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Chronic Disease Management in Families: A Public Health and Biomedicine Perspective

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Abstract: Chronic illnesses, such as cardiovascular disease, diabetes, and cancer, have become a global health burden that must be tackled in an integrated manner that transcends the single patient. In this review, we focus on the critical significance of family dynamics in the care of chronic diseases and the junction between public health strategies and biomedical discovery. This review investigates how family behaviors, caregiver activities, and support groups affect illness prevention, drug adherence, and patient outcomes. It also highlights the socioeconomic and cultural effects of family access to healthcare and disease management resources. This systematic review aims to assess the effectiveness of family-based therapies and gaps in research, specifically addressing long-term outcomes and the role of emerging digital health interventions on family functioning. In addition, this review discusses the role of public health policies and biological discoveries, particularly genomic knowledge and customized therapy, in promoting family-based management of chronic disease. However, there are challenges, such as variations in healthcare access and the ethical question of accepting emerging technologies. Future research should also be on building long-term, family-based health promotion programs and measuring how health technology influences family involvement in disease management. It concludes with policy proposals for strengthening family involvement in chronic illness management through family-friendly health policies and interdisciplinary treatment models to enhance health.

Keywords: chronic disease, family dynamics, public health, biomedicine, caregiving, healthcare policy, personalized medicine

1. Introduction

1.1. Global burden of chronic diseases

Cardiovascular disease (CVD) remains the major cause of death worldwide, accounting for nearly 18 million deaths yearly. It comprises various types of heart and blood vessel problems, including coronary artery disease, heart attacks, strokes, and hypertension. CVD is primarily attributable to preventable risk factors including inadequate nutrition, lack of physical exercise, tobacco consumption, and excessive alcohol intake. Nonetheless, non-modifiable factors such as age, genetics, and family history exert a significant influence. Low- and middle-income countries account for approximately 75% of global CVD-related fatalities. This elevated frequency is generally associated with increased urbanization, lifestyle alterations, and restricted access to healthcare services [1]. The economic burden of CVD is substantial, impacting both healthcare systems and household finances due to costs related to long-term care, hospitalizations, and diminished productivity. Mitigating CVD requires a multifaceted approach, including public health initiatives, lifestyle modifications, early detection, and advancements in therapy and prevention [2].

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Diabetes is a major chronic condition affecting around 537 million persons globally as of 2021, with projections indicating an increase to 643 million by 2030. There are two primary types: Type 1 diabetes, which is an autoimmune disorder where the pancreas produces little to no insulin, and type 2 diabetes, which is defined by insulin resistance or an inability of the body to use insulin properly. Type 2 diabetes constitutes approximately 90% of global diabetes cases and is closely associated with obesity, sedentary behavior, and poor dietary habits. The prevalence of diabetes is notably pronounced in low- and middle-income countries, where urbanization and dietary shifts have led to a rise in incidence [3]. Beyond its immediate impact, diabetes is a substantial risk factor for other chronic illnesses such as CVD, renal failure, and neuropathy. Managing diabetes takes lifetime attention to blood sugar monitoring, treatment, and lifestyle adaptations, all of which can impose great psychological and financial stress on individuals and families. Public health strategies targeting early diagnosis, prevention through lifestyle adjustments, and the integration of biological technology, such as continuous glucose monitoring and increased insulin administration, are crucial to addressing the rising diabetes epidemic [4].

Cancer is a main cause of death globally, responsible for roughly 10 million deaths in 2020, with a projected 19.3 million new cases diagnosed in the same year. There are about 100 kinds

of cancer, with lung, breast, colorectal, and prostate cancers being the most frequent. Cancer arises from the unregulated division of abnormal cells, which can invade and spread to other bodily parts. While genetic changes are the main driver of cancer, environmental variables such as tobacco use, poor diet, alcohol intake, exposure to radiation, and infections like human papillomavirus also contribute greatly to its development [5]. The global burden of cancer is rising, particularly in low- and middle-income nations, where about 70% of cancer fatalities occur. These regions usually lack the healthcare infrastructure necessary for early detection, treatment, and palliative care, contributing to greater mortality rates. The economic repercussions of cancer are immense, not only due to the immediate expenses of treatment, such as chemotherapy, surgery, and radiation therapy but also because of lost productivity and long-term damage. Advances in biomedical research, such as immunotherapy, targeted therapy, and precision medicine, are revolutionizing cancer treatment and offering new hope for better survival rates. However, fair access to these technologies remains a considerable obstacle, particularly in resource-limited environments [6].

Chronic diseases are collectively responsible for almost 70% of mortality globally. These diseases share common risk factors, including poor diet, physical inactivity, tobacco use, and problematic alcohol drinking, which are frequently compounded by socioeconomic inequalities, environmental risks, and limited healthcare access. The worldwide burden of chronic diseases is predicted to increase as populations age, and the incidence of risk factors continues to rise, especially in low- and middle-income nations where healthcare infrastructure is often poor. The economic impact is as significant, with chronic diseases imposing huge costs on healthcare systems, limiting labor productivity, and driving people and families into poverty due to medical expenses [7]. Public health initiatives targeted at prevention, early identification, and management, coupled with developments in biomedicine, are crucial to reducing the global burden of chronic diseases (Table 1). Global health organizations, governments, and healthcare providers must work to develop integrated methods that focus on reducing risk factors, enhancing healthcare access, and supporting breakthroughs in treatment and management. Chronic diseases offer substantial difficulties to world health, economics, and families. While great progress has been achieved in identifying and managing chronic illnesses through biological discoveries and public health measures, the burden remains disproportionately high in underprivileged groups. A concerted effort is needed to create sustainable, family-centered, and internationally accessible solutions [8].

Table 1 provides the global prevalence, annual mortality, and economic burden of important chronic diseases, including CVDs, diabetes, cancer, chronic respiratory diseases, and mental disorders. The report underlines these diseases' tremendous health and financial challenges, emphasizing the importance of combined public health and biomedical interventions. These values are estimates based on recent global reports and may vary by region and data sources.

