Dual-Disease Co-management in an Aging Society: The Social Roots and Governance Pathways of the Comorbidity of Cardiovascular Disease and Depression

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Abstract. In the context of population aging, the comorbidity of cardiovascular disease and depression among older adults has emerged as a prominent public health challenge. These two conditions interact through multiple biological mechanisms, including immune-inflammatory responses, neurotransmitter imbalance, and dysregulation of the hypothalamic–pituitary–adrenal axis. Such interactions create a vicious cycle that leads to poor prognosis and increased mortality among patients. However, the traditional specialty-segmented medical system has intensified the fragmentation of healthcare services, making it difficult to effectively manage comorbid conditions. This study finds that social determinants—such as disparities in socioeconomic status, insufficient social security, weak social support, and the digital divide—constitute the fundamental drivers of the comorbidity of cardiovascular disease and depression among older adults and further exacerbate health inequalities. In response to these challenges, this paper proposes an integrated governance pathway centered on the concept of "dual-disease co-management." Specific measures include establishing a targeted medical subsidy mechanism to reduce economic barriers, improving social pension programs to strengthen social security, implementing community-based intervention strategies to alleviate loneliness among older adults, promoting age-friendly electronic health technologies to bridge the digital divide, and integrating collaborative care models for chronic disease management within primary healthcare. From a social-ecological perspective, this framework integrates medical interventions with social governance, thereby providing a new theoretical basis and practical paradigm for addressing the complex health challenges associated with population aging.

Keywords: population aging, dual-disease co-management, cardiovascular disease, depression, social determinants.

1. Introduction

Population aging has become an irreversible trend in global social development, and the twenty-first century is expected to be an era of profound demographic aging worldwide. According to official statistics from the World Health Organization (WHO), the global population aged 60 and above will double between 2000 and 2050. Its share of the world's population will increase from 11% to 22%, reaching approximately two billion people [1]. In aging societies, the central challenge has shifted from "achieving longevity" to "ensuring healthy longevity." Life expectancy tends to be lower in rural or remote areas, while the prevalence of chronic non-communicable diseases is higher. This pattern reflects a clear characteristic of "longevity without health" [2]. On average, for every 1% increase in the rural elderly population, the number of hospital inpatients rises by approximately 138,000. At the same time, the high-frequency demand for medical services among individuals aged 65 and above, combined with limited healthcare resources, has created one of the most severe structural pressures on contemporary health systems [3]. Against this background, the comorbidity of chronic diseases and mental disorders among older adults has become increasingly prominent, particularly the coexistence of cardiovascular disease and depression. As the complexity of cardiovascular comorbidities increases, the risk of depression rises significantly. For example, for each additional cardiovascular comorbidity in the elderly population, the risk of depression increases by approximately 15% [4]. Meanwhile, psychological disorders such as anxiety and depression are

closely associated with a higher risk of cardiovascular disease, increased mortality, and poorer clinical outcomes. Studies have shown that patients with these psychological conditions face a risk of adverse outcomes that is 50% to two times higher than that of individuals without such conditions. This finding suggests that mental health disorders may further accelerate the progression of cardiovascular disease and lead to unfavorable prognoses [5–6]. The interaction between physical illness and mental health conditions makes it difficult to improve the control rate of single diseases. At the same time, disability risk and suicide risk may accumulate. As a result, this mind–body interaction has gradually become a major public health challenge that urgently needs to be addressed in aging societies.

Faced with the severe reality of the comorbidity of cardiovascular disease and depression in aging societies, the specialty-segmented healthcare system under the traditional biomedical model is unable to fully capture the evolving and holistic relationship between these conditions. This fragmented and non-integrated medical model has become a deeper source of healthcare crises. It has led to continuously rising medical costs, uneven service quality, and increasingly prominent health inequalities [7]. In contrast, general practice–oriented care has the potential to break the vicious cycle between cardiovascular disease and depression. It can improve treatment outcomes and prognoses for patients with comorbid conditions while also reducing the waste of healthcare resources. Against this background, the concept of "dual-disease co-management" has emerged. It has been recommended for elderly patients with depression who also suffer from cardiovascular diseases, such as coronary heart disease. This approach advocates multidisciplinary collaboration. It emphasizes systematic assessment and intervention for the complex condition of cardiovascular disease and geriatric depression comorbidity. In doing so, it provides a scientific basis and practical guidance for clinical practice [8]. This model effectively promotes collaboration across medical specialties, reduces the need for patients to move repeatedly between different departments, and improves both treatment accessibility and patient acceptance.

