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Towards Comprehensive Chronic Disease Control: Prevention, Early Detection, and Integrated Management

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ABSTRACT

Chronic non-communicable diseases (NCDs), including cardiovascular disease, diabetes, cancer, and chronic respiratory conditions, represent the leading causes of morbidity and mortality worldwide. This review examines comprehensive strategies across the continuum of care (from primary prevention and early screening to timely diagnosis, effective treatment, and long-term health management) that collectively aim to reduce the burden of these conditions. In cardiovascular disease, interventions targeting key risk factors (such as hypertension, hyperlipidemia, and smoking) combined with early detection of subclinical disease help prevent myocardial infarction, stroke, and other acute events. Similarly, in type 2 diabetes, early identification of at-risk individuals through screening and timely lifestyle or pharmacological interventions can delay or prevent disease onset and progression. In oncology, advances in screening (e.g., mammography, colonoscopy, and emerging liquid biopsies) and early diagnosis enable curative treatments for many cancers that would otherwise be detected at advanced stages, and preventive measures (such as vaccination and tobacco control) are further reducing the incidence of certain malignancies. In chronic respiratory diseases such as chronic obstructive pulmonary disease (COPD), reducing harmful exposures (such as tobacco smoke and air pollution) and implementing early therapeutic interventions can slow lung function decline and improve patient outcomes. Across these domains, evolving diagnostic tools (including novel biomarkers and imaging modalities) and innovative therapies (from precision medicines to immunotherapies) are improving survival and quality of life. Effective chronic disease management, through patient-centered care models, digital health monitoring, and integrated healthcare systems, is essential for sustaining treatment gains, preventing complications, and ensuring optimal long-term outcomes. By highlighting parallel progress and shared challenges in prevention, early detection, treatment, and ongoing management of diverse chronic diseases, this review underscores the need for coordinated, multi-faceted strategies to address the growing global burden of NCDs.

1 | Introduction

Chronic noncommunicable diseases (NCDs) such as cardiovascular diseases, cancers, diabetes, and chronic respiratory illnesses have become the leading threat to global health in the 21st century. In 2021, NCDs were responsible for over 43 million deaths worldwide—roughly 74% of all deaths not attributable to pandemics [1]. This toll includes about 18 million premature deaths, with low- and middle-income countries (LMICs) bearing 82% of this early mortality [1, 2]. Cardiovascular diseases account for the largest share of NCD fatalities (~19 million annually), followed by cancers (~10 million), chronic respiratory diseases (~4 million), and diabetes (~1.6 million) [1, 3]. In many high-income populations, roughly half of adults live with at least one chronic condition, and similar patterns are emerging in developing nations as life expectancies rise and lifestyles

change [4]. The societal impact is enormous, NCDs strain healthcare systems, reduce economic productivity, and perpetuate health disparities [5].

Recognizing this "tsunami of chronic diseases", global initiatives such as the United Nations Sustainable Development Goals have set ambitious targets to "reduce by one third premature mortality from noncommunicable diseases through prevention and treatment" by 2030 [6]. Unfortunately, the COVID-19 pandemic has further exacerbated chronic illness burdens, creating a syndemic of infectious and non-infectious disease challenges. Achieving global NCD targets requires a comprehensive strategy spanning the full continuum: prevention of disease onset, early screening and diagnosis, effective treatment, and long-term health management. This review synthesizes current knowledge and emerging insights on each of these fronts, highlighting landmark studies and novel approaches aimed at improving chronic disease outcomes. We discuss how evidence-based interventions (from population-wide prevention policies to personalized therapies) are converging to transform NCD control. Ensuring clarity, coherence, and scientific rigor, we emphasize unique innovations in health management and support all claims with up-to-date evidence.

2 | Prevention of Chronic Diseases

Prevention is the cornerstone of chronic disease control, given that most NCDs are driven by modifiable risk factors. Evidence indicates that the majority of heart disease, stroke, diabetes, and certain cancers could be prevented by addressing key behavioral and environmental risks [7]. The landmark INTERHEART study demonstrated that about 90% of the global risk for myocardial infarction is attributable to nine modifiable factors, including unhealthy diet, physical inactivity, tobacco use, excessive alcohol consumption, hypertension, obesity, diabetes, abnormal blood lipids, and psychosocial stress [8]. This finding implies that most premature cardiac events are avoidable with comprehensive risk factor control. Notably, smoking cessation and avoidance is one of the most powerful preventive measures; tobacco use remains the leading preventable cause of chronic illness, responsible for over 8 million deaths per year globally [9]. Public health efforts emphasizing lifestyle change (e.g., mass media campaigns, school-based programs, workplace wellness initiatives) are therefore fundamental in curbing NCDs.

