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Health Score (0-850): A Comprehensive Framework for Assessing Chronic Disease Exposure

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Abstract: Chronic diseases, or NCDs (noncommunicable diseases), constitute a major global health challenge, causing millions of deaths and imposing substantial economic burdens annually. This paper introduces the Health Score, a comprehensive framework for assessing chronic disease risk by integrating diverse determinants of health, including social, economic, environmental, behavioral, treatment, culture, and nature factors. The Health Score, ranging from 0 to 850, quantifies individual and population-level health risks while identifying protective factors through a structured methodology that supports targeted interventions at individual, corporate, and community scales. The paper highlights the rising prevalence of chronic diseases in the United States, projecting that nearly half of the population will be affected by 2030, alongside a global economic burden expected to reach trillions of dollars. Existing surveillance tools, such as the CDS (Chronic Disease Score) and CDIs (Chronic Disease Indicators), are examined for their roles in monitoring health disparities. The Health Score advances a holistic, proactive approach, emphasizing lifestyle modifications, equitable healthcare access, economic opportunities, social support, nature exposure, cultural awareness, and community engagement. By elucidating the complex interplay of health determinants, this framework equips stakeholders with actionable insights to implement effective prevention strategies, ultimately fostering healthier, more resilient populations.

Key words: Health score, chronic disease exposure, noncommunicable diseases, social determinants of health, health risk assessment, population health, preventive medicine, environmental health.

1. Introduction

Chronic diseases, or NCDs (noncommunicable diseases), are the leading cause of death and disability worldwide. The WHO (World Health Organization) reports that "noncommunicable diseases (NCDs) killed at least 43 million people in 2021, equivalent to 75% of non-pandemic-related deaths globally" [1]. These include cardiovascular diseases, cancers, diabetes, and chronic respiratory conditions, primarily driven by modifiable risk factors such as tobacco use, physical inactivity, unhealthy diet, and harmful alcohol consumption. In the United States, the Centers for Disease Control and Prevention (CDC) notes that "chronic diseases are the leading causes of death and disability and are also the leading drivers of the nation's $4.9 trillion in annual healthcare costs" [2], with nearly half the population affected and projections reaching 170 million by 2030 [3].

Approximately six in ten U.S. adults have at least one chronic condition, and four in ten have two or more [4]. Heart disease, stroke, cancer, diabetes, and obesity are the most common and costly. Heart disease and stroke alone cost over $233 billion annually, plus $184.6 billion in lost productivity [5]. Diabetes adds $413 billion [6], and obesity contributes nearly $173 billion in healthcare expenditures [4]. Globally, chronic diseases may cost $47 trillion by 2030, threatening economic development and health system sustainability [7]. Per capita NCD and mental health

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spending ranges from $2 to $80 in African countries, yet NCDs receive only 1%-2% of global health financing, with households in low-resource settings covering up to 74% out of pocket [1, 8].

To monitor and address this burden, the CDC developed the CDIs (Chronic Disease Indicators) with over 100 measures [4] and the PLACES project, which models local-level prevalence to identify high-risk communities [2]. The CDS (Chronic Disease Score) identifies areas with multiple chronic conditions using BRFSS and ACS data. Each ZCTA (ZIP Code Tabulation Area) receives a score for ten diseases: 0 for the lowest 25%, 1 for the middle 50%, and 2 for the highest 25%. Summed scores range from 0 to 20, classifying communities as least (≤6), moderate (7-13), or highest prevalence (≥14), enabling targeted interventions [2].

Chronic diseases impose both health and economic burdens while revealing gaps in system preparedness. Surveillance tools like CDI, PLACES, and CDS provide data for targeted interventions, yet global inequities demand stronger commitments to prevention, treatment, and equitable investment.

The Health Score framework offers a holistic approach, viewing health as a dynamic, multifactorial state. It integrates Social, Economic, Habits, Treatment, Environment, Culture, and Nature domains, helping individuals, corporations, and communities identify risk and protective factors to improve quality of life and lifespan.

Social factors are critical: isolation and loneliness pose mortality risks comparable to smoking and obesity [9]. Cohen and Wills [10] note, "Social support provides a buffer against stress and promotes health-protective behaviors, highlighting its profound impact on physical and mental well-being."

Economic status predicts health outcomes. Lower socioeconomic status correlates with higher chronic disease rates and premature death [11]. Kawachi and Kennedy [12] stated, "Income and wealth are powerful predictors of health, reflecting a person's ability to invest in their well-being and navigate the health-care system."

Habits such as diet, exercise, and smoking are primary NCD drivers [13]. Breslow [14] observed, "The single most important factor determining health and illness is the individual's lifestyle." Corporations and communities can encourage healthier behaviors through wellness programs, nutritious food, and recreational spaces.

Treatment emphasizes timely, effective healthcare. Preventive screenings and medication adherence reduce disease progression. Starfield et al. [15] argued, "Timely access to preventive care and effective management of chronic conditions are critical for reducing morbidity and mortality from NCDs."

