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The role of the centers for disease control and prevention in chronic disease surveillance in the United States

O papel dos centros de controle e prevenção de doenças na vigilância de doenças crônicas nos Estados Unidos

El papel de los centros para el control y la prevención de enfermedades en la vigilancia de enfermedades crónicas en los Estados Unidos

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ABSTRACT

Chronic diseases pose a major public health challenge in the United States, accounting for a large share of morbidity, mortality, and health care costs. Approximately 60 percent of U.S. adults live with at least one chronic condition, and 40 percent have multiple conditions at the same time. Given this prevalence, systematic surveillance is required to monitor trends, identify risk factors, and guide prevention and management strategies at national and local levels. The Centers for Disease Control and Prevention plays a central role in this process through an extensive network of surveillance programs that track prevalence, incidence, and associated factors for conditions such as heart disease, cancer, stroke, and diabetes. The CDC draws on multiple data sources, including surveys, vital records, and electronic health data, which are integrated into tools such as the Chronic Disease Indicators web tool. This platform standardizes and centralizes key indicators for public health professionals. Ongoing modernization of data systems, with emphasis on the integration of electronic health records and the use of advanced technologies such as artificial intelligence and large scale data analytics, improves the accuracy, scope, and timeliness of collected information. This supports more targeted and timely public health interventions, including emerging precision public health approaches that incorporate genetic, socioenvironmental, and behavioral factors into tailored prevention strategies. Persistent challenges remain, particularly regarding data quality, system interoperability, and the need for continued workforce training to ensure effective use of these tools.

Keywords: Center for Disease Control and Prevention. United States. Epidemiological Monitoring. Chronic Disease.

RESUMO

As doenças crônicas representam um grande desafio para a saúde pública nos Estados Unidos, sendo responsáveis por uma parcela significativa da morbidade, mortalidade e custos com assistência médica. Aproximadamente 60% dos adultos americanos convivem com pelo menos uma doença crônica, e 40% apresentam múltiplas doenças simultaneamente. Diante dessa prevalência, a vigilância sistemática é essencial para monitorar tendências, identificar fatores de risco e orientar estratégias de prevenção e manejo em níveis nacional e local. Os Centros de Controle e Prevenção de Doenças (CDC) desempenham um papel central nesse processo por meio de uma extensa rede de programas de vigilância que rastreiam a prevalência, a incidência e os fatores associados a doenças como doenças cardíacas, câncer, acidente vascular cerebral e diabetes. O CDC utiliza diversas fontes de dados, incluindo pesquisas,

registros vitais e dados eletrônicos de saúde, que são integrados a ferramentas como a ferramenta online de Indicadores de Doenças Crônicas. Essa plataforma padroniza e centraliza indicadores-chave para profissionais de saúde pública. A modernização contínua dos sistemas de dados, com ênfase na integração de registros eletrônicos de saúde e no uso de tecnologias avançadas, como inteligência artificial e análise de dados em larga escala, aprimora a precisão, o alcance e a atualidade das informações coletadas. Isso apoia intervenções de saúde pública mais direcionadas e oportunas, incluindo abordagens emergentes de saúde pública de precisão que incorporam fatores genéticos, socioambientais e comportamentais em estratégias de prevenção personalizadas. Desafios persistentes permanecem, particularmente em relação à qualidade dos dados, à interoperabilidade dos sistemas e à necessidade de treinamento contínuo da força de trabalho para garantir o uso eficaz dessas ferramentas.

Palavras-chave: Centro de Controle e Prevenção de Doenças. Estados Unidos. Monitoramento Epidemiológico. Doenças Crônicas.

RESUMEN

Las enfermedades crónicas representan un importante desafío para la salud pública en Estados Unidos, representando una gran parte de la morbilidad, la mortalidad y los costos de la atención médica. Aproximadamente el 60% de los adultos estadounidenses viven con al menos una enfermedad crónica, y el 40% padece múltiples enfermedades simultáneamente. Dada esta prevalencia, se requiere una vigilancia sistemática para monitorear tendencias, identificar factores de riesgo y orientar las estrategias de prevención y manejo a nivel nacional y local. Los Centros para el Control y la Prevención de Enfermedades desempeñan un papel fundamental en este proceso a través de una extensa red de programas de vigilancia que rastrean la prevalencia, la incidencia y los factores asociados para enfermedades como las cardiopatías, el cáncer, los accidentes cerebrovasculares y la diabetes. Los CDC se basan en múltiples fuentes de datos, incluyendo encuestas, registros vitales y datos de salud electrónicos, que se integran en herramientas como la herramienta web Indicadores de Enfermedades Crónicas. Esta plataforma estandariza y centraliza indicadores clave para los profesionales de la salud pública. La modernización continua de los sistemas de datos, con énfasis en la integración de registros de salud electrónicos y el uso de tecnologías avanzadas como la inteligencia artificial y el análisis de datos a gran escala, mejora la precisión, el alcance y la puntualidad de la información recopilada. Esto apoya intervenciones de salud pública más específicas y oportunas, incluyendo enfoques emergentes de salud pública de precisión que incorporan factores genéticos, socioambientales y conductuales en estrategias de prevención personalizadas. Persisten desafíos persistentes, en particular en lo que respecta a la calidad de los datos, la interoperabilidad de los sistemas y la necesidad de capacitación continua del personal para garantizar el uso eficaz de estas herramientas.

