

Review

From Mineral Waters to Mental Wellbeing: A Biopsychosocial Framework for Health Resort Medicine

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Abstract

Chronic non-communicable diseases and persistent stress-related disorders are increasingly conceptualized as complex biopsychosocial conditions in which neuroimmune, autonomic, behavioral, and social processes interact, creating a need for integrative care models; this narrative review therefore examines Health Resort Medicine as a medically supervised, residential therapeutic ecosystem and synthesizes evidence on its psychosocial effects and plausible mediating pathways. A concept-driven, non-systematic search of PubMed/MEDLINE and Scopus targeted Health Resort interventions (e.g., balneotherapy, hydrotherapy, aquatic rehabilitation), psychosocial outcomes (stress, mood, sleep, fatigue, QoL), and candidate mediators (e.g., HRV, inflammatory markers), complemented by reference screening and focused topic searches. The reviewed literature suggests that resort-based programs are associated with improvements in perceived stress, mood symptoms, sleep disturbance, fatigue, and related patient-reported outcomes, within a multimodal context combining mineral water exposure and immersion physiology with structured exercise, natural environment exposure, care experience factors (expectancy, detachment, education), and social processes (belonging, social buffering). However, mechanistic inference is limited by heterogeneity of protocols and predominantly pre-post designs with scarce mediation analyses and incomplete biomarker integration. Health Resort Medicine may be interpreted as a complex biopsychosocial intervention; future work should prioritize standardized reporting, component and sequence testing, and biomarker-informed designs to clarify pathways and sources of response heterogeneity.



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1. Introduction

Chronic noncommunicable diseases represent a major and increasing burden for global healthcare systems [1,2]. Increasingly, these conditions are conceptualized not as isolated peripheral pathologies, but as complex biopsychosocial syndromes in which tissue alterations interact with central sensitization, nociplastic mechanisms, autonomic dysregulation,

and affective disturbances [3,4]. Converging evidence indicates that chronic pain and stress-related disorders share partially overlapping neurobiological substrates, including maladaptive salience network activation, impaired descending inhibitory pathways, neuroinflammatory signaling, and dysregulation of the hypothalamic–pituitary–adrenal (HPA) axis [5,6]. Within this framework, psychological stress may represent not merely a secondary reaction to illness, but a potential contributor to symptom onset and persistence [7]. Over time, clinical manifestations often become partly dissociated from the extent of peripheral tissue damage and instead may be shaped by maladaptive behavioral and cognitive patterns, including hypervigilance to bodily sensations, fear-avoidance behaviors, sleep disturbance, and sustained neuroendocrine activation [3,8]. These processes are hypothesized to be maintained through bidirectional feedback loops between biological and psychological systems. Chronic low-grade inflammation, for example, can be associated with mood and motivational changes via cytokine-mediated effects on neurotransmitter metabolism, while persistent stress exposure has been linked to shifts in autonomic balance toward sympathetic predominance and reduced vagal tone [9,10]. Altered heart rate variability, flattened diurnal cortisol rhythms, and sleep fragmentation are frequently reported in chronic pain and depressive symptomatology, and may further impair recovery and stress resilience [11]. Accordingly, chronic musculoskeletal and stress-related disorders may be more appropriately framed not as localized tissue-based entities, but as systemic conditions arising from intertwined neuroimmune, autonomic, behavioral, and social processes [12].

Despite growing recognition of these multidimensional processes, the management of the psychological components of chronic musculoskeletal and stress-related disorders remains variable and often insufficiently integrated. Effective management requires a paradigm shift toward integrative therapeutic models capable of targeting biological, psychological, and contextual determinants simultaneously. Such models should aim to extend beyond isolated symptom relief and also focus on emotional regulation, adaptive coping strategies, improved self-efficacy, and restoration of functional capacity [13,14]. Within this broader context, Health Resort Medicine (including balneotherapy, hydrotherapy, thermal medicine, aquatic rehabilitation, and residential spa-based programs) represents an established practice with a still-evolving evidence base and conceptual framing [15]. Health Resort Medicine differs from spa tourism and isolated hydrotherapy interventions in that it represents a structured, medically supervised, residential therapeutic ecosystem integrating groundwater-based treatments with rehabilitation, environmental immersion, contextual factors, and psychosocial modulation [16]. Traditionally, Health Resorts have been framed primarily within a biomedical paradigm, attributing clinical benefits to the specific hydrochemical properties of mineral waters and peloids. The biological effects of immersion are well characterized: hydrostatic pressure influences venous return and cardiovascular dynamics; buoyancy reduces gravitational load and joint stress; thermal conductivity induces vasodilation and muscle relaxation; and, in selected contexts, transcutaneous exposure to mineral constituents has been proposed to influence inflammatory pathways [17,18]. Mineral waters derived from groundwater systems often contain distinctive combinations of bicarbonate, sulfate, magnesium, and trace elements that could modulate immune signaling and oxidative stress [19]. However, this reductionist perspective does not fully account for the broader therapeutic effects of Health Resort Medicine. Emerging research indicates that Health Resorts may be associated with psychological benefits in addition to physical rehabilitation. Clinical and observational studies report reductions in perceived stress, depressive symptoms, anxiety, sleep disturbances, and fatigue following balneotherapy [20,21]. In clinical populations, Health Resort treatments have been associated with alleviation of mental stress and general health complaints, with improvements in mood and fatigue correlating with treatment frequency and duration [22].

