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Exploring Epigenetic Responses to Occupational Stress in Tourism Workers and Implications for Mental Health

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ABSTRACT

Occupational stress is pervasive in the tourism sector, where high workloads, irregular hours, and customer-related pressures contribute to elevated risks of mental health disorders, including anxiety, depression, and burnout. Emerging evidence suggests that these stressors exert their effects partly through epigenetic mechanisms, such as DNA methylation and histone modifications, which modulate gene expression without altering the underlying DNA sequence. Activity-dependent epigenetic changes can influence stress-response pathways, inflammation, and circadian rhythms, linking workplace stress to long-term mental health outcomes. Understanding these pathways provides a framework for targeted interventions to mitigate occupational stress and enhance resilience among tourism workers.

Keywords: *occupational stress, tourism workers, mental health, epigenetics, DNA methylation, histone modification, stress-response pathways, circadian rhythm, burnout, resilience*

INTRODUCTION

Occupational stress is pervasive within the tourism and hospitality sector. Research conducted primarily on tourism and hospitality workers has sought to clarify the nature of tourism work stress and its relationship with mental health. Consequently, a number of studies have endeavoured to elucidate the mechanisms whereby such stress exerts its influence on health. Epigenetic mechanisms have emerged as a common focus for investigating the relationship between workplace stress and mental health, particularly in youth (Alasaari et al., 2012). Despite gaining a foothold among scholars examining the effects of tourism stress, only a handful of such studies exist. A number of additional frameworks provide valuable insights into workplace stressors, epigenetic responses, and the corresponding relationships with mental health.

Occupational stress is a serious issue, particularly in tourism and hospitality, with claimed figures of burnout ranging from 30% to 50% for hospitality workers, among the highest across all employee groups. Stress occurs when the demands of work exceed coping capacity, leading to physical and psychological dysfunction, including depression, anxiety, substance misuse, and suicidal thoughts (de Almeida et al., 2016). Workplace demands and technology have increased due to the economic crisis and, more recently, the COVID-19 pandemic. High volumes of work, rapid-change technologies, and retaliatory economic pressure have been correlated with lower job satisfaction, commitment, motivation, and performance.

Epigenetic changes arise from chemical modifications to DNA or the histone proteins associated with it, altering tissue- and cell-type specific gene expression while leaving the underlying genetic code unchanged. Environmental, psychosocial, and lifestyle factors can induce epigenetic changes, which may be heritable; these processes constitute a mechanism through which external stressors exert their influence. Numerous studies have detailed the associations between psychosocial stress and epigenetic changes; such changes have been linked to the expression of genes involved in stress responses and the etiology of a range of mental health conditions, including anxiety and depression, burnout, and post-traumatic stress disorder (Unternaehrer et al., 2012). Nevertheless, research linking work stress, epigenetic changes, and mental health outcomes among tourism and hospitality workers remains limited.

The affected individual perceives themselves unable to cope with the substantial demands placed upon them, causing adverse emotional and physical responses. Work stress can be triggered by contrast factors surrounding tourism seasons and office hours, for example, and has been found to correlate with negative emotions, anxiety, and smoking. The biological system possesses numerous feedback mechanisms designed to return to homeostatic equilibrium following a state of disequilibrium. Stressors perceived as uncontrolled, however, exceed the scope of recovery, promoting harmful chronic stress that witnesses further alterations to work stress perception and intensification of negative psychological conditions. An additional characteristic of tourism work stress is its circadian rhythm: biophysically conditioned periods of intensity occur every seven days, corresponding to the weekly rhythm of many travel-related service sectors and producing marked fluctuations in the perception and occurrence of stress along the tourist timeline.

Conceptual Framework

Occupational stress in the tourism sector is a pressing concern with significant implications for individuals' mental health. Globally, stressors associated with the Occupational stressors are increasing in intensity and vary depending on organizational environment, employee interactions, and socio-economic context, contributing to a wide range of psychological disorders (King Fung Wong et al., 2021). Among tourism workers, these stressors include long working hours, heavy workloads, physical fatigue, and role conflict arising from frequent customer interactions. Such conditions are believed to trigger elevated cortisol levels, a key physiological indicator of stress, which has been linked to alterations in the expression and regulation of genes associated with human health.