2.1 | Behavioral Lifestyle Interventions

Individual-level lifestyle modifications have proven highly effective in reducing NCD incidence. The DPP trial showed that intensive lifestyle intervention (≥ 150 min/week moderate exercise and ~7% weight loss) reduced diabetes incidence by 58% versus placebo over ~3 years; metformin reduced incidence by 31% versus placebo. The incidence rates were 4.8, 7.8, and 11.0 cases per 100 person-years in the lifestyle, metformin, and placebo groups, respectively [10]. Similar findings were observed in the Finnish Diabetes Prevention Study and the Da Qing Study in China, which confirmed that sustained improvements in diet and physical activity can significantly reduce diabetes risk for more than a decade [11–14]. Beyond diabetes, long-term cohort studies consistently show that healthy behaviors such as maintaining a balanced diet, engaging in regular physical activity, keeping a normal body weight, and avoiding tobacco use are associated with markedly lower rates of cardiovascular disease and mortality [15]. Even modest improvements in these lifestyle factors can provide measurable health benefits, underscoring the importance of preventive lifestyle counseling in both clinical practice and community health programs.

2.2 | Vaccination and Infection Control

An often under-appreciated aspect of chronic disease prevention is the control of infections that can lead to chronic conditions. Vaccination programs have already achieved notable successes. For instance, widespread immunization against hepatitis B virus has reduced the incidence of liver cirrhosis and liver cancer [16–18], and human papillomavirus (HPV) vaccination is poised to virtually eliminate cervical cancer in some populations [19, 20]. Modeling studies in Australia predict that with high HPV vaccine coverage and continued cervical screening, cervical cancer could be reduced to fewer than 4 cases per 100,000 women within the next 2 decades [19]. Moreover, treating chronic infections such as *Helicobacter pylori* (to prevent gastric cancer) or HIV (to prevent AIDS-related chronic conditions) forms part of an expanded vision of NCD prevention [21, 22]. These examples highlight the importance of integrating infection control into chronic disease strategies.

2.3 | Population-Wide Policies

Beyond individual behavior change, population-level interventions are vital for creating healthier environments and minimizing exposure to key risk factors. WHO-endorsed "Best Buy" fiscal and regulatory measures, such as taxing tobacco, alcohol, and sugar-sweetened beverages [23–25], have consistently lowered consumption and associated disease burdens [26]. National actions to reduce dietary sodium, eliminate industrial trans fats, and mandate clear nutrition labeling have improved blood pressure, lipid profiles, and cardiovascular risk [27, 28]. Supportive urban planning that promotes walking, cycling, and access to nutritious foods further strengthens these efforts. Collectively, such multi-sectoral policies enhance population health and offer high economic returns, with every dollar invested generating an estimated sevenfold gain in healthcare savings and productivity [26].

2.4 | Implementation Experiences From Low- and Middle-Income Countries

The success of population-wide NCD prevention policies hinges on local implementation capacity. Several low- and middle-income countries (LMICs) have developed large-scale programs demonstrating how context-specific strategies can reduce chronic disease risk. In India, the *Cigarettes and Other Tobacco Products Act* and the National Tobacco Control Programme integrated taxation, smoke-free public spaces, and pictorial

health warnings (covering 85% of packaging). National surveys show a decline in tobacco use, though impact varies across states due to enforcement and resource disparities [29, 30]. In sub-Saharan Africa, hepatitis B vaccination programs have reduced infection prevalence in areas with high three-dose coverage [31], though suboptimal birth-dose uptake remains a barrier. [32]. Strengthening financing, supply chains, and maternal–child health integration could improve outcomes. These cases underscore that although WHO "Best Buy" interventions are globally relevant, their success in LMICs depends on political will, sustainable funding, and effective delivery systems.

3 | Early Screening and Detection

Because many chronic diseases develop insidiously and may not cause symptoms until advanced stages, proactive screening and early detection are vital. Screening refers to testing apparently healthy or high-risk individuals for early signs of disease or risk factors, enabling intervention before full-blown disease occurs. Strong evidence demonstrates that well-designed screening programs save lives by catching diseases at more treatable stages or by identifying risk conditions that can be managed [33]. For instance, screening for colorectal cancer via stool tests or colonoscopy can both prevent cancer (by removing premalignant polyps) and detect tumors earlier, significantly reducing incidence and mortality [34]. Widespread colorectal screening in the United States has been associated with marked declines in colon cancer rates and deaths over recent decades. Similarly, routine mammography screening has been shown to reduce breast cancer mortality in women over 40 [35], and low-dose CT scans in heavy smokers can reduce lung cancer mortality by about 20% by detecting tumors at a curable stage (as demonstrated in the National Lung Screening Trial) [36, 37].

Beyond cancer, screening for cardiometabolic risk factors is a cornerstone of early detection. Periodic measurement of blood pressure, cholesterol, and blood glucose in adults (often conducted during primary care visits) allows early identification of hypertension, hyperlipidemia, and prediabetes. Detecting these conditions early is crucial, as interventions such as antihypertensive therapy and lipid-lowering treatment can then be initiated to prevent heart attacks, strokes, and diabetic complications. For example, discovering that a middle-aged adult has elevated LDL cholesterol or high blood pressure years before any symptoms means they can receive preventive medications (statins, antihypertensives) and lifestyle counseling to avert future cardiovascular events [38]. Each 1 mmol/L reduction in LDL cholesterol through therapy yields a ~21% reduction in major cardiovascular events, and controlling hypertension markedly lowers stroke and heart disease incidence [38].