Environment considers air and water quality, pollution, and the built environment. Frumkin [16] noted, "The physical environment is not a passive backdrop to health but an active determinant of it, shaping our behaviors and exposures." Safe neighborhoods and parks promote activity and well-being.

Culture shapes health behaviors and attitudes. Betancourt et al. [17] emphasized, "Cultural competence in health promotion is essential, as it allows for the development of interventions that are meaningful and effective within a specific community context."

Nature recognizes the restorative power of natural spaces. Bratman et al. [18] found, "Time in nature has a restorative effect, reducing rumination, enhancing cognitive function, and lowering cortisol levels." Green space access serves as a protective factor against stress and chronic disease.

By synthesizing these seven domains into a single metric, the Health Score moves beyond risk assessment to identify protective factors. Corporations applying this framework can enhance employee well-being and organizational performance [19], while communities can collaboratively build healthier, more resilient populations.

2. Factors, Indicators, and Measurements

2.1 Social Factors (7 Indicators): Employment, Education, Family Support, Social Support, Racism, Discrimination and Pets

Employment is a vital social determinant of health, providing income, purpose, social connection, and stability, all linked to improved mental and physical health. Stable employment allows access to healthy food, safe housing, healthcare, and education. As Marmot and Wilkinson [20] note, "The gradient in health is a social gradient. People in less advantaged social circumstances are at greater risk of poor health." Unemployment increases the risk of mortality, mental health disorders, and chronic diseases [21], while job stress and insecurity predict poor outcomes, including cardiovascular disease and mental health problems [22].

Education influences health through literacy, socioeconomic mobility, and resilience. Higher education improves health behaviors such as diet, exercise, and smoking cessation [23] and reduces adult mortality [24].

Family support provides emotional closeness, caregiving, and trust, buffering stress and aiding recovery, with mortality effects comparable to smoking [9]. Social support from friends, peers, colleagues, and community networks strengthens mental and physical health, reducing cardiovascular risk and enhancing immunity [25].

Racism affects health through chronic stress, systemic inequities, and physiological pathways, contributing to conditions like hypertension, diabetes, and cardiovascular disease [26]. Discrimination—based on gender, age, disability, sexual orientation, religion, or other factors—also limits access to resources, education, and stable employment, increasing risk for chronic disease and poor mental health [27].

Pets and human–animal interactions reduce loneliness, buffer stress, improve mood, and encourage physical activity, benefiting cardiovascular health and overall well-being [28, 29].

Together, employment, education, family support, social support, racism, discrimination, and pets illustrate the complex web of social determinants shaping health. Holistic public health strategies must address structural inequities, social resources, and behaviors to improve population health.

Mitigation:

Mitigating social determinants of health requires structural, institutional, and community-based strategies that address inequality. Employment-related disparities can be reduced through strong labor protections—fair wages, regulated working hours, and limits on precarious contracts—which decrease job insecurity and psychosocial stress [22]. Lifelong training and reskilling programs prevent long-term unemployment and enhance adaptability, while workplace mental health initiatives and integrating occupational health into primary care reduce cumulative stress-related effects [21].

In education, mitigation begins with universal early childhood programs to build health literacy and social mobility [24]. Embedding comprehensive health curricula equips children with lifelong skills in nutrition, physical activity, and mental health [23]. Expanding financial aid and fostering university-community partnerships ensure health knowledge reaches broader populations.

At the family level, paid leave, flexible work, financial support, caregiver programs, and family counseling reduce stress and improve resilience. Involving families in clinical care enhances adherence and outcomes [9].

Broader social support networks are also critical. Inclusive community centers, cultural hubs, peer networks, and social prescribing reduce isolation—a risk factor as serious as smoking [25]. Digital platforms can extend support to marginalized groups.

Addressing racism requires strong anti-racism laws, equity audits, public reporting, community oversight, and diverse leadership representation [26]. Supporting grassroots movements further strengthens community

resilience. Discrimination based on gender, disability, sexual orientation, or socioeconomic status also demands universal protections, bias training, inclusive policies, and institutional monitoring [27].

Human-animal interaction is an underexplored mitigation strategy. Animal-assisted therapy and pet-friendly public spaces reduce stress, promote physical activity, and foster social interaction [28, 29]. Partnerships to ensure equitable access to pets and therapy programs can enhance psychological and physiological outcomes.

Together, these strategies—targeting employment, education, family and social networks, racism, discrimination, and human-animal interaction—demonstrate that improving health equity requires coordinated action across policy, institutions, communities, and individual support systems.

2.2 Economic Factors (4 Indicators): Income, Savings, Cost of Living, Debt

Economic factors strongly influence health outcomes, particularly regarding NCDs (non-communicable diseases). Clarke et al. [30] note that "sociodemographic patterns of chronic disease consistently show higher prevalence among groups with lower income and assets" [28]. The relationship is bidirectional: financial strain can increase NCD risk, while chronic illness can worsen economic insecurity. Key economic indicators—income, savings, cost of living, and debt—play a dual role in shaping NCD risk and prevention opportunities.

