PUBLIC HEALTH RESEARCH

The Influence of Work Environmental Risk Factors on Fatigue in The Construction Industry: A Review of Literature

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ABSTRACT

Introduction	The construction workers are performing manual tasks in harsh conditions. Various environmental risk factors could have significant influence on work fatigue.
Methods	This review article discussed the environmental causal factors which involved in work fatigue development in the occupational health perspective, with the aim in enhancing the body of knowledge specifically in the construction industry so that mitigation measures and interventions can be formulated and implemented for fatigue prevention and productivity enhancement.
Results	Data derived from a total of 11 relevant articles identified climatic heat, vibration and elevation change as the major risk factors that associated with work fatigue. The mechanism of the environmental factors' influences on muscle, mental and visual fatigue were understood, pointedly the underlying physiological alteration. Additionally, appropriate preventive measures in accordance to the OSHA guides including work-break cycles, work management, cool-down arrangements with drinking water were discussed. The limitation of existing OSH requirements on work limits at heat exposure was recognized, including the lack of consideration on personal characteristics therefore might inaccurately estimate the personal heat tolerance time.
Conclusions	The proper understanding of the environmental stressors and its impact on workers production and safety performance may help construction organisations and regulatory body to develop strategies for workers protection and fatigue-related accidents prevention.
Keywords	Environmental influence - Risk factors - Fatigue - Construction.

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INTRODUCTION

The respectable workplace is one where employees can accomplish their tasks in an efficient, healthy, safe and comfortable manner. It has been proposed that achieving a balance between the working environment and human resources will boost productivity and ensure the safe work performance.[1] There is an ongoing interactions between individual worker and the physical environment,[2] hence the environmental risk factors such as noise, heat, pressure, illumination, and vibration could have significant influence on work fatigue.[3,4] It was reported that approximately two-third of the occupational accidents were caused by physical or mental fatigue.[5]

Fatigue is defined as an imbalance psychophysiological body mechanism, where individual presented with a reduced capacity to perform activities at the desired level, due to inadequate recovery from the physical or mental exhaustion or both.[6,7] Sadeghniiat conceptualized fatigue as a state of feeling tired, weary, or sleepy that results from prolonged physical or mental work, exposure to harsh environmental factors or lack of rest.[8] Fatigue is multidimensional due to the multifaceted nature of weariness, localized muscular fatigue and mental fatigue.[8] Numerous internal and external variables are the causative factors of fatigue.[9] Individual's sociodemographic characteristics like age, sex, lifestyle and working experience are among the internal determinants. On the other hand, the physical working surroundings and environments are the external elements which have been highlighted in ample of studies as the main trigger of work fatigue, although the impacts might be indirect.[5,8,10]

Fatigue has been reported prevalent among the working population.[11] The consequences of work fatigue can be catastrophic; workers might have a reduced cognitive function in addition to physical or muscular capabilities.[12,13] A fatigued worker will be less alert, less able to process information and react to hazardous events when compared with worker who is not fatigued.[7] Fatigue may cause errors in task performance, leads to injuries and fatalities.[14] Literatures confirmed the view that weariness could contribute to human errors through muscle and mental depletion that affects attentiveness and subsequently, impair the ability to accomplish jobs safely.[15] In fact, many fatigue-related accidents were discovered as a result of lassitude following a lack of adaptation to uncomfortable working environments.[4,16]

The construction industry is growing rapidly in many parts of the world and was being recognized as one of the risky industries.[17] Construction workers are handling a variety of exhausting tasks while working on different projects related to building, repair and maintenance; renovation and demolishing; transportation such as construction of highways, bridges and airports, docks and harbours.[4] Conventionally, construction is characterized as a labor-intensive with heavy physical demanding industry that subject workers to high strain level as they are working under direct sunlight exposure. Consequently, workers are more vulnerable to high temperatures in the indoor or outdoor environments which induce metabolic heat gain.[18,19] Additionally, the International Labor Organization has highlighted that construction workers are expected to be open to numerous occupational risk especially the stiff working situation; manual handling; hot climatic condition; high elevation tasks; excessive noise; vibration and heavy machinery where work fatigue were inplicated.[20] In addition, the origins of fatigue among the construction workforce were most cited as excessive temperature in the outdoor work environment which leads to dehydration.[15,21]