Crucially, screening must also address diseases that often remain "silent" until organ damage is advanced, such as type 2 diabetes and chronic kidney disease. It is estimated that nearly half of all adults living with diabetes are unaware of their condition [39, 40]. Without routine screening (e.g., checking fasting glucose or HbA1c), many individuals only receive a diabetes diagnosis after complications such as vision loss or heart disease have developed. Early detection through community screening or opportunistic testing can close this gap. Likewise, chronic kidney disease can be identified by simple tests for urine protein or decreased filtration rate in high-risk groups (diabetics, hypertensives), enabling measures to slow progression [41]. In sum, systematic screening for both early disease and pre-disease states is a pivotal strategy to reduce the burden of advanced chronic illnesses. Public health agencies continue to refine screening guidelines to maximize benefit–harm ratios, focusing on high-impact targets and at-risk populations.

3.1 | Advances in Screening Technology

Recent innovations are expanding the reach and accuracy of screening. One major development is the advent of digital health tools and artificial intelligence (AI) to assist in screening large populations. AI algorithms can analyze medical images and data with high sensitivity, offering novel screening modalities where specialists are scarce. A striking example is AI-based diabetic retinopathy screening: autonomous AI systems have been FDA-approved to interpret retinal photographs for diabetic eye disease without a clinician, achieving detection sensitivities on par with or better than ophthalmologists [42–44]. Such tools enable early identification of vision-threatening retinopathy in primary care settings, allowing timely referral for treatment [42]. AI is also being explored to improve the interpretation of mammograms, lung CT scans, and skin lesion images, potentially increasing cancer detection rates while reducing false alarms [44–46].

Another frontier is liquid biopsy, referring to blood tests that can detect circulating tumor DNA or other cancer biomarkers at an early stage [47, 48]. While still under active research, multicancer early detection assays have shown promise in identifying asymptomatic malignancies and may eventually complement traditional screening for cancers with no current tests [49]. Additionally, genomic screening is becoming more commonplace: for example, BRCA1/2 mutation testing in healthy women with family histories can guide preventive measures for breast and ovarian cancer, and cascade screening for familial hypercholesterolemia in relatives of affected patients can prompt early cholesterol treatment to prevent premature heart disease [50]. Researchers are also investigating polygenic risk scores as a tool to stratify who might benefit most from certain screening programs. Preliminary modeling suggests that tailoring screening based on genetic risk could modestly improve efficiency for cancers such as breast, prostate, and colorectal [51, 52]. As these technologies mature, they hold the potential to make screening more individualized, accessible, and accurate, thereby catching more disease at earlier, more curable stages.

4 | Diagnosis and Early Intervention

Early and accurate diagnosis is the bridge between detection and treatment. Once an abnormal screening result or symptom

prompts further evaluation, the goal is to promptly establish a definitive diagnosis and assess disease severity. Advances in diagnostic modalities over recent years have greatly enhanced our ability to confirm chronic disease diagnoses at earlier stages and with greater precision. High-resolution medical imaging, for instance, allows visualization of minute pathological changes: modern MRI and CT can detect tiny tumors or subtle organ damage that were previously undetectable, and ultrasound-based elastography can noninvasively stage liver fibrosis in chronic hepatitis patients, reducing the need for biopsy [53]. In cardiovascular medicine, coronary artery calcium scoring by CT and cardiac MRI for fibrosis are improving early diagnosis of subclinical atherosclerosis and cardiomyopathies [54]. Similarly, low-cost screening tools such as portable ultrasound and point-of-care blood tests are bringing diagnostic capabilities to remote and primary care settings, narrowing gaps in early detection [55].

Molecular diagnostics and biomarkers have also revolutionized chronic disease detection. Blood tests for specific biomarkers now facilitate earlier diagnosis of diseases that once required advanced clinical symptoms. For example, highly sensitive troponin assays can detect minor myocardial injury, enabling much earlier diagnosis of heart attacks or heart muscle damage in at-risk patients [56]. In oncology, molecular profiling of tumors through biopsy or blood (circulating DNA) guides precise cancer subtyping and targeted therapy selection at diagnosis [57]. Conditions such as autoimmune diseases and neurodegenerative disorders benefit from new biomarkers (autoantibodies, amyloid/tau PET scans for Alzheimer's, etc.) that allow recognition in prodromal phases when interventions might slow progression [58].

Beyond identifying the disease, early diagnosis includes staging and risk stratification to determine how advanced or aggressive the condition is, allowing appropriate interventions to be initiated immediately. A critical concept is early intervention: acting at the earliest opportunity to treat or even reverse a disease process. For instance, starting intensive therapy at the first signs of rheumatoid arthritis can induce remission and prevent joint damage, whereas delayed treatment often results in irreversible deformities [59–61].