For example, in complex conditions such as fibromyalgia, balneotherapy has been associated not only with reductions in pain and disability but also with decreases in depressive symptoms, with benefits often persisting for several months after treatment [23]. Moreover, preliminary biomarker studies suggest possible modulation of stress-related pathways, including short-term reductions in cortisol levels and changes in inflammatory markers in selected populations, potentially contributing to improvements in quality of life and perceived well-being [24]. Importantly, Health Resort interventions are inherently multimodal. Beyond hydrochemical exposure, they typically integrate structured physical exercise, supervised rehabilitation, immersion in natural environments, and opportunities for social interaction within residential therapeutic communities. Together, these elements create a therapeutic milieu that extends beyond the physical properties of water alone.

Nevertheless, while balneotherapy and related interventions are increasingly recognized as valuable complementary approaches for mental health support in chronic conditions, the specific psychosocial, neurobiological, and environmental mechanisms underlying these effects remain incompletely characterized. Many studies isolate single components without integrating them into a comprehensive mechanistic framework. Furthermore, variability in hydrogeochemical profiles, immersion protocols, environmental contexts, and participant characteristics complicates generalization and mechanistic inference. Few studies systematically examine mediating pathways linking biological changes to psychological outcomes, and biomarker integration remains limited [25,26]. In response to these gaps, the present narrative review conceptualizes the Health Resort as a complex intervention operating across multiple interacting levels, aiming to delineate the neurobiological and psychological pathways through which Health Resort interventions may promote mental resilience and psychological well-being. By synthesizing current evidence within a biopsychosocial systems framework, we seek to clarify potential mediators of change and identify critical directions for future mechanistically informed research.

2. Materials and Methods

2.1. Study Design

This manuscript is a narrative (non-systematic) review aimed at integrating clinical, mechanistic, and theory-driven evidence into a biopsychosocial framework for Health Resort Medicine. A targeted, concept-driven literature search was conducted in PubMed/MEDLINE and Scopus to reduce database-specific selection bias. The search was last updated on 31 January 2026.

2.2. Search Strategy

Given the conceptual and multidisciplinary nature of the topic, a structured but non-exhaustive literature search strategy was adopted to enhance transparency and minimize selection bias while maintaining the flexibility inherent to narrative synthesis. Search terms were structured across three intersecting domains: (i) Health Resort interventions (balneotherapy, hydrotherapy, Health Resort medicine, aquatic exercise); (ii) psychological and functional outcomes (stress, anxiety, depression, sleep, well-being, quality of life, fatigue, self-efficacy, kinesiophobia); and (iii) mediators and biomarkers (HRV, HPA-axis indices including cortisol awakening response, salivary α -amylase, inflammatory pathways and neuroinflammation, attentional restoration, stress recovery, psychological detachment, and social support). Human studies were prioritized. We preferentially focused on publications from 2016–2026 to reflect contemporary biopsychosocial models and current clinical practice, while retaining earlier seminal contributions when conceptually foundational. Eligible records included randomized controlled trials, controlled clinical studies, observational studies, systematic reviews, meta-analyses, and mechanistic studies relevant to the targeted

mediators. Grey literature and conference abstracts were not systematically searched. To enhance conceptual completeness, reference lists of eligible articles and key reviews were screened, and focused topic searches were performed in Scopus for central constructs (e.g., autonomic regulation, attention restoration, psychological detachment, social buffering). Articles were excluded if they: focused exclusively on dermatological or cosmetic spa applications without psychosocial or systemic outcomes; addressed tourism or leisure contexts without clinical relevance; were purely descriptive reports without outcome data; involved non-human models without translational relevance. Evidence was synthesized narratively according to mechanistic domains (biological, autonomic, neurotrophic, environmental, cognitive, and social). Because this review was conceived as a narrative rather than a systematic synthesis, records were not prospectively tracked through a formal PRISMA-style screening process, and the literature search was not intended to be exhaustive. Consequently, some relevant studies may not have been identified or discussed, particularly in rapidly evolving and multidisciplinary areas such as environmental health, sustainability, and emerging biological mechanisms.

3. Results

Table 1 synthesizes the multilevel components contributing to the psychosocial effects of Health Resort interventions, organizing the evidence according to primary mechanisms and key psychological outcomes.