It seems that further studies are needed to investigate work fatigue among the construction labours with the exploration on its environmental risk factors. By enhancing the body of knowledge specifically in the construction field, appropriate mitigation measures and interventions can be formulated and implemented to prevent work fatigue as well as enhance productivity. Therefore, in this study, we aimed at exploring the environmental causal factors which involved in work fatigue development. Although a large body of research has investigated the effect of environmental strains on general fatigue and muscular fatigue, up to date limited number of studies have assessed the effect of environmental risk factors of fatigue in construction industry. This review aimed at answering the following research question:

1. What are the environmental risk factors that associated with work fatigue in the construction industry?
2. How do these environmental risk factors result in fatigue? What is the underlying mechanism?
3. How can those environmental risk factors mitigated and managed?

METHODS

In this narrative review, papers discussing on the environmental variables of work fatigue among the construction workers were identified, selected and classified. A total of three databases, including Scopus, PubMed and Web of sciences were used to collect relevant published papers. The keywords (Table 1) were used to identify the papers. All selected papers were imported into the resource management software and duplicates were removed. Articles from the initial search were screened on the titles and abstracts, followed by full texts. The additional relevant papers were also further identified via the review of references cited in all selected articles.

The papers were recruited based on following inclusion criteria:

- Articles published in peer-reviewed journals.
- Articles published in the past 20 years, from 2002-2022.
- All study types, including cohort, case-control, clinical trial, and retrospective record review studies.
- Work fatigue secondary to the work environment attribute must have been the main topic of the study.
- Articles written in both Malay and English.

The article was excluded if not relevant to the construction industry; and if the full text is non-assessable.

Table 1 Keywords used in the article's identification

Categorization	Key words
Category 1	factor* OR cause*OR determinant* OR associated factor* OR related factors*OR risk*OR risk factor*
Category 2	environmental OR environment*OR work environment* OR physical environment* OR surrounding* OR heat OR climate OR vibration OR noise
Category 3	work fatigue OR fatigue OR occupational fatigue OR job fatigue OR lassitude* OR weariness*
Category 4	Construction worker* OR Construction industry OR Construction trade OR Construction sector OR Industrial Construction OR Construction* OR building OR building workers

Articles were identified via category 1 AND category 2 AND category 3 AND category 4.

RESULTS

The initial search strategy produced a total of 179 publications with the combination of all categories of keywords. After the removal of duplicate entries and screening the titles, abstracts, and full text of the detected studies, 11 papers that met the exclusion and inclusion criteria were enrolled into the study, including original articles, review papers and reports. The selected articles were analysed and the data was extracted then categorized. Finally, a supplementary article was added after manual searches in the bibliography lists of all papers included. Table 2 illustrates the descriptive characteristics of the study locations, and study designs of the 11 studies. Majority of the studies were conducted in Asia, mainly in Hong Kong, Taiwan and China. With regards to the year of publication, the selected papers were published in year 2008 (n=1), 2009 (n=2), 2011(n=1), 2012(n=1), 2014(n=3), 2016(n=1), 2018(n=1) and 2019(n=1). Huge proportion of the studies employed experimental design. The data obtained from the literatures was further divided into the following headings:

- The types of environmental risk factors
- The mechanism of the environmental risk factors influences on fatigue
- The mitigation strategies for the environmental risk factors

Table 2 Descriptive characteristics of all included studies (n=11)

Characteristics	Source
Study location	
Hong Kong (n=4)	[15], [45], [59], [69]
Taiwan (n=3)	[19], [20], [42]
China (n=1)	[21]
Australia (n=1)	[28]
Egypt (n=1)	[48]
Spain (n=1)	[32]
Study design	
Experimental (n=8)	[20], [28], [32], [42], [45], [48], [59], [69]
Cross-sectional (n=1)	[19]
Review (n=1)	[15]
Case study (n=1)	[21]

DISCUSSION

The Environmental Risk Factors

Climatic heat risk

The Intergovernmental Panel on Climate Change's Fifth Assessment Report evidently declared that since the pre-industrial era, greenhouse gas emissions have been rising, primarily due to anthropogenic activity hence has resulted in the globally trend of increasing surface temperature.[22] As a consequence of the climate change, heat waves are projected to last longer and occur more frequently and intensely, as confirmed by ample of studies employing a variety of climate models.[23]