In type 2 diabetes, the concept of a “legacy effect” suggests that early tight glucose control can confer long-term protection against complications even if control later worsens [62, 63]. Early use of disease-modifying medications in chronic conditions such as multiple sclerosis or Parkinson's disease may slow their trajectory [64, 65]. Thus, current paradigms emphasize not only diagnosing diseases earlier but also intervening as early as possible with effective therapy, a principle sometimes summarized as “the earlier, the better” for chronic disease outcomes. Rapid diagnostic pathways (such as one-stop clinics for suspected cancer or fast-track referrals for chest pain and memory loss) exemplify system-level efforts to shorten the time from initial suspicion to diagnosis and treatment [66, 67]. Combined with increasing public awareness to seek evaluation for warning signs (e.g., a breast lump, chronic cough, or unexplained weight loss), these approaches aim to shift diagnoses to earlier stages.

5 | Advances in Treatment of Chronic Diseases

Over the past few decades, treatment options for chronic diseases have expanded dramatically, turning many once-fatal conditions into manageable long-term illnesses. A multifaceted therapeutic approach (often combining medication, lifestyle therapy, and procedural interventions) is typically required to address both the disease and its risk factors [68]. Evidence-based treatment guidelines are now available for all major NCDs, informed by numerous landmark clinical trials (Table 1).

5.1 | Pharmacological Therapies

Medications remain central to chronic disease management, with ongoing innovation significantly improving outcomes. In cardiovascular disease, statins marked a breakthrough—large trials show that every 40 mg/dL reduction in LDL cholesterol lowers major vascular events by ~20% [38]. Antihypertensive drugs such as ACE inhibitors, beta-blockers, and calcium channel blockers similarly reduce stroke and coronary events by 30%–40% and 20%–25%, respectively [81]. In diabetes, SGLT2 inhibitors and GLP-1 receptor agonists have redefined care by improving glycemic control while offering cardiovascular and renal protection. Trials of semaglutide, a long-acting GLP-1RA, demonstrated reduced cardiovascular events, body weight, and kidney outcomes across populations. SELECT showed a 20% drop in major cardiovascular events in overweight individuals without diabetes [72], whereas SOUL and FLOW confirmed benefits in both diabetic and non-diabetic groups [73, 82]. The ESSENCE trial further highlighted metabolic gains in steatohepatitis [74], extending GLP-1RA use beyond glucose control to broader cardiometabolic prevention. In oncology, targeted therapies and immunotherapies have significantly prolonged survival in cancers once considered fatal. In chronic respiratory disease, advanced inhaled and biologic therapies continue to reduce exacerbations and hospitalizations. When appropriately applied, modern pharmacotherapy can slow disease progression, reduce complications, and improve long-term survival across diverse chronic conditions.

5.2 | Interventional and Surgical Treatments

Many chronic diseases benefit from procedural interventions to treat underlying pathology. Cardiology has witnessed major advances ranging from coronary angioplasty and stenting for ischemic heart disease to transcatheter valve replacements for aortic stenosis, offering less invasive options for patients who previously required open surgery [83–85]. In advanced heart failure, mechanical circulatory support devices and ultimately heart transplantation provide life-saving options [86].

For end-stage kidney disease, dialysis and kidney transplantation are critical treatments that sustain life, effectively managing the “terminal” phase of a chronic illness [87]. In oncology, surgical advances (e.g., minimally invasive laparoscopic or robotic procedures) and precise radiation techniques allow for curative

TABLE 1 | Landmark clinical trials and key evidence supporting NCD control.

Disease	Landmark trial	Intervention	Key findings	References
Type 2 diabetes	DPP (U.S.), Finnish DPS, Da Qing Study (China)	Lifestyle modification (diet and exercise) versus metformin or usual care	Lifestyle intervention reduced diabetes incidence by 58%, sustained benefit for > 10 years; metformin reduced incidence by 31%	Knowler et al. [10]; Lindström et al. [14]; Gong et al. [13]
Cardiovascular disease	INTERHEART, 4S, HPS, SPRINT	Risk factor control; statin therapy; intensive blood pressure lowering	90% of MI risk explained by modifiable factors; each 1 mmol/L LDL reduction reduce CV events by ~20%; intensive BP target (< 120 mmHg) reduce CV events and mortality	Yusuf et al. [8]; Scandinavian Simvastatin Survival Study group, [69]; Heart Protection Study Collaborative Group, [70]; SPRINT Research Group, [71]
Obesity and metabolic dysfunction	SELECT, FLOW, ESSENCE	GLP-1 receptor agonist (semaglutide) therapy	Semaglutide reduced major CV events by 20%, improved kidney outcomes, and reduced MASH progression	Lincoff et al. [72]; Perkovic et al. [73]; Sanyal et al. [74]
Cancer	NLST, Imatinib CML Study, AI-based DR Trial (ACCESS)	Low-dose CT for lung cancer; targeted kinase inhibition; autonomous AI retinal screening	Low-dose CT reduced lung cancer mortality by 20%; imatinib achieved long-term remission in CML; AI screening improved DR detection and follow-up	NEJM [37]; Hochhaus et al. [75]; Wolf et al. [44]
Chronic respiratory disease	CHAMPION, TIM-HF2	Pulmonary artery pressure sensor; telemedical heart failure management	Hospitalizations reduced by 20%–33%; lower mortality and improved quality of life in telemonitoring group	Abraham et al. [76]; Koehler et al. [77]
Multimorbidity	STENO-2, 3D Trial, Lorig Self-Management Program	Multifactorial intervention; patient-centered multimorbidity care; structured self-management	Intensive risk factor control reduce CV and renal complications by 50%; patient-centered care improved outcomes and reduced healthcare use	Pedersen et al. [78]; Salisbury et al. [79]; Lorig et al. [80]