Table 1. Hypothesized components contributing to the psychosocial effects of Health Resort interventions.

Component	Primary Hypothesized Mechanisms	Associated Psychological Outcomes
Mineral water immersion [24,27–49]	Modulation of low-grade inflammation, oxidative stress, and the HPA-axis; thermo-mechanical and hemodynamic effects with a shift toward parasympathetic dominance; passive hyperthermia; interoceptive modulation; tactile input (mud/hydromassage)	Reductions in depressive symptoms, fatigue, and illness-related distress. Reduced anxiety, improved mood, enhanced emotional regulation, and improved sleep
Aquatic and land-based exercise [50–68]	Neurotrophic signaling (e.g., BDNF), endocannabinoid/ β -endorphin pathways, and neurotransmitter-related mechanisms; myokine-mediated immunomodulation; mastery experiences	Reduced psychological distress; increased mastery, autonomy, and self-efficacy; reductions in kinesiophobia/catastrophizing
Natural environment exposure [69–83]	Stress recovery (SRT) and attentional restoration (ART); effects on autonomic and endocrine systems (e.g., cortisol/HRV); nature relatedness	Reduced stress, cognitive fatigue, depressive symptoms; improved attentional recovery and emotion regulation
Care experience [84–96]	Expectancy effects; therapeutic alliance; psychological detachment; immersive education; architectural/aesthetic factors	Improved self-efficacy, well-being, coping, and adherence; improved quality of life; reduced anxiety
Social dimension (therapeutic community) [97–114]	Social buffering (HPA-axis attenuation; prefrontal engagement); peer modeling (“coping models”), narrative exchange and normalization; group belonging supporting motivation and adherence	Reduced distress and improved motivation/resilience; enhanced self-efficacy and perceived social support; reduced stigma

3.1. Mineral Waters and Psychological Health

Recent meta-analyses show that elevated inflammatory markers (particularly IL-6, CRP, and TNF- α) are associated with depressive symptoms and treatment resistance [27]. Pro-inflammatory cytokines produced in chronic musculoskeletal diseases (such as IL-6 and TNF- α) are known to cross the blood–brain barrier, altering neurotransmitter metabolism

and driving sickness behavior, a constellation of symptoms including lethargy, anhedonia, and anxiety [28]. Chronic inflammation also alters the hypothalamic–pituitary–adrenal (HPA) axis, exacerbating psychological symptoms and contributing to treatment resistance [29]. In this context, evidence suggests that mineral waters have specific biochemical properties that modulate systemic low-grade inflammation [30]. By modulating these peripheral mechanisms, mineral water exposure may decrease cytokine-driven activation of central stress circuits and neuroinflammation. Experimental studies suggest that specific trace elements, such as fluoride, bromide, and iodide, present in certain mineral waters may directly attenuate inflammatory signaling through inhibition of pro-inflammatory cytokine expression [31,32]. Furthermore, balneotherapy may influence glucocorticoid receptor sensitivity and reduce oxidative stress, which has been implicated in fatigue and depressive symptoms [33,34]. These findings support a neuro-immune mechanism by which mineral waters may contribute to psychological symptom relief in chronic conditions; however, the precise mineral compositions, exposure durations, and concentrations required to achieve clinically meaningful HPA-axis modulation and anti-inflammatory effects in humans remain unclear. Concurrently, by effectively treating the underlying inflammatory pathology, mineral waters may alleviate a fundamental stressor that fuels psychological suffering. Chronic illness imposes a significant psychological burden, often leading to distress, anxiety, and depression that negatively impact quality of life [35,36]. Reduction in inflammation-driven symptoms may allow psychological resources to be redirected from coping with physical disease to restoring well-being.

Beyond the specific biochemical constituents of mineral waters, balneotherapy and hydrotherapy provide multimodal sensory input that may modulate emotional state through bottom-up processes [37]. Warm water immersion produces thermal and mechanical effects on the body, altering circulatory and neuromuscular dynamics through the combined influence of temperature and water pressure. Buoyancy reduces gravitational strain on joints and soft tissues, while hydrostatic pressure enhances venous return and peripheral blood flow [38]. Together, these effects promote systemic vasodilation and muscular relaxation, contributing to reduced sympathetic activation and attenuation of the muscle tension commonly associated with chronic stress and anxiety [39,40]. Passive hyperthermia also functions as a neurobiological moderator, triggering thermoregulatory responses that partially overlap with mechanisms implicated in antidepressant interventions [41]. Although direct evidence on neurotransmitter kinetics in humans remains limited, current hypotheses suggest that thermal stress may engage serotonergic raphe nuclei, potentially enhancing serotonin (5-HT) signaling relevant to mood regulation [42]. Studies on whole-body hyperthermia demonstrate sustained antidepressant effects up to several weeks post-intervention, associated with reductions in inflammatory signaling and improved sleep continuity [43]. Recent mechanistic models propose that thermal stimulation activates interoceptive pathways within the insula, supporting emotional regulation and parasympathetic recovery [44]. Neurobiological research has also identified shared neural substrates for processing physical warmth and interpersonal warmth, primarily located in the insula and anterior cingulate cortex (ACC), which could contribute to autonomic regulation during immersion [45]. Furthermore, mud applications and hydromassage may provide tactile stimulation that targets C-tactile afferents, enhancing well-being through neurophysiological pathways involving nociceptive inhibition at the spinal level [46,47].