Social determinants encompass multiple dimensions, including economic status, educational attainment, social support, healthcare accessibility, and living environments. The influence of social determinants on mortality among individuals with depression is significantly greater than that observed in the general population. These determinants are also closely associated with major cardiovascular risk factors and adverse outcomes, such as cardiovascular disease (CVD), cancer, and mortality [9]. Individuals with depression who simultaneously face a high burden of adverse social determinants exhibit a 2.52-fold increase in all-cause mortality risk and a 2.79-fold increase in cardiovascular mortality risk [10].In China, a series of social realities—including the uneven distribution of primary healthcare resources, disparities in educational attainment, widening gaps in pension income, and the growing number of empty-nest and solitary older adults—collectively form a structural network of health inequality. These factors not only represent important determinants of cardiovascular disease but also serve as key triggers of depression among older adults. More importantly, they constitute the fundamental driving forces underlying the comorbidity of these two conditions. Based on this context, the present study moves beyond a single-individual attribution perspective and adopts a social-ecological framework to systematically analyze the social determinants of the comorbidity of cardiovascular disease and depression among older adults. On this basis, it further explores an integrated pathway through which the concept of "dual-disease co-management" can move from theoretical proposition to practical implementation, with the aim of providing insights for building a more resilient health governance paradigm in an aging society.

2. Pathophysiological Mechanisms

The comorbidity of cardiovascular disease and depression involves multiple pathophysiological mechanisms, including immune-inflammatory responses, neurotransmitter regulation, and dysfunction of the hypothalamic–pituitary–adrenal (HPA) axis. These mechanisms may arise from complex interactions among stress-sensitive neuropeptides, neurotransmitters, and inflammatory processes. Once inflammatory cytokines are produced locally in the brain or enter the brain from

peripheral circulation, they can modulate the levels of various neurotransmitters and neuropeptides, including serotonin (5-HT), norepinephrine (NE), corticotropin-releasing factor (CRF), and brain-derived neurotrophic factor (BDNF). Among these, 5-HT and NE are monoamine neurotransmitters that jointly regulate mood, cognition, sleep, and stress responses. Dysregulation of these neurotransmitters constitutes a key pathological basis for affective disorders such as depression. Inflammatory processes primarily stimulate the release of CRF and NE while generally inhibiting the activity of 5-HT and BDNF, as well as the phosphorylation of the BDNF-activated receptor TrkB [11]. In addition, excessive production of CRF can induce behavioral, neuroendocrine, and cardiovascular effects associated with the comorbidity of depression and cardiovascular disease. Consistent with this pathogenic mechanism, animal studies have demonstrated that selective blockade of the CRF_1 receptor can prevent stress-induced sympathetic nervous system activation, whereas the conventional antidepressant desipramine does not exhibit this effect [12–13]. Therefore, an inflammatory environment may trigger a series of adaptive changes within these stress-sensitive systems, leading to the formation of a susceptible phenotype and thereby promoting the development of both depression and cardiovascular disease [11].

For patients with cardiovascular disease accompanied by depression, depressive disorders often trigger inflammatory responses characterized by elevated levels of inflammatory markers, including IL-6, TNF-α, high-sensitivity C-reactive protein, and ICAM-1 [14]. Research indicates that approximately one-quarter of patients with major depressive disorder (MDD) exhibit low-grade inflammation marked by elevated C-reactive protein (CRP) levels. This finding suggests the existence of an "inflammatory MDD" subtype, which may be particularly closely associated with an increased risk of cardiovascular disease (CVD) [15]. Elevated levels of inflammatory cytokines not only mediate nonspecific inflammatory responses and alter immune reactivity but also exert significant effects on cardiovascular health. More specifically, increased IL-6 levels are significantly associated with a higher risk of myocardial infarction and cardiovascular mortality. TNF-α, IL-1β, and C-reactive protein promote the progression of atherosclerotic lesions by facilitating foam cell formation, accelerating intraplaque hemorrhage, and inducing the secretion of matrix-degrading enzymes. Elevated IL-1β levels can trigger both neuroinflammation and peripheral inflammation, which may drive pathological changes through persistent chronic inflammatory responses. These changes include cardiac remodeling, left ventricular dilation, and fibrosis, thereby impairing long-term cardiac function. In addition, these cytokines can directly affect myocardial contractility and induce apoptosis of cardiomyocytes [14].

