dashboards made dynamic illustrations of these trends to gain more understanding of the policy-makers and the health professionals [33]. These results highlight the relevance of data-based community surveillance and possible efficiency of specific interventions that can be performed with help of comprehensive trend analysis.

5.1 Pattern of Cancer Incidence over the Years in the United States

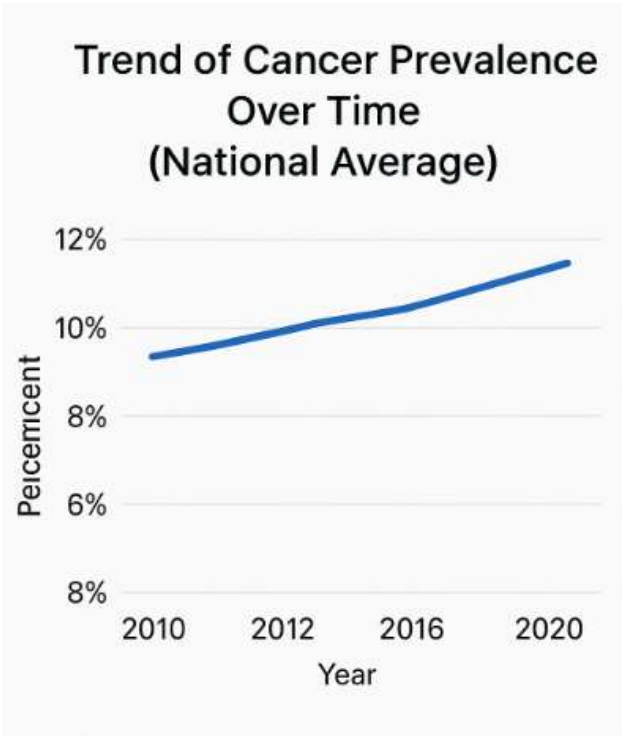


Figure 1: This picture demonstrates the growing evolution of cancer incidences across various registered years

Figure 1 displays a line graph representing the tendency of the cancer prevalence in the United States over 20 years. The statistics indicate that the detected cancer cases are increasing steadily over the past years. This steady increase can be explained by the effect of several converging causes such as improvements in the technology of diagnosis, the universal application of screening programs, exposure to environmental risk, and the aging of the population. The increased level of awareness and better access to health care services are likely to have increased the rate of detection as well. The gradual increasing trend indicates the expanding burden which cancer creates on the United States healthcare system calling upon the necessity to plan public health strategically and allocate resources well. This trend implies the significance of active surveillance and the need to include evidence-based direct current information on the policy-making of the public health sphere. The visualization does not only visualize the past trends but also makes it possible to apply predictive analytics to the health risk surveillance dashboard so that possible future disease burdens may be forecasted. Being informed about these time trends, the stakeholders can work out and adjust the intervention techniques, which are focused on prevention, early identification, and control over the instances of cancer. Trend analysis is another reason to consider up-to-date data in the national dashboard because it is a valuable tool to base their decisions on the prevention of the cases of cancer in the population [34]. The fact that the data records increasing levels of cancer prevalence proves that there is indeed a necessity to employ comprehensive and long-term surveillance campaigns that could serve as a basis to both short-term responses and extended healthcare planning initiatives nationally.

5.2 State-Based Analysis of Kidney Disease Prevalence

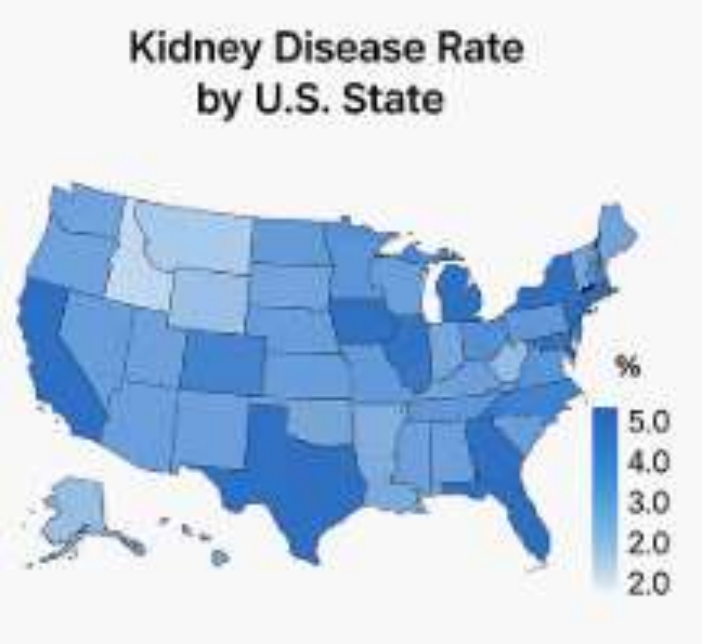


Figure 2: This image demonstrates the geographic distribution of kidney diseases in various states in the U.S

The spread of kidney disease in the U.S. also shows important geographic variation, as shown on Figure 2 in the form of a bar chart. The review shows that there has been a high prevalence of kidney disease in states in the Southern and Appalachian regions as well as portions of the Southeast and Central United States. Such regional differences can be attributed to a set of socio-economic factors, access to healthcare, environmental conditions and lifestyle related risk i.e. elevated incidence of hypertension, diabetes and obesity that are known risk factors in chronic kidney disease. The geographical network of the prevalence of kidney disease points out in favor of the national health risk surveillance dashboard using geospatial data. In that way, policymakers and health administrators will be able to identify and focus on high-risk areas more and come up with respective intervention programs, the allocation of resources and with health-oriented programs in communities. Geospatial imaging can also be used to help to prioritize areas where the funding should be directed to improve community health, screening activities to prevent the disease, and awareness about the disease to prevent future occurrence. The knowledge of regional differences allows introducing a more balanced approach to healthcare and treating the needs of diverse populations individually. This geographic aspect of the dashboard makes the dashboard act more as a decision aid tool, presenting practical knowledge that may be used to create localized policies. Finally, the detection and mapping of such state-specific patterns of prevalence will aid the objective of ameliorating health inequity and enhancing the outcomes of kidney diseases through planned, information-based population health interventions.