Palabras clave: Centros para el Control y la Prevención de Enfermedades. Estados Unidos. Monitoreo Epidemiológico. Enfermedades Crónicas.

1. INTRODUCTION

Chronic diseases represent a pervasive public health challenge, contributing significantly to morbidity, mortality, and healthcare expenditures in the United States (Barth et al., 2024). Indeed, chronic conditions affect a substantial portion of the adult population, with approximately six in ten adults managing at least one chronic disease and four in ten living with multiple such conditions (Carney et al., 2023). This widespread prevalence underscores the critical need for robust surveillance systems to monitor disease patterns, identify risk factors, and inform effective prevention and management strategies at both national and local levels (Greenlund et al., 2022).

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The Centers for Disease Control and Prevention plays a pivotal role in this endeavor through its extensive network of surveillance programs aimed at tracking the prevalence, incidence, and risk factors associated with various chronic conditions across the nation (Hacker & Kaufmann, 2024; Watson et al., 2024).

This includes conditions such as heart disease, cancer, stroke, and diabetes, which are not only costly but also primary drivers of death and disability in the US (Watson et al., 2025). Furthermore, lifestyle factors such as tobacco use, inadequate nutrition, sedentary lifestyles, and excessive alcohol consumption are significant contributors to these chronic diseases, necessitating comprehensive strategies for prevention and control (Carney et al., 2023).

The CDC's surveillance efforts extend beyond merely tracking disease occurrence; they encompass the collection and analysis of diverse data types, ranging from individual health behaviors to vital statistics, to gain a holistic understanding of chronic disease epidemiology and inform targeted public health interventions (Hacker & Kaufmann, 2024).

One of the CDC's key tools in this regard is the Chronic Disease Indicators web tool, which centralizes and standardizes data from numerous sources to provide critical insights for public health professionals, researchers, and policymakers (Watson et al., 2024).

This tool aggregates information from surveys, vital records, and administrative data, applying standardized definitions to track key indicators related to chronic diseases and their associated risk factors at both national and state levels (Watson et al., 2024). This comprehensive data collection and dissemination are crucial for understanding the evolving landscape of chronic disease burdens, particularly given the increasing prevalence of these conditions earlier in adulthood (Watson et al., 2025).

Outdated information regarding the prevalence and trends of chronic conditions and multimorbidity across different adult life stages highlights the imperative for continuous and modernized data collection efforts (Watson et al., 2025).

Such efforts are vital for developing targeted public health interventions and informing policy decisions aimed at mitigating the substantial impact of chronic diseases on both individual well-being and the national economy, considering that these conditions account for an estimated $4.1 trillion in annual healthcare expenditures (Carney et al., 2023).

The sustained increase in chronic disease prevalence over the past two decades further amplifies this urgency, with projections indicating a continued upward trend in the coming years (Watson et al., 2025). This necessitates ongoing, adaptive surveillance to accurately capture shifts in disease burden and identify emerging public health challenges (Carney et al., 2023; Watson et al., 2025).

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The escalating financial burden, evidenced by direct healthcare costs exceeding $1.1 trillion for chronic conditions in 2016, further underscores the economic imperative for effective surveillance and intervention strategies (Watson et al., 2025). Therefore, comprehensive and continuously updated chronic disease surveillance is paramount for guiding public health initiatives and optimizing resource allocation to address this multifaceted crisis (Carney et al., 2023).

Overview of Public Health Surveillance

Public health surveillance, in this context, involves the systematic, ongoing collection, analysis, interpretation, and dissemination of health data essential to the planning, implementation, and evaluation of public health practice (Barth et al., 2024).

This systematic process is fundamental for identifying disease trends, detecting outbreaks, and informing evidence-based public health interventions to mitigate chronic disease burden (Carney et al., 2023).

It encompasses a broad spectrum of activities, from monitoring environmental hazards to tracking health behaviors, all designed to safeguard and improve population health (Carney et al., 2023). The CDC employs various surveillance systems, some of which are disease-specific, while others, like the Behavioral Risk Factor Surveillance System, encompass a broader range of chronic conditions (Carney et al., 2023; Watson et al., 2025).

These systems are crucial for providing the timely, accurate data required to inform public health policies and programs, ultimately leading to improved health outcomes across the United States (Carney et al., 2023).

However, challenges persist in maintaining the precision, continuity, and comprehensiveness of this surveillance data, which can hinder the effective deployment of prevention strategies and optimal health management for patients with chronic diseases (Liu & Wang, 2025).

Addressing these challenges necessitates a continuous modernization of data systems to ensure the timely availability of actionable information, particularly at local levels where interventions are often implemented (Carney et al., 2023).

This modernization must account for the complexities of the chronic disease landscape and the distinct data requirements of healthcare, social services, and public health sectors, each possessing unique chronic disease data assets (Carney et al., 2023).