1.2. Global burden and impact of chronic diseases

Family dynamics are crucial in creating health habits, caregiving patterns, and general support in managing chronic diseases. Chronic diseases require long-term management and could lead to serious physical, mental, and financial challenges for individuals. In this context, the family unit becomes a critical support system, influencing how patients manage their disease and the effectiveness of treatment adherence, emotional well-being, and health outcomes. Family dynamics refer to the patterns of interaction, roles, communication styles, and interactions among family members. These dynamics can dramatically modify health behaviors, including eating, exercise, medication adherence, and

Table 1. Global burden of chronic diseases

Chronic disease	Global prevalence	Annual mortality	Economic burden	Source
Cardiovascular Diseases	Approximately 523 million cases (2020)	Over 19 million deaths (2021)	Estimated to reach $1 trillion annually by 2030 (direct and indirect costs)	World Heart Report 2023: Confronting the World's Number One Killer. Geneva, Switzerland. World Heart Federation. 2023.
Diabetes	Approximately 537 million adults (2021)	1.5 million deaths (2021)	Global economic burden projected to reach $2.1 trillion annually by 2030 (including healthcare costs and productivity loss)	https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases?utm_source
Cancer	Nearly 20 million new cases (2022)	Approximately 9.7 million deaths (2022)	Global economic burden estimated at $1.16 trillion annually (direct treatment and care costs)	https://doi.org/10.3322/caac.21834 or https://acsjournals.onlinelibrary.wiley.com/
Chronic Respiratory Diseases	Over 545 million cases (2017)	Approximately 4 million deaths (2021)	Estimated annual economic burden of $300 billion (direct healthcare costs)	https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases?utm_source
Mental Disorders	Approximately 970 million people affected (2019)	Over 700,000 suicide deaths (2021)	Global economic burden projected to reach $6 trillion annually by 2030	https://www.who.int/news-room/fact-sheets/detail/noncommunicable-diseases?utm_source

lifestyle alterations, which are crucial in managing chronic illnesses [9]. Additionally, the caregiving role that family members typically assume is vital in aiding persons with chronic diseases and offering physical, emotional, and practical assistance. The relevance of family dynamics in chronic disease management is increasingly acknowledged in both public health and biomedical sectors, where family-centered therapies and policies are being studied to optimize health outcomes [10]. Family involvement is critical in chronic disease management because it influences patient adherence to treatment, lifestyle modifications, and overall well-being. Beyond caregiving, families play a crucial role in fostering emotional resilience, facilitating communication with healthcare providers, and creating a supportive environment that enhances disease self-management. Socioeconomic factors within families, such as financial stability and health literacy, also determine access to medical care and the ability to maintain long-term disease control. Moreover, family members can help identify early warning signs of disease progression, reducing complications and hospitalizations. Given these multidimensional roles, integrating family-centered approaches into chronic disease management can significantly improve patient outcomes and healthcare efficiency [10].

1.2.1. Role of family dynamics on health behaviors

One of the most crucial components of regulating chronic diseases, including diabetes, CVD, and cancer is food. Family dynamics strongly influence eating patterns, food choices, and meal preparation, making the family a key predictor of nutrition-related behaviors. In many cultures, families share meals, and the dietary habits of the home can either promote or obstruct the management of chronic diseases. For instance, in the case of diabetes management, families that support excellent eating patterns such as reduced sugar intake and balanced meals can lead to better glycemic control for the patient [11]. Conversely, families that continue unhealthy eating practices, such as high-fat or high-sugar meals, could exacerbate the patient's sickness. Additionally, family members can promote or discourage behaviors, including portion management, meal planning, and cooking methods, which are crucial for managing chronic diseases.

Physical activity is another key component of chronic disease treatment, particularly CVDs and diabetes. Family relationships can either stimulate or discourage individuals from engaging in regular exercise. Families participating in physical activities together, such as walking, sports, or gym sessions, establish an environment where physical fitness becomes a common objective. On the other side, sedentary family situations, where members do not prioritize or engage in physical activity, might severely affect an individual's capacity to adhere to exercise programs. Social support from family members is commonly regarded as a primary motivator for sustaining regular physical activity, particularly in patients who are elderly or have mobility issues owing to chronic conditions [12].

Medication Adherence and Health Monitoring: Family relationships also have a crucial role in promoting medication adherence and regular health monitoring, essential for managing chronic diseases. Chronic diseases generally require complex prescription regimens, and the support of family members can considerably enhance adherence. Family members may remind patients to take their medication, help handle prescriptions, and accompany them to doctor's appointments. In homes with substantial and supportive communication, patients are more likely to adhere to their treatment plans, attend regular check-ups, and monitor their health conditions. However, patients may find it difficult to effectively manage their illness in families where there is discord or a lack of support, which could result in subpar health results. For instance, studies have shown that improving blood pressure and glucose management in patients with diabetes or hypertension can result from family members participating in their daily drug regimens [13].

1.2.2. Caregiving and emotional support

Chronic diseases often lead to a progressive decline in physical and functional capacities, prompting family members to take on the role of caregivers. Family caregivers provide a wide range of services, from helping with daily activities such as bathing, dressing, and feeding to managing medical care such as delivering medicine, monitoring symptoms, and coordinating healthcare professionals. This caring function is crucial in ensuring the patient's well-being and quality of life. The presence of a loving family caregiver can prevent hospitalizations, enhance adherence to therapy, and facilitate recovery or illness management. Family members may take on more specialized caregiving responsibilities in diseases like cancer, such as scheduling chemotherapy sessions, seeing wounds, or even giving injections [14]. However, caregiving can also be physically and emotionally challenging for family members. It is not uncommon for caregivers to experience caregiver stress, burnout, and emotional exhaustion, especially when caring for a loved one with a chronic or terminal illness. Family relationships can either decrease or worsen these challenges. Caregivers report reduced stress and better emotional health in homes where caregiving responsibilities are divided and communication is open. In contrast, households whose caregiving tasks are inadequately allocated, or when there is a dispute over caring roles, are likely to suffer higher strain and stress levels [15].

Family members' emotional and psychological support is essential for managing chronic diseases and providing physical care. As they struggle with the long-term nature of their illness and the lifestyle changes it requires, people with chronic diseases frequently experience emotions of loneliness, hopelessness, and anxiety. Emotional support from family members can help buffer these adversarial impulses and offer a sense of stability and belonging. Family members who offer support, listen to the patient's problems, and provide positive reinforcement can assist in boosting the patient's mental health and general resilience. Research has indicated that emotional support from family members can contribute to better psychological adjustment to chronic disease, increased quality of life, and even extended longevity in patients with life-threatening conditions like cancer [16]. Conversely, dysfunctional family relationships, such as poor communication, neglect, or antagonism, might contribute to inferior health outcomes. The psychological burden of chronic illness can be exacerbated by family disputes, a lack of empathy, or excessive stress in the home. These factors can also result in poor treatment compliance, disregard for medical needs, and a deterioration of the patient's condition.

1.2.3. Socioeconomic and cultural factors in family dynamics

Socioeconomic factors significantly impact family relations and, consequently, how chronic illnesses are managed. Families with higher socioeconomic levels usually have better access to healthcare services, health knowledge, and resources for treating chronic conditions. In contrast, families from weaker socioeconomic backgrounds may struggle with access to cheap healthcare, medicine, and nutritious nutritional options, making it more challenging to manage chronic diseases. The inability of one or more family members to work due to illness can also cause financial hardship, making it more difficult for them to manage the disease. In many cases, family dynamics are impacted by

financial issues, which could impair the family's ability to provide critical assistance [17].