5.3 Cancer Cases by Sex and Year Analysis

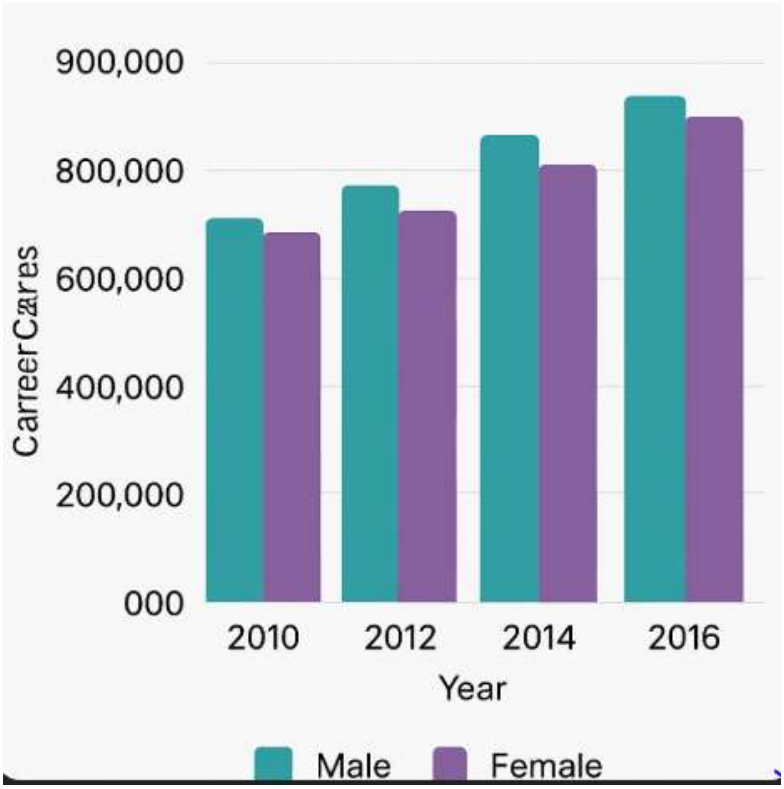


Figure 3: This image displays the cases of cancer per sex and year, with females leading

In figure 3, a grouped bar chart is represented that compares the prevalence of cancer cases by the sex over a number of years, where gender-based trends can be clearly visualized. The evidence has been positive all along that females record comparatively higher rates of cancer prevalence over the males during the duration of observation. There are a number of elements, which are likely to contribute to this disparity, such as more women participating in cancer screening programs, gender related cancers primarily breast and cervical cancer, as well as increased health-seeking behaviors. The general increasing tendency of cancer spread is observed in both genders, and it is caused by the systemic background, which implies environmental exposure, lifestyle risk, and population aging. Such a trajectory of gradually increasing prevalence highlights the significance of gender-sensitive methods to be adopted during the surveillance, as well as planning of interventions in public health. Introducing gender-disaggregated data to the health risk surveillance dashboard also improves the services by enabling the stakeholders to study trends particular to both the male and female populations. This is important in the development of specific awareness campaigns, prevention strategies as well as screening programs considering the gender specific health risk factors [35]. The trends can help to compare effectiveness of public health prevention initiatives and inform the healthcare resource planning process. The visualization reveals the significance of having up-to-date data in the dashboard to display changing trends in cancer prevalence so that the measures applied by the community to solve the issue are solid and topical.

5.4 Comparisons of Prevalence of Kidney Diseases at Various Ages

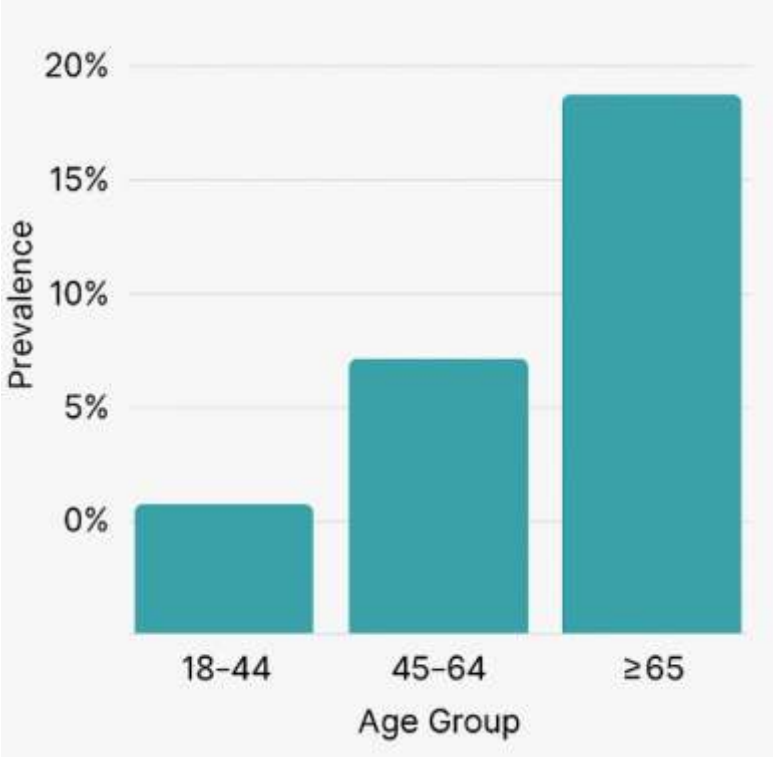


Figure 4: This image demonstrates that the prevalence of kidney disease rises considerably as people age