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Significance of the CDC's Role in Chronic Disease Surveillance

The CDC's dedication to modernizing chronic disease data programs is crucial for enhancing public health practice, aiming to improve the health and well-being of Americans by preventing and managing chronic diseases more effectively (Carney et al., 2023).

This modernization involves leveraging innovative information systems to facilitate robust data collection, exchange, and analysis among federal, state, tribal, local, and territorial health departments and their partners (Carney et al., 2023).

A key aspect of this modernization includes integrating electronic health record data into surveillance efforts, which offers objective measurements and more timely insights compared to traditional survey-based methods (Jackson et al., 2024).

This integration enhances the timeliness and completeness of surveillance data, providing a more comprehensive picture of chronic disease prevalence and trends (Ghildayal et al., 2024; Nansikombi et al., 2023). However, data quality issues often hamper the utility of electronic health record data for public health surveillance, such as missing information, which necessitate robust remediation strategies (Hohman et al., 2024).

Addressing these challenges involves developing frameworks to inform data quality processes for potential users of EHR data para vigilância, identifying common data quality problems, and proposing effective remediation strategies to enhance the reliability of these data (Hohman et al., 2024).

For instance, validation processes, such as those implemented in the Multi-State EHR-Based Network for Disease Surveillance pilot project, are essential to identify and resolve issues that could impact the accuracy of chronic disease prevalence estimates derived from EHR data (Hohman et al., 2024).

These efforts are crucial for overcoming the inherent challenges in leveraging electronic health records for public health surveillance, thereby ensuring that the derived insights accurately reflect the chronic disease burden within communities (Hohman et al., 2024).

Such initiatives, coordinated by entities like the National Association of Chronic Disease Directors and funded by the CDC, are instrumental in transforming raw EHR data into actionable public health information through platforms such as the Electronic Medical Record Support for Public Health surveillance system (Hohman et al., 2024).

This strategic integration facilitates comprehensive public health surveillance for both chronic and infectious diseases, providing rich, timely information available soon after data collection (Ghildayal et al., 2024). Strategic funding and financing models further support this approach, which are essential for

establishing EHRs as a sustainable mechanism for public health surveillance, as exemplified by initiatives like PCORnet, the National Patient-Centered Clinical Research Network (Ghildayal et al., 2024).

2. HISTORICAL CONTEXT AND EVOLUTION OF CDC'S ROLE

The CDC's engagement in chronic disease surveillance has undergone a significant evolution, transitioning from largely manual, episodic data collection methods to sophisticated, integrated digital systems. This progression reflects a broader shift in public health, emphasizing data-driven approaches and the strategic utilization of technological advancements to monitor and combat the rising prevalence of chronic conditions (Ghildayal et al., 2024).

Initially, surveillance efforts were often localized and relied heavily on administrative data and periodic surveys, which provided valuable but often retrospective and incomplete insights into disease patterns. The advent of digital technologies and the increasing sophistication of data analytics have allowed the CDC to develop more dynamic and comprehensive surveillance systems, moving towards real-time data acquisition and analysis (Ghildayal et al., 2024).

This paradigm shift has enabled a more proactive stance in identifying public health threats and evaluating the effectiveness of interventions against chronic diseases. The increased adoption of electronic health records across healthcare settings, driven by federal incentives, has presented a significant opportunity to enhance chronic disease surveillance by offering longitudinal patient health information that is often more timely and comprehensive than traditional survey data (Ghildayal et al., 2024).

This integration allows for a more granular understanding of disease progression, comorbidity patterns, and the impact of various social determinants of health on chronic disease outcomes (Canfell et al., 2022).

Furthermore, the evolution of CDC's role has been marked by a concerted effort to overcome limitations inherent in fragmented data systems by promoting interoperability and data sharing among diverse stakeholders (Barth et al., 2024). This ongoing modernization is critical for developing more targeted public health interventions and policies aimed at reducing the burden of chronic diseases nationwide.

The CDC's Data Modernization Initiative further underscores this commitment, aiming to transform legacy information technology and surveillance systems, thereby increasing data samples, connectivity, and usability for chronic disease monitoring (Carney et al., 2023).

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Establishment and Early Initiatives

This initiative seeks to improve the nation's capacity to collect, manage, and analyze public health data, addressing challenges posed by antiquated data management systems and facilitating the integration of evolving technologies (Jack, 2023). This strategic approach aims to build robust, interconnected public health data systems capable of supporting population health, emergency preparedness, and disease management capacity across various jurisdictions (Barth et al., 2024).

This includes the development of statewide chronic disease registries, such as Michigan's CHRONICLE, which leverages electronic health record data to monitor conditions like stroke and hypertension in near real-time (Barth et al., 2024). These systems provide a detailed and timely understanding of chronic disease prevalence and incidence, allowing for more precise public health interventions and resource allocation (Barth et al., 2024).

Such advancements highlight the CDC's ongoing commitment to enhancing chronic disease surveillance capabilities through innovative data utilization and strategic modernization efforts (Carney et al., 2023). The initiative also focuses on leveraging cloud technologies to enhance data security, scalability, and the integration of artificial intelligence for dynamic data processing and machine learning, crucial for addressing health equity and social determinants of health challenges (Carney et al., 2023).