Cultural attitudes and customs also influence family interactions and health-related behaviors. In some cultures, there is a considerable emphasis on family engagement in healthcare decisions, which might provide supportive settings for treating chronic diseases. Families' approaches to managing illness may be influenced by cultural norms surrounding food, caregiving, and traditional medicine. For example, extended families may be the primary caregiver for people with chronic illnesses in some cultures, while in others, a single person may be the primary caregiver. Families' openness in discussing and addressing the management of chronic diseases may also be influenced by cultural stigmas associated with specific illnesses, such as mental health disorders or cancer [12].

1.3. Objective of the review

This review examines public health policies and biological discoveries to evaluate the important role that family dynamics play in managing chronic diseases. Effective chronic disease management demands a thorough strategy, with family participation being accepted as a critical element in developing health habits, ensuring treatment compliance, and giving emotional support. In order to improve illness outcomes, this review investigates how family-centered care is used in efforts to promote public health. It additionally examines how biomedical advancements, such as digital health tools and personalized medicine, can help families better manage chronic illnesses. This review assesses the influence of family roles on caring, decision-making, and lifestyle modifications, therefore presenting a full grasp of how family dynamics affect patient outcomes. Furthermore, it investigates the inclusion of these dynamics into public health policy and the potential of emerging biomedical technology to improve family-oriented disease management. The major purpose is to provide insights into effective interventions that can strengthen the family's participation in managing chronic diseases, thereby improving public health outcomes.

1.4. Research gaps

Research gap in family-centered chronic disease management emphasize various topics demanding deeper study. A notable shortcoming is the demand for additional longitudinal studies on the efficacy of family-based therapy. While short-term advantages of various therapies, such as better medication adherence and healthy lifestyle improvements, have been proven, the sustainability of these effects over time is less understood. Research is needed to understand how family dynamics evolve in chronic disease treatment and if these treatments lead to sustainable benefits in patient health and family well-being. Another topic requiring deeper exploration is the impact of digital health tools on family dynamics. While technology like mobile health apps and wearable gadgets present prospective means to monitor and manage chronic diseases, their effects on family connections, communication, and caregiving tasks are not entirely investigated. Understanding how these tools influence family support networks, decision-making, and the emotional components of caregiving should motivate the invention of more effective, family-friendly health technology [18]. Additionally, there is a need to assess if these tools cause disparities in care for families with limited access to technology or digital literacy. Addressing these research gaps could lead to more refined strategies for family-centered chronic illness care, ensuring both long-term efficacy and fair access.

1.5. Study selection process

We conducted a comprehensive literature search across multiple databases, including PubMed, Scopus, Web of Science, and Google Scholar. The search strategy involved using keywords and MeSH terms related to chronic disease management, family dynamics, caregiving, and health outcomes. Boolean operators (AND, OR) were applied to refine the search results.

Inclusion Criteria:

1). Peer-reviewed articles published within the last five years (unless historically significant).
2). Studies focusing on the impact of family involvement on chronic disease management.
3). Articles written in English and accessible in full text.

Exclusion Criteria:

1). Studies unrelated to family dynamics in chronic disease care.
2). Review articles, editorials, or opinion pieces without original data.
3). Non-English publications lacking translations.

2. The Impact of Family Dynamics on Chronic Disease Management

The management of chronic diseases is greatly impacted by family dynamics. Healthy behaviors that are essential for managing chronic diseases, like taking medication as prescribed, eating a balanced diet, and getting regular exercise, can be encouraged by positive family connections (Figure 1). Families also provide vital emotional support, helping patients cope with the psychological stress that frequently accompanies chronic sickness. Additionally, family members frequently act as caregivers, helping with everyday care and medical duties, which can improve treatment compliance and avoid hospital stays. On the other hand, dysfunctional family dynamics, such as inadequate support, conflict, or poor communication, may hinder the successful management of disease [19]. Family-related stress can affect health outcomes by contributing to neglect of treatment programs, unhealthy habits, and emotional distress in patients. Therefore, knowing the significance of family dynamics is crucial for creating therapies that leverage family support networks to promote chronic disease management and patient well-being [19].

Figure 1 illustrates the central role of family dynamics in influencing chronic disease management through three interconnected domains: health behaviors (diet, exercise, and medication adherence), caregiving roles (emotional, psychological, and physical support), and socioeconomic factors (income, cultural beliefs, and healthcare access).

2.1. Family influence on health behaviors

Family influence is crucial in influencing health practices to avoid and manage chronic diseases. The lifestyle choices of an individual are directly influenced by the food habits, physical activity, and daily routines of their family. For instance, in households where healthy eating is encouraged, individuals are more likely to follow healthful dietary patterns, which are crucial for treating illnesses like diabetes and CVD. On the other side, in families with terrible eating habits, people may struggle to make good dietary choices, elevating the risk of chronic disease. Similarly, when physical activity is interwoven into family life, such as engaging in frequent walks or sports together, it produces an environment that fosters exercise, a critical ingredient in

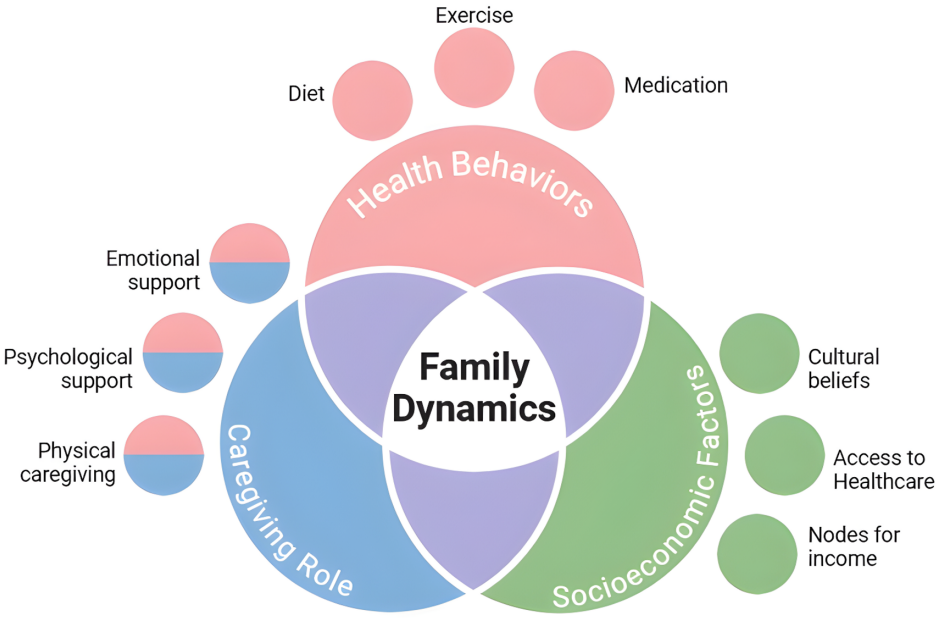

Figure 1. Conceptual framework of family dynamics in chronic disease management.

managing weight, blood pressure, and overall health [12]. Communication within the family also has a critical effect on health practices. Families who regularly discuss health-related subjects, including disease prevention and management, tend to make more knowledgeable health decisions. These discussions can encourage members to follow medical recommendations, adhere to treatment regimens, and seek medical care when necessary. Additionally, effective communication facilitates the coordination of support, including helping with medical appointments and reminding family members to take their medications. Families that help one other in managing chronic conditions usually have better outcomes, as emotional encouragement and practical assistance can promote adherence to treatment regimens [10].