During acute myocardial infarction, peripheral cytokines can modulate the release and metabolic processes of several neurotransmitters within the central nervous system, including dopamine, norepinephrine, and serotonin (5-HT). These neurotransmitters play a crucial role in regulating sympathetic nervous system output to the cardiovascular system, and they are also closely associated with the pathogenesis of depression. Specifically, the pathophysiological mechanisms of depression are closely linked to dysfunction in the norepinephrine and dopamine systems. In certain patients with depression, elevated norepinephrine levels may even increase the risk of congestive heart failure. Evidence indicates that antihypertensive agents capable of depleting monoamine neurotransmitters, such as reserpine, may induce depressive symptoms. In contrast, monoamine oxidase inhibitors and tricyclic antidepressants exert antidepressant effects by increasing the synaptic concentrations of monoamine neurotransmitters within the central nervous system. Furthermore, results from the dexamethasone suppression test show that non-suppressors exhibit higher plasma norepinephrine concentrations both at baseline and after exposure to cold stimulation. In addition, some pharmacological agents that act on the central dopaminergic system have also demonstrated antidepressant effects. Taken together, these findings suggest that the pathogenesis of depression is closely associated with dysfunction of the brain's monoaminergic neurotransmitter systems [16].

In patients with depression, the hypothalamic–pituitary–adrenal (HPA) axis becomes activated. The paraventricular nucleus of the hypothalamus synthesizes and releases corticotropin-releasing hormone (CRH) and arginine vasopressin. These substances are subsequently transported to the

anterior pituitary, where they stimulate the secretion of adrenocorticotropic hormone (ACTH) into the systemic circulation. ACTH then acts on the zona fasciculata of the adrenal cortex, promoting the synthesis and release of cortisol (CORT) [17]. Under physiological conditions, when CORT levels reach saturation, they activate glucocorticoid receptors (GRs). This activation stimulates the hippocampus to send negative feedback signals that regulate the HPA axis and reduce CORT secretion. However, chronic or acute elevations in CORT can lead to excessive activation of GRs. This process results in hippocampal damage and dysfunction of the HPA axis negative feedback regulation, ultimately leading to hyperactivity of the HPA axis. Such dysfunction forms a vicious cycle. Persistent elevation of CORT exacerbates hippocampal damage, disrupts neurotransmitter homeostasis, and impairs neural circuit function, thereby aggravating depressive symptoms. At the same time, elevated CORT not only worsens depression but also induces vasoconstriction, increases blood pressure, and enhances cardiovascular sensitivity to catecholamines. These effects promote the excessive release of pro-inflammatory cytokines, such as TNF-α, IL-1β, and IL-6. The resulting inflammatory responses accelerate the progression of hypertension, myocardial ischemia–reperfusion injury, and other cardiovascular diseases [14].

