Scientific-Expert Journal of Anthropological Aspects of Sports, Physical Education and Recreation

Submitted: 15/04/2026
Accepted: 08/06/2026
Online first: 23/05/2026
UDK: 796.01/.09:001.891

Original article

Methodology for operationalization of organized multi-day hiking

[1]*Vladimir Miletić, [1]Nenad Janković, [2]Milorad Marković, [3]Željko Vukić

[1]University of Belgrade, Faculty of Sports and Physical Education, Belgrade, Serbia
[2]Mountaineering Association of Belgrade, Belgrade, Serbia
[3]University of Banja Luka, Faculty of Physical Education and Sports, Banja Luka, Republika Srpska, Bosnia and Herzegovina
Correspondence: vladaprof@gmail.com

Abstract

Walking is a basic motion that a human can accomplish. This action will be simpler when walking on flat terrain or downhill. In contrast to the aforementioned, walking will be more challenging on an elevation with a higher slope. Another crucial element that may have an impact on the action's complexity is the surface on which the movement is performed. The choice of appropriate footwear and walking technique are directly influenced by the characteristics of the terrain. The complexity of this fundamental action will be greatly impacted by any departure from the intentional step (raising or lowering the step, adjusting its frequency, lateral movement brought on by any source, etc.). An individual's social component is opened up by additional social association, which in and of itself necessitates adaptation to the weakest member. The extension of the duration of the hike leads to a higher energy expenditure and, consequently, to the need for adequate logistics (water, food, spare equipment, etc.), which affects the change of the picture observed from the organizational aspect. The extended time of hiking in the field significantly affects the exposure of hikers to environmental conditions and thus influences their outcome. Further complexity of the organization comes with the motive for hiking, shortening of deadlines, the occurrence of fatigue, injuries, the occurrence of bad weather conditions, etc. This type of multi-day hiking requires accommodation of people and nutrition, which further affects the organization through the inevitable need for mobile camping. The hike's duration increases energy consumption, necessitating the use of suitable logistics (water, food, extra equipment, etc.), which influences the change in the picture perceived from an organizational perspective. Hikers' exposure to environmental circumstances is greatly impacted by prolonged field trekking, which in turn affects their results. Further complexity of the organization comes with the motive for hiking, shortening of deadlines, the occurrence of fatigue, injuries, the occurrence of bad weather conditions, etc. This kind of multi-day hiking requires food and accommodation, which has an additional impact on the organization due to the unavoidable requirement for mobile camping.

Keywords: Walking Tour, March, Mobile Camping, Outdoor Activity

Citation: Miletić, V., Janković, N., Marković, M. & Vukić, Ž. (2026). Methodology for operationalization of organized multi-day hiking. *Sportlogia*. 22(2), 9-19. https://doi.org/10.63356/spl.2026.008

Introduction

Walking is one of the most fundamental modes of mobility for humans and one of the most basic forms of movement in both everyday life and the physical cultural system (O'Mara, 2021). In addition to its utilitarian value, upright walking occupies a central place in anthropological terms; the transition to bipedalism was a key evolutionary moment that, through the liberation of the upper extremities from the function of locomotion, enabled the development of fine motor skills, the use of tools, and also the cognitive liberation of the mind for abstract thinking, planning and social interaction (O'Mara, 2021). From an ontogenetic standpoint, the development of motor skills from infancy to adulthood culminates in the mastery and improvement of walking biomechanics and whole-body coordination, which is the primary indicator of the physical development and neuromuscular maturity of the individual (Zajac, Neptune & Kautz, 2002). However, beyond its biological and everyday function, walking in modern society takes on a deeper dimension when it is organized into institutional and group frameworks. This format of movement not only encourages physical activity, but also provides a specific experience of community, ethical connection with nature and the transformation of ordinary locomotion into a structured social-educational practice (Paintendre, Quidu & Favier-Ambrosini, 2025).