Family support networks are essential for ensuring individuals stay dedicated to controlling their health. For patients with chronic conditions, having a family that provides both emotional and practical support increases the chance of favorable health habits. When family members actively assist with duties like preparing nutritious meals, monitoring medication regimens, or participating in exercise routines, it reaffirms the patient's commitment to controlling their illness. Additionally, this support helps lessen feelings of loneliness or stress, contributing to greater mental health and overall well-being. Thus, family impact is a major driver in disease prevention and chronic disorders' long-term management [20].

2.2. Caregiving and emotional support

Family members often take on the role of primary caregivers for people with chronic conditions, and this job involves a range of psychological, emotional, and physical components. The caring profession may be fulfilling and difficult, involving great time, effort, and emotional engagement. Caregivers aid with everyday activities such as medication management, meal preparation, transportation to medical appointments, and even physical care, especially when the patient's disease leads to incapacity or fragility. These responsibilities are essential for improving disease management and reducing hospitalizations, as they ensure the patient follows treatment plans and maintains a quality of life [21]. Patients frequently receive critical emotional support from family caregivers, who reassure, uplift, and soothe them during trying times.

Chronic sickness can bring up feelings of anxiety, frustration, and loss, and having a caring family member present might help alleviate these emotions. This emotional support is necessary for patients since it can increase their mental resilience and overall well-being, which are key variables in treating chronic diseases. However, caring can also be emotionally exhausting for family members, leading to stress, worry, and even caregiver burnout if not appropriately managed [22].

The physical responsibilities of caregiving may lead to exhaustion, sleep deprivation, and physical health concerns for the caregivers themselves. In some cases, caregivers may overlook their health needs, risking their well-being. Therefore, it is vital for caregivers to have enough aid and resources, both from healthcare practitioners and the greater family, to help balance caring chores with self-care. When family caregivers are supported, both emotionally and physically, they are more effective in helping manage chronic diseases, contributing to improved outcomes for patients [23].

2.3. Socioeconomic and cultural factors

Access to healthcare and the management of chronic illnesses in families are significantly influenced by socioeconomic and cultural factors. A person's socioeconomic status (SES) can have a direct impact on their ability to pay for prescription drugs, follow treatment plans, and seek medical attention. Access to high-quality healthcare services, such as routine check-ups, specialized treatments, and preventative care, is frequently better for families with greater SES. They are also more likely to have the resources to embrace recommended dietary and lifestyle alterations that are important for treating chronic illnesses. In contrast, families with lower SES may experience problems such as limited access to healthcare facilities, absence of health insurance, or financial limitations that hinder their capacity to obtain drugs or attend regular medical appointments. These barriers can result in delayed diagnoses, inefficient therapy, and inferior disease management outcomes [24]. Cultural attitudes and beliefs can strongly

influence chronic disease management. In many cultures, family members play a key position in healthcare decision-making, which can either aid or hinder the management of chronic diseases. For instance, cultural practices or beliefs about illness may influence people's inclination toward traditional medicine over modern healthcare or their reluctance to seek medical advice until their symptoms are severe. This can delay therapy and negatively damage health consequences. On the flip hand, some cultures place a strong premium on family support, where extended family members actively participate in caregiving, which can foster a more collaborative and successful approach to managing chronic diseases [25].

The management of chronic diseases is also influenced by family structure, especially when it comes to caregiving duties. In cultures with extended family systems, caregiving may be shared among multiple relatives, which can minimize the mental and physical stress on any particular caregiver. However, in more nuclear family structures, caregiving often falls on one or two adults, which can lead to caregiver strain if not appropriately supported. Additionally, family members' awareness of chronic diseases, determined by cultural attitudes and educational background, can either encourage or hinder successful disease management. For instance, among families with good knowledge of the requirement of early intervention and adherence to medical advice, chronic disease care is likely to be more effective [26].

3. Public Health Approaches to Family-Based Chronic Disease Management

3.1. Family-centered health promotion programs

Family-centered health promotion programs aim to engage families directly in disease prevention and management, acknowledging families' vital role in shaping health practices. These programs often encourage healthy lifestyle changes, such as improved nutrition, regular physical activity, and better stress management, which are critical for avoiding and managing chronic diseases. Family-based lifestyle interventions often engage several family members in building supportive environments for healthy living, making it simpler for individuals to adopt sustainable habits [21]. For example, programs may integrate family fitness activities or culinary instruction aimed at promoting diet and activity habits inside the house. In addition to lifestyle improvements, educational programs are an important component of family-centered health promotion. These programs educate families with knowledge about chronic diseases, their risk factors, and suitable management options. By teaching family members, these programs strive to develop a supportive environment where everyone understands the importance of medication adherence, regular check-ups, and good lifestyle choices. Family-centered programs usually incorporate techniques that address cultural and socioeconomic factors, ensuring that they are relevant and accessible to various groups. These efforts encourage families to take an active part in sickness prevention and management, ultimately improving health outcomes and reducing the burden of chronic diseases on individuals and healthcare systems [27].

The success of family-centered health promotion initiatives is predicated upon their flexibility to fit the individual requirements of distinct families. These demands adjusting interventions to meet cultural, social, and structural inequalities among families. For example, a program targeted at promoting healthy eating can include culturally relevant recipes and incorporate family members' traditional culinary tastes to enhance engagement. Similarly, programs must target the socioeconomic condition of families to ensure that interventions are accessible and durable. This can involve offering free or subsidized services, providing educational materials in many languages, or making resources available online to enhance accessibility for families with restricted mobility or time [28]. Family-centered health promotion initiatives provide a promising technique for chronic illness prevention and management. By involving families in health promotion, these projects harness the collective power of family dynamics to establish positive health behaviors, increase illness management, and minimize health disparities. As public health programs continue to increase, it is vital to recognize the importance of family involvement in sickness prevention and integrate family-centered strategies into healthcare policies and treatments [29].