Concurrently, the National Center for Chronic Disease Prevention and Health Promotion within the CDC is actively enhancing data accessibility at the local level and emphasizing social determinants of health through a health equity lens in its funding opportunities and partnerships (Hacker et al., 2021).

This holistic strategy ensures that data collected from various sources, including electronic health records, are not only integrated but also analyzed through a lens that accounts for the complex interplay of social, economic, and environmental factors on chronic disease outcomes (Carney et al., 2023; Wiltz et al., 2024).

Evolution of Surveillance Methodologies

The evolution of surveillance methodologies at the CDC has increasingly focused on integrating disparate data sources, such as electronic health records, to overcome limitations of traditional surveillance methods and provide more comprehensive insights into chronic disease trends (Barth et al., 2024; Jackson et al., 2024).

For instance, projects like the Multi-State EHR-Based Network for Disease Surveillance and the innovative use of Health Information Exchanges in systems like Michigan's CHRONICLE demonstrate the

potential for near-real-time, comprehensive monitoring of chronic conditions by linking clinical and community data (Barth et al., 2024; Carney et al., 2023).

This integration facilitates a more robust understanding of disease incidence and prevalence, enabling public health officials to identify emerging patterns and respond with targeted interventions more rapidly (Barth et al., 2024). This shift toward using electronic health record data for surveillance also provides enhanced opportunities to assess the attributes and challenges of these data sources, thereby informing future directions for optimizing public health surveillance(Ghildayal et al., 2024).

Furthermore, the CDC recognizes the critical role of social determinants of health and data on health-related social needs in chronic disease surveillance, despite challenges in obtaining population-level information from healthcare systems (Hacker et al., 2024). Consequently, the integration of behavioral, environmental, network, and community data into NCD surveillance is becoming increasingly vital for developing more effective, holistic interventions that address the multifaceted nature of chronic diseases and improve population health outcomes (Li et al., 2022; Matus et al., 2024).

This paradigm shift towards precision public health leverages digital technology and integrated data to guide targeted interventions and policy, moving beyond conventional evidence-based approaches to create a more agile and responsive public health system (Canfell et al., 2022).

This strategic roadmap emphasizes the development of digital health workflows, the development of advanced population health data analytics, and the ultimate realization of precision public health to prevent non-communicable diseases (Canfell et al., 2022). This involves developing advanced polygenic and multifactorial risk prediction tools to identify individuals at future risk of chronic disease or those with undiagnosed conditions, thereby enabling more proactive and personalized public health interventions (Thomas et al., 2023).

Moreover, the systematic application of real-world data, including electronic medical records, is foundational to this approach, offering granular and contemporaneous insights into disease patterns and healthcare utilization (Canfell et al., 2022; Ghildayal et al., 2024). This integration of diverse data streams facilitates a more nuanced understanding of disease determinants, moving towards a precision public health model that targets interventions based on individual and population-specific risk factors rather than broad generalizations (Canfell et al., 2022).

This emerging paradigm, termed precision public health, represents the next generation of public health, integrating data from human and pathogen genomics, social, behavioral, and environmental research, and artificial intelligence to transform public health interventions (Canfell et al., 2022; Roberts et al., 2024).

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This approach incorporates large datasets, population genomics, and unconventional data sources with near real-time surveillance to efficiently address public health problems (Kenney & Mamo, 2025).

3. CDC'S FRAMEWORK FOR CHRONIC DISEASE SURVEILLANCE

The CDC's framework for chronic disease surveillance is therefore undergoing a evolution, shifting from traditional, aggregated data collection methods to a more dynamic, integrated system that leverages advanced analytics and real-world data to inform public health action (Canfell, Davidson, et al., 2022; Canfell, Kodiyattu, et al., 2022). This transformation is bolstered by the integration of digital health systems, which support greater efficiency in population-scale health prevention and intervention programs (Thomas et al., 2023).

This expanded framework facilitates the deployment of polygenic and multifactorial risk prediction tools, enabling precise screening for individuals at heightened risk of chronic diseases and informing targeted prevention strategies (Thomas et al., 2023).

This forward-looking approach also incorporates real-world data and advanced digital health workflows to enhance the precision and effectiveness of public health interventions against non-communicable diseases (Thomas et al., 2023). This comprehensive approach aims to optimize the delivery of tailored interventions to specific populations at opportune moments, thereby maximizing disease prevention and treatment outcomes (Roberts et al., 2024).

This evolution marks a significant convergence of precision medicine and public health, moving towards a "precision public health" model that analyzes extensive genetic, socio-environmental, and clinical factors for a holistic understanding of health (Velmovitsky et al., 2021).

This integrated approach uses advanced technology to collect, analyze, and store vast volumes of real-time, diverse, and continuous health data, enabling more sophisticated and responsive public health strategies (Velmovitsky et al., 2021).

Furthermore, by incorporating diverse data sources such as social, behavioral, and environmental research alongside genomic data, the CDC aims to provide the right interventions to the right populations at the right time (Roberts et al., 2024).

This allows for a more granular understanding of disease etiology and progression, moving beyond a one-size-fits-all approach to public health interventions. Such an adaptive framework is crucial for addressing the growing global burden of chronic diseases, which are exacerbated by aging populations and fragmented healthcare systems (Wang et al., 2025).