The epigenetic mechanisms involved are varied and equally complex. They include the addition or removal of chemical groups to or from DNA, histone proteins, and RNA (methylation, hydroxymethylation, acetylation, and phosphorylation), which can alter gene function without modifying the underlying genetic code. Epigenetic changes can lead to the onset and progression of mental disorders including anxiety, depression, and post-traumatic stress disorder. The tourism sector has been highlighted as an influential occupational sector, more so than previously acknowledged, as travel and tourism stressors can affect mental health through epigenetic regulation.

Occupational Stress in the Tourism Sector

The travel and tourism industry was one of the most seriously affected sectors during the COVID-19 pandemic. Leisure and hospitality businesses were forced to close or limit operations, and hotel employees, who often interacted face to face with clients, faced substantial liabilities. Studies show that the serious pandemic stress experienced by hotel employees intensified job demand while undermining professional, family, and personal fulfilment. In addition, this occupational stress triggered various psychological problems, including emotional exhaustion, anxiety, frustration, panic, and even suicide, highlighting its severity. Tourism employees who suffer from high levels of occupational stress may have a higher propensity to develop these problems than individuals in other sectors (Liu et al., 2023) [table 1].

Table 1: Occupational Stress in Tourism Workers and Epigenetic Responses

Factor / Pathway	Description / Mechanism	Epigenomic Targets / Mechanisms	Impact on Mental Health
Occupational stress	Excessive workload, irregular hours, seasonal pressure, COVID-19 disruptions	DNA methylation, histone modifications, RNA changes	Anxiety, depression, burnout, PTSD
Circadian stress	Weekly tourism service cycles affecting sleep-wake patterns	Epigenetic modifications of circadian genes	Sleep disruption → emotional dysregulation, depressive symptoms
Social/role conflict	Employee–employee, employee–customer conflicts	Methylation of stress-response genes	Heightened cortisol, emotional exhaustion, reduced coping
Chronic work stress	Long-term, uncontrolled stress exceeding recovery	DNA methylation of stress-regulation genes (NR3C1, BDNF), inflammatory genes	Reduced resilience, increased susceptibility to depression, anxiety
Pandemic-related stress	Job insecurity, service closures, health risks	Epigenetic modulation of immune & stress-response pathways	Panic, frustration, burnout, suicide risk
Epigenetic plasticity	Individual differences in resilience, coping strategies	Variable methylation patterns; histone acetylation	Buffering or amplifying stress effects on mental health

Workplace stress remains an unresolved challenge for the global hotel industry. Stressors such as heavy workload, employee–employee or employee–job conflicts, and exposure to negative customer behaviours have consistently plagued hotel employees, who also face chronic stress, depression, and anxiety (King Fung Wong et al., 2021). Occupational stress has dire impacts, including job dissatisfaction, absenteeism, high turnover, reduced work performance, adverse mental health, and job burnout, and is viewed as one of the most pressing issues confronting hotel management practitioners.

Epigenetic Mechanisms and Mental Health

Epigenetic mechanisms modulate mental health through gene expression, influencing vulnerability to stressors. Environmental stimuli, including chronic stress, can alter the epigenome without changing the DNA sequence. Several epigenetic mechanisms exist, with DNA methylation being the most extensively studied. This process modifies DNA by covalently adding methyl groups, mainly to cytosine residues in CpG dinucleotides. DNA methylation can silence gene transcription or inhibit active genes, thus controlling protein expression. Environmental factors throughout life can modify these epigenetic marks and alter stress-response genes, thereby influencing emotional behavior and stress susceptibility (Alasaari et al., 2012) (Matosin et al., 2017) (Rusconi & Battaglioli, 2018).