3.2. Community health initiatives

Community-based programs play a crucial role in supporting families managing chronic conditions by providing resources, social support, and education in a local environment. These projects are aimed to empower individuals and families by developing a network of care that extends beyond the hospital system. Peer support groups are one of the most effective community-based projects, where folks facing similar chronic conditions gather together to share experiences, trade coping techniques, and provide mutual emotional support. These groups not only lessen feelings of loneliness but also generate a sense of belonging and collective strength, which is crucial for both patients and their family members. The shared experiences in these groups can help families feel more capable in facing the day-to-day issues of chronic disease [30]. In addition to peer assistance, community health seminars are another key endeavor that helps families manage chronic conditions. These workshops often contain a wide range of themes essential to disease management, including healthy meals, exercise routines, stress management, and medication adherence. By delivering practical knowledge in an accessible style, workshops allow families to learn together, underlining the relevance of collective involvement in health promotion. Families also benefit from the ability to communicate with healthcare professionals, ask concerns, and receive tailored advice in a comfortable setting [31].

Moreover, community health initiatives often provide a platform for families to access resources and services that they might otherwise struggle to obtain. For example, local organizations may offer free or low-cost testing for chronic diseases, health education materials, and links to healthcare specialists. These services might be especially valuable in underdeveloped regions, where access to healthcare might be limited. By integrating healthcare support into the community, these efforts assure that families have the resources and information essential to manage chronic conditions effectively. Overall, community-based projects provide a key layer of support for families managing chronic conditions, delivering practical knowledge, emotional support, and access to healthcare resources in a way that is both accessible and sustainable. These programs serve to create adaptability within families, increasing collaboration and empowerment, ultimately enhancing health outcomes and quality of life [32].

3.3. Policy recommendations for family health support

Policy initiatives that emphasize family involvement in chronic disease prevention and management are crucial for building an

environment where families may effectively support their loved ones while also addressing broader public health concerns. Family-friendly healthcare policies are one critical area where public health may play a huge impact. These regulations may include provisions that let family members to go with patients to doctor's appointments, confer with doctors, or use medical services that address the needs of the entire family rather than just the patient. Families are better able to understand their loved ones' medical needs and take an active role in their treatment when family-centered care is included in healthcare policies. This can enhance disease management and health outcomes [33]. Another key challenge is the integration of counseling and support services into healthcare systems. Policies that enable access to mental health counseling and emotional support for both patients and caregivers are crucial in lowering the psychological burden associated with chronic diseases. Chronic sickness often implies great worry, anxiety, and emotional strain on families, particularly on primary caregivers. Access to counseling services, support groups, or family therapy can help ease some of these emotional concerns and prevent caregiver burnout. Support programs that offer guidance in managing caregiving tasks and coping with the emotional components of chronic illness are particularly crucial in retaining family involvement in long-term disease management [34].

Moreover, public health policies that boost the provision of preventative healthcare services for families can have a big impact on chronic illness management. Chronic disease can be prevented or at least detected and treated early with the support of policies that promote regular screenings, immunizations, and family health education. Ensuring that families have access to affordable healthcare services, including preventative care and disease management programs, is a key step in minimizing the burden of chronic diseases on both people and families. Finally, families' overall well-being and, consequently, their capacity to manage chronic illnesses, can be enhanced by policies that address the socioeconomic determinants of health, such as housing, education, and employment. Families with better economic stability and access to nutritious food, safe living conditions, and educational opportunities are better positioned to avoid and manage chronic diseases. Therefore, reducing health disparities and making sure that all families, regardless of SES, have the resources necessary to properly manage chronic diseases should be the top priorities of public health policy [35].

4. Biomedical Advances in Family-Based Disease Management

4.1. Genomic insights and personalized medicine

Precision medicine and genomics developments are rapidly changing the healthcare environment, especially when it comes to treating chronic diseases that run in families. Healthcare professionals can now offer more tailored and successful treatment options based on individual genetic profiles because of the growing accessibility and affordability of genomic sequencing technologies. This is particularly critical for chronic diseases, which generally contain hereditary components that predispose individuals to elevated risks. Genomic insights enable more specific identification of some hereditary hazards, leading to earlier detection and better-targeted therapy. The ability to detect genetic mutations or susceptibilities early enables healthcare practitioners to deliver tailored preventive measures and treatment programs, not just for the affected individual but also for family members who may have the same genetic predispositions [36]. Genomics has additionally helped to a clearer understanding of the complicated links between genetic and environmental factors in the genesis and progression of chronic diseases. Genomic insights can help differentiate between those whose issues are primarily caused by hereditary reasons and those whose disorders are influenced by environmental variables. For instance, CVD combines both genetic and lifestyle-related risk factors. This understanding allows for a more complete approach to sickness prevention and management, with family members being educated on both inherited risks and lifestyle adjustments that can lower their likelihood of developing chronic disorders [37].

In particular, one of the key benefits of genomic developments is the discovery of familial genetic variants that contribute to the inheritance of chronic diseases. Genetic testing, for instance, can identify mutations in tumor suppressor genes like BRCA1, BRCA2, or MLH1 in families with a history of hereditary cancer syndromes like Lynch syndrome or hereditary breast and ovarian cancer syndrome. Once detected, afflicted family members can be followed more closely, participate in frequent screenings, and take preventive interventions, such as prophylactic surgeries or chemoprevention, to minimize their risk [38]. According to a person's unique genetic risk, precision medicine provides the chance to customize the type, frequency, and timing of screening or intervention. Similarly, for chronic disorders like type 2 diabetes, where genetic predisposition plays a crucial role, precision medicine allows for tailored treatment regimens. Genetic characteristics impact how individuals absorb medications, how they respond to lifestyle alterations, and their overall risk for developing diseases. By integrating genetic testing into regular diabetes care, healthcare practitioners can select the most appropriate medicines for managing blood glucose levels [39]. For example, genetic variations in the glucokinase gene can vary how a patient responds to various diabetes drugs, allowing for more effective and individualized treatment choices. By customizing interventions to individual genetic profiles, precision medicine decreases trial-and-error procedures, eliminates unpleasant effects, and promotes overall patient adherence to treatment regimens.

Moreover, precision medicine offers significant promise for increasing family-based care by extending its benefits beyond the individual. Early disease screening and genetic counseling are beneficial for family members who have similar genetic predispositions. For instance, if one family member is diagnosed with early-onset CVD or diabetes, more members may be encouraged to do genetic testing to evaluate their own risks. Since therapies can be combined to address both individual and family health needs, genomic medicine offers a chance for family-wide health management. This collaborative approach to health management is becoming an increasingly significant aspect of tailored therapy [40]. Hereditary counseling also plays a vital role in enabling families to identify their hereditary risks and navigate the repercussions of disease treatment. Genetic counselors help family members understand the potential advantages and restrictions of genetic testing, help interpret the results of genetic tests, and offer comprehensive information about the inheritance patterns of chronic diseases. They also offer recommendations on preventative strategies, screening choices, and lifestyle adjustments that could lessen the probability of chronic illness development. Genetic counselors collaborate closely with families in cases of hereditary cancer syndromes to make sure that everyone is informed of their genetic risks and has access to the right preventative measures [41].