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Definitions and Core Principles of Surveillance

Within this evolving landscape, surveillance is redefined as the continuous, systematic collection, analysis, and interpretation of health-related data essential for the planning, implementation, and evaluation of public health practice. This redefinition emphasizes a proactive, data-driven methodology that underpins precision public health by leveraging advanced analytics and real-time data streams to enhance public health interventions and optimize resource allocation (Rajendran et al., 2024).

This strategic shift allows public health authorities to more accurately identify at-risk populations and deploy targeted interventions, thereby maximizing the impact of public health initiatives and improving overall population health outcomes. Precision public health, emerging as a critical framework, leverages these integrated data streams to deliver tailored interventions to specific populations at the most opportune moments, taking into account individual variability in genes, environment, and lifestyle (Roberts et al., 2024; Velmovitsky et al., 2021).

This data-driven approach moves beyond traditional surveillance by incorporating large quantities of diverse data, enabled by advances in health data collection such as smart technologies, electronic health records, and genomic sequencing (Velmovitsky et al., 2021).

This convergence of precision medicine and public health, often referred to as precision public health, aims to revolutionize traditional public health approaches by integrating data-driven solutions para abordar os problemas de saúde pública mais desafiadores do mundo (Kenney & Mamo, 2025; Velmovitsky et al., 2021).

This paradigm usa comprehensive data, including genomics and advanced analytics, to optimize population health interventions, moving beyond generalized strategies to those tailored to specific community needs (Roberts et al., 2024; Velmovitsky et al., 2021).

Data Collection Methods and Sources

The efficacy of such tailored interventions hinges on robust data collection methods that encompass a broad spectrum of information, from individual-level genomic data to population-level environmental and social determinants of health (Khoury & Holt, 2021). This comprehensive data acquisition, including both structured and unstructured data, is critical for informing the development of targeted public health strategies and optimizing resource allocation (Abad et al., 2021).

This necessitates the adoption of advanced data science techniques, including artificial intelligence and machine learning, to process, harmonize, and integrate disparate data sources effectively, thereby

enabling predictive modeling and decision support for public health initiatives (Bosward et al., 2025; Dhanda et al., 2025; Talias et al., 2022).

The integration of machine learning further enhances surveillance capabilities through real-time prediction and identification of risk factors, addressing data challenges such as access and completeness (Baker & Bjerregaard, 2023; Dhanda et al., 2025).

However, despite the immense potential of AI in public health, its application requires careful evaluation of methodological rigor and an assessment of potential biases, particularly concerning differential implementation and measurement bias, which could exacerbate health inequities in underserved populations (Roberts et al., 2024).

Therefore, addressing these ethical considerations and ensuring equitable implementation is paramount to realizing the transformative potential of artificial intelligence in advancing public health outcomes (Bavli & Galea, 2024).

Data Analysis and Interpretation

Advanced analytical methods, including sophisticated statistical modeling and machine learning algorithms, are indispensable for extracting meaningful insights from these complex, multi-dimensional datasets (Velmovitsky et al., 2021).

These methods are crucial for discerning subtle patterns and associations that inform targeted public health interventions, moving beyond traditional epidemiological approaches that may overlook the intricate interplay of genetic, environmental, and behavioral factors (Roberts et al., 2021). Specifically, data science aims to integrate diverse data sources, visualize them effectively, and combine advanced analytic methods from various scientific fields, such as artificial intelligence, machine learning, statistics, and high-performance computing, to enhance decision-making and develop novel applications in public health (Talias et al., 2022).

The ability of AI to analyze both structured and unstructured data, such as that found in electronic health records and online sources, offers a significant advantage over traditional surveillance methods, enabling a more comprehensive understanding of disease trends and public health challenges (Morgenstern et al., 2021; Okoro et al., 2023).

This enables the identification of potential outbreaks and real-time tracking of disease spread, thereby guiding public health initiatives and mitigating the spread of infectious diseases (Olawade et al., 2023).

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Key Chronic Disease Surveillance Programs and Systems

The Centers for Disease Control and Prevention play a pivotal role in orchestrating a comprehensive array of surveillance programs and systems designed to monitor the burden of chronic diseases across the United States. These programs leverage extensive data collection and sophisticated analytical techniques to track disease prevalence, identify risk factors, and inform evidence-based public health interventions at national, state, and local levels. These initiatives are critical for understanding disease trends, evaluating the effectiveness of prevention strategies, and allocating resources efficiently to address public health challenges posed by chronic conditions (Igwama et al., 2024).

A key component of this surveillance involves the integration of artificial intelligence and big data analytics to not only track diseases but also to predict outbreaks and identify individuals at high risk for chronic conditions, enabling more personalized interventions (Anjaria et al., 2023; Igwama et al., 2024; Okoro et al., 2023). This advanced analytical capability allows for the development of more precise predictive models, facilitating proactive public health interventions and optimizing resource allocation for chronic disease management (Igwama et al., 2024).