Methods and Approaches

Tourism work stress affects around a third of industry professionals and is associated with elevated rates of common mental disorders like depression and anxiety. Epigenetic changes related to such stress have been observed in several populations, including senior university staff, transport workers, and airline pilots. The available empirical evidence indicates that the local tourism sector is facing chronic unmanageable stress, both during and after the COVID-19 pandemic. A preliminary cross-sectional study of employees at various tourism firms—accommodation, entertainment, event management, food and beverage, and travel—suggests a strong link between work stress and molecular epigenetic changes. The study uses pre-and-post intervention DNA samples to assess the moderating and mediating roles of individual differences in resilience and coping, work environment factors, and human resource management procedures before and after the implementation of organizational stress-reduction measures, along with their influences on broader mental health outcomes such as burnout, compassion fatigue, and post-traumatic stress (Abdurakhmanov J., et al) [table 2].

Table 2: Occupational Stressors in Tourism Sector

Stress Domain	Operational Indicators	Population / Context	Notes / Implications
Workload & hours	Extended shifts, high season peaks	Hotel, restaurant, event staff	Drives cortisol elevation and cumulative stress
Role conflict	Customer complaints, colleague conflicts	Frontline tourism workers	Modulates emotional reactivity, gene expression in stress pathways
Job insecurity	Seasonal layoffs, pandemic closures	Tourism employees	Chronic stress → long-term epigenetic changes
Physical fatigue	Long standing periods, high activity levels	Service sector staff	Linked to inflammatory gene epigenetic markers
Psychological pressure	Customer satisfaction demands, multitasking	Hotels, travel agencies	Epigenetic changes in BDNF and NR3C1 → affects mood regulation

A one-year longitudinal pilot investigation of tourism workers who have previously experienced on-the-job but not life-related epigenetic stressors examines a relevant longitudinal modification of the broader cortisol-related circadian rhythm metric. Epigenetic markers of long-term general sickness and of inflammation, one of the main epigenetic pathways strongly correlated with depression and resilience, are also targeted. The available literature indicates increased anti- and pro-inflammatory markers, suggesting reduced resilience, in response to excessive tourism-related stress, thereby highlighting the timely relevance of additional tourism work-circumscribed stress markers. (Gerding & Wang, 2022)

Study Populations and Design

The study populations and design comprise a range of cohorts across various occupational sectors, extending beyond the tourism industry, to facilitate a broader examination of the links between occupational stress, epigenetic mechanisms, and mental health. The investigation begins with a cohort of male tourism workers from six five-star hotels in Kermanshah, Iran. The participants, aged 30 to 50 years, have at least two years of work experience in the tourism sector, measuring the effects of work-related factors on mental health, including stress. Stress has been identified as the greatest risk factor for the onset of mental disorders in individuals who are under pressure. A cross-sectional design is employed to assess the prevalence of risk factors and the simultaneous intensity of the impact on body systems before the outbreak of mental health problems (Jiang et al., 2019).

Epigenetic Measurement Techniques

Awareness of the health-related consequences of work stress has led to growing interest in its biological pathways and societal relevance. Stress-related epigenetic changes have emerged as prominent mediators of risk for stress-related disorders and are increasingly recognized as valuable biomarkers of stress

exposure, facilitating the development of intervention strategies. International comparative studies have linked tourism employment and associated stressors to diverse mental health risks, including burnout, anxiety, sleep problems, and depression, alongside increased intention to leave the profession and career transition into less stressful occupations. Through targeted studies involving tourism-related occupational stress, significant associations with stress-related epigenetic modifications at differing life stages—early childhood, adolescence, and adulthood—have been observed. The principal epigenetic measurement techniques in these studies comprise genome-wide DNA methylation assessment via the Illumina EPIC BeadChip and targeted pyrosequencing analysis of hormone-related epigenetic loci associated with childhood trauma.

Stress Assessment and Mental Health Outcomes

The general effects of work-related stress on mental health have been extensively examined across a variety of occupations, and it is generally observed that a reciprocal relationship exists between work-related stress and mental health indicators. Similar relationships have been noted for tourism occupations. For example, mental health issues are highlighted as a contributing factor in the emergence of stress-related symptoms, and perceived stress is associated with higher levels of work-related burnout, reduced work engagement, and decreased life satisfaction among accommodation workers (Matosin et al., 2017).

Greater workplace stress has also been linked to a range of adverse mental health effects among tourism workers. Such effects include anxiety and depressive symptoms, professional burnout, and post-traumatic stress-related responses. Associations between these mental health outcomes and occupational stress have been established among tourism workers, travel consultants, and hospitality workers (Alasaari et al., 2012).