The integration of genomic medicine and tailored treatment strategies into family care models is crucial for improving chronic illness outcomes. By assessing the genetic makeup of family members, clinicians can design tailored solutions that not only fit

the current requirements of the specific patient but also account for the threats posed to other family members. By fostering a holistic perspective on family health, this approach guarantees that every member takes an active role in managing and preventing illness [42].

4.2. Advancements in technology for monitoring chronic diseases

Technological breakthroughs have altered the care and monitoring of chronic diseases, providing families with advanced tools to monitor health in real time and handle problems more efficiently. This process is greatly aided by wearable technology, such as fitness trackers and smartwatches, which continuously monitor vital indications including blood pressure, heart rate, glucose levels, and physical activity. These electronic devices provide vital, current health information that may be shared with medical professionals for families dealing with chronic conditions like diabetes, hypertension, or CVD. This permits quicker interventions, decreasing hospital visits and enhancing illness management by permitting immediate adjustments to treatment plans based on real-time data. Additionally, mobile health applications have become important resources for managing chronic illnesses in families [43]. These apps allow users to track medications, report symptoms, and monitor food and exercise regimes. For instance, diabetes management programs enable users to enter blood glucose levels, check insulin dosage, and even receive reminders for medication or imminent visits. Family members and medical professionals can more easily track development when these apps are connected to wearable technology and gather data in one place. With these tools, families can collaborate more effectively in managing a loved one's sickness, ensuring adherence to treatment procedures and lifestyle adjustments [44].

Moreover, health technologies enable for enhanced customization of disease management regimens. Many apps and gadgets allow users to establish specific goals, such as target blood glucose levels or fitness goals, which may be updated as needed. This level of personalization is particularly crucial for chronic disease treatment, since it allows family members to track individual progress and alter interventions accordingly. Additionally, some apps and gadgets provide educational resources and prompts that enable family members to take a more active role in providing care and have a better understanding of the illness they are treating. Another advantage of these technologies is the capacity to increase communication between patients, caregivers, and healthcare practitioners [45]. Real-time data exchange via applications and wearable devices guarantees that healthcare practitioners are informed of a patient's health status, allowing for fast modifications to treatment regimens when necessary. For instance, if a wearable device identifies irregular heart rhythms in a patient with cardiovascular illness, the information can be rapidly conveyed to their healthcare professional for assessment, decreasing the time between detection and intervention [46].

Telemedicine technologies further complement these improvements by enabling remote consultations and continuing monitoring, which can be especially useful for families living in rural or underserved areas with restricted access to healthcare services. Virtual consultations allow families to remain regular communication with healthcare specialists without the need to travel, ensuring that chronic conditions are consistently managed and monitored. In conclusion, technology innovations such as wearable gadgets and mobile health apps have substantially increased the management of chronic diseases, especially within family situations. These solutions give families the option to track, monitor, and manage health issues in real time, guaranteeing better sickness management, adherence to therapy, and timely interventions. These technologies will become increasingly important in enabling families to manage chronic diseases in a proactive and cooperative manner as they develop [47].

4.3. Biomarkers and early detection

Advances in biomarker research have substantially boosted the early identification and risk assessment of chronic diseases, giving new alternatives for proactive family health management. Biomarkers, which are biological signs that can detect the presence of disease, have become significant tools in diagnosing and monitoring chronic conditions such as CVD, diabetes, and cancer. These breakthroughs permit for early intervention, potentially before the disease reaches an advanced stage, increasing overall health outcomes and reducing the burden of chronic diseases on families [48].

The identification of specific biomarkers, such as B-type natriuretic peptide or high-sensitivity C-reactive protein, has allowed physicians to identify people at risk for CVD long before symptoms appear. It is possible to take timely preventative measures, including changing one's lifestyle or taking medicine, when risk markers, such as elevated cholesterol or inflammatory signs, are identified early. In families with a history of CVD, this early diagnosis can assist in monitoring numerous family members who may be genetically prone to heart difficulties, leading to better-targeted preventative approaches and minimizing the chance of disease development. In the case of diabetes, markers like fasting glucose levels and glycated hemoglobin have become standard in assessing risk and diagnosing the condition [2]. Healthcare professionals can now identify people at higher risk of type 2 diabetes even before their blood sugar levels reach dangerous limits thanks to studies that have discovered additional genetic and metabolic biomarkers. For families with a history of diabetes, early identification of at-risk individuals allows for more targeted health therapies, such as dietary modifications and exercise regimes, potentially delaying or eliminating the beginning of the illness [49].

Cancer biomarkers have similarly transformed the early identification and therapy of various cancers, including breast, prostate, and colorectal cancer. For instance, BRCA1 and BRCA2 mutations are essential indications for hereditary breast and ovarian cancers, whereas prostate-specific antigen levels are used to determine prostate cancer risk. These indications assist in identifying individuals with a hereditary vulnerability to cancer, enabling early screenings and preventative therapies, such as prophylactic surgery or chemoprevention, for high-risk family members. This is especially crucial in families with a history of genetic malignancies, as early diagnosis can considerably boost treatment outcomes and survival rates [50]. The inclusion of biomarkers into family health care enables a more customized and proactive approach to chronic disease prevention. Families might decide on lifestyle modifications, early testing, and preventive therapies after learning about their inherited risks. For example, other family members can be urged to get tested and engage in preventive measures if one of them tests positive for a genetic risk factor. Every family member is more actively involved in preventing sickness when there is a shared understanding, which results in collaborative health management [51].