Behavioral Risk Factor Surveillance System (BRFSS)

The Behavioral Risk Factor Surveillance System stands as one of the largest continuously conducted health surveys in the world, collecting state-specific data on health-related risk behaviors, chronic health conditions, and preventive practices among adult residents of the United States. Using telephone surveys, BRFSS provides critical insights into the prevalence of behavioral risk factors associated with chronic diseases, such as insufficient physical activity, unhealthy dietary patterns, and tobacco use, which are essential for guiding public health interventions (Maha et al., 2024).

The data collected through BRFSS aid in monitoring trends in chronic disease indicators and evaluating the impact of public health programs aimed at promoting healthier lifestyles and reducing the burden of chronic diseases nationwide (Carney et al., 2023).

Beyond its core function, BRFSS data further contributes to understanding the interconnectedness of chronic and infectious diseases, for example, by identifying populations with chronic conditions that may be more vulnerable to severe outcomes from infectious diseases such as COVID-19 (Huston & Porter, 2023).

For instance, the BRFSS data have been instrumental in examining associations between physical inactivity, vaccination status, and the development of long COVID among US adults (Heath et al., 2025).

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Moreover, researchers have employed machine learning models, including Logistic Regression, Gaussian Naive Bayes, Support Vector Machines, Random Forest, and K-Nearest Neighbors, using BRFSS data to predict 13 chronic health conditions based on demographic characteristics, Adverse Childhood Experiences, Social Determinants of Health, and health behaviors among U.S. adults, thereby explaining the relative importance of these variables in predicting each condition (Afzal et al., 2024).

This extensive dataset, encompassing both landline and cellular phone users, facilitates a comprehensive understanding of chronic conditions and risk behaviors among the noninstitutionalized adult population across all US states and territories (Budhathoki et al., 2023).

National Health and Nutrition Examination Survey (NHANES)

The National Health and Nutrition Examination Survey is another cornerstone of CDC's surveillance efforts, employing a unique combination of interviews and physical examinations to assess the health and nutritional status of adults and children in the United States. This program is particularly valuable for generating nationally representative data on the prevalence of chronic diseases, their risk factors, and nutritional deficiencies, which are critical for informing public health policy and clinical practice. NHANES data have been instrumental in tracking trends in obesity, hypertension, and diabetes, providing a detailed picture of the nation's health that complements survey-based data by including objective physiological measurements (Watson et al., 2025).

These objective measures provide a more accurate assessment of disease burden and risk factor prevalence than self-reported data alone, offering invaluable insights for epidemiological research and public health interventions (Watson et al., 2024).

National Chronic Disease Surveillance System (NCDSS)

The CDC's National Chronic Disease Surveillance System integrates data from various sources to provide a comprehensive overview of chronic disease burden and trends across the United States (Watson et al., 2024). This system synthesizes information from surveys, administrative data, and vital statistics to offer a holistic perspective on disease prevalence, incidence, mortality, and associated risk factors (Carney et al., 2023; Kim et al., 2023).

This integrated approach allows for a more nuanced understanding of the multifaceted challenges posed by chronic diseases, enabling the development of more effective and targeted public health strategies (Carney et al., 2023).

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This comprehensive system, which includes the Chronic Disease Indicators web tool, synthesizes data from multiple sources such as surveys, vital records, and administrative data, employing standardized definitions to estimate and track crucial indicators related to chronic diseases and their risk factors at both national and state levels (Watson et al., 2024). By aggregating diverse data types, the system facilitates cross-sectional analyses and longitudinal studies, offering critical insights into the natural history of chronic conditions and the effectiveness of public health interventions.

Disease-Specific Surveillance Initiatives

Beyond broad surveillance systems, the CDC also undertakes specialized initiatives focused on particular chronic diseases, recognizing that conditions like heart disease, cancer, and diabetes require tailored monitoring strategies due to their distinct etiologies, risk factors, and progression patterns (Watson et al., 2025).

These disease-specific surveillance efforts often involve detailed data collection through registries, enhanced surveillance systems, and epidemiological studies, allowing for a deeper understanding of disease burden, disparities, and intervention effectiveness. For instance, cancer registries collect incidence and survival data that are crucial for understanding cancer epidemiology and evaluating the impact of screening and treatment advancements.

4. IMPACT AND OUTCOMES OF CDC SURVEILLANCE

The continuous collection and analysis of data on chronic diseases are pivotal for comprehending the population's health status and trends, identifying emergent health challenges, and assessing the efficacy of public health interventions (Hacker & Kaufmann, 2024).

These surveillance activities underpin evidence-based policy-making, resource allocation, and the development of targeted prevention and control programs for chronic conditions, ultimately contributing to improved public health outcomes. The modernization of these surveillance systems, particularly in data flow and accessibility, is crucial for enhancing the public health system's capacity to monitor and address chronic diseases effectively (Carney et al., 2023).

This modernization effort aims to improve the timeliness, granularity, and representativeness of chronic disease data, thereby overcoming limitations inherent in traditional surveillance methods such as reliance on manual data collection and potential self-report biases (Li et al., 2025). Such advancements are vital for transitioning from a reactive to a proactive public health paradigm, enabling more precise identification of high-risk populations and earlier intervention strategies.