Income is a major predictor of health disparities. Lower income limits access to nutritious food, safe environments, and quality healthcare [5, 6, 31]. Individuals with limited income may face high-risk environments, food insecurity, or delayed medical care, creating a cycle where poverty drives poor health and reduced earning potential. The WHO emphasizes that "NCDs and poverty form a vicious cycle. People with fewer resources are more exposed to NCD risk factors and face major barriers to health" [32].

Savings provide a buffer against financial shocks, but when absent, households experience heightened health vulnerability. Lack of savings can delay healthcare-seeking behavior, intensify stress, and worsen outcomes for chronic conditions [18]. Financial insecurity is a psychological stressor linked to cardiovascular disease, hypertension, and mental health conditions.

High cost of living compounds economic strain, forcing trade-offs between healthcare and other necessities. Individuals facing steep housing or food costs may compromise diet quality, delay care, or ration medicines, contributing to stress and worsening chronic conditions [2, 33, 34]. As one testimony illustrates, "Because of the cost of treatment, I sometimes have to make choices between medication and other basic necessities like rent, food, or school" [33].

Debt—especially medical debt—is a growing public health issue, associated with stress, anxiety, depression, and physical illness [23, 30]. Medical debt directly affects healthcare utilization, with many households delaying treatment or skipping medications due to financial obligations [15]. Himmelstein et al. highlight that "Medical debt is adversely associated with multiple aspects of well-being, including delaying and forgoing recommended health care, prescription medication nonadherence, and food and housing insecurity" [35].

These economic indicators are interconnected. Low income reduces the ability to save, amplifying the effects of high living costs and increasing debt risk. Addressing NCDs requires a holistic approach integrating economic, social, and healthcare policies. Public health interventions should prioritize economic opportunity, financial risk protection, and policies that lower the cost of healthy living [16].

In summary, income, savings, cost of living, and debt are interwoven determinants that reinforce health inequities. Policies targeting wage protections, savings incentives, cost reduction, and debt relief can reduce the burden of chronic diseases and foster healthier,

more resilient populations. As the WHO and experts note, "investing in cost-effective NCD interventions can generate substantial economic benefits and save millions of lives".

Mitigation measures:

Policies that promote income security—such as living wage laws, job training programs, and social protection—can alleviate health inequities. Increasing access to stable employment not only improves economic stability but also reduces the long-term pressures that contribute to unhealthy coping mechanisms and debt accumulation [7]. Targeted investments in employment initiatives within vulnerable communities can strengthen resilience against NCDs by enabling healthier lifestyles, access to preventive care, and reduced economic stress.

Economic resources fundamentally shape access to food, housing, healthcare, and cultural participation. Clarke et al. [30] demonstrated that "sociodemographic patterns of chronic disease consistently show higher prevalence among groups with lower income and assets."

Savings mechanisms—both at the individual and policy level—can substantially reduce the burden of NCDs. Encouraging the use of HSAs (Health Savings Accounts) or similar models has been shown to improve consumer engagement in healthcare decisions [36]. Furthermore, Bloom et al. [37] highlight that "the economic value of reducing avoidable deaths from cardiovascular disease would be between 2% and 8% of annual income in 2019 in any region of the world" [4], underscoring the macroeconomic returns of preventive investment. Public programs that match savings for health-related expenses or provide micro-savings schemes in low-income settings can protect households from health-induced poverty traps.

Interventions that lower the structural cost of healthy living can substantially reduce NCD risk. These include subsidies for nutritious foods, affordable housing initiatives, transportation support, and zoning policies that increase access to safe spaces for physical activity. Governments can also regulate pharmaceutical and medical service pricing to reduce treatment-related financial hardship. Such policies not only improve equity but also prevent the intergenerational perpetuation of health disparities.

Expanding access to affordable health insurance and reducing out-of-pocket costs are key strategies to mitigate the health impact of debt. Policy reforms that cap interest rates on medical debt, provide debt forgiveness, or create financial counseling programs can improve population health outcomes. At the structural level, investing in universal health coverage reduces the risk of catastrophic health expenditures, shielding households from the vicious cycle of illness and indebtedness.

2.3 Habits (9 Indicators): Smoking, Alcohol, Diet, Physical Inactivity, Sleep, Exercise, Meditation, Travel and Sexual Activity

Smoking is a major preventable risk factor affecting nearly every organ and contributing to cancer, heart disease, and respiratory illnesses, reducing life expectancy and quality [33].

Alcohol—especially in excess—can cause liver disease, cardiovascular problems, cancer, and mental health issues, while disrupting social and professional life.

Diet influences physical and mental health. Diets high in processed foods, unhealthy fats, and sugars increase risk of obesity, diabetes, and cardiovascular disease, whereas balanced diets with fruits, vegetables, lean proteins, and whole grains protect against chronic disease and support cognitive function.

Physical inactivity raises risk of obesity, heart disease, stroke, and diabetes. Regular activity manages weight, strengthens the cardiovascular system, improves insulin sensitivity, and reduces stress.

Sleep is essential for physical and mental restoration. Chronic deprivation impairs cognition, mood, immunity, and increases chronic disease risk [38].

Exercise, as structured and repetitive movement, strengthens muscles and bones, enhances cardiovascular health, and helps regulate stress, serving as a key protective factor against NCDs.