Although cyclic activity, which is in itself every day and simple to apply (minimalist), is mechanically and coordinationally very demanding (Zajac, Neptune & Kautz, 2002), and can be further complicated through training methodology. The main profession (e.g., physical education, sports sciences, kinesiology, etc.) operates through methods of difficulty and facilitation in order to successfully solve targeted educational, recreational and training tasks (Miletić, 2018; Charlton et al., 2021; Zajac, Neptune & Kautz, 2002). In the context of these methodological modifications, organized walking of longer distances and off-road terrain stands out as a form that far exceeds the framework of a mere sports-recreational method. This specific form of organizing movement actually corresponds to our deep anthropological and ontological essence. Anthropologically, the human body is evolutionarily designed as a system for long-term exploration of space and movement across natural, uneven terrain; overcoming distances in a group is the mode through which our species has survived and developed its community (O'Mara, 2021). Ontologically, long-term hiking on natural terrain returns modern man to his original way of being ("battle with space and self"), allowing him a mental reset and existential rooting that is completely denied in urban, sedentary environments (Paintendre, Quidu & Favier-Ambrosini, 2025). Although cyclic activity, which is in itself every day and simple to apply (minimalist), is mechanically and coordinationally very demanding (Zajac, Neptune & Kautz, 2002), and can be further complicated through training methodology. The main profession (e.g. Physical education, sports sciences, kinesiology, etc.) operates through methods of difficulty and facilitation, in order to successfully solve targeted educational, recreational and training tasks (Miletić, 2018; Charlton et al., 2021; Zajac, Neptune & Kautz, 2002). In the context of these methodological modifications, organized walking of longer distances and off-road terrain stands out as a form that far exceeds the framework of a mere sports-recreational method. This specific form of organizing movement actually corresponds to our deep, anthropological and ontological essence. Anthropologically, the human body is evolutionarily designed as a system for long-term exploration of space and movement across natural, uneven terrain; overcoming distances in a group is the mode through which our species has survived and developed its community (O'Mara, 2021). Ontologically, long-term hiking on natural terrain returns modern man to his original way of being ("battle with space and self"), allowing him a mental reset and existential rooting that is completely denied in urban, sedentary environments (Paintendre, Quidu & Favier-Ambrosini, 2025).

When moving beyond the confines of flat urban asphalt and onto uneven, sloping terrains, the locomotor apparatus is faced with complex kinematic changes and additional loads. Scientific research shows that walking on uneven and natural terrain dramatically changes the biomechanics and energetics of locomotion

as there is a significant increase in stride variability, coactivation of the hamstring and calf muscles, and an increase in mechanical work in the hip and knee joints, which increases the metabolic cost of walking by almost 30% compared to flat terrain. Additionally, long distances in organized hiking almost always involve carrying an external load (backpack), which linearly increases the ground reaction force, requires posture adaptation through forward trunk tilting, and significantly changes the kinetics of the lower limb joints (Huang & Kuo, 2014; Wang et al., 2023). In order to successfully implement such a complex, much-needed activity within an organized event, it is nevertheless necessary to carefully analyze and structure the conditions in which it takes place. Regardless of the inherent naturalness of human walking, covering desired (often extreme) distances and dealing with unpredictable terrain requires a systematic approach. Therefore, in the process of planning and implementing organized walking, it is necessary to pay attention to the basic factors – both internal (biomechanical, functional, and motor capacities of the individual) and external (terrain configuration, slope, external load, and equipment) – given that they can significantly affect safety and ultimate success but also the overall subjective experience of the walking process itself.

Further consideration of hiking as a minimalist motor form will be presented in the presented paper in such a way that, through a logical inductive methodological concept, it is brought from the individual to the general complexity and optimal difficulty for those who apply and manage it. For sports experts, kinesiologists, and guides, this transition from the individual to the group level is the primary challenge. For this reason, the organization's success depends on the application of a rigorous and scientifically supported methodological approach. Leading a group through long distances and challenging terrains requires disciplined planning and adaptive control, not improvisation. Effective leadership rests on (1) precise dimensioning of the group's load (physical and logistical), (2) recognition of heterogeneous physical capacities within the group, and (3) timely adjustment of pacing in light of external environmental factors. Across the literature on wilderness leadership, expedition planning, and related applied fields, these elements repeatedly emerge as core competencies for safe, effective, and educational outdoor experiences. This synthesis draws on diverse sources that, while drawn from different domains (outdoor leadership, wilderness medicine, expedition cognition, and related risk-management literatures), converge on a common framework: rigorous pre-planning and ongoing, evidence-based pace management are essential to manage risk, optimize performance, and achieve objectives in demanding terrains (Stonehouse & Furman, 2022**;** Smith et al., 2017; Mellor et al., 2015). A systematic methodological framework allows for optimal management of the risks of acute fatigue and injury, ensuring that movement is performed within safe biomechanical and physiological parameters (Voloshina et al., 2013). In this way, an adequately structured methodology not only preserves the integrity and health of each participant, but also directly transforms physiological effort into a positive, cohesive and transformative group experience (Paintendre et al., 2025). Therefore, this work offers concrete guidelines and practical methodological tools that facilitate decision-making in the field, making the work an applicable guide for the effective management of organized hiking tours.