However, recent hydrogeochemical research emphasizes that variability in groundwater-derived mineral composition (e.g., bicarbonate, sulfate, magnesium content) may influence physiological effects and inflammatory modulation. For example, magnesium-rich drinking water has been associated with reduced systemic inflammatory markers and improved cardiovascular and metabolic outcomes, while sulfate-containing waters may further in-

fluence gastrointestinal physiology, including bile secretion and intestinal function, with downstream implications for gut microbiota composition and immune modulation [48,49]. Future studies should systematically characterize water properties, including major ions, trace elements, and microbiological quality, and relate them to standardized exposure protocols, such as immersion duration, frequency, and temperature range, in order to clarify their potential contribution to psychological outcomes. Furthermore, human trials integrating inflammatory markers and cortisol profiling are needed to clarify whether specific groundwater-derived mineral profiles can reliably modulate chronic inflammatory and stress-related conditions. Such reporting would support cross-site comparability and enable hypothesis testing about whether specific hydrogeochemical profiles are associated with differential psychological responses.

3.2. Physical Exercise: Neurotrophic Effects and Mastery Experiences

Therapeutic interventions in Health Resorts are multimodal, integrating land-based kinesiotherapy with aquatic exercise. Land-based programs emphasize strength training, flexibility, balance, and progressive loading tailored to individual capacity, thereby promoting musculoskeletal adaptation and neuromotor control. Aquatic exercise, performed in thermomineral or heated pools, leverages buoyancy, hydrostatic pressure, and thermal effects to reduce joint loading, alleviate pain, and facilitate movement in individuals with limited mobility [50]. While the primary clinical objective is often functional restoration, such as improving muscle strength, joint mobility, and cardiovascular endurance, current evidence suggests that these activities may also influence neurobiological and psychosocial outcomes [51].

Meta-analytic evidence in other settings supports exercise as an effective intervention for mild-to-moderate depression and anxiety, with effect sizes comparable to pharmacological or psychotherapeutic approaches in some populations [52,53]. Longitudinal studies indicate that maintaining or increasing leisure-time physical activity is associated with lower psychological distress over time, while reductions in activity correlate with increased anxiety and stress symptoms [54]. Age appears to moderate these effects, with moderate and vigorous physical activity becoming increasingly important for managing psychological distress in older people [55]. Exercise-induced improvements in mood are mediated through multiple interacting pathways, including neurotrophic signaling, neurotransmitter modulation, and anti-inflammatory effects [56]. For example, long-term engagement in exercise programs can increase brain-derived neurotrophic factor (BDNF), which is relevant to neuroplasticity in circuits implicated in depression, and modulate endocannabinoid and β -endorphin signaling [57,58]. Exercise-related neurotransmitter modulation has been proposed as an additional pathway; exercise may upregulate tryptophan hydroxylase (TPH) and modulate serotonin receptor expression, boosting serotonin production and contributing to improved mood and reduced depressive symptoms [59]. Moreover, skeletal muscle functions as an endocrine organ, releasing a wide range of anti-inflammatory molecules during contraction, including myokines, cytokines, and peptides such as interleukin-6, irisin, and cathepsin B [60]. By reducing peripheral inflammatory tone, regular physical activity may also attenuate neuroinflammation, which is increasingly recognized as contributing to depressive symptoms, fatigue, cognitive slowing, and anhedonia [61]. Within the context of Health Resort interventions, structured land-based and aquatic exercise delivered in supervised and supportive environments may amplify these effects due to the integration of physiological, psychological, and contextual factors.