Meditation reduces stress, lowers cortisol, improves emotional regulation, and indirectly protects against stress-related physical conditions.

Travel promotes psychosocial well-being by offering new experiences, social interaction, and stress relief [1], enhancing quality of life.

Sexual activity supports physical and psychological health, lowering stress, improving mood, aiding cardiovascular function, and strengthening relationships.

Mitigation:

Smoking: Effective strategies combine policy and behavioral interventions. Policies include higher tobacco taxes, public smoking bans, and advertising restrictions to reduce access and normalize non-smoking. Behavioral support involves cessation programs, counseling, and nicotine replacement therapy. A meta-analysis found that "a combination of behavioral support and pharmacotherapy is more effective than either alone" [39].

Alcohol consumption: Mitigation includes regulatory controls—minimum legal drinking ages, sales restrictions, and increased taxes—and public education campaigns on risks and responsible use. Support for individuals with alcohol use disorder via therapy and support groups is crucial. WHO notes that "population-based policies and interventions are key to reducing the harmful use of alcohol" [40].

Diet: Strategies target individual choices and the food environment. Policies regulate marketing to children, tax sugary drinks, and improve labeling. Education promotes fruits, vegetables, whole grains, and healthy fats, while access to nutritious foods reduces disparities. The AHA (American Heart Association) recommends "a dietary pattern that emphasizes fruits, vegetables, whole grains, low-fat dairy products, poultry, fish, and nuts, while limiting red meat, sweets, and sugar-sweetened beverages" [41].

Physical activity: Promoting activity involves supportive environments and personal motivation. Urban planning, schools, and workplaces can encourage exercise, while campaigns educate on benefits. The CDC states that "regular physical activity can help prevent chronic diseases, such as heart disease and diabetes, and improve mental health" [33].

Sleep: Improving sleep quality includes promoting good hygiene—consistent schedules, optimal bedroom conditions, and limiting stimulants—plus screening for disorders. The NSF suggests that "creating a regular sleep schedule, even on weekends, is one of the most effective ways to improve sleep quality" [42].

Exercise: Structured exercise is encouraged through community programs, subsidized gyms, school curricula, and campaigns. WHO recommends adults engage in "150-300 minutes of moderate-intensity aerobic physical activity throughout the week" [43].

Stress & meditation: Reducing chronic stress involves wider access to meditation and mindfulness via workplaces, schools, and healthcare. Mayo Clinic notes that "meditation can produce a deep state of relaxation and a tranquil mind. During meditation, you focus your attention and eliminate the stream of jumbled thoughts that may be crowding your mind and causing stress.

Travel: Policies supporting work-life balance, flexible work, and vacation time promote psychosocial well-being. Encouraging travel enhances mental and social health. Research shows that "vacation time significantly enhances life satisfaction and well-being" [34].

Sexual activity: Healthy sexual behavior is supported through comprehensive education and access to sexual health services. The APA (American Psychological Association) emphasizes that "a healthy sexual relationship is associated with improved emotional well-being, reduced stress, and increased intimacy" [32].

2.4 Treatment Factors (3 Indicators): Early Screening, Treatment Availability and Treatment Quality (Including Adherence)

NCDs (Non-communicable diseases)—including cardiovascular diseases, cancer, diabetes, and chronic respiratory conditions—are leading causes of morbidity and mortality worldwide [1]. Often developing gradually without early symptoms, timely detection and management are essential. Early detection enables interventions that can halt or reverse disease progression; for example, identifying high blood pressure early can prevent cardiovascular events. Early detection also enhances the quality of life for individuals. Workplace screenings and community programs facilitate timely intervention and reduce morbidity and mortality.

Direct access to healthcare providers ensures prompt care. When patients can directly contact their physicians, they can receive timely interventions that prevent complications. Corporate wellness and community strategies, including universal healthcare coverage, improve chronic disease management. Adherence to therapy is a pivotal factor in the effective management of chronic diseases such as diabetes, hypertension, and cardiovascular conditions. Poor adherence leads to complications and higher costs; Effective treatments are therefore failing to realize their potential… owing to poor patient adherence. Workplace and community programs can mitigate barriers to adherence.

Lifestyle risks—unhealthy diet, inactivity, tobacco, and alcohol further increase NCD prevalence [1]. Socioeconomic constraints worsen outcomes: “The risk of dying prematurely from a major NCD in low-income countries is double that in high-income countries” [1]. Community empowerment strengthens resilience. With growing awareness, communities are becoming more active in taking preventive measures. Workplace wellness reduces risk; Employees participating in wellness programs have a 28% lower risk of developing coronary heart disease. Integrated, people-centered care improves outcomes and patient satisfaction. Addressing inequities is essential [1]. Sustainable, evidence-based programs and culturally relevant interventions are critical.

Early screening, timely access, and adherence are pivotal for reducing NCDs. Addressing lifestyle and socioeconomic factors while empowering communities through integrated strategies can improve health, reduce costs, and foster long-term well-being.