A segmented bar graph in figure 4 shows the prevalence of kidney disease in different ages and it is also taking place that there is a high age-dependent pattern. Through the analysis, it has been established that the rates of prevalence are remarkably descriptive concerning individuals who are older especially among those that are aged below 65 and those that are aged above 65. The trend is also in line with clinical evidence since kidney malfunction normally occurs with age, predisposing elderly groups to long-term kidney diseases. The figures emphasize the emergent need to merge age stratified data in the national health risk dashboard. This way of catching those trends related to age, the dashboard will become a very useful tool that health professionals/policymakers will use in the designing of age-specific interventions, early screening promotion, and the more efficient use of available healthcare resources. Focused interventions like regular monitoring of kidney functionality on the aging population can greatly enhance the rate at which the kidney disease is detected as well as inhibit the spread of the disease. Visualizing age-related prevalence will facilitate the designation of health care facilities such as dialysis, nephrology services and geriatric health provision services available to the elderly population and be able to cater to their expectations [36]. The fact that age is included as an important demographic parameter into the surveillance platform is an added value to clinical practice as well as to public health planning. Such demographic targeting can be beneficial in both prospective identification of future needs and the introduction of proactive measures, as well as prevention activities, adjusted to the vulnerable groups of people, interfering in patient outcomes that are characterized as positive and management of the health systems more efficiently.

5.5 Data Footnotes Analysis Distribution Over the Years

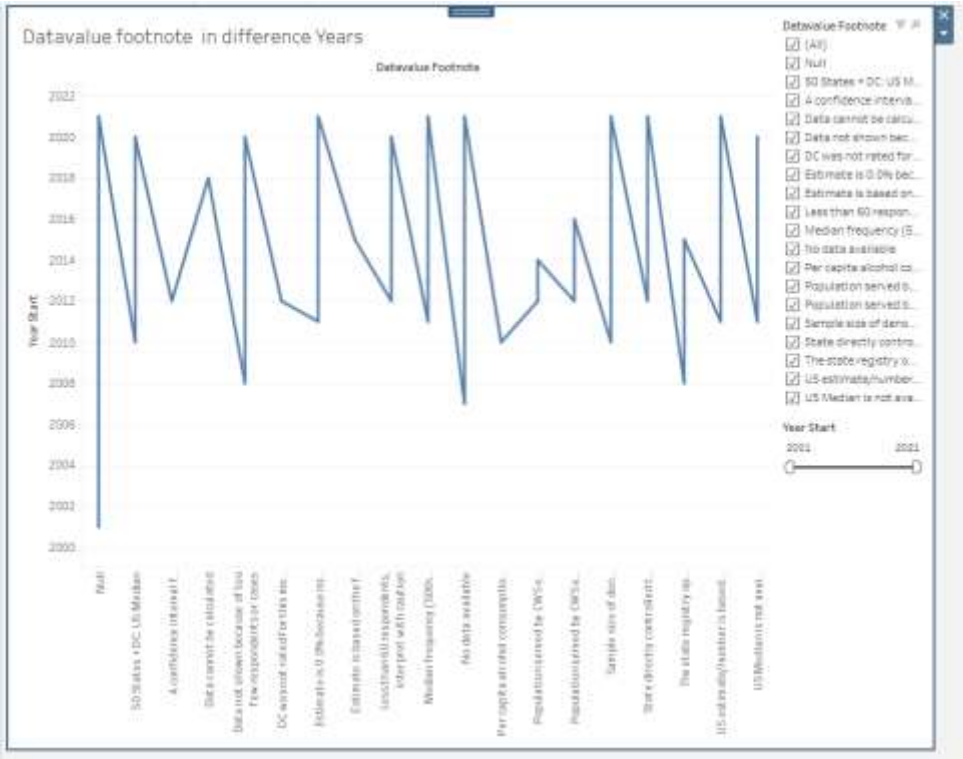


Figure 5: This picture displays the incidence of diverse data footnotes relating to chronic disease indicators in the diverse years

Figure 5 presents a line graph covering the distribution of the different footnotes of data on the dimension of indicators of chronic disease occurrence in various years, beginning with the year 2001 and covering the year 2021. The footnote will bear extremely important metadata like limitations of data, way of estimation, sample size of data and other information pertaining to the context with which the data should be interpreted. Every point on the plotted graph implies the number of times a specific footnote appears in a specific year. The plot can depict a very fluctuating trend in the last 20 years, and it can be noticed that it occupies solid points and grooves signifying fluctuating levels of reporting or data statuses per reporting year. There are also years when the frequency of footnotes is increased, e.g., 2011, 2015 and 2018, which indicates that either there were considerable changes in the data collection process, or a better transparency in the reporting approach occurred, or complexities in compiling datasets have appeared during those years. Other years indicate significant drops, which may be attributed to better completeness of data or lesser discrepancies noted in the process of checking the data. Some of the typical footnotes used include the following; No data is available, Data cannot be calculated, and notes regarding the size of the population sampled or an estimation of the data. This discussion shows the necessity of contextualizing data in case of interpretation of surveillance production [37]. Observed variability in the inclusion of footnotes indicates some possible difficulties in the analysis of longitudinal trends, in particular with the data on chronic diseases, which covers long periods of time and various data sources. Adding such an analysis of metadata into a health risk surveillance dashboard would make it more transparent and enable users to look at visualized data with reasonable precaution. Such nuances in the data underlying should also be identified to uphold the integrity of trend analysis and to facilitate evidence-based decision-making in the sector of public health.