5. Integrating Public Health and Biomedical Approaches

5.1. Collaborative models of care

Collaborative models of care, which integrate public health programs with innovations in biology, have been indispensable in

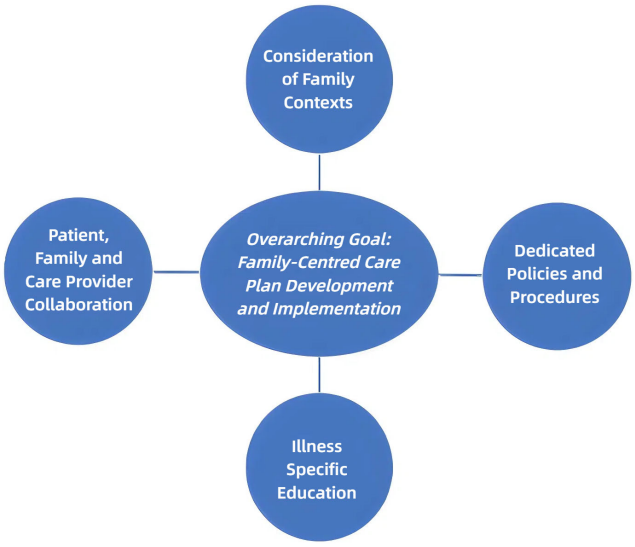

Figure 2. Universal model of family-centered model.

improving family-based disease treatment, particularly for chronic diseases. These models highlight the complexity of chronic diseases and the demand for coordinated, diversified approaches to care. By bringing together healthcare experts from multiple disciplines such as doctors, nurses, dietitians, social workers, and family caregiver these models promote a more holistic and tailored approach to managing chronic diseases within families [52]. Multidisciplinary care teams are at the core of collaborative models. These teams work together to build comprehensive care plans that address all elements of a patient's disease, from medical treatment to lifestyle management. For instance, a social worker may be consulted for the psychological and emotional aspects of caregiving, a nurse for blood glucose monitoring, a dietician for dietary counseling, and an endocrinologist for medication management for a family member with diabetes. This collaborative approach guarantees that all elements influencing a patient's health are examined and addressed in harmony, leading to more effective disease control and better patient outcomes [53].

This provides a graphical summary of the essential components of FCM. Figure 2 [54] demonstrates the general purpose of FCM models and the main components required to accomplish this goal, including universal and illness-specific components.

In addition to medical professionals, family members are crucial players in collaborative care models. As primary caregivers, family members help manage the daily components of chronic disease care, such as medication adherence, dietary adjustments, and physical activity. Public health activities that educate families on how to participate in care are crucial to enhancing this relationship [18] (Table 2). In these approaches, care is coordinated throughout primary, intermediate, and tertiary levels of care, allowing for seamless transitions between different stages of disease management. For instance, a patient diagnosed with cancer might initially receive treatment in a hospital environment but would also require follow-up care in outpatient clinics, rehabilitation services, and home care. By developing a network of care that encompasses both healthcare facilities and community-based services, integrated care models ensure that patients and their families have continuous support, eliminating fragmentation in care and improving overall disease management [54].

Table 2. Examples of public health initiatives in family-based chronic disease management

Program name	Program type	Target population	Key metrics and outcomes	Source
Diabetes Prevention Program (DPP)	Lifestyle management	Adults at high risk for type 2 diabetes	58% reduction in diabetes incidence over 3 years; larger impact (71% reduction) among participants aged 60+ (CDC).	[63]
Million Hearts	Cardiovascular health project	General U.S. population	Reduced smoking rates, better cholesterol management, and avoided ~500,000 heart attacks and strokes (2017–2021).	[64]
Family-Based Obesity Prevention Program	Community and school programs	Kids and teenagers	Decrease in BMI percentiles by ~10% among participants; improved family engagement in physical activities (WHO).	[65]
Peer-Led Family Cancer Support	Support organizations	Family of people with cancer	Improved psychological well-being and reduced caregiver stress; 25% increase in caregiver-patient communication efficacy.	[66]
CHWs for Hypertension Control	Community health worker (CHW) program	Low-income households with hypertension	~20% improvement in blood pressure control among participants; greater adherence to medication and healthy lifestyles (American Heart Association).	[67]

Table 2 summarizes successful public health programs that promote managing chronic diseases utilizing family-centered techniques.

Public health actions can also play a crucial role in promoting collaborative care. Community health programs that foster awareness, prevention, and early detection of chronic diseases aid in enhancing the family's engagement in managing the disease. For example, a community-based program may educate families about the indicators of diabetes or CVD, advising them to seek early medical consultation and keep to prescribed lifestyle modifications. To assist families in navigating the challenges of managing chronic diseases, these programs typically offer services like family workshops, peer support groups, and instructional resources [55]. Biomedical breakthroughs, particularly in telemedicine and health technologies, considerably increase the effectiveness of collaborative care techniques. Real-time communication between patients, medical professionals, and family members is made possible via telehealth platforms, guaranteeing consistent care that is attentive to the patient's evolving needs. With wearable technology and smartphone health apps, families can keep an eye on chronic illnesses from the comfort of their homes, sharing information with medical professionals to help guide decisions. This use of technology guarantees that the collaborative care process is not confined to in-person visits but is continuous, eliminating impediments to treatment and boosting illness management [56].

5.2. Challenges and opportunities

Integrating public health and biological strategies for addressing chronic diseases poses considerable difficulties and potential. One of the important difficulties is inequalities in healthcare access, particularly in low-income and rural locations. These populations typically face limited access to medical professionals, cutting-edge medical technology, and preventative programs, which makes it difficult to implement integrated care models that merge biological developments with public health initiatives. There may be gaps in disease management, for instance, if families in disadvantaged areas lack access to telemedicine tools or multidisciplinary care teams [57]. Addressing these discrepancies requires particular measures, such as extending healthcare infrastructure and telemedicine services and boosting healthcare literacy to empower families in managing chronic conditions. Ethical considerations can offer challenges in integrating public health and biology endeavors. Privacy, authorization, and data security occur, especially with the increased usage of health technology such as wearable devices and smartphone apps that gather sensitive health data. Ensuring that patients and families are sufficiently informed about how their data will be used and enacting rigorous data protection measures are crucial for keeping trust and encouraging the widespread use of new technologies. Moreover, there is the ethical difficulty of assuring fair access to modern scientific breakthroughs, since these technologies may disproportionately benefit persons with more substantial socioeconomic situations, worsening existing health inequities [58].

Another challenge is the fragmentation of healthcare systems, which usually operate in silos, making it difficult to coordinate between public health programs and biomedical care. For instance, public health programs aiming at promoting lifestyle adjustments may not always be aligned with the clinical care offered by healthcare professionals. This lack of coordination can lead to missed opportunities for early intervention and comprehensive care. Overcoming this obstacle requires enhanced integration of services, including the adoption of policies that encourage collaboration between public health agencies, healthcare providers, and families [58]. Despite these constraints, there are huge opportunities for expanding the convergence of public health and biological endeavors. Advances in health technology, such as telemedicine and mobile health apps, offer new techniques to bridge gaps in healthcare access, especially in rural or disadvantaged locations. By delivering biomedical care to patients' homes, these technologies enable more regular monitoring and assistance from medical professionals while also enabling families to take a more active role in the treatment of their loved ones' illnesses. Expanding the use of these technologies can improve the reach of public health efforts, such as educational programs on chronic disease prevention, and integrate them with biomedical interventions [59].