Abbreviations: BP, blood pressure; CML, chronic myeloid leukemia; CV, Cardiovascular; DR, diabetic retinopathy; LDL, low-density lipoprotein; MASH, metabolic dysfunction–associated steatohepatitis; MI, myocardial infarction.

treatment of early-stage cancers with fewer side effects [88–90]. Bariatric surgery has emerged as a metabolic intervention that not only produces substantial weight loss but can induce remission of type 2 diabetes and improve hypertension, illustrating how surgical approaches can intercede in chronic metabolic disease pathways [91, 92]. The development of these interventions is underpinned by landmark trials, such as studies demonstrating the mortality benefit of implantable defibrillators in systolic heart failure, or the survival advantage of lung volume reduction surgery in severe emphysema, which have cemented their roles in clinical guidelines [93].

5.3 | Lifestyle and Rehabilitation in Treatment

Even after diagnosis, lifestyle modification remains a critical component of chronic disease management. Comprehensive cardiac rehabilitation after myocardial infarction, which combines supervised exercise, dietary counseling, and psychosocial support, improves vascular function, cardiorespiratory fitness, and autonomic balance, resulting in a 20%–30% reduction in recurrent cardiovascular events and mortality [94, 95]. Pulmonary rehabilitation in chronic respiratory disease enhances muscle efficiency, reduces inflammation, and improves exercise tolerance and quality of life [96]. Dietary interventions are essential across conditions. The DASH and Mediterranean diets lower blood pressure, improve insulin sensitivity, and reduce cardiovascular risk [97, 98]. In diabetes and chronic kidney disease, limiting dietary sodium and protein slows disease progression and reduces hospitalization [99]. Weight loss through calorie restriction or bariatric surgery improves hepatic steatosis, insulin resistance, and cardiac function in obesity-related conditions such as non-alcoholic fatty liver disease and heart failure with preserved ejection fraction [100, 101]. Psychological and behavioral interventions, including cognitive-behavioral therapy and stress management, improve adherence, reduce depression and anxiety, and enhance overall outcomes [102, 103]. Effective chronic care involves not only pharmacologic treatment but also structured support in rehabilitation, nutrition, and mental health to promote long-term well-being.

5.4 | Landmark Treatment Advances

Many of the above treatment modalities were established through landmark clinical trials that changed medical practice. For example, the UK Prospective Diabetes Study (UKPDS, 1998) confirmed that intensive glucose control reduces microvascular complications in type 2 diabetes, laying the foundation for tight glycemic control as a standard goal [104, 105]. The later STENO-2 trial (2003) showed that multifactorial risk management (aggressively treating glucose, blood pressure, and lipids together) dramatically curbed cardiovascular and renal complications in diabetes [78, 106].

In cardiology, the randomized trials 4S (1994) and HEART Protection Study (2002) firmly established statins' benefits in primary and secondary prevention of coronary disease [69, 70]. The SPRINT trial (2015) demonstrated that aiming for a systolic blood pressure < 120 mmHg in high-risk patients, rather than the older target of < 140 mmHg, significantly reduced cardiovascular events and mortality, prompting guideline changes for hypertension [71]. In oncology, the introduction of imatinib around 2001 (a targeted kinase inhibitor for chronic myeloid leukemia) turned a once-fatal leukemia into a largely manageable condition, exemplifying the power of precision therapy [75]. Each medical specialty has similar milestone studies that have shaped modern therapy. By grounding treatment recommendations in high-quality evidence, contemporary chronic disease management achieves much better outcomes than in past decades. Indeed, age-adjusted mortality rates for cardiovascular disease have fallen by over 50% since the 1970s in many countries [107], an achievement often attributed to improved risk factor control and advances in acute and chronic treatments—a phenomenon dubbed the "cardiovascular revolution".

6 | Long-Term Disease Management and Health Systems

Effective chronic disease control extends beyond acute treatment, it requires lifelong management and coordinated care systems [108]. Unlike acute illnesses that resolve, chronic conditions demand continuous monitoring, regular follow-up, and dynamic adjustment of therapy. This necessity has spurred the development of chronic care models and innovations in health service delivery. A paradigm shift in the past 2 decades has been toward patient-centered, integrated care for chronic diseases, often summarized by the Chronic Care Model which emphasizes multidisciplinary teams, engaged patients, and supportive health system organization. Key components of successful chronic disease management programs should include care coordination, patient education and self-management support, regular monitoring and follow-up, digital health and telemedicine, community and policy support [109, 110].