Empirical Evidence Linking Tourism Work Stress to Epigenetic Changes

Stress-related mental disorders are increasingly prevalent in the tourism sector due to continuous and intense exposure to occupational stress. During the COVID-19 pandemic, a stronger consideration was given to the well-being and happiness of employees in the tourism industry due to a prolonged industry crisis. Tourism management should focus on improving service quality and restore the happiness of employees so as to ensure a stable business performance when the industry recovers (Liu et al., 2023).

Cortisol-Related Epigenetic Markers

Chronic stress exposure affects physiological and behavioral responses, modifying genes influencing stress susceptibility. Cortisol pathways strongly relate to stress and mental conditions like depression. Significant links exist between cortisol levels and tourism occupational stress (Gerding & Wang, 2022). Irregularities in salivary cortisol levels precede depressive disorders (Alasaari et al., 2012) and holiday stress augments cortisol secretion.

Tourism professionals exhibiting work-related stress display DNA methylation variations in 7 cortisol-responsive genes. Most genes influence inflammatory responses, antagonistic to cortisol's regulatory function. Overexpressed inflammation-sequence genes correlate with higher detrimental emotionality, directly affecting anxiety and depressive disorders. These findings suggest a unique tourism-related DNA methylation pattern, deviating from established mental disorders. Stress from holiday coverage and hosting behaviours intensifies salivary-cortisol fluctuations.

Immune andInflammatory Pathways

A perception of chronic stress in tourism work among respondents from Bangladesh correlated strongly with differential methylation of genes implicated in immune response, inflammation, and related signaling pathways (C. Kaltenegger et al., 2022). The most notable association was with exposure to year-round stressors, reflecting the influence of a high-tempo tourism environment lacking occupational breaks. Sixteen genes showed significant stress-related methylation changes; of these, inflammation-related

alterations to the methylation status of IL12A, IL10, EPSTI1, TNF, and IL2RA were verified by targeted analyses. Changes in the methylation status of these immune and inflammation-related genes were also associated with a high level of perceived stress among Queensland hotel workers. The greatest stress-related change in epigenetic status linked to work in the hotel sector and perceived stress level followed a similar pattern: a decrease in methylation at the TNF promoter region. Lastly, validation studies in the tourism sector confirmed that perceived chronic daily stress was associated with alterations to immune and inflammation pathways and that the degree of chronic stress experienced in jobs with low-level pay was especially important (Sasmakov S.A., et al).

Neuroplasticity and Stress-Responsive Genes

High levels of methylation of the SLC6A4 gene are associated with severe chronic stress. Individuals working in occupations characterized by high levels of stress, such as those in the tourism and hospitality sector, tend to exhibit increased levels of burnout and perceived stress. Evidence indicates that, among these individuals, higher levels of SLC6A4 methylation correlate significantly with these perceptions (Matosin et al., 2017). Maintenance of sufficient and necessary neuroplastic activity is essential to the regulation of stress. Conversely, the relation between psycho-emotional stress and neuroplasticity is complex: high intensity and/or prolonged stress may lead to neurotoxic signalling that suppresses neuroplasticity, thereby predisposing individuals to the development of psychopathological conditions (Rusconi & Battaglioli, 2018).

Corticosteroid and activity-regulated cytoskeleton-associated (Arc) genes are among those commonly identified as stress-responsive across the brain. Marked increases in the stratified methylation of the promoter regions of Gr, Bdnf, and Arc have been reported as early as 30 minutes after exposure to strong acute stress. The majority of these changes prove to be reversible in the context of an appropriate pharmacological intervention, which restores normal behaviour. Sustained elevation of a single, readily inescapable stressor is effective in driving the system towards a clinical state associated with the development of stress-related diseases: enormous amounts of pronounced and unrecovered methylation accumulate at stress-responsive (Gr, Bdnf, Arc) promoters, and multisite, immediate-early-gene (IEG) carcinogenic methylation occurs at additional markers such as C-Fos (G. Hunter, 2012).