6. Future Directions and Research Opportunities

Emerging trends in family-based disease management are redefining the landscape of chronic disease care, presenting fresh opportunity for promoting family-centered strategies through advances in both public health and biomedicine (Table 3). One notable trend is the increased use of personalized medicine, fueled by genetics and precision healthcare developments. As genetic profiling becomes more accessible, families can obtain insights into hereditary risks for chronic diseases such as CVD, diabetes, and cancer. This makes it possible to implement early treatments and preventative measures that are more specifically tailored to the genetic predispositions of a family. Families can make educated decisions about routine screenings, lifestyle changes, and other preventative measures to reduce the risk of illness by integrating these genetic insights into public health initiatives [60]. Another noteworthy trend is the rise of digital health solutions that empower families to participate more actively in regulating chronic diseases. Health markers including blood sugar, heart rate, and physical activity may now be continuously monitored thanks to wearable technology, mobile health apps, and telemedicine platforms. With the use of these technologies, family members may monitor their loved ones' health in real time and take appropriate early action. For example, smartphone apps can send reminders for medication adherence or urge families to engage in healthy habits, such as exercise and food preparation, establishing a collaborative approach to managing illnesses. As these technologies become more integrated into healthcare systems, families can receive tailored guidance and support from healthcare professionals online, enhancing the treatment of chronic conditions at home [61].

Public health trends are also evolving towards more community-driven approaches to illness management, which can benefit families. Family-centered health promotion projects are increasingly focused on community engagement, where families are seen as care users and active participants in health advocacy and education. The growth of community health programs that include families in peer support groups, health education seminars, and preventive screenings indicates this trend. These activities strive to establish a sense of shared responsibility for health within families and communities, enabling collective action in avoiding and managing chronic diseases. Additionally, such initiatives can be customized to local communities' cultural and socioeconomic conditions, ensuring that public health interventions are relevant and effective [27]. In biomedicine, breakthroughs in artificial intelligence (AI) and machine learning are also emerging as key tools in family-based disease management. AI-driven algorithms can examine vast sets of health data, forecasting illness progression and establishing optimal treatment solutions for specific patients. Families can benefit from AI's capacity to spot early warning indicators of

Table 3. Emerging trends and research gaps in family-based chronic disease management

Category	Emerging trends	Research gaps	Potential studies/Technologies
Genomics and Biomarkers	Advancements in multi-omics integration for individualized family health Expansion of functional technology and health applications for real-time family health monitoring	Limited knowledge about epigenetic inheritance in family-based disease management	Studies on familial epigenomic patterns and their impact on chronic illness risk
Digital Health Tools	Increasing usage of genetic risk assessments for inherited chronic diseases	Lack of long-term information on the efficacy of digital technologies in family-centered care	Development of AI-driven apps geared to family-based interventions
Precision Medicine	Utilization of behavioral health therapies for family-driven lifestyle changes	Limited access to precision medicine for marginalized populations	Large-scale studies on precision medicine's effectiveness in varied households
Behavioral Health	Growing emphasis on family-friendly healthcare policy	Insufficient research on long-term behavioral outcomes in family dynamics	Implementation of family-based behavioral health trials
Policy and Public Health	Applications of AI in forecasting chronic illness risks based on familial health data	Lack of global frameworks for integrating family dynamics into public health systems	Policy analysis on the integration of family-based models throughout healthcare systems
Community Health	Incorporation of emotional and mental health support in family caregiving models	Limited understanding of how cultural differences affect the success of family-focused public health programs	Comparative study of culturally customized family health programs
Psychosocial Factors	Advancements in multi-omics integration for individualized family health Expansion of functional technology and health applications for real-time family health monitoring	Lack of defined tools for assessing psychological implications of family-based disease management	Studies addressing the psychological resilience of caring

sickness progression, enabling timely adjustments to treatment plans and caring practices. Additionally, AI systems can help coordinate care among various medical specialists, guaranteeing that families receive a comprehensive, integrated approach to managing long-term illnesses. As these technologies continue to evolve, they hold the potential to enhance decision-making and provide individualized care for patients inside the family unit [62].

Table 3 summarizes cutting-edge trends in the field while identifying gaps in current research and technologies for future exploration.

Future research should focus on evaluating the long-term effectiveness of digital health tools in family-based chronic disease management, particularly their role in improving patient adherence, disease outcomes, and reducing caregiver burden. Key areas requiring further study include the impact of telemedicine on sustained patient engagement, the effectiveness of wearable devices in early disease detection, and the integration of AI-driven decision support systems into family-centered care. To generate robust evidence, randomized controlled trials should be conducted to assess the efficacy of digital health interventions in enhancing treatment adherence and health outcomes. Longitudinal studies are essential to evaluate their sustained impact on disease progression, patient quality of life, and family involvement over time. Additionally, combining quantitative assessments with qualitative research, mixed-methods approaches could provide valuable insights into user experience, barriers to adoption, and the sociocultural dynamics influencing technology acceptance within families [60].

7. Conclusion

This review describes the significant value of family dynamics in regulating chronic diseases such as CVD, diabetes, and cancer. Family engagement is critical in forming health behaviors, providing emotional and physical care, and maintaining adherence to treatment regimens. Family support networks can help avoid sickness, manage chronic conditions more effectively, and enhance general health results. The interplay between family members and their ability to offer both practical and emotional support dramatically influences patient well-being and the effectiveness of treatment efforts. To strengthen family-centered care, linking public health policies with biological processes is necessary. Public health programs focused on educating families and encouraging good lifestyle practices and scientific breakthroughs like precision medicine and health technologies give a more holistic approach to managing chronic diseases [19]. This integration allows for a personalized, comprehensive strategy that addresses both the medical and social components of disease treatment, establishing a pathway for more successful, permanent health interventions at the family level. From a policy and practical basis, public health measures should support family involvement in chronic disease treatment. Policies that increase access to family-friendly healthcare services, such as counseling, caregiver support, and educational programs, are crucial for improving disease outcomes. Furthermore, while developing treatments and care plans, biomedical interventions should take the family context into account. This will guarantee that advances

in genomics, digital health tools, and personalized medicine are available and flexible enough to be used in family environments. By implementing these guidelines, healthcare systems can better support families in managing chronic diseases, leading to improved patient outcomes and more resilient family health systems [33].

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Ethical Statement

This study does not contain any studies with human or animal subjects performed by any of the authors.

Conflicts of Interest

The authors declare that they have no conflicts of interest to this work.

Data Availability Statement

The data that support this work are available upon reasonable request to the corresponding author.

Author Contribution Statement

Rufus Oluwagbemileke Ajayi: Conceptualization, Formal analysis, Investigation, Data curation, Writing – review & editing, Supervision. **Oluwafikayo Seun Adeyemi-Benson:** Resources, Visualization. **Oluwateniola Ajoke Adeyemi-Benson:** Conceptualization, Writing – original draft, Project administration. **Taiwo Temitope Ogunjobi:** Methodology, Formal analysis, Data curation, Writing – original draft, Writing – review & editing.

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