Another key characteristic of Health Resorts is the possibility of using water immersion to modulate movement biomechanics. Specifically, aquatic exercise enables patients to perform movements in a controlled, low-load environment, where buoyancy reduces effec-

tive body weight and joint loading, thereby facilitating safer task execution and progressive exposure to movement [62]. Chronic pain patients frequently exhibit sedentary behavior driven not merely by physical inability but by maladaptive pain-related cognitions and emotions, most notably kinesiophobia and pain catastrophizing. Kinesiophobia refers to an excessive and persistent fear of physical movement or activity, caused by the expectation that movement will provoke pain or cause tissue damage, injury, or re-injury [63]. Catastrophizing is a cognitive process characterized by rumination, magnification, and helplessness, which amplifies perceived threat and increases hypervigilance to bodily sensations [64]. Together, these processes heighten anticipatory anxiety and defensive motor behavior, leading to avoidance of activity, deconditioning, reduced self-efficacy, and social withdrawal. In Health Resorts, water immersion creates a controlled multisensory environment characterized by thermal input, hydrostatic pressure, buoyancy, and altered proprioceptive feedback. These signals differ qualitatively from everyday bodily experiences and may transiently reduce gravitational load and attenuate nociceptive signals [65,66]. When patients successfully perform movements in water that are difficult on land, this mastery experience may enhance self-efficacy, reframing beliefs regarding physical limitations and reducing kinesiophobia and pain catastrophizing [67]. Furthermore, immersion and controlled movement in water alter somatosensory feedback, potentially enhancing embodied self-awareness and recalibrating maladaptive body representations observed in chronic pain and affective disorders [68]. Repeated exposure to non-threatening bodily sensations during immersion may gradually reduce threat appraisals, allowing patients to experience movements without anticipated harm. Importantly, exercise dosing and supervision within Health Resorts are typically structured and individualized. Professional guidance ensures safety, graded exposure, and progressive overload, thereby reducing injury risk while optimizing the physiological stimulus. Because it incorporates behavioral support and professional feedback, this structured environment may amplify both biological and psychological benefits compared with unsupervised community exercise.

3.3. *The Environment as a Healing Factor*

Another significant factor contributing to psychological well-being within Health Resorts is immersion in natural environments, which can act as a therapeutic agent with measurable effects on the central nervous system. Among different theories within Environmental Medicine, Ulrich's Stress Recovery Theory (SRT) posits that the human autonomic nervous system evolved to function optimally in natural environments, making modern urban settings potential sources of chronic, low-grade physiological stress because of their artificiality and sensory overload [69]. According to this framework, exposure to nature may trigger an immediate, pre-cognitive affect characterized by a positive emotional tone and a rapid downregulation of physiological arousal through parasympathetic and limbic responses [70]. Meta-analyses show that exposure to natural environments reduces stress markers such as heart rate and skin conductance, supporting the hypothesis that nature promotes stress recovery and well-being [71]. For example, a recent meta-analysis of 47 experimental studies found a small-to-medium effect of natural environments in lowering physiological stress compared with urban settings [72]. Proposed mechanisms include inhalation of biogenic volatile organic compounds (BVOCs) such as phytoncides, which can enhance immune function and reduce levels of stress hormones (adrenaline and norepinephrine) and daylight-related effects on serotonergic pathways and circadian regulation [73,74]. Overall, evidence supports beneficial effects of natural environments on physiological stress, though methodological heterogeneity and individual factors influence effect magnitude. Recent syntheses support consistent small-to-moderate effects of nature exposure on cortisol reduction, HRV enhancement, and depressive symptom improvement,

and dose–response analyses suggest that prolonged immersive exposures may produce stronger and more durable effects compared with brief urban park visits [75].

Nature exposure may also support psychological health through cognitive restoration, the recovery of depleted cognitive resources after periods of prolonged mental effort, stress, or distraction [76]. Chronic illness imposes sustained load on executive resources, contributing to cognitive fatigue and reducing coping capacity, emotion regulation, and stress tolerance [77]. In this context, Kaplan’s Attention Restoration Theory (ART) proposes that exposure to natural environments may support recovery from directed-attention fatigue through “soft fascination,” whereby environmental stimuli capture attention with relatively limited cognitive effort [78]. This process has been hypothesized to reduce demands on executive control and to support functions involved in emotional regulation, decision-making, and the self-management of chronic illness. However, ART remains a theoretical framework whose empirical support is mixed and not fully consistent. While some studies report improvements in attention and cognitive performance following nature exposure, others have found small, task-dependent, or non-significant effects [79,80].

Finally, the construct of Nature Relatedness (NR) may help explain the therapeutic effects of the natural environment in Health Resorts. NR is a psychological construct that reflects how people perceive and relate to nature, indicating an individual’s affective, cognitive, and experiential connection to the natural world [81]. The Nature Relatedness Scale (NRS) was developed to measure this construct, demonstrating strong reliability and validity across diverse populations and correlating with environmental concern, behavior, and time spent in nature [82]. NR is associated with various positive outcomes, including higher levels of well-being, personal growth, and life satisfaction, suggesting that a sustained connection to nature supports psychological health [83]. A Health Resort stay may help restore this connection, which is often weakened by urbanization.

Future research should adopt rigorous designs to quantify the “dose” of nature exposure (e.g., duration, frequency, sensory immersion, biodiversity indices) and to model dose–response relationships with psychological outcomes, explicitly controlling for confounding variables inherent to retreat settings. By disentangling environment-specific mediators from non-specific retreat effects, future investigations can more precisely define the therapeutic contribution of natural settings within integrated Health Resort interventions.