3. Social Factors

3.1. Socioeconomic Inequality

The relationship between socioeconomic status and both cardiovascular disease and depression is highly significant. Self-assessed social status, particularly the perception of low social standing, may lead to chronic physiological stress. This stress is a known factor contributing to both cardiovascular disease and depression. Lower social status is often associated with unfavorable healthcare-seeking behaviors, which may result in delayed diagnosis or missed diagnosis of cardiovascular disease and depression. It is also associated with unhealthy lifestyle choices, which further exacerbate these health problems. Among populations with lower social status, hypertension is often linked to limited access to nutritious foods, high salt intake, reliance on low-cost dietary options, tobacco and alcohol consumption, and unstable access to healthcare services [18]. Research suggests that low socioeconomic status may increase the risk of coronary heart disease through psychosocial mechanisms. For example, individuals with lower socioeconomic status often exhibit higher levels of hostility, depression, and anxiety. These negative emotional states may trigger adverse physiological changes that ultimately increase the risk of coronary heart disease [19]. The higher prevalence of cardiovascular disease among low-income populations is likely multifactorial. Social factors such as food insecurity, lack of adequate housing and transportation, limited education and health literacy, inability to afford medications, reduced access to preventive healthcare services, and a higher prevalence or poorer control of traditional cardiovascular risk factors are all considered contributors to poorer health outcomes among low-income groups. The higher prevalence of cardiovascular disease among low-income populations may also be attributed to psychosocial stressors and maladaptive coping behaviors, such as substance or alcohol misuse [20]. Research findings indicate that the risk of cardiovascular disease among low-income groups is 14% higher than that of high-income groups. In addition, the risk of cardiovascular mortality in low- and middle-income groups is 45% and 18% higher, respectively, than that observed in higher-income populations [21]. Other studies examining the impact of socioeconomic factors on depression have shown that individuals with the lowest incomes are typically 1.5 to 3 times more likely to develop depression than those with the highest incomes. Further evidence indicates that low socioeconomic status—measured by occupational status, income level, or educational attainment—is a major psychosocial risk factor for both men and women. However, the social gradient appears to be stronger among women than among men. Women with fewer than eight years of education have a fourfold higher risk of developing coronary heart disease during a 14-year follow-up period compared with women who have at least twelve years of education [22].

A study conducted in the United States and Japan reported two main reasons for the lower diagnostic rate of depression among low-income populations. First, individuals in lower-income groups may have limited awareness and understanding of depression, which reduces the likelihood of recognizing depressive symptoms and consequently lowers the detected prevalence of diagnosed depression. Second, compared with higher-income groups, individuals with lower incomes may be less willing to seek medical care, which further contributes to the lower rate of depression diagnosis in these populations.

3.2. Social Security and Welfare Policies

When addressing the social risks associated with the comorbidity of cardiovascular disease and depression, social security and welfare policies play a crucial role as economic buffers. Research has shown that the level of pension insurance has a significant positive effect on the mental health of older adults, and this effect is even greater than its impact on physical health. The provision of pensions can directly alleviate depressive symptoms among the elderly [23]. The underlying mechanism lies in the fact that pensions improve the economic conditions of older adults and enhance their capacity to afford expenditures such as healthcare services, thereby exerting a positive influence on overall health. This also implies that older individuals with lower pension benefits often experience poorer mental health and lack sufficient financial risk-buffering capacity when facing the comorbidity of cardiovascular disease and depression [24]. Evidence indicates that for every one-unit increase in public pension benefits, unmet healthcare needs among individuals aged 65 and above decrease by 1.11 percentage points. The absence of inadequacy of such social protection is directly reflected in the sharp increase in healthcare costs. From a macro perspective, chronic diseases have become a major driver of healthcare expenditures. For instance, in 2019 the average medical expenditure for older patients with heart disease reached USD 5,397 per person, ranking second among nine common disease categories. Moreover, both the prevalence and mortality of heart disease increase with age. Given this dual upward trend, healthcare expenditures associated with heart disease have posed a serious challenge to public health and the healthcare system in China. When psychological problems resulting from insufficient social security interact with physical diseases, the economic consequences become even more severe. Specifically, compared with heart disease patients without depression, those who exhibit depressive symptoms incur substantially higher medical expenditures. Studies examining the economic burden associated with depression and heart disease have found, through meta-analyses of the excess costs of depression, that these costs tend to increase when depression coexists with other illnesses. This finding confirms that the medical costs of heart disease patients with depression are significantly higher than those of patients without depression. Similarly, among patients with hypertension, depressive symptoms have been found to be associated with increased direct economic burdens among middle-aged and older adults, and the magnitude of economic loss is positively correlated with the severity of depression. In summary, within the context of population aging, the comorbidity of cardiovascular disease and depression among older adults is significantly and positively associated with increased healthcare expenditures [25].