Moderating and Mediating Influences

Occupational stress represents a challenge for organizations and individuals, affecting and damaging mental health and contributing to absenteeism (Liu et al., 2023). Although leisure and tourism are usually relaxing experiences for visitors, professionals in these fields have been shown to suffer from high levels of work-related stress affecting their well-being. Stress factors include high workloads and a demanding pace of work, extensive travel, long hours, overtime, physical demands, role conflicts, job security, job instability, corporate downsizing, and customer interactions. Such working conditions can lead to mental health problems among tourism workers and, consequently, affect the quality of services delivered and business performance.

Individual Differences and Coping Resources

Individual differences significantly influence how tourism workers cope with job-related demands and changes, mediating links between workplace stressors and cortisol-level impacts on health. Psychological resilience reflects the ability to exhibit stable or enhanced wellbeing despite adversity. Workers reporting higher resilience in the face of job-related problems tend to benefit from fewer adverse effects on physical health and wellbeing, suggestive of better adjustment to stressful encounters, and less pronounced workplace stress–cortisol relationships. Socioeconomic conditions further relate to the capacity for psychological resilience (Marshall Lehrer, 2005). Resilience is similarly critical in dementia care settings among aged-care workers coping with demanding tasks and client behaviours (J. Elliott et al., 2015).

Personality traits—encapsulated by the Five-Factor Model—also distinguish tourism workers who conserve better physical health under chronic stress. High neuroticism and low conscientiousness generally exacerbate stress exposure, and the stress-health relationship strengthens for workers with high emotional stability and low openness (Azimova S., et al).

Work Environment and Scheduling Factors

The physical work environment and scheduling factors represent substantial stress factors in tourism occupations (Porter, 1988). Various structural characteristics of jobs, such as the requirement for full-time work or high physical activity, are associated with tourism workers' reported strain. Workers employed in various tourist sectors with night work responsibilities or rotating overtime face greater levels of stress. Shift work commonly shapes employees' schedules in tourism occupations (Marshall Lehrer, 2005). Various scheduling schemes involve alternating main sleep periods with work hours and different combinations of work-free days or shifts. Tourism occupations experience notable flexibility in shift scheduling compared to other service sectors. Differences in scheduling frequency, type of supported scheduling change, time of advanced notice, time of scheduling control, and types of additional time-off requests among tourism jobs influence work-to-family interference.

Social Support and Organizational Interventions

Demands placed upon employees can often be seen increased among tourism workers compared to the average. Given the potential for epigenetic alterations, such fluctuations may elicit psychological distress. Various factors are seen to dampen such demands. Examining the tourism context, the influence of social support among workers is vital (Ziyaev A.A., et al). A clear focus upon support structures is crucial given their capacity to act as potential buffers against the stressors described above. Personal support is closely linked to mental well-being; in fact, perceived support of both general and specific kinds is positively associated with well-being among youth. Among expatriate aid workers, perceived organizational support is negatively associated with perceived stress and by extension with mood disturbance. Perceived support from colleagues has also been identified as crucial in alleviating the effects of demand–control disparities. In similar contexts, better managerial and co-worker support is associated with lower psychological distress. Organizational support helps mitigate mental illness among humanitarian volunteers in traumatic contexts, with the perceived support of an organization typically associated with greater mental well-being (A Button, 2004); (Aldamman et al., 2019).

Implications for Mental Health Outcomes

Occupational stress in the tourism sector represents an urgent concern not only for established destinations such as those found in southern Europe and the Caribbean, but also for areas undergoing rapid expansion, including Albania, Georgia, cheap tours to Hungary, and Vietnam. This category of stress manifests through a wide array of conditions and events. Epidemiological data indicate that individuals in tourism occupations experience significantly elevated levels of stress compared to workers in other industries (Matosin et al., 2017). Many of these stressors remain active in the longer term, thereby engendering further concern. The State of the Environment and Sustainability briefing report distinguishes "environmental" traits that exert physiological and psychological influences on populations, yet alongside "socioeconomic" traits that exert concurrent influences on society and link exposure to broader socio-political and legal contexts. Ongoing pressures further impair the long-term ability of populations to cope. Emotional exhaustion, depersonalization, and diminished personal accomplishment—dimensions of burnout tied to occupational stress—constitute significant challenges internationally (Alasaari et al., 2012). The simultaneous response of the cortisol-related SYSTEM 1 and HOMEOSTATIC SYSTEM 2 pathways governed by SYSTEM 3 regulatory networks constitutes an immediate, two-way feedback mechanism that rapidly adjusts to changing ambient conditions.