3.4. *The Experience of Care in Health Resorts: Expectations, Detachment, and Education*

Central to the psychosocial efficacy of Health Resorts is the quality of the care experience, including different factors such as structured therapeutic regimens, facilitation of psychological detachment, and immersive educational interventions. The structured, health-oriented environment of Health Resorts acts as a set of stimuli that may generate positive expectations; anticipatory beliefs about treatment success are associated with better clinical outcomes across clinical settings, including chronic pain and oncology [84,85]. This effect may be amplified by the therapeutic alliance during prolonged resort stays, as studies consistently show a robust positive correlation between alliance quality and treatment success [86]. The enriched architectural environment of many traditional Health Resorts may also foster recovery processes, as hypothesized by recent research on neuroaesthetics showing that exposure to harmonious architecture and art may activate brain areas related to pleasure and emotion regulation, leading to reduced stress and improved mood [87]. Furthermore, qualitative research with patients in neurological settings suggests that aesthetic elements promote relaxation and recovery by providing a sensory experience that contrasts with standard clinical environments [88].

Another characteristic of the Health Resort care experience is the facilitation of psychological detachment. The Recovery Experience framework by Sonnentag and colleagues

posits that effective recovery from chronic stress is not simply a matter of physical absence from stressors, but critically depends on the individual's ability to mentally disengage from work- or illness-related demands [89]. Health Resorts may provide an optimal context for such detachment. Removal from habitual environments interrupts conditioned cues associated with stress, pain, or illness roles, reducing ongoing cognitive engagement with stressors. Longitudinal evidence indicates that higher levels of psychological detachment predict improved well-being, lower anxiety, reduced emotional exhaustion, and better sleep over time [90,91]. These outcomes are particularly relevant in chronic musculoskeletal and stress-related conditions, where rumination and hypervigilance contribute to symptom persistence.

A further driver of psychological well-being within the Health Resort setting is the educational potential afforded by the intensive and prolonged nature of the treatment. While traditional medicine often delivers lifestyle advice in a fragmented, informational manner, Health Resorts offer an immersive environment for the practical implementation of Lifestyle Medicine interventions, such as nutritional adjustments, physical activity, stress management, and restorative sleep [92]. Educational interventions for chronic conditions have demonstrated significant efficacy in improving a range of patient outcomes, including health knowledge, self-efficacy, treatment adherence, and psychological well-being [93]. Combining structured education with rehabilitation interventions has consistently been shown to improve clinical and psychosocial outcomes beyond those achieved by exercise alone [94]. For example, the integration of Pain Neuroscience Education and group physical exercise significantly improved quality of life, pain intensity, disability, and psychological factors in patients with chronic spinal pain, with benefits maintained at six months [95]. Experiential learning within Health Resort settings, where education is reinforced through supervised activity, mastery experiences, and peer interaction, may strengthen health-related self-efficacy, which is consistently associated with improved medication adherence, self-management capacity, and perceived control across chronic conditions [96].

3.5. *The Social Dimension: Communities and Social Learning*

Chronic conditions frequently precipitate a progressive retreat into social withdrawal and reduced participation [97,98]. Although isolation has traditionally been interpreted as a consequence of pain, fatigue, and functional limitation, a growing body of literature suggests that it can also operate as an active moderator of illness trajectories, amplifying disability and psychological distress [99]. Neuroimaging studies indicate that socially threatening experiences engage a distributed network that partially overlaps with nociceptive and affective pain processing, including insular and cingulate regions, and some authors suggest that social exclusion can increase pain sensitivity and pain-related reactivity [100,101]. Within this framework, Health Resort stays may provide a context in which social connectedness is temporarily restored: the residential setting, shared schedules, and group-based activities can foster therapeutic communities that may function as protective factors against psychological distress. A key candidate mechanism is social buffering, defined as the attenuation of physiological and behavioral stress responses in the presence of supportive others [102]. Social buffering has been linked to reduced activity in regions such as the amygdala, the dorsal anterior cingulate cortex, and the hypothalamic–pituitary–adrenocortical (HPA) axis, alongside increased engagement of prefrontal regulatory circuits that integrate social information and support emotion regulation [103]. Oxytocinergic signaling is frequently proposed as a mediator of these effects, potentially promoting feelings of safety while modulating autonomic and neuroendocrine responses [104]. Overall, these findings support the hypothesis that social support may influence stress biology through converging pathways involving threat detection, neuroendocrine regulation, and reward

processing; however, resort-specific evidence remains limited, and future studies should quantify social exposure by evaluating group participation and perceived support.