Mitigation:

To mitigate NCDs (non-communicable diseases), strategies must emphasize early detection, access to care, and treatment adherence across individual, corporate, and community levels. Early screening enables interventions that halt or reverse progression: identifying high blood pressure, for instance, can prevent cardiovascular events through lifestyle changes or medication notes, early detection allows interventions that can halt or reverse disease progression. Workplace wellness programs also help, as employees show a 28% lower risk of developing coronary heart disease. Communities benefit when integrating screening programs into healthcare systems are essential strategies to reduce morbidity and mortality from major NCDs.

Timely access to physicians ensures personalized care that prevents complications—when patients can directly contact their physicians, they can receive timely interventions that prevent complications. Corporate initiatives such as on-site clinics and insurance coverage, alongside community-level measures like universal healthcare and mobile clinics, enhance access and reduce mortality.

Adherence to therapy is a pivotal factor in the effective management of chronic diseases. Yet, effective treatments are therefore failing to realize their potential in reducing the burden of NCDs owing to poor patient adherence. Individualized support, workplace flexibility, and community-based programs addressing cost, education, and access barriers are essential, as WHO [44] highlights that “language barriers, and

restricted healthcare access" directly affect adherence and outcomes.

2.5 Environmental Factors (10 Indicators): Air Quality, Water Quality, Scent, Housing Quality, Transit, Food & Beverage, Work Environment Pressure, Work Environment Conflicts, Work Environment Sexual and/or Moral Harassment, Work Environment Verbal and/or Physical Violence

Air quality profoundly affects health. Exposure to pollutants like $PM_{2.5}$ and NO_2 is linked to respiratory and cardiovascular disease, neurological disorders, and reduced life expectancy. The Lancet notes that "air pollution is the largest environmental cause of disease and premature death in the world," while the WHO calls polluted air a "silent killer". Mental health is also impacted; JAMA Psychiatry found that long-term exposure to particulate matter raises risks of depression and anxiety.

Water quality is equally critical. Contaminated water spreads infections (cholera, typhoid) and chemical poisonings (lead, arsenic). The WHO estimates "829,000 deaths each year from diarrhea alone," while the EPA warns that drinking water often carries serious contaminants. Unsafe water harms organs, child development, and mental health, with scarcity and lead exposure linked to anxiety, depression, and cognitive problems.

Scents strongly influence well-being. Pleasant odors ease stress, while foul ones cause discomfort, nausea, and psychological distress. Environmental Health Perspectives notes that malodors like hydrogen sulfide trigger headaches and irritation, while Dr. Rachel Herz emphasizes smell's unique link to memory and mood.

Housing quality shapes health outcomes. The WHO states that "inadequate housing conditions… can lead to infectious diseases, chronic illnesses, injuries and mental health problems." Dampness, mold, pests, and toxins raise illness and injury risks, while unsafe homes fuel chronic stress. The APA reports that poor housing and instability are tied to depression and anxiety.

Transit affects both access and stress. Long commutes increase blood pressure, obesity, and stress (American Journal of Preventive Medicine), with the University of the West of England finding longer travel times heighten anxiety.

Food quality and access determine chronic disease risks. The CDC warns that "unhealthy diets and physical inactivity are leading causes of death in the U.S." Diet influences mental health too; Harvard Medical School notes that "the food we eat affects our brain chemistry," with healthy diets linked to lower depression risk.

Workplace stressors undermine health. Heavy workloads raise risks of cardiovascular and chronic illnesses (American Institute of Stress) and contribute to burnout and depression (The Lancet). Interpersonal conflicts, as the Mayo Clinic notes, elevate risks of heart disease, sleep problems, and digestive issues, while harassment and violence cause trauma, PTSD, and long-term psychological distress (APA; OSHA).

Mitigation:

Air quality is a critical determinant of health, with pollutants like $PM_{2.5}$ and NO_2 linked to respiratory, cardiovascular, and neurological disorders. Mitigation includes clean energy, sustainable transport, green spaces, stricter emissions standards, and air filtration.

Water quality impacts health through exposure to bacteria, lead, and arsenic, causing acute and chronic illness [1]. Solutions include treatment systems, source protection, safe hygiene practices, and affordable filtration. Ensuring access to safe drinking water is a cornerstone of public health.

Olfactory environments influence mental health, with malodors from waste and emissions linked to stress. Source control, better infrastructure, and plants can improve quality of life.

Housing quality affects chronic illness and stress. Safe, ventilated homes free from mold, lead, and asbestos, plus subsidies for repairs, improve health. "Stable and safe housing is associated with lower rates of respiratory and cardiovascular disease" [1].

Transit accessibility shapes activity and exposure. Walkable cities and efficient transit reduce emissions and improve well-being.

Food quality is central to NCD prevention. Local food systems, access to fresh produce, nutrition education, and regulation of processed foods reduce disease. Access to nutritious foods is a key social determinant of health.

Workplace factors such as stress, conflicts, harassment, and violence harm health. Effective strategies include flexible policies, well-being programs, mediation training, zero-tolerance frameworks, and violence prevention. A positive social climate at work mitigates stress and enhances productivity.

Integrating these strategies across environmental, social, and occupational domains yields measurable improvements in both mental and physical health, underscoring the interconnectivity of social determinants and public health.