Methods

The subject of this paper is focused on the systematic categorization and scientific-practical operationalization of key factors that determine the efficiency, safety and logarithm of multi-day organized hiking management. In methodological terms, the paper uses the method of theoretical analysis and synthesis of available scientific and professional literature, complemented by the biographical method (Savić, 2023), i.e., a structured analysis of the author's rich professional and existential experience gained through decades of real planning, organization and direct participation in complex hiking and mountaineering tours. Starting from an inductive methodological concept, empirical findings from the field are scientifically contextualized in order to generalize isolated kinesiological and organizational factors into applicable matrices for managing heterogeneous motor groups. The voluntary step, characteristic of normal human

motor actions, is taken as the basic reference value and fundamental biomechanical construct for the consideration of the subject matter. The term "voluntary step" refers to a kinematic pattern with length, frequency, and mode of treading (contact with the ground) that are characteristic of the phylogenetically automated and everyday movement of an individual without the influence of extreme external stressors. However, the operationalization of multi-day hiking, which is realized in the form of a march or a specific multi-day tour, requires that a wide range of variables be simultaneously evaluated in the planning process. A march or tour in this context is defined as a purposeful, structured movement planned for targeted social and motor structures, carried out in a specific form of mobile camping. This format implies a continuous succession of phases of active movement and phases of planned accommodation for rest and substitution of energy deficits, which each time takes place in a different geographical location, within the route of a previously designed route. Accordingly, in the following steps, the factors that enter into the regular procedure of operationalization and systemic complexity of this minimalist motor form will be presented in detail and scientifically elaborated. This matrix of factors includes:

1. External conditions (weather conditions and terrain and topography) in which movements are performed (Schmidt et al., 2023).
2. Load parameters (mass, ergonomics and distribution of external load/backpack, as well as footwear and technical equipment of the participant) (Višnjić, Jovanović & Miletić, 2004);
3. Spatial-temporal determinants (total route length and planned transition duration) (Kerouanton et al., 2024)

Other related and indispensable elements of multi-day organized hiking—such as structured rest, specific nutritional regimens (diets), and hygiene and preventive procedures—will be discussed and mentioned in this paper exclusively as integral links of a scientifically guided organizational chain, viewed through the exact prism of the elements of logistics and operational management in the field (Miletić, Rajković & Jotov, 2019).

Discussion

The main intention of this work was the systemic operationalization of the holistic transition of walking from its minimalist motor form to a complexly structured, multi-day group phenomenon. The results of theoretical analysis and empirical distillation of the author's professional experience (Savić, 2023) indicate that the voluntary step, although deeply automated in basic conditions, is subject to extreme kinematic changes when performed on off-road terrain and under the influence of external loads. When this basic pattern is loaded with a backpack and dislocated on an unorganized surface with a pronounced slope, the locomotor system compensates for the increased mechanical work by changes in posture and muscle coactivation, which drastically increases the metabolic cost of movement (Voloshina et al., 2013; Huang & Kuo, 2014). For this reason, successful management of this process implies the need to abandon intuitive organizational patterns and adopt exact logistical and kinesiological algorithms.

This segment substantiates the rationale for the proposed inductive methodological concept, as the diversity of participant composition necessitates careful calibration of intensity to minimize cumulative fatigue, a primary contributor to injury under load (Višnjić et al., 2004; Liew et al., 2023). Finally, the conceptualization of multi-day hiking in the form of mobile camping requires that rest, nutritional regimen and hygiene-prophylactic procedures be viewed as critical determinants within an integrated logistics chain (Miletić, Rajković & Jotov, 2019). The prompt replacement of energy deficiencies at various sites serves as a fundamental safety measure to prevent a reduction in the group's motor efficiency. The organizing of a multi-day hike is a complex kinesiological-managerial endeavor, where the success hinges on the leader's capacity to concurrently navigate external topographical limitations and the internal psychophysical capabilities of the group.