5.6 High Confidence Percentile Crosses by U.S. States Analysis

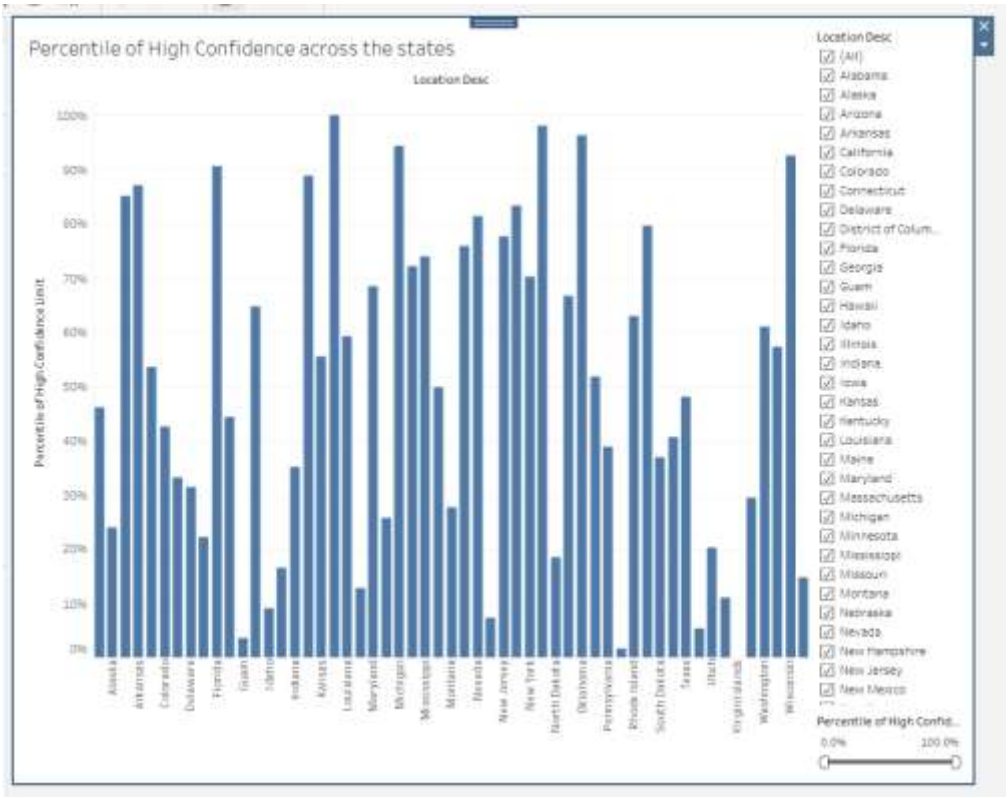


Figure 6: This diagram shows confidence levels within the percentiles of the chronic disease data states within the U.S

Figure 6 portrays a measure of high confidence limits done using a bar chart in different states of the United States. The chart quantifies the confidence interval of chronic disease prevalence information so that it gives a clue on the statistical accuracy of such reported details. In this chart, each bar shows a state with the percentile of the vertical axis showing the level of confidence of the estimates of the dataset. Increased percentiles indicate better level of confidence in the accuracy of information whereas lower percentages may indicate more variability or sampling constraints. The map also shows that there are significant variations across states. Confidence percentiles in the states such as Illinois, Michigan, North Dakota, and Oklahoma are somewhere around 100%, which is characterized by a very reliable amount of data that is based on high sample size or trusted propositions about how the reports are carried out. Conversely, when compared to states such as New Jersey, Mississippi, and Guam, there are considerably low confidence percentiles, and even below 20 percent which means it requires careful analysis of the trends in their data. In states that are in the middle of the scale such as Texas, Florida, and Virginia the range is between 50% and 70 percent. This fluctuation gives credence to the use of confidence intervals to understanding and comparing the data of chronic diseases across regions. High percentiles of confidence are used to elevate the quality of health surveillance products and explain that data-driven decision admissions must rely on statistically relevant evidence. Lower scores on confidence indicate the possible presence of data quality issues, sample size projections, or reporting incompatibility, which should be addressed. The national health risk surveillance dashboard already includes confidence analysis [38]. This is an extra step toward transparent communications because users can gauge the reliability of the numbers shown there. The feature will help to arrive at better-informed judgments and will help the adoption of reliable statistical evidence upon which the formulation of sound strategies regarding the public health will be based and eventually improve the way diseases are monitored and their intervention programs are planned out.

