Effect of Cooling Vest on Fatigue and Spatiotemporal Gait Parameters on Multiple Sclerosis: A Narrative Review

Mina Khalil Essa Ibrahim[1*2], Shaima Mohamed Abdelmageed[1], Nagwa Ibrahim Rehab[1], Rania Shehata Ismael[3]
[1]Department of Physical Therapy for Neurology, Faculty for Physical Therapy, Cairo University, [2]Faculty of Physical Therapy, May University, Egypt; [3]Department of Neurology, Faculty of Medicine, Cairo University, Egypt
Corresponding author: Mina Khalil Essa Ibrahim, **Email:** ptrservices2022@gmail.com,
Mobile: 01274483515

ABSTRACT

Background: Relapsing-remitting multiple sclerosis (RrMS) is the most common type of multiple sclerosis, where a person experiences episodes of new or worsening symptoms (relapses) followed by periods of recovery (remissions). These symptoms come and go and while they may disappear completely during a remission, they can also leave lasting effects or increase disability over time.

Aim: This study aimed to investigate the effectiveness of a wearable cooling vest in reducing fatigue and improving spatiotemporal gait parameters in RrMS.

Methods: We searched PubMed, Google Scholar, and Science Direct for Multiple sclerosis, Fatigue, Cooling vest, Gait analysis, Spatiotemporal parameters and Thermoregulation. Only the most recent or thorough investigation, from 2003 to 2024 was taken into account. The writers evaluated relevant literature references as well. Documents written in languages other than English have been ignored. Papers that were not regarded as significant scientific research included dissertations, oral presentations, conference abstracts, and unpublished manuscripts were excluded. The literature was reviewed in order to review the various conservative treatment options regarding the efficacy of cooling effect on fatigue and spatiotemporal gait parameters on multiple sclerosis patient using Kinovea software.

Conclusion: Cooling vest is a good option for improving fatigue and gait parameters, including step length, cadence and walking speed on multiple sclerosis patients. Cooling vests can be a beneficial non-pharmacological strategy to reduce fatigue and enhance gait performance in RrMS, offering a promising addition to rehabilitation protocols.

Keywords: Multiple sclerosis, Fatigue, Cooling vest, Gait analysis, Spatiotemporal parameters, Kinovea, Thermoregulation.

INTRODUCTION

Inflammatory demyelination and axonal transection are hallmarks of multiple sclerosis (MS), an autoimmune disease affecting the central nervous system (CNS). Irreversible neurologic damage is the clinical equivalent of axonal transection. About 900,000 individuals in the United States are impacted by M.S. Between the ages of 20 and 30, persons often receive a diagnosis of 1-3 MS. Uncertain genetic (e.g., the major histocompatibility complex HLA-DRB1 locus) and environmental (e.g., vitamin D levels; elevated risk at certain levels) variables contribute to multiple sclerosis [(1)].

Primary progressive MS (PPMS), relapsing remitting MS (RRMS), progressive relapsing MD (PRMS), and secondary progressive MS (SPMS) are the four clinical manifestations of this disease. Acute episodes (relapses) followed by partial or complete recovery (remission) define RRMS, which is experienced by around 87% of individuals [(2)].

The higher risk of falls among people with multiple sclerosis (MS) is likely rooted in their poor postural control. Slowed somatosensory conduction and decreased cerebral integration appear to be the principal processes underpinning the reported alterations in MS-related balance and gait, according to many investigations. Typical gait abnormalities seen in multiple sclerosis research include slower walking speeds, shorter strides, slower cadence and impaired joint mobility. Physical exhaustion is a prevalent symptom that can impact quality of life and heat sensitivity is a major contraindication in adults with relapsing-remitting multiple sclerosis (RrMS). Raised core temperature has the potential to worsen heat exhaustion and other heat-related complaints. According to prior research, lowering core body temperature with the use of cooling devices may alleviate symptoms of illness while simultaneously enhancing functional capacity and overall well-being [(3)].

PATHOPHYSIOLOGY OF MULTIPLE SCLEROSIS

Inflammatory demyelination and axonal transection are hallmarks of multiple sclerosis (MS), an autoimmune disease affecting the central nervous system (CNS). Irreversible neurologic damage is the clinical equivalent of axonal transection [(1)]. Myositis is believed to be an infectious disease. Some of the possible infectious agents that might cause multiple sclerosis are Chlamydia pneumoniae, Epstein-Barr virus (EBV), and human herpesvirus-6 (HHV-6). T cell-triggered autoimmune tissue inflammation can occur when either

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the central (thymic) tolerance mechanisms fail or when the peripheral immune compartment fails, resulting in abnormally high precursor frequencies of autoreactive T cells or aberrant activation or skewing of these cells [4].

1. Fatigue in MS and role of thermal sensitivity:

Among the many symptoms experienced by people with multiple sclerosis, fatigue ranks high [5]. With an impact on as many as 80% of individuals. Feelings of low energy, both mental and physical, that are not proportionate to effort and get in the way of everyday life are hallmarks of this condition [6]. Multiple sclerosis patients have trouble keeping their balance when standing or walking, which, along with their increased tiredness, reduces their ability to do daily tasks and makes them more likely to fall [7]**.** A thermoregulatory deficit makes it difficult, if not impossible, for multiple sclerosis patients to maintain a normal core body temperature. Damage to the hypothalamus and its surrounding subcortical regions is mostly to blame. Temperature sensitivity is a distinct feature of multiple sclerosis (MS). When a patient's core and skin temperatures rise, their MS symptoms may temporarily become more severe. In particular, pseudo-exacerbations can occur when there is a change in core body temperature because changes in core body temperature can impair or completely halt neuronal transmission in demyelinated neurons in the CNS [8].