2.6 Culture (3 Indicators): Availability, Quality, Frequency of Cultural Access

Cultural engagement is a significant determinant of physical and mental health, shaped by the availability, quality, and frequency of access. Proximity to museums, theaters, and libraries predicts participation and correlates with better health outcomes. As the WHO notes, "the arts and culture sector is a health-promoting resource and is effective in tackling health challenges" [45]. Accessible cultural spaces also foster social cohesion and reduce loneliness, key factors for mental health.

The quality of experiences matters: meaningful, emotionally resonant activities enhance well-being more than passive exposure. "Active and high-quality cultural engagement is associated with greater life satisfaction" [46]. Well-designed, well-managed venues further boost benefits by promoting comfort, safety, and positive social interaction.

Frequency is equally important. Occasional participation helps, but regular engagement has cumulative effects on mental and physical health. Longitudinal research shows that "cultural participation over time is associated with better survival" [47]. Continuous involvement supports resilience, belonging, and healthier routines, particularly for older adults or socially isolated groups.

In sum, availability, quality, and frequency of cultural engagement shape its health impact, making accessible, high-quality, and sustained participation vital for public well-being.

Mitigation:

Communities can address challenges related to cultural engagement by implementing strategies that target the availability, quality, and frequency of cultural opportunities. These interventions aim to enhance public health and well-being by facilitating broader participation and access to cultural resources.

Increasing the availability of cultural venues and events requires attention to both physical and economic accessibility. Establishing new cultural institutions in underserved areas and supporting existing ones through public and private investment ensure that these resources remain operational and open to the public. Providing subsidized or free admission, particularly for low-income families and students, reduces financial barriers and encourages participation. As the World Health Organization [45] emphasizes, "The arts and culture sector is a health-promoting resource and is effective in tackling health challenges," highlighting the importance of widespread access to cultural resources.

Improving the quality of cultural experiences involves enhancing both programming and physical infrastructure. Engagement in meaningful and emotionally resonant cultural activities is linked to greater life satisfaction. Fancourt and Steptoe [46] note that "Active and high-quality cultural engagement is associated with greater life satisfaction." To achieve this, cultural institutions should develop interactive and diverse programs that appeal to a wide range of

interests and demographics. Maintaining venues to ensure safety, comfort, cleanliness, adequate lighting, ventilation, and seating fosters welcoming environments that support well-being. Well-designed and well-managed public spaces enhance individual well-being and social capital, providing positive social, economic, and environmental value.

Promoting frequent engagement requires strategies that encourage regular participation in cultural activities. Long-term involvement has cumulative health benefits and is associated with improved survival rates. Bygren [47] reports that "Cultural participation over time is associated with better survival." Communities can foster this by implementing membership or subscription programs that incentivize repeated visits, establishing community-based workshops, arts classes, and programs that offer consistent opportunities for creative expression, and organizing recurring events such as weekly live music markets or monthly arts festivals to integrate cultural participation into everyday life.

2.7 Nature (3 Indicators): Availability, Quality, Frequency of Green Space Access

The connection between human health and exposure to nature is increasingly studied in public health, especially for chronic disease prevention. As urbanization grows, understanding how access to "green spaces" influences health has become critical. Nature exposure works through environmental, psychological, and social pathways. As John Burroughs reflected, "I go to nature to be soothed and healed, and to have my senses put in order," a sentiment supported by modern research.

Green spaces support physical activity, reducing risks of obesity, diabetes, and cardiovascular disease, while also mitigating air and noise pollution and moderating heat. They foster psychological restoration—lowering stress and enhancing cognition [48]—and promote social interaction, reducing isolation, a known health risk.

Indicators of exposure fall into three dimensions: availability, quality, and frequency. Availability is often measured through proximity or vegetation indices such as NDVI, with higher values linked to lower prevalence of chronic conditions. WHO recommends access to green space within 300 meters of residences. Quality depends on facilities, maintenance, aesthetics, and biodiversity, with perceptions of safety strongly shaping use. Frequency of visits, tracked by surveys or GPS, informs dose-response relationships, such as whether daily short walks differ from occasional longer visits.

Evidence shows that meaningful, frequent, and high-quality nature engagement helps reduce the burden of chronic diseases. If you truly love nature, you will find beauty everywhere. Future research should integrate objective measures with subjective perceptions to guide urban planning and health policy toward healthier, greener communities.

Mitigation:

Limited access to natural environments is increasingly recognized as a determinant of physical and mental health. Exposure to green spaces is linked to reduced cardiovascular risk, improved mental well-being, and lower all-cause mortality [48]. Mitigation strategies therefore emphasize enhancing the availability, quality, and frequency of green space exposure through planning, policy, and community programs.

Availability is improved by integrating parks, greenways, and riparian restoration into urban design, supported by regulatory measures requiring minimum allocations and prioritizing underserved communities. Quality enhancements—such as walking paths, lighting, native planting, and participatory design—boost safety, usability, biodiversity, and community ownership. Frequency of use is encouraged through health campaigns, community activities (e.g., guided walks, gardens, outdoor yoga), and active transportation policies that connect neighborhoods to parks.