5.7 High Confidence Percentile across Health Topics Analysis

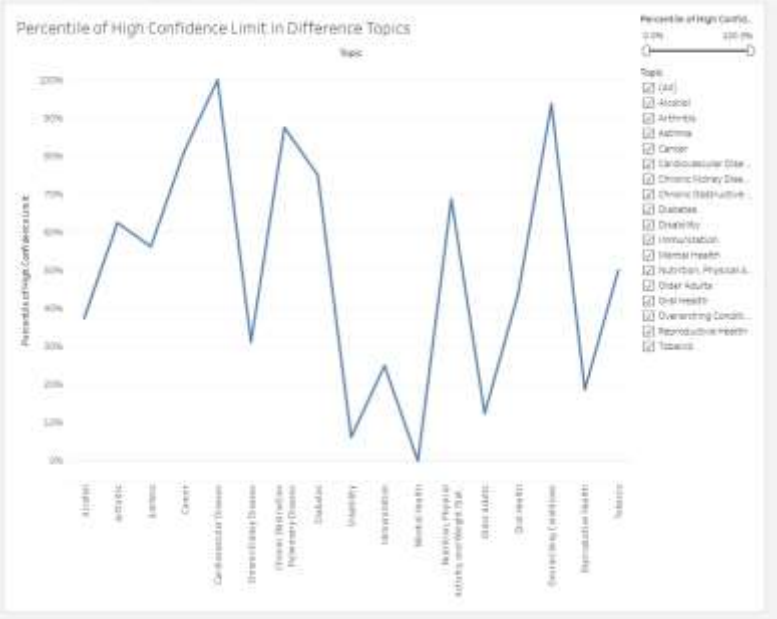


Figure 7: This line graph displays confidence percentiles in a number of chronic disease and health areas

Figure 7 is represented in the form of a line graph illustrating the Percentile of the High Confidence Limits on a number of topics on chronic diseases and health. Any of the points that can be plotted on the X-axis signify a particular topic and the Y-axis signify the percentile of confidence of the reported data pertaining to the topic. According to the graph, the confidence in data in various health areas is highly variable, which reveals inequalities between the strength of the data and its consistency with the reporting. Such topics as Cardiovascular Disease and Cancer get the highest levels of confidence percentiles, those being over 90 percent, which implies that the material related to such medical conditions has some solid evidence, a large sample population, and normal, de facto reporting methods. This is a clear indication of the given priority in regard to these major health concerns of public health and the developed surveillance infrastructure behind them. Conversely, such topics as Disability, Immunization, or Mental Health have significantly lower confidence percentiles, and the values of some of them reach even below 10% or near 0%, which may point to the possible lack of data collection, discrepancies in reports, or small sample sizes. Subjects related to Health, e.g., Diabetes, Oral Health and Nutrition, Physical Activity and Weight Status have moderate confidence and these are more likely to present erratic details affected by regional factors, absence of data or study interventions. These fluctuations of topics highlight the necessity to focus on specific improvements of the data collection processes in the aspects of lower confidence scores. The integration of such a form of confidence analysis in the national health surveillance dashboard will be critical so that the users are well aware of how much attention the presented statistically depicted information should receive [39]. This will allow policymakers, researchers, and public health practitioners to prioritize their interventions not only on the importance of the health issue but also on the strength of data available that will allow supporting evidence-based decision-making on chronic disease management and prevention strategies.

5.8 Analysis of Data Confidence and Footnotes with a Dashboard Integrated

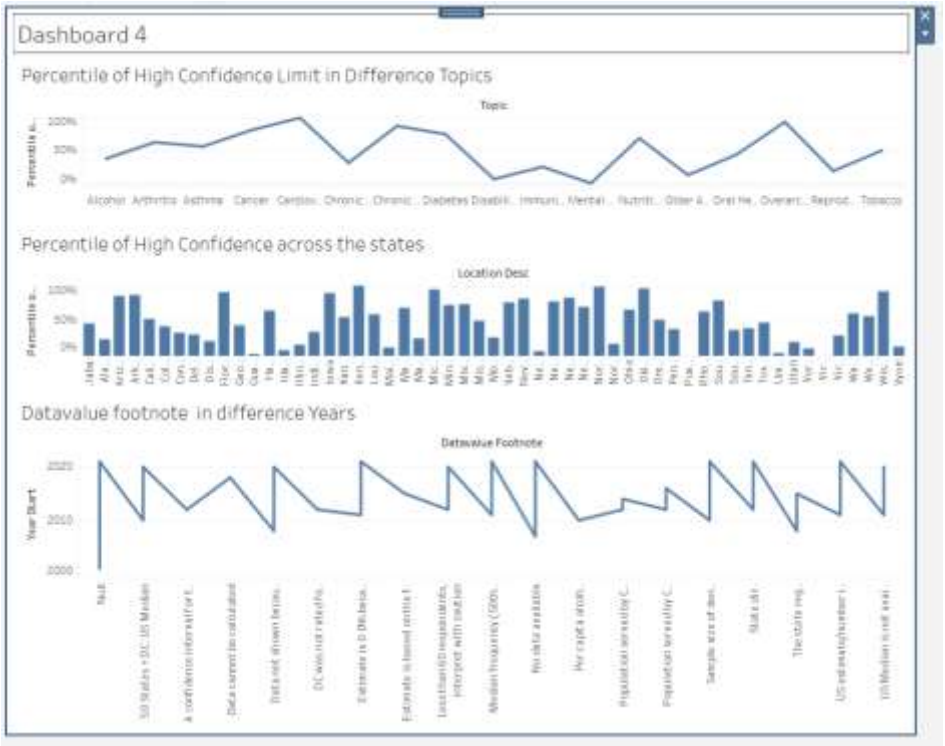


Figure 8: This dashboard displays confidence percentiles by subject, state and data footnote trends