3.3. Social Support and Social Capital

Loneliness and social isolation increase the risk of coronary heart disease by 29% and the risk of stroke by 32%. Early review studies have reported that the prognosis of cardiovascular disease (CVD) tends to be poorer among individuals with weak social relationships. The impact of poor social relationships on the occurrence of cardiovascular disease is comparable to other recognized psychosocial risk factors, such as anxiety and occupational stress [26]. The “empty-nest” phenomenon has become increasingly common among older adults and has emerged as a distinctive family pattern within aging populations, with significant implications for the mental health of the elderly [27–28]. The empty-nest condition refers to older adults living alone while their children reside elsewhere for education or employment. This situation may increase the risk of mental disorders among older individuals. A growing body of research indicates that empty-nest older adults

face greater risks of social exclusion, weaker social relationships, limited participation in social activities, restricted access to basic services, lower quality of life, feelings of frustration, and loneliness, all of which are positively associated with depression. In Chinese culture, strong emphasis is traditionally placed on raising children to ensure care and support in old age. Consequently, older adults often maintain strong emotional dependence on and high expectations of their adult children. When children leave home, many elderly parents experience loneliness, and numerous studies have demonstrated a close association between loneliness and depression. Empirical findings show that the prevalence of depression among empty-nest older adults is significantly higher than among those living with their children. One study reported that the prevalence of depression was 44.2% in the empty-nest group, compared with 26.3% in the non–empty-nest group. Compared with older adults living with their children, empty-nest older adults are therefore more likely to develop depression [29]. In addition, the prevalence of dyslipidemia, diabetes, chronic pulmonary disease, and heart disease among empty-nest older adults was reported to be 27.0%, 16.6%, 19.4%, and 26.3%, respectively. These rates were all higher than those observed among non–empty-nest older adults (25.0%, 15.1%, 16.4%, and 23.4%), and the differences were statistically significant ($P < 0.05$).

3.4. Digital Divide

The intersection of population aging and digitalization has become a defining feature of the contemporary era. Although digital technologies have brought considerable convenience, they also require older adults to adopt tools that did not exist during their formative or working years. Studies have shown that individuals aged 50–59 are more likely to use Internet-based health services (IHS) than those aged 70 and above. This age gradient may reflect the persistence of the digital divide, as older adults face greater challenges in adopting emerging technologies. Age-related cognitive decline, such as slower processing speed and limited memory capacity, may hinder the development of digital literacy among older populations. In addition, older adults may prefer traditional face-to-face medical consultations due to deeply rooted cultural preferences and long-established healthcare-seeking behaviors [30].

3.5. Fragmentation of the Healthcare Service System

China’s hierarchical medical system was designed to optimize the allocation of healthcare resources. However, it has unintentionally intensified the fragmentation of healthcare services. Patients with multiple comorbidities are frequent users of healthcare systems. Although the supply of medical services has increased, fragmented service delivery may still lead to suboptimal treatment outcomes. For example, patients with coexisting cardiovascular disease and depression often face significant challenges in self-management, particularly with respect to medication adherence and lifestyle modification. This situation highlights an urgent need for integrated care. However, the healthcare systems of many low- and middle-income countries, including China, remain relatively fragmented. They tend to focus primarily on acute conditions and the management of single diseases, while lacking effective coordination mechanisms. This structural disconnection not only complicates the management of complex cases and reduces coordination among specialized departments but also increases the financial burden on patients. Importantly, the negative effects of healthcare fragmentation do not occur in isolation. Studies have shown that higher levels of all clinical indicators of healthcare fragmentation are associated with increased all-cause mortality, suggesting that fragmentation may function as an independent risk factor for adverse patient outcomes. This finding further indicates that multiple aspects of fragmented care may collectively contribute to poorer health outcomes. From a global perspective, the fragmentation of healthcare resources is a common challenge faced by many health systems. For instance, Zeleke and colleagues found in their study of patients with comorbid conditions in Ethiopia that fragmented care increased unmet treatment needs and contributed to higher morbidity and mortality. Similarly, among patients with coexisting psychological and cardiovascular disorders in other contexts, systemic, cultural, and infrastructural barriers have also led to fragmented care, high levels of unmet treatment needs, and increased

morbidity and mortality. In summary, healthcare fragmentation remains a major barrier to achieving integrated care [31–33].