The extreme heat is defined by the Centers for Disease Control and Prevention (CDC), as "*a hot weather condition exceeding the usual average temperature considered for a certain location and time*". Heat-related health effects among construction workers are a critical, significant but understudied public health topic,[24] given the trend of the generally increasing global temperatures due to climatic change.[25] In most of the circumstances, construction activities involve manual workloads for longer duration in an uncomfortable working posture and as a result, workers undergo physical fatigue.[26,27] Heat exposure vary depending on the job task environment and between the individual worker. Study among the Australian construction workers remarked that heat stress as a severe impact that most affected by extreme high temperature exposure during construction tasks.[28] On the other hand, study among small group of rebar workers in Beijing discovered the diminished labour productivity secondary to work fatigue, with increasing temperatures. The influence was more prominent among the elderly or less-experienced workers.[21]

It is also important to note that working in direct sunlight or unventilated buildings can increase the ambient temperature to a greater degree. Construction workers are subjected to heat stress not only from outdoor physically demanding work but also in confined spaces which could be even worse. Physically demanding works combined with the exposure to high temperature, humidity, solar radiation and poor air ventilation not only results in physical fatigue but leads to a loss in productivity.[29] Several studies investigated alertness levels throughout the day discovered the drop in alertness level specifically during early afternoon.[30,31] A study among the Spanish construction workers reported that occupational accidents were more severe and possibly fatal if they occur between 13:00 and 17:00, when the climatic temperature were peak. On the other hand, times closer to the lunchtime had been reported accounted for almost one-fifth of all accidents and approximately one-third of the accidents involving death in Spain.[32] In homogenous with this, study in the United States had also found a surge in fatal construction accidents, accounting for one-fifth of all accidents between 14:00 and 16:00.[33] The extended exposure to heat or humidity can lead to general fatigue and decrease workers' energy and focus on their work, increase their irascibility, and lead them to spectrum of heat-related sickness.[4] Construction workers in general, especially those involved in scaffolding and form work, steel fixing and erection, and concrete work, are thought to be the most affected by hot work environment because their daily tasks typically take place in open spaces where they must spend several hours working under the heat of the sun. There are indications that certain building sites had temperatures that were higher than the surrounding atmosphere. For instance, Chan et al. reported that a building site might reach temperatures of 45°C even while the surrounding air is just 32°C.[34]

Vibration

Ergonomic hazards are physical factors present in the work environment. The ergonomics risk factors refer to all workplace situations that cause wear and tear on workers' body; which includes part of the work environmental risk factors like vibration, extreme temperature and noise.[35] Contruction worlers who frequently operate hand-held power tools or workers who hold construction materials that are often processed by a power machine at the highest risk of hand-arm vibration injuries. The vibration is transmitted from chainsaws, impulse tools, hammer drills and jigsaws. On the other hand, a local study examined the effect of different levels of hand-arm vibration that was produced during construction drilling task and concluded that vibration can increase the amplitude as well as decrease the power spectrum of electromyogram (EMG) signals; therefore, contributed to muscular fatigue and reflect the impact of environmental risk factors on worker's fatigue.[36]

The vibration transmission will leave multiple impacts on the musculoskeletal activities, depending on the impedance of musculoskeletal system; as well as the frequency, amplitude, and duration of vibration.[37] Literatures had widely reported that vibration-exposed workers suffer from a diminished muscular strength, force, performance and balance and the development of muscle fatigue.[38-40] An Italian study exposed upper limbs of 34 participant to hand arm vibration at different frequency level of 20, 30, 33 and 40 Hz with a constant velocity amplitude of demonstrated that muscle fatigue can be influenced by the exerted force and vibration frequency.[41] The tasks that expose construction workers to vibration hazard has been confirmed statistically to induce an early muscular fatigue or a neuromuscular inefficiency which is likely to result in work injury.