The resort environment can also facilitate social learning through peer observation. Health Resorts offer constant exposure to coping models that can positively influence patient rehabilitation by helping individuals recalibrate their perceived limitations and learn strategies to overcome functional impairments [105]. Patients who observe peers with comparable impairments successfully performing tasks report higher confidence and better functional outcomes, and group-based rehabilitation has been shown to reduce anxiety, depression, and perceived functional limitations in chronic illness populations [106]. Furthermore, through the exchange of shared illness narratives, patients may reduce stigma and shame attached to chronic disability. Peer support interventions that involve exchanging lived experiences are associated with reduced self-stigma and improved psychological well-being among people with chronic illness and disability [107]. Narrative-based interventions in chronic disease management have been shown to enhance self-acceptance and reduce feelings of isolation. For example, research on Long Covid communities demonstrates that collective narration provides validation and mutual confirmation [108].

Group activities have also been shown to enhance motivation, participation, and adherence by improving key psychosocial factors such as self-confidence, social support, and self-efficacy [109,110]. Social prescribing programs connecting individuals to community groups (e.g., football, singing, gardening) increase self-confidence, social support, and a sense of belonging, which contribute to better mental health outcomes [111]. Group-based interventions for chronic conditions demonstrate that social support and self-efficacy are positively associated with sustained behavior change and emotional well-being [112]. Activity-based group therapy in mental health settings improves coping self-efficacy and subjective well-being, which can enhance overall mental health recovery, motivation, and adherence [113]. Additionally, intrinsic motivation, psychological need satisfaction, social support, and self-efficacy are consistently identified as critical psychosocial factors underpinning adherence to exercise referral schemes [114].

4. Discussion

The present review supports the interpretation of Health Resort Medicine as a complex adaptive biopsychosocial intervention, in which clinical effects on mental health and broader patient-reported outcomes likely emerge from the coordinated action of multiple interacting components. Across the available literature, mineral water exposure, immersion-related physiology, structured exercise, environmental immersion, and relational-care processes are recurrent elements of resort programs and are plausible contributors to psychological improvement. Nonetheless, because most interventions are delivered as multimodal packages and evaluated with heterogeneous protocols, the relative contribution of each component and the degree of synergy remain incompletely defined. At the biological level, mineral water exposure and hydrothermal immersion may influence low-grade systemic inflammation, oxidative-stress pathways, and neuroendocrine regulation (including HPA-axis dynamics) [115]. However, mineral composition varies markedly across sites, and mechanistic human studies that link specific hydrogeochemical profiles to changes in endocrine and immune markers and to psychological outcomes are still limited. In parallel, immersion-related physiology engages thermoregulatory and autonomic mechanisms: warm-water immersion and hydrostatic pressure can shift autonomic balance toward parasympathetic dominance, reduce somatic tension, and improve subjective relaxation [116]. Although these effects align with observed short-term improvements in stress and sleep-related outcomes, their durability and their role as mediators require longitudinal testing. Structured physical exercise also likely represents another critical

component, both through biological mechanisms (neurotrophic signaling, β -endorphin pathways, and immune modulation) and through psychological mechanisms (mastery experiences, improved self-efficacy, and reduced fear-avoidance) [117]. Aquatic movement may be particularly relevant for individuals with pain-related activity limitation, as buoyancy can enable graded exposure to movement under conditions perceived as safe, potentially weakening threat-based motor patterns. Simultaneously, psychosocial and contextual processes may amplify and stabilize biological changes. The residential format can facilitate psychological detachment from habitual stressors and illness-related rumination, providing a temporal “reset” that may improve sleep opportunity and reduce ongoing cognitive load [118]. Exposure to natural environments may further support stress recovery and attentional restoration [119]. The care experience itself, including structured routines, therapeutic alliance, and positive expectations, may recalibrate symptom appraisal and strengthen adherence. Finally, temporary therapeutic communities may engage social buffering processes: perceived support and belonging can attenuate threat-related reactivity and stress physiology, while peer modeling and narrative exchange may reduce shame and increase agency [120]. Collectively, these findings support a One Health and environmental health perspective in which natural and hydrothermal resources should not be regarded merely as passive therapeutic settings, but as components of interconnected socio-ecological systems in which human health, ecosystem integrity, and the sustainable management of environmental resources are interdependent [121].