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Furthermore, by leveraging advanced analytics and interoperable data systems, these modernized approaches aim to illuminate complex interactions between various determinants of chronic disease, thereby facilitating a holistic understanding of disease progression and prevention (Carney et al., 2023).

Informational Role in Policy Development

The insights gleaned from comprehensive chronic disease surveillance directly inform the formulation of public health policies and guidelines, ensuring that interventions are evidence-based and aligned with the current epidemiological landscape (Hacker & Kaufmann, 2024). This critical function involves translating complex surveillance data into accessible, actionable intelligence for policymakers, enabling the development of targeted strategies to mitigate chronic disease burden and reduce health disparities. Moreover, these data facilitate the evaluation of existing policies, providing a feedback loop that allows for continuous refinement and optimization of public health initiatives.

The push for modernizing data infrastructure, particularly through initiatives like the Data Modernization Initiative, is essential to overcome outdated systems and facilitate a more rapid translation of data into actionable public health strategies (Carney et al., 2023). This modernization is not merely about technological upgrades but also about fostering a culture of data-driven decision-making, emphasizing the importance of timely, accurate, and integrated data for effective public health practice (Carney et al., 2023).

This transformation involves moving beyond classic surveillance approaches by incorporating electronic health record data and coordinating across all levels of public health to build sustainable monitoring tools (Barth et al., 2024).

These efforts are critical for enhancing the capacity of the public health system to effectively monitor and address chronic diseases, overcoming significant lag times in data availability and fostering more timely interventions (Carney et al., 2023). This systematic integration of diverse data streams, from electronic health records to various surveillance platforms, allows for a comprehensive and agile response to evolving chronic disease patterns, thus enabling precision public health interventions (Barth et al., 2024; Canfell et al., 2022; Jackson et al., 2024).

Influence on Public Health Interventions

The CDC's surveillance data are instrumental in shaping public health interventions by identifying populations at high risk, pinpointing geographic areas with elevated disease burdens, and assessing the effectiveness of preventive measures and treatment protocols (Ghildayal et al., 2024; Hacker & Kaufmann, 2024). This evidence-based approach ensures that resources are allocated efficiently and that interventions

are tailored to the specific needs of communities, maximizing their potential impact on chronic disease prevention and management.

This includes leveraging data from systems such as PCORnet to monitor chronic disease trends and adapt surveillance strategies for public health emergencies, as demonstrated by its utility in both chronic disease and COVID-19 surveillance (Ghildayal et al., 2024; Nansikombi et al., 2023). This adaptability underscores the potential of integrating diverse data sources to create a more resilient and responsive public health surveillance infrastructure (Ghildayal et al., 2024).

Contribution to Scientific Understanding

The comprehensive data collected through CDC surveillance initiatives significantly advances the scientific understanding of chronic diseases by elucidating their natural history, identifying novel risk factors, and informing the development of new diagnostic tools and therapeutic strategies. These extensive datasets also facilitate epidemiological research, enabling the study of disease determinants and outcomes on a population scale, thereby contributing to the evidence base for public health practice (Ghildayal et al., 2024).

The integration of electronic health records into surveillance systems, particularly through networks like PCORnet, has further augmented this scientific understanding by providing extensive longitudinal health information that captures clinical, treatment, and geographic data across large populations (Ghildayal et al., 2024). This enables researchers to analyze real-world clinical data, offering insights into disease progression and treatment effectiveness que metodologias de pesquisa tradicionais podem não capturar (Ghildayal et al., 2024).

Such comprehensive data sets allow for more robust analyses of disease prevalence, incidence, and the impact of various interventions over extended periods, thereby enhancing our ability to predict future trends and improve public health strategies (Ghildayal et al., 2024).

5. CHALLENGES AND LIMITATIONS IN CHRONIC DISEASE SURVEILLANCE

Despite the critical role of surveillance in chronic disease management, several inherent challenges limit the comprehensiveness and efficacy of existing systems. These limitations frequently stem from issues with data standardization, interoperability across disparate health information systems, and the timely aggregation and analysis of vast datasets (Ghildayal et al., 2024).

Moreover, the dynamic nature of chronic diseases, coupled with evolving diagnostic criteria and treatment modalities, poses continuous challenges for maintaining consistent and comparable surveillance

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data over time. These challenges compromise the precision, continuity, and comprehensiveness of chronic disease surveillance data, thus impeding the effective deployment of prevention and control strategies (Liu & Wang, 2025).

Data Quality and Completeness Issues

A significant obstacle in chronic disease surveillance is the variability in data quality and completeness, often arising from inconsistent data entry practices, missing information, or the reliance on self-reported data which can introduce recall bias. Furthermore, the fragmentation of surveillance systems and a lack of coordination between healthcare and public health sectors often leads to data silos, further exacerbating issues of data completeness and hindering comprehensive analyses (Barth et al., 2024).

This disaggregation complicates the accurate assessment of disease burden and the identification of nuanced trends across diverse populations, limiting the utility of surveillance for targeted interventions (Carney et al., 2023). These data quality concerns can impede the effective use of advanced analytical techniques, such as process mining, which relies on consistent and comprehensive datasets to accurately map disease trajectories and identify critical intervention points (Chen et al., 2024). Moreover, the absence of precise time stamps and the inherent stability of chronic disease spatial distribution, unlike the dynamic nature of infectious disease data, further complicate efforts to establish clear temporal relationships and evaluate the impact of interventions on disease progression (Hu et al., 2025).