Elevation change

Unfamiliarity with the construction worksite had been cited to raise safety issues for high-elevation construction workers in past studies.[20] Additionally, workers may experience physiological adjustment issues that prone to fatigue when doing strenuous or delicate jobs in high-elevation work environments, particularly in conditions that are out of the ordinary, such as thermal or cold stress, strong winds, humidity and rain.[42, 43]

Studies have demonstrated that physiological responses such as heart rates, differed between high-elevation and ground-level workers.[20,44] Heart rate is typically regarded as an accurate indicator of physiological strain.[45] Mao and colleagues discovered that heart rates among the workers working at higher elevations were found to be 10–20 beats/min faster than those working on bridge construction sites.[44] This was best explained by the increment of levels of luminance and UV with increasing floor height; hence the rise in ambient air temperature explain the increased heart rates among workers.[46] Some easy ground-level tasks become more difficult when performing at high-elevation workplaces whereas the self-reported rates of ''unsteady footsteps'', ''tired'' and ''dyspnoea'' among high-elevation construction workers were statistically significantly higher than those of ground-level workers via the measurements of balance function, calf circumference and response time.[42,44] Additionally, a study was undertaken to investigate physiological (calf circumference, blood pressure, heart rate, critical flicker fusion and muscular strength) and psychological fatigue among high-rise building construction workers working on different floor heights in Taiwan. Based on the post-shift subjective fatigue symptoms, all high-rise building construction workers are categorized as physically-demanding type. Several workplace environmental stressors like wind velocity, temperature and level of ultraviolet light were being monitored and showed that the impacts of environmental disturbances on worker's fatigue were greater as the elevations increased from 6th to 10th floor.[20] Among the physiological indicators of fatigue, the Critical Flicker Fusion (CFF) value was found varies with the extent of visual fatigue among the high-rise construction workers. In consistent with similar research in earlier year[47], the sensitivity of human visual system increases with the amplitude light. Hence, the readings differ between the CFF descending and ascending tests assured that the magnitude of the change in CFF values decreases with increasing floor height, which stipulated that workers experienced visual fatigue at higher elevations; their physiological condition and instinctive fear might impair their judgment capacities.

In comparison to other type of construction workers who work on the ground level, the scaffolders and concreters were reported more prevalently complaint of general physical fatigue or 'whole body feel exhausted'. In addition, the results from objective fatigue measurement of post-shift back-strength also showed that they were more exhausted, due to the nature of the harsh and physically demanding tasks including the involvement of body postures of bending, kneeling and crouching while working at height.[42] In light of this, it was recommended that changes in physiological measurements may shed light on the frequency of body part utilisation among various types of construction workers as well as the relationship between working postures and the prevalence of musculoskeletal complaints such muscular fatigue.

The Mechanism of Environmental Factors Influences on Work Fatigue

The combination of internal heat generated within body and environmental heat resulting in increased core body temperature.[48] Thermal stress (TS) results from exposing the human body to extremely heated temperatures when it is unable to release its tension. The value of TS control in the workplace is supported by numerous compelling arguments. Working in intense heat causes a temporary increase in body temperature, which can further cause a series of physical and mental deficiencies[49], discomfort[50] and fatigue.[51] Fatigue, both physical and mental, has been proven as a primary risk factor for occupational accidents in hot working environment exposure.[18] Furthermore, exposure to an extreme temperature may significantly induce neural function deterioration, and the alteration of metabolic processes and vascularity within muscles. Racinais et al. has postulated that the amplitude of muscle contraction is lower in hot environments, indicating an increased level of fatigue in such environments. Apart from that, hyperthermic environment will also impairs short-term memory capacity and peripheral motor drive transmission.[52]

The overheat temperature leads to an increase in heart rate, body temperature, and sweat production. Following this, the surge in blood pressure causes more vigorous load to the heart.[53] Consequently, some of the blood will pool in the tissues of the legs and lungs when the heart is unable to pump blood throughout the body. Therefore, blood that has built up in the lung tissues will make breathing difficult providing that the less amount of the oxygen will be obtained.[54] The oxygen level is one of the main triggers of fatigue when there is accretion of lactic acid. In broad, it has been proposed that higher the temperature in the workplace can cause more sweat produced by the workers,[55] which in consequence, the workers will get dehydrated more easily. As dehydration progresses, the body redirects blood to the working muscles and away from the skin, impairing body's ability to diffuse heat. The increase in internal heat will lead to muscle cramps and fatigue.[56] When workers are performing activities requiring prolonged standing, they are at risk of developing heat edema which results in lower limb swelling and hence trigger muscle fatigue.[57] Apart from the physical fatigue, the mental weariness is also affected by reduced hydration levels. It had been shown that workers' mental performance decreased when inadequately hydrated Consequently, they tend to become distracted, irritated, agitated and have frequent mood changes workplace which positively linked to the occupational accidents.[58]