4. Governance Measures

4.1. Targeted Financial Relief Mechanisms through Medical Assistance

Research findings indicate that medical assistance coverage reduces the prevalence of undiagnosed depression by nearly 50% and decreases the prevalence of untreated depression by more than 60%. Overall, the proportion of individuals screening positive for depression declined by 9.2 percentage points, while the proportion of individuals with a prior diagnosis of depression decreased by 13.1 percentage points [34]. The expansion of medical assistance significantly improves access to healthcare services by providing more convenient channels for obtaining care. This increased accessibility facilitates the detection of previously undiagnosed conditions and enables subsequent treatment, thereby reducing the prevalence of both untreated and undiagnosed depression and significantly alleviating depressive symptoms. Consequently, policy decisions concerning medical assistance coverage for vulnerable populations are likely to produce substantial health outcomes [35]. Financial protection provided through medical assistance can reduce economic stress and contribute to improvements in mental health. Such economic support is particularly beneficial for patients who frequently utilize healthcare systems. This may also explain why the expansion of medical assistance has been found to be associated primarily with improvements in mental health outcomes among adults with chronic diseases. Moreover, improved access to healthcare services may lead to higher rates of mental health treatment utilization [36].

4.2. Social Pension Programs

Social pensions are government-led social security measures designed to provide basic economic support for populations that are not covered by formal pension insurance systems, particularly older adults in rural areas. The program aims to enhance life satisfaction among rural elderly residents before and after retirement by providing stable income security [37]. Through this system, older adults can obtain a reliable source of income to cover daily living expenses. This financial stability reduces depressive and anxiety symptoms caused by economic hardship. In addition, pension benefits help reduce the elderly population's dependence on physically demanding labor, such as farming and other labor-intensive activities. As a result, the risk of cardiovascular disease associated with prolonged physical strain may be reduced, further improving overall health and quality of life in later years [38]. Research indicates that social pension programs can significantly improve both the physical and mental health of workers, particularly among low-income and agricultural populations [39]. The additional income generated by these programs, like social pension schemes implemented in other countries, may improve self-rated economic status, enhance nutritional intake, and improve living conditions. The implementation of social pension programs also contributes to increased utilization of healthcare services and reduced labor supply, thereby benefiting overall health capital. Survey data show that the total annual household income of pension recipients increased by 8,092 yuan, compared with an increase of 6,497 yuan among non-recipients. This difference results in a net income increase of 1,595 yuan for pension recipients, representing approximately a 15% net gain. Although descriptive statistics indicate that this net increase is relatively modest, it remains meaningful. The approximately 15% increase in net income generated by the New Rural Pension Scheme (NRPS) can significantly improve health outcomes among older adults [40].

4.3. Community-Based Intervention Strategies to Alleviate Loneliness Among Older Adults

To address loneliness, social isolation, and the empty-nest phenomenon among older adults, a variety of intervention measures can be implemented. However, not all older individuals experience loneliness in the same way or to the same degree. Therefore, interventions should be tailored to individual needs [41]. Family- and community-based care services aim to help older adults maintain

healthy and independent living, particularly by addressing their needs related to social isolation and loneliness. These services include home-based care provided by clinicians, allied health professionals, and support workers, as well as telehealth support delivered through telephone or online platforms. Such interventions are typically conducted on a one-to-one basis and focus on reducing social isolation. In addition to individualized services, interventions may also take the form of group-based activities, such as regular physical and recreational programs held at community activity centers. These activities are usually organized by professionals with relevant expertise, including instructors, psychological counselors, social workers, or nurses. They are typically conducted in face-to-face settings on a weekly basis and often target specific groups, such as widowed older adults or those experiencing mental health difficulties. Moreover, interventions in this field also include companionship and emotional support provided by non-human partners, such as household pets, virtual animals, or robotic pets, which can enhance emotional well-being among older adults. In parallel, innovative approaches have been encouraged to promote social interaction and create platforms where older adults can establish new social connections and maintain existing relationships. These approaches include training in information and communication technologies, peer communication activities among older adults, telephone or video-based "befriending" programs, as well as the production and listening of radio programs. Such initiatives are often home-based and utilize technological tools to strengthen social connections [42].