Basic rules for group movement in the terrain

Personal technical equipment (adequate footwear, snowshoes, crampons, and gaiters) must be adapted to the specifics of the terrain and the characteristics of the individual, since it represents a primary safety factor. In multi-day actions, already used (worn-out) footwear is mandatory to prevent foot injuries. During locomotion, participants maintain their voluntary step and pace, but preserving the compactness of the group is key. In the case of column fragmentation, the last participants of the separated segments must maintain visual contact. The basic tactical rule requires positioning the physically weaker individuals at the head of the column so that they dictate the pace, with the front and rear in constant communication. If the route includes public roads, the column moves along the edge or next to the roadway, leaving the roadway clear.

Safety management also includes recognizing signs of bad weather in the field for timely thermoregulation (changing garments) and avoiding objective dangers such as lightning strikes, landslides or avalanches. In winter conditions, frost protection measures are implemented, and movement takes place in a “one-by-one” formation. Individuals at the head are cyclically replaced according to the time or number of steps taken to break through deep snow (snowdrift). After the completed interval, the leading pedestrian steps aside, lets the group through and rests at the rear, waiting for the last participant. This rotational cycle is continuously repeated, thus achieving optimal energy economy for the entire group until the end of the given section.

Leadership and Guide Skills

The central coordinating element that integrates and manages all other variables affecting organized, multi-day hiking tours is leadership and guide skills (Morsiani et al., 2023). This role necessitates a complex blend of technical expertise, tactical decision-making, and interpersonal management. Competent guides continuously plan and modify itineraries—including walking pace and break frequencies—according to the abilities, skills, and characteristics of participants, while simultaneously adapting to environmental shifts such as weather deterioration, physical obstacles, and terrain asperities (Morsiani et al., 2023). Practical pacing strategies under effective leadership include setting realistic daily mileage goals based on terrain and weather forecasts, scheduling proactive rest periods to prevent excessive fatigue, and employing dynamic pacing to modify routes or daily distances in response to group fatigue signals (Hill et al., 2008; Fruchart & Rulence-Pâques, 2024; Yousef et al., 2019).

Because wilderness trekking involves inherent environmental hazards (e.g., volatile weather, complex terrain, wildlife) alongside human-factor risks (e.g., participant incompetence, poor judgment, or outdoor leader error), the responsibility for group safety places immense pressure on guide expertise (Morsiani et al., 2023). To manage these dynamics, experienced leaders utilize ongoing assessments of participants' comfort and fitness levels to guide pace setting and break decisions, progressively increasing moving time and distance as trail confidence improves (Lesser et al., 2020). This adaptive approach ensures that multi-day tours remain challenging yet attainable while strictly upholding safety standards.

To navigate complex environments effectively, guides must possess comprehensive logistical and technical skills. This involves managing detailed route planning, verifying land access, analyzing terrain classifications, and interpreting meteorological forecasts to transmit timely information to the group (Marin, 2021). Furthermore, guides must actively instruct and model fundamental personal movement skills, including energy preservation techniques, pace management, precise foot placement, stability, and biomechanical coordination (Marin, 2021).

Weather Conditions

Weather is one of the most volatile and unpredictable elements influencing planned multi-day hiking trips, capable of fundamentally altering the physical demands and safety profile of any route. Extreme ambient temperatures increase metabolic effort and necessitate specific gear considerations, while low temperatures

and reduced oxygen availability at high elevations introduce severe physiological stressors that require continuous monitoring (Pastrana et al., 2015). Consequently, the seasonal timing of tours is critical, as diverse annual weather patterns dictate strict clothing and equipment requirements that must be communicated to participants well in advance.

Adverse conditions such as heavy rain and strong winds pose immediate challenges to hiking progression and safety (Maciejko et al., 2019). When combined with difficult terrain and heterogeneous group fitness levels, these circumstances frequently lead to unplanned, extended trail stops lasting up to 33 minutes (Kerouanton et al., 2024). Furthermore, elevated ambient temperatures trigger heightened physiological stress reactions, turning what is typically a low-intensity walk into an intense, high-exertion physical activity for many participants (Freese et al., 2021).

The unpredictability of mountain meteorology significantly complicates trip execution, as unseasonable, rapid storms can produce life-threatening conditions. Although many weather-related risks can be mitigated through appropriate protective gear, conservative route selection, and adequate environmental literacy, hazardous events remain an active threat (Schmidt et al., 2023). This reality underscores the value of competent leadership; experienced guides must remain highly organized to continuously adjust itineraries, walking speeds, and rest stop frequencies in response to changing weather fronts (Morsiani et al., 2023).