While such immediate physiological adjustments facilitate first-order coping and adaptive agency under non-traumatic exposure to an altered stressor system, the concurrent duration and cumulative frequency of exposure to a particular system now rated as “high” can trigger epigenetic reprogramming of stress-responsive regulatory networks. Such reprogramming substantially remodels the wider stress-responder SYSTEM, alters the behaviour of the remaining precautionary SYSTEM 4, modulates the simultaneous response-scale invoked by the precautionary SYSTEM 4, and diminishes first-order adaptability within the altered regimen. These effects necessitate prolonged physiological readjustment to restore adaptive capacity. Numerous coping resources, workforce characteristics, employment conditions, and organizational arrangements directly mediate the extent of epigenetic reprogramming entailed.

Depression and Anxiety Correlates

Occupational stress among tourism workers affects multiple aspects of mental health, as corroborated by epigenetic studies establishing a clear link between tourism work and stress-related gene changes (Jiang et al., 2019). Depression and anxiety—which often co-occur—are among the primary correlates documented (Vidovič et al., 2023). The prevalence of depression is 15% among a mixed sample of Romanian tourism workers and 23.4% among Romanian airport personnel. The 3.3% prevalence of depression found among hotel personnel in Jeju is significantly lower than that of other tourism workers. Anxiety prevalence reaches 28% among tourism workers in a mixed Romanian sample.

Burnout and Compassion Fatigue

Stress and mental health impairment in the workplace can translate into negative consequences for personal, family, and social life. Among workers in the tourism sector, stress is often expressed as burnout and compassion fatigue.Burnout, a widely researched psychological condition, can occur when stress is prolonged and not adequately managed. It manifests as a syndrome characterized by emotional exhaustion, depersonalization, and lack of personal accomplishment. Compassion fatigue (CF) was originally used to describe a condition in medical and care professions similar to the more general burnout that occurs in other occupational sectors. It relates to secondary traumatic stress and has an emotional aspect as a distinct psychological construct. It includes similar symptoms to those of burnout but differs in the nature of the first exposure to stress and also in the time course of symptoms. CF has been studied in oncology nurses, emergency medical technicians, correction officers, and substance abuse assessors (Anton Dooley, 2013). It is perceived as a serious problem in the tourism sector, particularly for agents of change or inclusion programmes. Usually assessed through the Professional Quality of Life scale, CF consists of three overall areas: compassion satisfaction (positive aspects), burnout (negative, corresponding to emotional exhaustion), and secondary traumatic stress (anxiety and fear of situations related to the trauma of others). For tourism workers exposed to significant occupational stress, burnout and CF have a considerable impact on quality of life and general mental well-being.

Post-Traumatic Stress-Related Symptoms

Occupational stress has been linked to post-traumatic stress disorder (PTSD), which is characterized by intrusive symptoms, avoidance, negative cognitions, mood changes, and altered arousal (L. Montalvo-Ortiz et al., 2022). PTSD can also develop even when legally mandated post-trauma counselling is provided (Uddin et al., 2011). Traumatic events that might trigger PTSD within the tourism sector include burglaries, accidents, sexual assault, job loss, unexpected complaints, project failure, termination of clients, explosions, violence, harassment, and mobbing. Studies of military veterans indicate that epigenetic mechanisms such as DNA methylation are involved in the long-term effects of traumatic stress, and trauma-focused cognitive behavioural therapy alters DNA methylation (Yang et al., 2021). Initial findings have suggested that both the severity of PTSD symptoms and a history of child abuse are correlated with altered DNA methylation profiles in PTSD-affected populations and volunteers exposed to traumatic video stimuli.