Most workers wear long-sleeved clothing and trousers even in hot and humid weather in order to minimize ultraviolet exposure. However, this might cause heat gain and prostration if body heat load is not appropriately released. The trigger of over-sweating can further lead to dehydration and general fatigue.[20]

Significantly more weariness affects workers at higher altitudes than does fatigue for workers at regular altitude. Heat related impact further adversely affect the workers' fatigue level as the ambient temperature on these types of workers is more significant than workers performing at ground level. Furthermore, workers have been evidently shown to experience difficulty in physiological adjustments when performing complicated tasks at higher altitudes therefore facilitate the mechanism of fatigue development.[59]

The effect of hand-held vibrating tools on several muscle groups have been examined and analysed.[36] It had been demonstrated the significant effect of vibration was transmitted from the tool's handle to the arm and shoulder muscle of Extensor carpi radialis, Biceps brachii and Trapezius, with the abnormally high maximum voluntary contraction (MVC) based on the evidence on EMG. This degree of muscle fatigue significantly varies with different work-related parameters including the gripping force, work posture and characteristics of vibration such as magnitude and frequency.[39,60,61]

Mitigation Strategies

Preventive measures like work-break cycles, work management, and cool-down arrangements with drinking water were suggested to ensure the wellbeing of construction employees in hot and muggy working circumstances have been implemented in many countries.[62] On the top of this, the OSHA instructions on safeguarding workers through the organizations of comprehensive heat illness prevention program can be adopted.[63] The guidelines incorporating the following elements:

a) Providing education and training to employees on how to safeguard oneself from dangers that could result in heat exhaustion.
b) Giving workers easy access to chilled water in the construction zone. Each employee needs to drink 150-200 cc of water a minimum every 15-20 minutes they are at work.
c) Creating work schedules that allow for frequent breaks so that employees can rest and drink water in facilities with shade.
d) Acclimatization which provides more frequent breaks and gradually increasing workloads for those who are not accustomed to the heat. For those employees who had a lengthier absence, a similar strategy should be used so that they can become used to working in the heat.
e) Designating an experienced staff member to monitor working conditions and protect employees who are susceptible to heat exhaustion.
f) Considering protective uniform and personal cooling devices that allows cooling, decrease thermoregulatory and cardiovascular stress, and enhance thermal relief .[62]

Liu and Wang had observed that conventional safety management of climatic heat risk primarily relies on the workers' awareness and behaviour. As a result, they have proposed a self-intelligent work site in Western Australia to manage construction heat stress proactively by integrating the functionality of Geographic Information System (GIS) and Building Information Modelling (BIS). In this initiative, the environmental conditions were monitored over the entire site using 3D spatial modelling and appropriate spatial sampling techniques to optimise the Cisco smart sensors. The health of workers who are subject to heat stress will be protected by this real-time monitoring and early warning system.[64]

The biggest challenge in the implementation of these mitigation measures is the hesitation to invest due to the usual perception that it will cost huge amounts. Nevertheless, the cost and benefit analysis research conducted in the United Kingdom revealed that the advantages considerably outweigh the costs of accident prevention by a ratio of about 3:1 when the overall costs of accident prevention were compared with the whole benefits of accident prevention.[65]

Legislation and policy

Up to date the regulations to prevent excessive heat exposure in the construction industry is scarce although construction workers are among the most likely to experience them.[24] The climatic heat risk and heat-related illnesses and fatalities are prevented with appropriate regime of rest, shade, and rehydration.[66] Among the low-cost recommendations include providing rest, shade and water; training; acclimatization; developing a monitor system for heat risk index signs; limiting physical tasks; rescheduling non-essential work; and closely monitoring workers' vital signs and strictly enforcing work/rest cycles, and the choice of these recommendations depends on risk categories.

The existing OSH requirements on work limits at heat exposure is lack of consideration on personal characteristics such as age, comorbid and lifestyle which would therefore inaccurately estimate the personal heat tolerance time. Japan Society for Occupational Health (JSOH) has established similar occupational exposure limits for heat stroke. For a healthy male person to work safely, effectively and continuously; JSOH advocates that the worker should work for no more than two hours.[29] Up to date, none of the existing guidelines have addressed the maximal exposure guide for fatigue prevention at construction site.