Despite converging signals of benefit, major knowledge gaps persist because much of the literature relies on global endpoints and pre–post designs that cannot identify which components drive change and through which pathways. Future research should therefore move from global Health Resort efficacy toward the evaluation of specific mechanisms (Table 2). First, component-specific effects should be dismantled using designs capable of isolating the incremental contribution of water composition, immersion temperature and duration, exercise dose and modality, environmental exposure, and group-based versus individual formats. Second, dose–response and threshold dynamics should be explicitly modeled across components using standardized exposure metrics. To strengthen mechanistic inference, trials should integrate objective psychophysiological monitoring with adequate temporal resolution, including measures such as heart rate variability indices, sleep regularity/fragmentation metrics, activity variability, and inflammatory panels (e.g., CRP, IL-6, TNF- α) alongside patient-reported outcomes. Standardized profiling of the cortisol awakening response and salivary α -amylase can help characterize HPA-axis and sympathetic-adrenomedullary dynamics. Where feasible, brief neurocognitive paradigms assessing threat reactivity, attentional control, and cognitive fatigue can test whether restoration of executive resources and reduced threat processing co-occur with physiological adaptation and mediate functional gains. Future studies should also incorporate environmental sustainability indicators, including thermal-water withdrawal and recharge rates, energy consumption, wastewater management, and the ecological consequences of repeated resource use, in order to determine whether clinical benefits can be achieved without compromising long-term water availability and ecosystem integrity. Greater attention is also needed for water-quality monitoring, disinfection strategies, microbiological safety, and the detection of emerging contaminants, while balancing infection-control requirements against the preservation of the physicochemical characteristics that may contribute to therapeutic effects [122,123].

Collectively, this program shifts the evidence base from asking whether Health Resort settings improve psychological well-being to specifying which components matter, at what dose and in what sequence, through which biopsychosocial pathways, and how effects are

sustained after discharge, supporting mechanism-informed optimization and, ultimately, more precise implementation of Health Resort Medicine.

Table 2. Proposed future research directions for investigating the psychosocial effects of Health Resort interventions.

Research Objective	Core Aim	Minimal Measurement Set
Component dismantling	Identify active components; additive vs. synergistic effects	Core outcomes (pain/function, QoL) + standardized exposure logs
Dose–response + sequencing optimization	Define optimal dose; test order/timing effects	Exposure metrics: immersion (min/day, °C), exercise (intensity/volume), nature time, social engagement
Mechanistic trajectories via intensive monitoring	Evaluate autonomic, endocrine, immune, and neurocognitive mediation	HRV; sleep regularity/fragmentation; activity variability; CAR + salivary α-amylase; CRP/IL-6/TNF-α; brief neurocognitive tasks
Phenomenology + mixed methods	Capture lived mechanisms; refine mediator hypotheses	Longitudinal interviews; diaries; engagement indicators
Precision stratification & personalization	Model heterogeneity; tailor format/dose by phenotype	HRV; sleep; fear-avoidance/kinesiophobia; stress burden + core outcomes

5. Conclusions

The rising prevalence of chronicity and disability is increasingly challenging traditional health systems. For many chronic conditions, particularly those characterized by persistent pain, fatigue, sleep disruption, emotional distress, and reduced social participation, the clinical need extends beyond symptom control to sustained functional restoration, self-management capacity, and long-term quality of life. In this context, it becomes strategically important to identify new settings that can deliver integrated rehabilitation, therapeutic education, and psychosocial support in a structured environment that facilitates adherence, continuity, and durable behavior changes. Health Resorts can deliver complex, multimodal biopsychosocial interventions in which hydrothermal exposure, immersion-related physiology, structured exercise, environmental immersion, and relational-care processes interact to influence psychosocial outcomes. Resort-based programs have been associated with improvements in stress-related symptoms, mood, fatigue, sleep-related complaints, and broader patient-reported outcomes.

Despite these converging signals, key mechanistic and implementation gaps remain. Future research should prioritize (i) standardized reporting of water composition and exposure protocols; (ii) component and sequence testing to disentangle the incremental and interactive effects of immersion, exercise, environment, and social-care ingredients; and (iii) mechanistically informed trials integrating HRV, sleep metrics, inflammatory panels, and stress-system markers, complemented by targeted neurocognitive tasks and mixed-method approaches. By shifting the evidence base from demonstrating global benefit to specifying which components matter, for whom, at what dose, and through which biopsychosocial mediators, the field can progress toward optimized, mechanism-informed implementation of Health Resort interventions as a complementary resource for psychosocial well-being in chronic conditions.

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Abbreviations

The following abbreviations are used in this manuscript:

5-HT	5-Hydroxytryptamine (serotonin)
5-HT1A	5-Hydroxytryptamine 1A receptor
ACC	Anterior Cingulate Cortex
ART	Attention Restoration Theory
BDNF	Brain-Derived Neurotrophic Factor
BVOCs	Biogenic Volatile Organic Compounds
CAR	Cortisol Awakening Response
CRP	C-Reactive Protein
HPA axis	Hypothalamic–Pituitary–Adrenal axis
HRV	Heart Rate Variability
NF- κ B	Nuclear Factor kappa-light-chain-enhancer of activated B cells
NR	Nature Relatedness
NRS	Nature Relatedness Scale
QoL	Quality of Life
SRT	Stress Recovery Theory
TPH	Tryptophan Hydroxylase

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