Terrain and Topography

Topography and terrain characteristics exert a direct impact on equipment requirements, safety protocols, and physiological demands across all phases of a multi-day tour. Detailed terrain analysis is indispensable for optimal trip planning, as the condition, technicality, and severity of specific routes may dictate specialized physical conditioning, unique motor skills, or technical equipment such as rappelling gear (Pastrana et al., 2015). Empirical research indicates that approximately 90% of individuals acknowledge that topography directly dictates their walking pace, demonstrating a clear relationship between terrain profiles and hiking performance (Sprent et al., 2024; Taylor et al., 2010).

Energy expenditure increases substantially when traversing mountainous topography, particularly during uphill ascents, with predictive models reliably demonstrating strong correlations between terrain slope, transit time, and metabolic cost (Brunyé et al., 2015). Ultimately, the geographic landscape shapes group mobility patterns, especially in regions characterized by sharp orographic and structural variations between different trail sectors (Gea-Garcia et al., 2021; Boller et al., 2010).

Managing these spatial variations requires specific preparation from both guides and participants. Skilled guides must analyze terrain types, identify optimal lines of progression, and conduct on-site route verifications while instructing participants in energy preservation, pace control, stability, and coordination (Marin, 2021). For the participants, preparation entails utilizing technical footwear that offers robust ankle support and traction, maintaining focused situational awareness, preserving upright posture, and modifying descent techniques through controlled deceleration and short, firm steps (Carrillo-Hernández et al., 2024).

Equipment and Gear

When trekking on natural, uneven terrain, the specific footwear utilized significantly influences both metabolic efficiency and injury risk. Compared to standard indoor footwear, rigid trekking boots are linked to higher metabolic demands in outdoor environments, which directly impacts fatigue management and daily distance targets over multi-day tours (Fattorini et al., 2012; Yousef et al., 2019). On short or low-difficulty segments, technical socks can mitigate minor foot lesions and stabilize skin temperature; however, on extended tours, specialized footwear-sock combinations must be carefully selected to minimize blister formation and maintain optimal thermal comfort (Pico et al., 2019). To prevent debilitating foot injuries and enhance structural comfort, organizers must ensure participants utilize weather-appropriate, high-traction,

and durable footwear paired with technical socks, allowing sufficient time prior to the tour for boot break-in and individual adjustments to expected elevation and moisture conditions (Pico et al., 2019; Fattorini et al., 2012; Yousef et al., 2019).

The integration of trekking poles interacts dynamically with load carriage and terrain technicality. Rather than driving significant reductions in net energy expenditure, the primary benefit of trekking poles lies in substantial stability gains and safer navigation (Jacobson et al., 1997; Pigman et al., 2017). Experimental data show that utilizing two trekking poles significantly enhances lateral stability and balance compared to using a single pole or none, resulting in fewer alignment deviations and a reduced risk of falls on alpine or uneven surfaces (Han et al., 2017).

This safety benefit is further supported by evidence that poles aid in upper body stabilization, thereby lessening undesired knee and trunk excursions on difficult terrain (Han et al., 2017). These stabilizing effects are most pronounced on uneven, sloping surfaces where lateral balance and precise foot placement are critical, and the mechanical benefits tend to increase as backpack load increases, facilitating safer navigation over obstacles like rocks and roots (Han et al., 2017).

Backpack Load Effects

Backpack load is a primary determinant of the physiological demands and performance outcomes of organized multi-day hiking expeditions. Research demonstrates that load weight significantly increases energy expenditure and ratings of perceived exertion (RPE) during extended backpacking, which shortens the time to exhaustion and degrades performance in subsequent trail segments (Hill et al., 2008). Total backpack mass and its distribution on the body consistently correlate with altered gait mechanics, postural deviations, balance compromises, and elevated injury risks during multi-day treks. Specifically, suboptimal load distribution exacerbates postural tension and musculoskeletal pain, while excessive weight elevates overall metabolic expenditure and perceived effort (Genitrini et al., 2022; Pigman et al., 2017; Hosick et al., 2017; Yousef et al., 2019). To lower energy costs and enhance stability on uneven terrain, technical load-carriage configurations—including heavy-duty hip belts, proper shoulder strap tensioning, higher and tighter load placement, and system designs that minimize torso lean—are strongly recommended (Genitrini et al., 2022; Pigman et al., 2017; Hosick et al., 2017).