4.4. Age-Friendly Electronic Health Technology Support

To better meet the practical needs of older adults, a range of facilitative measures can be adopted. These include providing enlarged digital text, optimizing the visual design of printed materials, and developing instructional guides that contain both audio and written versions. At the same time, to reduce the difficulties older adults experience when adapting to emerging healthcare technologies, related services should prioritize platforms and interfaces that they are already familiar with and promote their use on this basis [43].Specifically, electronic health tools that are easy to access and comfortable to use—such as those with larger screens (e.g., tablets or desktop/laptop computers), adjustable font sizes, audio prompts, message notifications, and personalized filtering functions—tend to have higher acceptance among older adults. In addition, older patients should be encouraged to participate in training and educational programs that enhance their ability to use digital and smart devices. This can be achieved by providing dedicated instructors who offer initial and ongoing guidance to help build trust, encouragement, and motivation. Low-cost group-based computer courses can also be organized to address deficiencies in basic digital skills. When appropriate support and training highlight the practical benefits of electronic health technologies, older adults are less likely to perceive these technologies as difficult to master, disconnected from their daily needs, or ineffective compared with traditional healthcare services such as telemedicine [44].

4.5. Collaborative Care Models for Chronic Disease Management in Older Adults

Because the care of patients with multiple chronic conditions in older adults accounts for a large proportion of healthcare expenditures, coordination among medical specialties is often insufficient. Therefore, within primary healthcare settings—particularly when psychological and physical illnesses coexist—effective approaches are required to manage such complex care needs [45]. One promising intervention is collaborative care, a multifaceted model that involves non-physician case managers working closely with patients' physicians (usually their primary care providers) while receiving support and supervision from mental health specialists, typically psychiatrists or psychologists. This approach aims to reduce disparities between physical health services and mental health services. The benefits of collaborative care extend beyond the alleviation of depressive symptoms. It also enhances patients' self-management abilities and overall disease management capacity [46]. Empirical studies focusing on older patients with comorbid cardiovascular disease and depression have demonstrated significant improvements following the implementation of a "dual-disease co-management" intervention. Data indicate that the intervention group achieved a 37%

comprehensive control rate across three core indicators—blood glucose, blood pressure, and blood lipid levels—substantially higher than the 22% observed in the conventional care group. In addition, the clinical remission rate of depressive symptoms in the intervention group reached 60%, which was twice that observed in the standard care group. These findings not only confirm the advantages of dual-disease co-management in improving physical health outcomes but also highlight its substantial value in addressing mental health problems [45].

5. Conclusion

This study systematically identifies the dual roots underlying the comorbidity of cardiovascular disease and depression among older adults. At the physiological level, immune-inflammatory processes, neurotransmitter imbalance, and dysregulation of the hypothalamic–pituitary–adrenal (HPA) axis constitutes the biological links connecting the two conditions. At the social level, five interrelated factors—socioeconomic inequality, insufficient social security, weak social support, the digital divide, and fragmentation of healthcare services—interact and jointly contribute to the high prevalence and worsening progression of this comorbidity. In response to the above structural social determinants, this study proposes an integrated governance pathway centered on the concept of "dual-disease co-management," establishing a precise correspondence between identified problems and targeted interventions. First, to address healthcare access barriers caused by socioeconomic inequality, a targeted financial relief mechanism through medical assistance should be established. By providing economic support, this approach can improve healthcare accessibility for low-income older adults. Second, to respond to the problem of insufficient social security, social pension programs should be strengthened to provide stable income sources that alleviate psychological stress and reduce cardiovascular disease risk among older adults. Third, to cope with weak social support and the loneliness associated with the empty-nest phenomenon, community-based intervention strategies should be implemented. These strategies can rebuild social connections among older adults through family care services, group activities, and innovative forms of companionship. Fourth, to address service exclusion caused by the digital divide, age-friendly electronic health technologies should be promoted. Interface optimization and digital skills training can help ensure that older adults equally benefit from digital healthcare services. Fifth, to overcome the structural problem of fragmented healthcare systems, collaborative care models for chronic disease management in older adults should be implemented within primary healthcare settings, thereby translating the concept of dual-disease co-management into practical application.

In summary, the governance of comorbid cardiovascular disease and depression among older adults must move beyond purely biomedical interventions and advance toward an integrated approach grounded in a social-ecological perspective. Only by organically integrating economic security, social support, technological innovation, and healthcare service restructuring can the vicious cycle of comorbidity be fundamentally disrupted. Such an approach will help transform aging societies from the predicament of "longevity without health" toward a new paradigm of healthy longevity and health equity.

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