2. Gait in MS and role of thermal sensitivity:

Although there is a wide variety of gait abnormalities associated with disorders of the central nervous system (CNS), some of the most common ones include a reduction in step length and single support time, a slowdown in speed, an increase in step width, and a decrease in ankle dorsiflexion angle and propulsive force [9]. Researchers have shown that somewhat disabled MS patients have kinematic asymmetries, most notably a decreased hip extension and range of motion during the stance phase. People with multiple sclerosis who also have spasticity are more likely to exhibit these symptoms. While making first contact, some writers have seen a reduction in ankle dorsiflexion, and before swinging, they have seen a reduction in plantarflexion. Also, a different study found that even minimally afflicted MS patients have different patterns of muscle coactivation when walking, particularly in the affected leg [10].

Uhthoff's phenomenon is characterized as a stereotyped impairment of neurological function in multiple sclerosis (MS) patients in response to rises in core body temperature, which increases the risk of falls. It is short-lived (less than 24 hours) [11].

3. Employing cooling vest as a symptom management technique in MS patients:

Reducing one's core and/or skin temperature before engaging in physical labor is one of the cooling techniques suggested to enhance exercise performance in MS [3].

4. Effects of Cooling Vests on Fatigue

Reduction in self-reported fatigue: Using mid-cooling techniques can decrease the detrimental effect of heat stress on endurance exercise capacity and performance, according to several studies. This means that wearing a cooling vest can significantly reduce felt weariness [12]. Researchers conducted a study by Watson that demonstrated the benefits of wearing a cooling suit for 45 minutes. The results showed that motor function, visual function, and subjective fatigue perception were all positively affected in both ambulatory and wheelchair MS patients. The benefits were further validated in certain activities of daily living [3].

PROCESSES CONTRIBUTING TO FATIGUE RELIEF:

- Cooling likely improves fatigue by:

Because of its accessibility, cooling vests may be used by MS in a variety of work and exercise settings, and they are a potential strategy for reducing the core temperature increase that happens during physical activity [3].

- Gait performance modulation via cooling vest application

Walking speed and endurance:

A systematic review and meta-analysis by **Stevens *et al.*** [13] examined 13 clinical trials involving 384 MS patients and found that cooling garments (liquid-perfused vests, phase-change vests, thigh-cuffs and palm devices) consistently improved walking capacity and functional mobility**.** And in a feasibility trial by **Devasahayam *et al.*** [14]**,** participants performed vigorous treadmill walking in a room cooled to 16 °C for 10 weeks (3 sessions/week). Results showed clinically meaningful improvements in total walking duration, distance, walking speed, and gait quality, so, cooling via a cool-environment treadmill training protocol enhances walking endurance and speed in MS patients with moderate-to-severe disability.

Spatiotemporal gait parameters

A pilot randomized controlled trial by **Gonzales *et al.*** [15] evaluated the use of phase-change cooling vests during a 7-week physical training program in MS patients (EDSS ≈ 5). Results showed significant improvements in the **6-minute walk test (6MWT)** distance—a proxy for combined spatiotemporal performance. In addition, a study by **Karpatkin *et al.*** [16] compared two groups—one that was cooled and one that was not—and discovered that the cooled condition had smaller mean disparities (-1.6') between the first and sixth minute distances walked compared to the uncooled condition (-12.4'). In the cooled condition, subjects reported lower levels of subjective tiredness (7.4 mm) compared to the uncooled condition (13.8 mm). Although these results are early, they provide credence to our theory that cooling might reduce of gait in MS and enhance gait endurance.

A comparative study on the impact of cooling garments design:

Cooling vests that use different cooling processes are readily available on the market. Some examples are liquid-cooling vests, fan-cooling vests, phase-change materials, and hybrid cooling vests [17]. Previous studies used thermal manikins and occupational physiology reveal that liquid-cooled and air-cooled vests generally provide stronger and longer-lasting cooling than phase-change material (PCM) vests, especially during prolonged activity or in high thermal environments [18]. However, PCM vests though lighter and simpler, tend to lose efficacy once the material fully transitions from solid to liquid—usually after 1–2 hours [19]. And at the end, selection often depends on patient preference.

LIMITATIONS

Despite encouraging findings, this study had several notable limitations:

1. Short-lived cooling efficacy: Phase-change material (PCM) vests typically lose effectiveness after 1–3 hours as the material melts and heat-absorbing capacity diminishes [20].
2. Impaired thermoregulation: Passive cooling may inhibit perspiration and natural evaporative cooling, reduce overall heat dissipation and occasionally even limit comfort during longer use [21].
3. Small sample sizes & limited follow-up less than 30 participants (e.g., n=10 in **Stella *et al.*** [3] and lack of long-term data restrict the statistical power and generalizability of findings. We also did not investigate participant adherence or comfort over extended periods.

CONCLUSION

This study highlights the positive impact of cooling vests on reducing fatigue and improving spatiotemporal gait parameters in individuals with multiple sclerosis. The intervention demonstrated measurable benefits in walking speed, stride length, and endurance, particularly among heat-sensitive patients. These findings support the use of cooling garments as a practical, non-pharmacological strategy to enhance mobility and functional independence in MS rehabilitation programs. Further research with larger cohorts and long-term follow-up is recommended to confirm and extend this outcome.

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