Methodological Hurdles

Methodological hurdles in chronic disease surveillance frequently involve the difficulty in attributing causation due to multifactorial etiologies and the ethical complexities associated with long-term data collection and intervention studies. Additionally, the reliance on routinely collected health data, which may not have been originally intended for research purposes, can introduce biases and limit the generalizability of findings across diverse populations and healthcare settings (Canfell et al., 2022).

These issues are compounded by the inherent challenges in establishing standardized data quality metrics and ensuring data interoperability, particularly given the varied data needs of healthcare, social services, and public health entities (Carney et al., 2023).

Such disparities in data collection and reporting mechanisms further complicate efforts to achieve a unified and reliable chronic disease surveillance system, impacting the ability to generate evidence-based public health policies effectively (Nguyen et al., 2023).

Resource Constraints and Funding Gaps

Persistent resource constraints and significant funding gaps further exacerbate these challenges, hindering the implementation of advanced surveillance technologies and the training of skilled personnel necessary for robust data collection and analysis. This scarcity often leads to reliance on outdated systems and methodologies, thereby compromising the timeliness and accuracy of surveillance data (Ijeh et al., 2024).

Furthermore, a lack of dedicated efforts at national, state, and regional levels impedes the establishment and enforcement of data quality standards, which are crucial for leveraging electronic health record data in public health surveillance and disease monitoring (Barth et al., 2024; Hohman et al., 2024).

These fiscal limitations also impede the adoption of innovative solutions, such as those leveraging mobile sensing data and machine learning, which could significantly enhance the scope and precision of chronic disease monitoring (Liu & Wang, 2025).

Addressing Health Disparities

One of the most critical challenges is the lack of comprehensive data to identify populations with the greatest needs, especially in rural communities where limited healthcare infrastructure and inconsistent data collection further obscure health disparities (Carney et al., 2023; Igwama et al., 2024).

This lack of granular data, particularly concerning race, ethnicity, and socioeconomic indicators, significantly hinders the ability to craft targeted interventions for vulnerable groups and evaluate their effectiveness in reducing health inequities (Hohman et al., 2024).

Moreover, data fragmentation across multiple systems and jurisdictions often prevents a holistic view of chronic disease burdens, making it difficult to link health behaviors, interventions, and outcomes with social determinants of health and other community factors (Adekugbe & Ibeh, 2024; Carney et al., 2023).

6. FUTURE DIRECTIONS AND RECOMMENDATIONS

Advancements in artificial intelligence and machine learning present unprecedented opportunities for enhancing chronic disease surveillance through sophisticated data analysis and predictive modeling, moving beyond traditional statistical methods to identify complex patterns and correlations (Hohman et al., 2023).

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Enhancing Data Sharing and Collaboration

Improved interoperability among disparate data systems is crucial for facilitating seamless data exchange between states and the CDC, particularly given past challenges highlighted during events like the COVID-19 pandemic (Carney et al., 2023). Such integration would enable more rapid data aggregation and analysis, enhancing the timeliness and relevance of public health responses to emerging chronic disease threats. This enhanced data sharing framework, underpinned by robust data modernization efforts, is essential for improving the capacity of the public health system to monitor and address chronic diseases effectively, ensuring that actionable information is available without significant lag times (Carney et al., 2023).

Strengthening Workforce Capacity

Investment in training public health professionals in advanced data analytics, informatics, and epidemiology is paramount to fully leverage these technological advancements and address the growing complexities of chronic disease surveillance. Moreover, fostering interdisciplinary collaborations between public health agencies, academic institutions, and technology developers can create a robust ecosystem for innovation, enabling the development and implementation of cutting-edge surveillance tools and methodologies.

Policy Recommendations

To optimize chronic disease prevention and control, policies should prioritize comprehensive measures that leverage big data and information technology (Liu & Wang, 2025). This includes establishing standardized protocols for data collection and exchange alongside regulatory frameworks that promote ethical data use while safeguarding individual privacy, which are crucial for overcoming the persistent challenges in surveillance (Liu & Wang, 2025).

7. CONCLUSION

The Centers for Disease Control and Prevention play a pivotal role in chronic disease surveillance, providing the foundational data necessary for public health interventions and policy formulation. Through its extensive surveillance systems, the CDC systematically collects, analyzes, and disseminates critical information on chronic disease prevalence, incidence, mortality, and risk factors, thereby illuminating the nation's health landscape and guiding strategic public health actions.

The ongoing modernization of data infrastructure is pivotal for addressing health equity and enabling swift responses to emerging health crises. Furthermore, such advancements enhance the capacity to monitor and mitigate the profound impact of chronic conditions, which currently afflict 6 in 10 American adults and contribute significantly to the nation's substantial healthcare expenditures.

Indeed, chronic diseases, including heart disease, cancer, stroke, diabetes, and chronic kidney disease, are leading causes of death, with lifestyle risk factors such as tobacco use, poor nutrition, physical inactivity, and excessive alcohol consumption playing a significant role.

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