Optimizing work-rest regime

It is recommended that a work-rest schedule be properly designed as a powerful tool for enhancing a worker's comfort, health, and productivity.[67] Effective job rotation involves the schedule of work-rest frequency, duration, and timing of rest breaks base on scientific evidence.[68] Earlier research has explored the maximum duration that a rebar worker could work to exhaustion in a hot and humid construction setting without endangering his/ her health based on mathematical calculations, considering then optimal recovery time.[34] However, the study was limited by the uncertain variations especially the physiological, environmental and personal parameters like workers' health and productivity in order to optimize the work-rest schedule and to predict all possible consequences of different work-rest patterns. Chan et al. continued to investigate how long nineteen rebar workers in hot weather should be given to rest after exhausting themselves, employing 411 sets of meteorological and physiological data collected over fourteen working day in order to derive the optimal recovery model.[69] The study established the relationship of rest duration and percentage of recovery in which a rebar worker could, on average, achieve an energetic recovery of 94% in 40 minutes, 93% in 35 minutes, 92% in 30 minutes, 88% in 25 minutes, 84% in 20 minutes, 78% in 15 minutes, 68% in 10 minutes, and 58% in 5 minutes. The strength of recovery is better when given more time to rest, albeit the pace of recovery slows down with increasing rest time. On the other hand, Yi et al. conducted another field study in order to maximize the labour productivity and minimizing the occurrence of heat-related fatigue on construction site during summer time in Hong Kong. The Monte Carlo simulation technique was employed on the basis of work-to- exhaustion-then-take-a-rest principle in order to account for the variations of meteorological and physiological parameters; an optimized work-rest schedule was developed in which having a 15 min break after working 120 min continuously in the morning (WBGT of 28.9 ± 1.3 °C), and having a 20 min break after working 115 min continuously in the afternoon (WBGT of 32.1 ± 2.1 °C) was proposed.[29]

The work fatigue symptoms were documented more severe with increasing elevations. This could be attributed to the extra workload required to overcome the increasing environmental disturbances and fear.[70] It had been also discovered that visual fatigue among high-rise building construction workers might be a life-threatening factor, which should not be underestimated.[20] The elevation changes from lower to higher floors may increase worker heart rate and physical workload, while decreasing visual sensitivity. As visual sensitivity is reduced and environmental disturbances such as wind velocity increase, high-rise building construction workers must be equipped with relevant protective measures as well as adequate rest.[42]

This is the first study provides an insight on the environmental risk factors including the heat, work elevation and vibration that are associated with work fatigue in the construction industry, together with the underlying mechanism and the mitigation strategies. Despite being conducted based on the updated literatures; this present study has several limitations. The language bias and publication bias need to be addressed. The review process did not consider articles published in languages other than English and Malay. Moreover, the unpublished research was also not included which might potentially exclude some relevant articles. Unlike the systematic review and scoping review, this literature review described and discussed the preliminary overview of the topic without synthesizing the comprehensive, transparent and unbiased output.

CONCLUSION

Construction workers are performing manual tasks in very harsh conditions. Data derived from the literature review has markedly pointed out several environmental risk factors that contribute to fatigue among the construction workers including the heat related risk, elevation and vibration. Given that work fatigue is one of the major challenges facing by the occupational safety and health professional, therefore mitigating or managing its causal factors together with the provision of recovery may reduce its risk and consequences among the construction workforce. The proper understanding of these factors and its impact on worker's production and safety performance may help construction organisations and government regulating body to develop strategies for worker's protection and fatigue-related accidents prevention.

The revelation of multiple important problems calls for the recommendations listed below.

1. It is imperative to identify all vulnerable individuals at risk and to implement the individualized customized rather than "one size fit all" workplace mitigation measures.
2. Workers handling different tasks may have different degrees of susceptibility to the environmental stressors. Therefore, a task specific scientific approach will better assess and reflect the real situation in order to design of an appropriate work-rest-schedule accordingly.
3. Future studies should detail out the real-time surveillance with larger sample and in-depth analyses in order to contribute more significant evidence to the existing body of knowledge on environmental risk factors in the construction industry.
4. The physiological assessment of fatigue among construction workers along with environmental measurements need further validation in order to provide a valid and reliable evidence for it to be taken seriously as an international index.

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