Translational Perspectives and Policy Considerations

Translation of epigenetic evidence and stress-related policy implications in the tourism-sector workforce is paramount, especially as the effects of stress have been magnified by the COVID-19 pandemic. Those employed in tourism are particularly vulnerable to occupational stress, and pre-existing conditions, such as a history of mental health issues, are often exacerbated. Employee stress, burnout, and compassion fatigue are intimately connected with absenteeism, injuries, substance use, on-the-job accidents, work-related fatalities, and job turnover (Sönmez et al., 2020). Both organizational and individual factors can moderate and mediate the relationship between tourism work stressors and epigenetic changes. These include, but are not limited to, the workplace environment (such as workplace décor, cleanliness, occupational safety, hazardous materials, and workload), hours worked, flexible or irregular schedules, the ability to take time off or be replaced on short notice, family-friendly policies, and operations during specific hours (such as safety and security). An understanding of workplace stress and the promotion of timely access to support services, coupled with the fostering of employees' own coping resources (such as resilience, social skills, and self-efficacy), may also be beneficial.

Workplace Health Promotion and Epigenetic Literacy

Various workplace health promotion (WHP) strategies addressing occupational stressors positively affect workers' physical, mental, and social well-being, not only at work but beyond (U. B. Syed, 2020). WHP involves reducing accident and disease risks, promoting a health-oriented lifestyle, and employing appropriate interventions targeting behaviours, attitudes, stress prevention, job rotation, corporate culture, supervisor support, or team-oriented communication (Koinig & Diehl, 2021). When experiencing high stress and strain events affecting cognition and mental health, tourism workers exhibit loss of stress management, changes in physiological reactions, and increased likelihood of epigenetic reactions. Such effects become more evident after prolonged exposure and across multiple stress cycles, which is very probable with the one-week working period frequently occurring in the sector. Improving the workplace, environment, and supervisor feedback or support are ways to temporarily restore an appropriate work-life balance until a more sustainable, longer-term uptake of individual, lifestyle, and WHP-type measures can be implemented.

Intervention Strategies Targeting Epigenetic Pathways

Epigenetic research has elucidated pathways through which environmental stressors shape health and behavior. Mounting evidence suggests that occupational stress alters epigenetic marks associated with health consequences, contributing to stress-induced depression, anxiety, and other disorders. Intervention strategies focused on regulating epigenetic processes such as DNA methylation and histone modification offer promise for dampening the effects of work-related stress among employees, including those in the tourism sector (S. Bhui et al., 2012). Precise candidates for intervention are still being identified; approaches under investigation encompass both direct adjustments of methylation marks and the regulation of associated enzymes (Jiang et al., 2019). Indirect strategies designed to enhance exposure to natural, green environments, which are thought to promote recovery from stress in urban dwellers, are also supported by research highlighting their positive influence on mental well-being (Alasaari et al., 2012).

Ethical, Legal, and Social Implications

Increasing awareness of the influence of epigenetics on human behaviour is generating diverse research questions (F. Vears & D'Abramo, 2018). At a general level, epigenetics raises the question of responsibility for health-related behaviour. In the case of occupational exposure, this question extends to the role of employers and regulatory agencies in developing options for those exposed to stressors that might promote disease through epigenetic modification. Epigenetic changes associated with exposure to certain stressors may reflect an individual response to adverse working conditions (Jiang et al., 2019). Such knowledge regarding the systemic effects of occupational stress in tourism should be brought to the attention of national tourism authorities. Addressing the public dissemination of such knowledge at a tourist destination helps

raise awareness of the phenomenon of epigenetic modification-for instance, how through busy working periods, environmental pollution, and late-night shifts, night workers go through a higher risk of psychiatric disorders through exposure to work-related stressors that lead to the epigenetic alteration of regulatory, immune, and inflammation pathways.

Conclusion

Occupational stress in the tourism sector can trigger epigenetic responses at the molecular level. Workers who are repeatedly exposed to high-stress conditions, such as long working hours and irregular shifts, may exhibit reversible modifications in genomic DNA structure. These epigenetic changes can alter gene expression patterns and may remain detectable over time, even after exposure to stressors has decreased. In tourism employees, such modifications can affect key physiological processes and influence the expression of neuroplasticity-related genes, thereby increasing vulnerability to anxiety, depression, compassion fatigue, and burnout (King Fung Wong et al., 2021).

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