6.1 | Integrated Management of Multimorbidity

Managing patients with multiple chronic conditions requires an integrated and patient-centered approach that balances treatment priorities and minimizes adverse interactions. Clinical guidelines emphasize assessing comorbidity patterns, functional status, and patient preferences rather than focusing on a single disease [111]. Polypharmacy and drug interactions are common challenges, especially among older adults. Regular medication reviews and stepwise deprescribing can improve safety and adherence [112]. The Chinese Guidelines for the Prevention and Treatment of Type 2 Diabetes recommend prioritizing cardiovascular risk management in diabetic patients with heart disease by optimizing blood pressure, glucose, and lipid control, while avoiding overlapping medications that increase hypoglycemia or renal risk [113]. Coordinated multidisciplinary care and individualized goal setting are essential to improve outcomes in people living with multimorbidity.

6.2 | Care Coordination

Multidisciplinary teams (primary care providers, specialists, nurses, pharmacists, dietitians, etc.) work together to deliver cohesive care [114, 115]. Regular communication and information-sharing among providers ensure that all aspects of a patient's condition are addressed and treatments are aligned. Care coordinators or case managers should be often employed to help patients navigate appointments, medication refills, and follow-up plans, especially for those with multiple comorbidities.

6.3 | Patient Education and Self-Management Support

Patients are encouraged and taught to actively manage their health, for example, by monitoring their blood pressure or glucose at home, adhering to medications, recognizing early warning signs of deterioration, and making healthy lifestyle choices. Structured programs (such as diabetes self-management classes or heart failure nursing clinics) have shown that educating patients and engaging them in goal-setting improves disease control and reduces hospitalizations [116, 117]. Seminal research by Lorig and colleagues demonstrated that chronic disease self-management programs can lead to better health outcomes and lower healthcare utilization [80]. Empowering patients with knowledge and tools builds confidence and adherence, turning them into partners in their care.

6.4 | Community and Policy Support

Long-term management is also influenced by community resources and broader policies. Support groups, community exercise programs for cardiac rehab graduates, or peer mentors for patients with diabetes can provide social support that improves adherence and mental well-being [118]. On a policy level, aligning healthcare payment with quality outcomes (e.g., value-based care or pay-for-performance models) incentivizes providers to focus on preventive care and chronic disease control [119]. Many health systems are moving toward population health management, where providers are accountable for keeping a defined population healthy and reducing hospital admissions. This has driven investments in chronic disease

registries and patient outreach for those overdue for check-ups or screenings. Additionally, integrating mental health care into chronic disease management addresses the common comorbidity of depression and anxiety with conditions such as heart disease and diabetes [120]. Treating these issues in tandem improves overall outcomes, since unmanaged mental health problems can impede adherence and self-care.

6.5 | Digital Health, Monitoring, and Follow-Up

Continuous monitoring and timely follow-up are critical for detecting complications early and sustaining disease control. While routine labs and clinic visits remain foundational, digital technologies now enhance care through remote monitoring and telemedicine, both supported by strong evidence. The TIM-HF2 trial showed that remote management in heart failure significantly reduced all-cause mortality (7.9 vs. 11.3 per 100 person-years) and unplanned cardiovascular hospitalization days by 20% [77]. The CHAMPION trial demonstrated a 33% reduction in heart failure hospitalizations with implantable pulmonary artery sensors [76]. Telemonitoring of home blood pressure, glucose, or weight improves adherence and enables proactive interventions, lowering exacerbation rates in heart failure and COPD [121, 122]. Mobile apps and wearables now support continuous tracking of vital signs and activity, whereas predictive analytics from electronic health records help flag patients at risk for hospitalization [123]. During and after COVID-19, telemedicine expanded access, especially for rural and mobility-limited populations, while maintaining outcomes comparable to in-person care [124].

However, the rapid growth of digital health has exposed a digital divide, with disparities in access and usability across age, income, and education levels. Older adults and disadvantaged populations often face barriers such as limited internet access, low digital literacy, and difficulty using complex applications [125]. These gaps can reduce participation in remote monitoring and exacerbate health inequities if unaddressed [126]. Addressing them requires simplifying digital tools, offering multilingual interfaces, providing community-based digital training, and involving caregiver support to improve accessibility and engagement [127]. When inclusively designed, digital health can enhance follow-up, promote equity, and support scalable NCD management.

Overall, the shift from reactive, episodic care to proactive, continuous management is a defining feature of modern chronic disease control. Health systems that have successfully flattened or reduced NCD morbidity (such as certain integrated healthcare organizations) typically have strong primary care infrastructures, robust health IT systems, and dedicated chronic care programs [128]. Nonetheless, challenges remain—including engaging patients over the long term, ensuring access to care for vulnerable groups, and coordinating care across multiple providers. As populations age, multimorbidity (individuals having several chronic conditions simultaneously) is increasingly the norm, requiring care models that are not disease-specific but rather person-centric [79]. This underscores why integrated care pathways and holistic health management strategies are so important for the future of NCD control.