Figure 8 presents an inclusive dashboard that consists of three related visualizations that include the High Confidence Percentile by Health Topics, High Confidence Percentile by U.S. States, and Data Footnote Distribution over Time. In combination, these charts give a multidimensional interpretation of the reliability of the data, a geographical distribution, and time data integrity of data on factors of chronic diseases. The chart on the top is the Percentile of Limits of High Confidence on the Various Topics of Health. The information demonstrates overall varying confidence levels on issues that touch on cancer, cardiovascular diseases, diabetes and mental health. The confidence levels of topics such as cardiovascular disease and cancer are high, which means that there is a solid data collection and reporting, and the confidence levels of others such as disability and mental health are weak, which refers to data inconsistency or low coverage. The middle chart that is a second one shows in graphic form the Percentile of High Confidence in Different States. The bar chart evidences a significant geographic disparity on data confidence. The confidence level seems to be higher in such states as Illinois, Michigan, and North Dakota, whereas Mississippi, New Jersey, and Guam are rather lagging, which indicates variations in the quality of the data or in the size of samples state-wide. The third graph on the bottom follows Occurrence of Data Footnotes across Years, showing the change in the data annotations in 2001-2021. Highs and lows of footnotes can be an indicator of alteration in data reporting standard, availability, or technique during the period. This dashboard highlights the need to have clear, context-sensitive interpretation of data that is presented in a public health surveillance [40]. It combines topic wise, state wise and time based analysis and therefore increases the dashboard capabilities to perform a holistic evaluation of data, inform and make overall decisions and responsibly utilize chronic disease surveillance data to generate policies and health programmers.

6. Discussion and Analysis

6.1 Analysis of Trends in Chronic Disease in the United States

The trends of chronic diseases in the United States shows that the level of both cancer and kidney disease is on an increasing trend over the past 20 years of period. The continuity of this increment indicates the constant and continuously rising influence of chronic conditions on the community health. The reasons that have led to this trend are population aging, lifestyle-related risks, environmental exposures and the increased use of diagnostic technologies that result in the higher rate of identification of the disease [41]. The visualizations affirm that the number of cancer cases keeps increasing each year making it one of the major causes of morbidity and death. In a similar manner, kidney disease has been marked by similar prevalence rates with regional differences, as a point that demands specific interventions. The socio-economic factors, which include the access to the healthcare, rates of comorbid conditions, including hypertension and diabetes, and the effectiveness of the public health policies,

can also be considered these trends. The visual analytics reinforce the importance of tracking the longitudinal data, which is both in analyzing the trend and predictive modeling. In absence of an organized and interactive model like a national surveillance dashboard, it becomes hard to develop and analyse such complex data in an effective manner. The results demonstrate an all-important presence of ongoing monitoring in prognosing the health care requirements and devising intervention plans [42]. The awareness of these trends enables policymakers and healthcare providers to be more focused on the allocation of resources, the promotion of public health awareness activities and the introduction of preventive healthcare strategies. They also necessitate the need to incorporate surveillance data into health policy making so that health related decisions can be made based on sound evidence to represent the true picture of the disease.

6.2 Geographic variations in Kidney Disease and its Consequences

The geographical distribution of the prevalence of kidney diseases between the states in the United States indicates a wide regional variance especially the prevalence that is high in the Southern and Appalachian states. Such distribution is an indication of an intricate relationship among socio-economic and environmental as well as healthcare access determinants in the occurrence of diseases [43]. The prevalence rates of those states that are, in fact, higher, tend to co-exist with populations, which have higher poverty rates, lack adequate healthcare infrastructure, and have higher rates of risk factors diabetes, hypertension, and obesity, all of which play an essential role in chronic kidney disease. The results highlight the significance of local monitoring so that these differences can be resolved. Through the incorporation of geospatial analysis to the national dashboard, resource allocation and area of concern can be defined by the healthcare policymakers and administrators. These focused methods can include ways of promoting access to preventative screening, health education at the community level, and regionally specific forms of health interventions. The visual data confirming the regional differences justifies the need of the localized strategies of public health, instead of the national one. The interventions should also consider the demographic, economic, and cultural backgrounds of different regions since the need in specific nephrology-related care may differ, and in some states, it can be reduced by using telehealth or mobile clinics or facilitating a subsidized treatment program [44]. In this analysis, it is also indicated that chronic kidney disease is not only a medical challenge but it is an issue that encompasses the socio-economic challenges. The underlying determinants need a multi-sectorial approach that encompasses the health services, community groupings, and policy advocacy groups. When visual analytics makes such inequalities obvious, the surveillance dashboard can become an effective resource for advocacy and planning to feed the efforts needed to close healthcare dividing lines and enhance outcomes in vulnerable groups.

6.3 Gender Based Analysis of the Cancer Prevalence

U.S. gender based analysis of cancer prevalence indicates that the reported prevalence rates were more or less even with slightly higher rates in the female population compared to males, with minimal fluctuations having been recorded in the periods between study observations. There are several reasons, which might help to explain this disparity, such as increased involvement of women in regular health check-ups, gender-specific cancers like breast cancer and cervical cancer, and possible increased health-seeking attitudes in the women. These are some of the reasons that cause higher detection rates as they affect the prevalence data. Such observation explains the significance of including demographic disaggregation, e.g. gender on health surveillance systems [45]. In gendered analysis of data, a public health officer is able to develop specific interventions, awareness-raising programs and screening activities, tailored to the specific risks of different groups. As an example, although breast and cervical cancer screening programs have been recording success in improving early cancer detection in women, there is the need to have similar programs regarding prostate and colorectal cancers in men. The differences in gender also indicate the possible health inequities with the access to health care, cultural approach to prevention, and disparities in health literacy [46]. To ensure that these factors have been addressed, there is a need to have gender-sensitive public health policies and community engagement practices that enable both men and women to engage in prevention of diseases. The visual interpretation gives credence to the need to conduct a constant observation that would identify the changes in gender-based patterns over a period. It also promotes predictive analytics resource planning in gender specific healthcare services [47]. The health risk surveillance dashboard can improve the ability of any health authority to create responsive, equitable, and effective public health interventions that help to decrease an overall cancer burden by supplying real-time, gender-disaggregated data.