A multifaceted approach combining these dimensions helps reduce health inequities and creates sustainable cities that support both ecological integrity and population well-being.

3. Score Mechanics

The Health Score represents a robust and reproducible approach to monitoring and predicting health outcomes by quantifying the influence of SDOH (social determinants of health). Derived through a structured, hierarchical process, the system aligns with established principles of social epidemiology and provides a transparent framework for assessing cumulative health risks across populations. The Health Score is calculated by mapping indicators to specific measurement categories, assigning point values to each category, summing partial scores at the factor level, and aggregating totals to generate an overall score that can be interpreted using standardized grade bands.

This hierarchy—factors → indicators → categories → point allocations—ensures reproducibility, transparency, and comparability across diverse contexts.

The conceptual foundation of the Health Score is rooted in the extensive literature on SDOH, which the World Health Organization defines as "the conditions in which people are born, grow, live, work and age" [43]. Empirical research consistently demonstrates that non-medical factors, including education, employment, and environmental quality, often exert a stronger influence on health outcomes than clinical care alone. By assigning point values to such indicators, the Health Score translates these complex social exposures into a quantifiable metric. This approach facilitates a more holistic understanding of health, moving beyond the clinical perspective to encompass the broader social and environmental determinants that shape morbidity and mortality patterns.

Braveman and Gottlieb [36] emphasized that "the social conditions that lead to inequities in health are both pervasive and potent," highlighting the necessity of integrating these determinants into systematic health assessment. The Health Score operationalizes this by capturing the cumulative effects of adverse social exposures; for instance, low scores associated with "No education" or "Worst water quality" directly correspond to increased risks for chronic or infectious diseases, respectively. Such a data-driven framework enables health systems to identify high-risk populations proactively, thereby facilitating targeted interventions

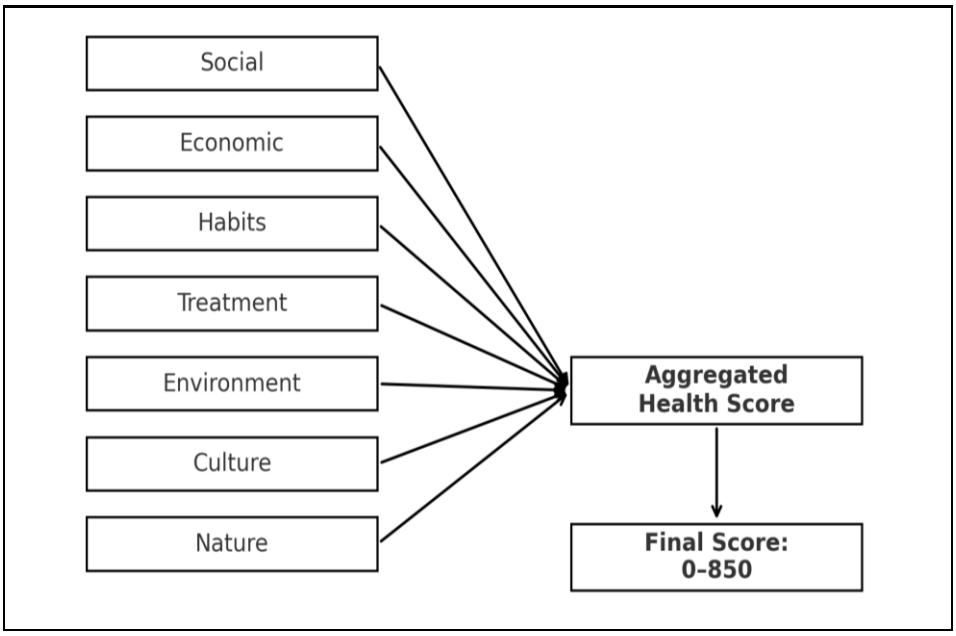

Fig. 1 Flowchart of domains contributing to the aggregated Health Score (0-850).

before clinical disease manifests. As noted by Egerter, Braveman, Sadegh-Nobari, Grossman-Kahn and Dekker [35], "identifying and prioritizing populations with the lowest scores allows health systems to allocate resources more efficiently to those most in need," promoting a shift from reactive treatment models to preventive and mitigating strategies.

The integration of artificial intelligence (AI) and machine learning (ML) further enhances the predictive power and operational utility of the Health Score. These technologies can analyze complex, high-dimensional datasets—including electronic health records, genomic information, and real-time sensor data from wearable devices—to detect subtle, non-linear relationships that static scoring systems may overlook. AI and ML algorithms refine their predictions continuously through exposure to new data, generating a feedback loop that improves accuracy over time.

For example, a declining Health Score may trigger AI-driven analyses that correlate genetic predispositions, lifestyle behaviors, and physiological metrics (e.g., sleep quality detected by wearable sensors) to forecast the risk of cardiovascular events months or years in advance. This real-time predictive capability enables personalized, actionable interventions, such as tailored recommendations for stress management or automated alerts to healthcare providers. Consequently, the Health Score evolves from a static monitoring tool into a dynamic system for individualized health management, supporting the transition from population-level recommendations to precision-focused strategies that mitigate risk and prevent adverse health outcomes.