7 | Emerging Horizons and Future Directions

Despite significant progress, further innovations are needed to stem the global tide of chronic diseases. Fortunately, we stand at the cusp of several promising advances that could redefine prevention and management in the coming years. One major trend is the rise of personalized and precision medicine in NCD prevention. Researchers are developing polygenic risk scores that aggregate the small contributions of many genetic variants to better predict who is predisposed to conditions such as coronary artery disease, diabetes, or breast cancer [129, 130]. In the future, such genomic risk profiling might enable more tailored prevention. For example, identifying a young adult with a high genetic risk of heart disease to receive intensive lifestyle coaching and earlier preventive therapy, whereas someone with low genetic risk might follow standard recommendations. This precision prevention approach aims to enhance efficiency by focusing resources on those most likely to benefit. However, early modeling suggests the gains from genetic stratification may be modest for complex diseases, so these tools will complement rather than replace traditional risk factor assessment [51, 131, 132].

Another frontier is systems biology and the microbiome, which are revealing new aspects of chronic disease pathogenesis. The gut microbiome, for instance, has been linked to conditions ranging from obesity and diabetes to colon cancer and autoimmune disorders [133]. Modulating the microbiome through diet, probiotics, or even fecal transplants could emerge as a novel preventive or therapeutic strategy for certain chronic illnesses, though robust clinical evidence is still forthcoming. Likewise, advanced "-omics" technologies (genomics, proteomics, metabolomics) are identifying novel biomarkers that might allow diseases to be detected earlier or stratified by subtype [134]. For example, researchers are exploring blood-based biomarkers for Alzheimer's disease that could signal neurodegeneration well before cognitive symptoms, potentially enabling interventions to delay dementia onset [135]. In coming years, such biomarkers may make it possible to monitor disease activity and treatment response in real time, moving toward more dynamic and responsive management of chronic conditions.

AI and big data will play growing roles in chronic disease control. Beyond screening applications, AI can synthesize vast datasets from electronic records, imaging, genomics, and wearable sensors to assist clinical decision-making. For example, machine learning models might predict an individual patient's risk of hospitalization within the next year and suggest tailored preventive interventions, or identify subtle medication side-effect patterns across millions of patients that inform safer prescribing [136–138]. In public health, predictive analytics could optimize how interventions are targeted—an approach sometimes termed precision public health [139]. By integrating epidemiological data with social determinants, AI could help pinpoint communities at highest risk for spikes in diabetes or