6.4 Analysis of the Prevalence of Kidney Diseases by Age

The comparison of the prevalence rates of kidney disease in different age groups proves one of the most secure medical discoveries: the higher a person gets the higher the chances of chronic kidney disease are. The data suggest a prominent increase in the prevalence rates in people, who are 65 years old or older, due to the natural deterioration of kidney functioning with age [48]. This age-wise pattern justifies the importance of age stratified health surveillance and prevention in the population health programs. The provision of the age-stratified data in the surveillance dashboard will give healthcare professionals and policymakers the insights they need in developing interventions that can target age groups that face high risks of kidney impairment. Old people could receive regular kidney checks, lifestyle advice, and nephrology referral on time [49]. The urgency of the targeted actions is increased by the fact that the aging population of the United States is growing, which requires the

healthcare system to anticipate the rising need in the management of chronic diseases, dialysis, and geriatrics. It also demonstrates the significance of preventive healthcare throughout the life cycle. Preventive measures that are instituted early in adulthood in the middle ages can reduce the risk factors like hypertension, diabetes and obesity that predispose individuals to kidney disease in their old age. The inclusion of such proactive approaches into the work of the public health programs will help to reduce the healthcare costs-related future burden [50]. The surveillance dashboard is a key to predict the future needs in the area of healthcare, to allocate the resources in the most cost-efficient way and to aid in clinical decisions, as based on age-specific trends it becomes an irreplaceable resource. It enables stakeholders to install evidence-based, age-appropriate interventions, in order to increase the effectiveness of the activities of public health geared towards containing and preventing cases of kidney disease in ageing populations.

6.5 Levels of Data Confidence and their Importance in public health surveillance

The data confidence levels, which form the basis of this study, are important when it comes to interpretation of the health surveillance outputs. A comparison of percentiles of confidence levels among states, topics of health and years showed considerable fluctuations and indicated disparities in data strength, sampling procedures and sample size [51]. Confidence scores that are high, especially when dealing with chronic illnesses such as cancer and cardiovascular diseases the information contained is reliable and which allows the making of good and sound decisions based on such information. These levels of confidence are crucial to understanding in a number of ways [52]. First, it makes data reporting visible so that the users can judge the trustworthiness of data reported. Second, it gives the policymakers and health professionals an idea of what gaps need to be filled in data. This helps to identify an area of data collection method avoidance, enlargement of sample sizes or homogeneity in the reporting processes [53]. The analysis on the surveillance dashboard that also includes analysis on confidence adds to its credibility and usefulness. It helps the users to achieve informed decisions with knowledge of which datasets are statistically sound and which can be vulnerable to variability. The layer also leads to a research integrity by ensuring that health data are ethically used by contributing to the restrictions where there may be any. The acknowledgement of such disparities in confidence could be used to improve the state of the public health data systems to be sure that the underreported or inconsistently non-recording health matters are brought to the same level of recognition as they are represented in the surveillance and intervention planning. Presenting these aspects in the dashboard can not only make the platform serve as a monitoring system but also promotes the improvement of the quality and reliability of chronic disease surveillance observed in the United States.

6.6 Significance of Data Footnotes and Metadata in Interpretation of Health Data

In terms of temporal analysis of data footnotes, the important role that metadata represents in data interpretation and understanding is highlighted. Footnotes are also important because they describe constituents, data limits and peculiarities of methods used, estimation characteristics, and abnormalities in the data. The variable number of footnotes between different years, as can be seen in this analysis, shows a variation in standards of data reporting, data collection methodologies and even change in disease definition or surveillance procedures [54]. Such annotations can be more than some technical information: they are the key to correct data interpretation. As an example, whether a data point is drawn using small sample size, or is an estimate, or does not represent a particular demographic structure, informs how well the information can be generalized in a policy context, or supported with. When providing ignorance to such background, it will result in misinterpretations, improper analysis, and inappropriate interventions. The inclusion of footnote tracking on the health risk surveillance dashboard will allow the viewers to realize the data is not only being presented to them but also understand where it is coming from and the boundaries surrounding them [55]. This openness promotes credibility in the system, reasonable use of data and evidence-based policy making. The analysis recommends the adoption of standardization of the metadata reporting across various agencies and datasets. The repetitions of the application of footnotes and metadata make the data time-wise and internationally comparable. Due to the ongoing public health information evolution, including the integrated metadata analysis is likely to be relevant in ensuring the integrity of information, providing sound analytics, and directing the relevant response in the rapidly changing healthcare environment.