4. Grade Bands, Risks, and Mitigation

The Health Score System is a structured framework designed to evaluate individual health status and stratify population-level health risks through a quantitative scoring mechanism. By translating complex health information into a clear numerical value, this tool allows healthcare providers, public health officials, and individuals to rapidly assess health status and guide appropriate interventions. The scoring range spans from 0 to over 850, with lower scores indicating more significant health challenges and higher scores reflecting more favorable health outcomes.

The scoring categories provide a graded approach to intervention. Table 1 summarizes the Health Score ranges, associated health status, and recommended actions.

The Health Score System aligns with principles widely recognized in public health and preventive medicine. Tiered intervention strategies acknowledge that populations exhibit heterogeneous health needs

Table 1 Health Score System: Risk stratification and recommended actions.

Score Range	Health Status	Description & Recommended Action
≥850	Excellent (Null)	Individuals exhibit optimal health determinants with minimal risk. Focus on supportive prevention to maintain status.
751-850	Very Low Risk	Health is very good; early warning signs should be monitored. Implement early preventive strategies.
651-750	Low Risk	Health is generally good; proactive preventive programming is recommended to avert potential future issues.
551-650	Average Risk	Moderate risk; recommend structured interventions including culture and nature prescriptions and frequent clinical follow-ups.
451-550	High Risk	Elevated risk for chronic diseases (obesity, diabetes, cardiovascular issues); broad interventions required.
301-450	Very High Risk	Likely presence of multiple chronic conditions; comprehensive public health measures and coordinated care needed.
0-300	Eminent Risk	Severe systemic disease burden; urgent multi-sectoral interventions required.

and that targeted interventions enhance both efficiency and effectiveness [11]. Importantly, the system incorporates SDOH (social determinants of health), including socio-economic status, education, healthcare access, and environmental exposures, recognizing that health outcomes are shaped by factors beyond clinical measures [36]. The system also complements chronic disease management programs, providing a measurable framework to track patient risk over time and guide interventions for conditions such as diabetes and obesity [49]. In corporate wellness and population health contexts, similar HRAs (health risk assessments) and biometric screenings have been shown to improve individualized recommendations and promote behavior change [50].

A distinctive feature of the system is the incorporation of culture and nature prescriptions for individuals at moderate risk. This approach reflects an emerging recognition of the therapeutic benefits of exposure to natural environments and social engagement, with studies demonstrating that interaction with green spaces and community activities can improve both mental and physical health outcomes [51, 52]. By integrating these factors into health assessment, the Health Score System addresses biomedical risks while emphasizing holistic determinants of well-being.

In conclusion, the Health Score System offers a practical, evidence-informed numerical framework for assessing individual and population health, stratifying risk, and guiding interventions. Its principles resonate with contemporary public health practices, supporting efficient allocation of healthcare resources and the promotion of overall well-being. As healthcare increasingly emphasizes precision prevention and holistic care, structured frameworks such as this will be central to addressing complex health challenges.

5. Conclusion

The Health Score provides an innovative, holistic framework for assessing chronic disease exposure. By integrating traditional determinants such as income, smoking habits, education, and air quality with emerging protective factors like cultural participation, pet ownership, and exposure to green spaces, it offers a multidimensional tool that extends beyond conventional clinical risk models. This structured approach not only facilitates accurate diagnosis but also provides a clear roadmap for interventions at individual, corporate, and community levels.

The escalating prevalence of chronic diseases poses a profound challenge to public health systems globally. Nearly half of the U.S. population is affected, generating substantial economic and societal burdens. Addressing NCDs (noncommunicable diseases) therefore requires strategies that account for social, economic, environmental, and behavioral determinants of health. The Health Score framework offers a practical and transparent mechanism for quantifying these complex interactions, translating a wide spectrum of health determinants into a single, comprehensible numerical score. This allows individuals, organizations, and communities to quickly gauge vulnerability and identify areas for targeted intervention.

Beyond assessment, the Health Score is dynamic and predictive. It illustrates how specific interventions—such as improved nutrition, increased physical activity, enhanced healthcare access, or engagement with cultural and natural environments—can positively influence health outcomes over time. This predictive capability supports proactive decision-making, empowering individuals to adopt lifestyle changes, guiding corporate wellness initiatives, and informing community-level policies designed to mitigate risk. By fostering a holistic understanding of health—emphasizing resilience and well-being rather than merely the absence of disease—the framework equips stakeholders to implement concrete, measurable actions.

In conclusion, the Health Score represents a paradigm shift in chronic disease management. It bridges clinical, social, and environmental perspectives,

transforming complex health determinants into actionable insights. By enabling precise assessment, continuous monitoring, and evidence-based prediction of health trajectories, the framework empowers a wide range of stakeholders to intervene earlier, design more effective prevention strategies, and ultimately build healthier, more resilient populations. As chronic disease burdens continue to rise globally, such integrative tools are essential for fostering a sustainable approach to public health that is adaptive, equitable, and forward-looking.

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