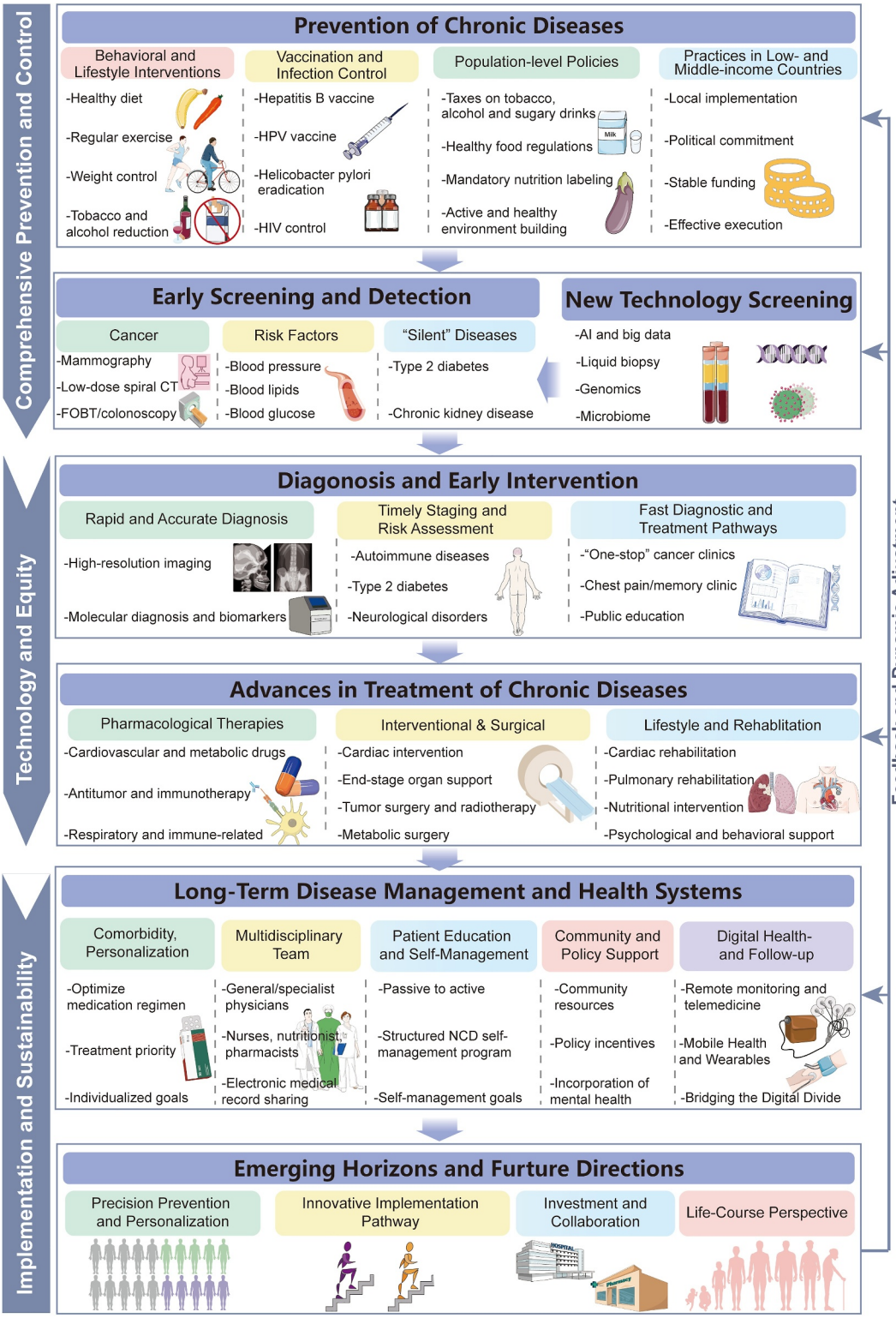

FIGURE 1 | Integrated strategies across the NCD care continuum. This schematic summarizes a life-course strategy encompassing prevention, early screening, diagnosis, treatment, long-term disease management, and future innovations. It highlights population-level policies, precision diagnostics, multidisciplinary care, lifestyle and behavioral interventions, and digital health integration, aiming to achieve precision, equity, and sustainability across the global NCD care continuum.

heart disease, so that community health workers and resources can be deployed more effectively [140]. The key will be implementing these technologies ethically and equitably, ensuring transparency and protecting patient privacy, while rigorously evaluating their impact on health outcomes [4]. If done right, digital and data-driven strategies have potential to greatly enhance both individual patient care and population-level NCD prevention.

7.1 | Implementation Pathways for Emerging Technologies

The translation of emerging technologies such as microbiome modulation, precision nutrition, and data-driven tools into real-world practice requires a phased approach. In the short term, pilot programs should assess feasibility, safety, and community acceptance. For example, a microbiome-based dietary intervention could be implemented in two low-income communities within 1 year to evaluate adherence and metabolic outcomes [141, 142]. In the medium term, effective models can be promoted through regional public health initiatives and integration into primary care and nutrition services [143]. In the long term, large-scale adoption will rely on sustainable funding, workforce training, and continuous outcome monitoring [144]. This stepwise pathway from pilot testing to broad implementation can accelerate the translation of innovative technologies from research to equitable population health benefits.

Effectively addressing chronic diseases on a global scale requires sustained investment and innovative financing. Growing evidence shows that NCD prevention delivers strong economic returns, with every dollar spent yielding an estimated sevenfold benefit [5]. Health taxes on tobacco, alcohol, and sugary drinks not only curb consumption but also generate revenue for reinvestment in health programs [5, 145]. International collaborations, including the WHO Global NCD Compact and public-private partnerships, are helping low-resource countries implement "best buy" interventions and strengthen primary care capacity [146]. Future strategies will likely place greater emphasis on life-course approaches that address risk factors from early development through old age. This includes promoting maternal and child health to reduce early-life risk, fostering healthy behaviors in youth to combat rising childhood obesity, and supporting wellness across adulthood and aging [147]. Together, these efforts reflect an evolving model of chronic disease care, integrating prevention, screening, early detection, treatment, and long-term management into a cohesive continuum (Figure 1).

8 | Conclusion

Chronic diseases remain a major global health burden, yet progress in prevention, early detection, treatment, and integrated care offers a path forward. Most NCDs are preventable through lifestyle interventions, vaccination, and supportive policies, whereas modern screening and precision diagnostics enable earlier, more effective detection. Evidence-based therapies and coordinated care models have transformed many NCDs into manageable conditions, improving survival and quality of life. Advances in genomics, multi-omics biomarkers, microbiome science, and digital health are accelerating a shift toward precision prevention and personalized management. These innovations promise more accurate prediction, monitoring, and treatment at both individual and population levels. Realizing this potential will require sustained investment, equitable access, and effective translation into practice. Strengthening primary care and closing digital gaps will be essential to ensure that innovation benefits all. With scaled-up interventions and responsible adoption of new technologies, chronic diseases need not remain the defining challenge of global health.

Author Contributions

Y.L. conceptualized the theme of the article. P.S. conducted the literature search, critically appraised the evidence, and drafted the manuscript. Z.W. designed and prepared the table and figure. All authors reviewed and approved the final version of the manuscript.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

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