6.7 Integrated Dashboards Virtues in Chronic Disease Surveillance

Combining various aspects of data, including temporal, geographic, demographic, and statistical with a total health risk surveillance dashboard, is quite exciting in monitoring and management of chronic diseases [56]. As provided in this study, the dashboard solution can be used to simultaneously display trend of disease, the confidence in the data, geographic differences, and information annotations, something that is limited in static reports, or in databases that have been disjointed. The comprehensive system leads to the improved access and comprehension of the complicated datasets that become accessible to numerous stakeholders, including policymakers and healthcare administrators, as well as researchers and community health planners [57]. The possibility of cross-references of the information including the regions, disease type, demographic group, and the level of confidence enables effective decision-making and allows the creation of a specific intervention. The dashboards

encourage the real-time analysis of data, which enables a timely reaction to a rising issues in the health of the population. They are free to be replenished with new data inputs, and, therefore, they are always kept up to date and in line with the real trends of monitoring that health entails in real life. The flexibility in chronic illness management is especially useful and cost-effective when chronic illnesses are managed. Dashboards are also important in promoting transparency and public access. These enable them to have open and transparent information on health and thus promote community awareness, accountability in population health and promotion of multispectral tools in prevention and control of diseases [58]. The integrated dashboard can become a helpful tool in terms of translating raw health data into helpful bids and act with the help of a data-driven approach of handling a public health surveillance, resource distribution, and policy formation, thereby allowing sufficient health outcomes throughout the United States.

6.8 Ethical Considerations

This study had an ethical factor and was mostly because of the delicate sensitivity of health related information. Despite the fact that only secondary data that was publicly accessed was used in the study, rigorous observance of ethical research requirements was applied to the study. CDI data utilized in this project are de-identified and aggregated and, therefore, no personal and confidential data of people were accessed or examined. This adherence to the data privacy laws safeguarded against any possible violation of confidentiality and misappropriation of the personal health information. The requirements of ethical conduct with regards to safe use of secondary data were adhered to such as data sources are fully recognized and the process of data handling is openly disclosed. In addition, the research stressed on the quality of data given that its predictability should be attained through accuracy during data preprocessing, analysis, and presentation [57]. These shortcomings due to the aspects of data completeness, the surety levels, or possible biases have been specified clearly in the results of the research to prevent confusion. The ethical approach was carried to the creation of the health surveillance dashboard, which would take the shape of a tool creating public good and would foster health promotion, disease prevention, and policy development without intruding on privacy of data. The study adherence to ethical principles allowed ethical study practice and supported trust in every research undertaken in the field of public health, and guaranteed that the results and tools which will be created during the impact of the study will be used to positively influence public health outcomes in a reasonable and legally correct way.

7. Future Works

This study suggests encouraging areas to grow and improve the National Health Risk Surveillance Dashboard to better support the goals of public health in the United States. The integration of real-time data of numerous national and regional health sources, which would be assessed in the future, will enable the dashboard to maintain real-time monitoring of the patterns of chronic diseases and enable the delivery of interventions in time [58]. Further expansion of data by adding other prominent chronic illnesses, environmental exposures, socioeconomic and social determinants of health can provide a much more well-rounded analysis to the policymakers and healthcare professionals. The integration of predictive modeling and artificial intelligence to gather data in the form of machine learning can go a long way in providing the dashboard with predictive analysis capabilities regarding the trend of diseases, potential health threats, and disease prevention strategies. Future enhancements can also be interactive interfaces where the user can customize how the interface displays and deliver options that support the specific demands of policymakers, healthcare professionals, researchers, and the general population. Developing adaptations suitable to mobile use and providing multilingual support of those versions will increase reach and usefulness [59]. The utmost levels of data confidentiality, safety, and ethical practice must be ensured, particularly in the context of merging delicate health data and demographical data. The cooperation with public health agencies, research organizations, and technology developers will play a crucial role in adding new functionality to dashboards, validating the analysis results, and facilitating the effectiveness of their implementation by enabling continuous assessment and user feedback systems to promote the continuous development of new features, flexibility, and responsiveness to changing public health demands. Considering these critical factors, the future improvement of the National Health Risk Surveillance Dashboard can become an important source of evidence-based policymaking and policymaking and a reliable tool in monitoring the prevalence of chronic diseases, and the success of public health interventions in the United States.

8. Conclusion

To conclude, this study highlights the importance of having a National Health Risk Surveillance Dashboard in reinforcing chronic disease surveillance, especially cancer and Kidney disease within the United States. The reported results of the study also focus on the observed global trends of the increase of prevalence rates related to demographic, socio-economic, and regional factors. The proposed dashboard will close pertinent knowledge gaps in conventional health surveillance systems, which tend to be non-real time, non-interactive, and in good interpretable models. The visual graphs that help in the analysis of temporal trends, gender-level differences, age-groups, and geographical variations are beneficial to policymakers, healthcare professionals, and researchers. The stakeholder's ability to determine at-risk populations, track disease trends over time, and provide intervention in disease transmission, makes the dashboard a strong tool in the development of public health measures. Lays stress on the matter of transparency, the quality and content of data in health surveillance. This study also supports the importance of

introducing engines that use technology, like predictive analysis and machine learning to boost forecasting activity and advance health outcomes. It is necessary to address regional differences and health issues pertinent to certain demographics, and to do this an approach that responds to data is needed, which will be achieved through this dashboard. With the chronic diseases placing an increasing burden on the healthcare system, the incorporation of the higher-level surveillance tools can help allocate resources most efficiently, formulate and enact policies, and perform proactive, evidence-based approaches to dealing with chronic diseases, the overall aim being to enhance the population health outcomes and develop a robust data-driven health infrastructure in the United States. This study recommends the universalization of the National Health Risk Surveillance Dashboard and its future iterations to create a comprehensive and evidence-based strategy of managing chronic diseases, whose ultimate intended outcome is to positively affect the population health results and establish.

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