The physiological strain of carrying a backpack becomes exceptionally pronounced when combined with challenging terrain conditions, as rough underfoot surfaces increase transportation costs by approximately 115% compared to smooth pathways (Sprent et al., 2024; Gast et al., 2018). For organized tours, where participants carry varying loads relative to heterogeneous fitness levels, this compounding effect represents a critical operational constraint. Consequently, guides must customize pace structures and rest schedules based on the combined, interactive effects of terrain difficulty, volatile weather, and each participant’s individual load-to-bodyweight ratio.

Walking Speed and Pace Management

Walking speed and pace management require continuous, real-time adaptation based on group composition, individual physical capacities, and ambient conditions. Guides must balance multiple overlapping constraints to maintain safe, steady progress throughout multi-day itineraries. Depending on the terrain profile and the required daily mileage, the physical demands of hiking can shift what is typically low-intensity exercise into a highly demanding athletic endeavor.

While flat-ground walking is generally categorized as low-intensity, long daily trekking distances (averaging 25.3 km per day) combined with high ambient temperatures expose subjects to severe physical stress (Freese et al., 2021). This physiological strain requires guides to carefully evaluate trail users' physical comfort and

fitness to dictate appropriate pace settings and break schedules, progressively increasing moving times and distances only as the group gains experience and confidence (Lesser et al., 2020).

Spatial movement patterns are fundamentally dictated by the geographic setting, particularly in zones characterized by acute orographic and elevation variations between successive trail sectors (Gea-Garcia et al., 2021). Additional pacing constraints are introduced by group dynamics and individual fitness differentials. For instance, frequent trail stops are rarely a matter of elective choice; rather, they reflect a physiological necessity to rest or wait for less experienced group members, resulting in cumulative, enforced pauses along the route (Kerouanton et al., 2024).

Finally, traditional, static pace-calculation formulas—such as Naismith's Rule, which estimates transit time purely as a function of horizontal distance and vertical ascent—exhibit clear limitations in these scenarios. These legacy metrics fail to account for variations in individual fitness, carried load, and changing underfoot conditions (Yang et al., 2014), making them applicable only to reasonably fit, unladen hikers managing typical terrain under standard weather conditions (Scarf, 2007).

Operational Metrics: Terrain-Specific Velocities and Group Rest Protocols

When operationalizing route planning, walking velocity is a primary determinant that exhibits a reciprocal relationship with backpack load and terrain complexity. On flat terrain, a hiker's average velocity shifts from approximately 5 km/h when carrying personal weekend gear (suitable for up to three days) to 4 km/h when equipped with a full week's load (Маршал, 1952). This metrics underscores the logistical trade-off between increased field autonomy and reduced locomotion speed.

Furthermore, terrain technicality dramatically scales down these baseline values. While ascending steeper inclines directly correlates with a reduction in velocity based on the terrain gradient, descending steep slopes—particularly following prolonged exertion—presents a distinct biomechanical paradox: while potential velocity increases, overall movement control and joint stabilization become significantly more demanding.

To provide future organizers with a predictive matrix for itinerary planning, the exact correlations between terrain gradient, elevation, and velocity are structured below.

Table 1. Hiker walking velocity relative to terrain slope and elevation (adapted from Đorđević, 1990).

Slope Gradient (Slope Angle)	Elevation (m)	Ascent Velocity (km/h)	Descent Velocity (km/h)
05 – 10°	500–1000 (Low-mountain terrain)	3	4
10 – 15°	500–1000 (Low-mountain terrain)	2.5	3.5
15 – 20°	1000 – 2000 (Mid-mountain terrain)	2	3
20 – 25°	1000 – 2000 (Mid-mountain terrain)	1.5	2.5

Beyond macro-topography, specific geomorphological structures severely impede progression. Traversing karst landscapes—characterized by karren, dolines, limestone pavements, and dry canyons with massive boulders—forces a velocity reduction down to 1 km/h. Similarly, navigating waterlogged, muddy, or slippery ground cuts predicted walking speeds by half.

Seasonal variations introduce alternative surface hazards; a dense layer of autumn fallen leaves poses similar traction challenges to winter conditions, where snow depth systematically dictates locomotion limits. These surface constraints are further compounded by altitude-induced microclimatic changes, specifically the progressive drop in ambient temperature and atmospheric pressure associated with higher elevations (Miletić et al., 2022).

Table 2. Hiker walking velocity relative to snowpack depth.

Snowpack Depth (cm)	Walking Velocity (km/h)
30 – 50 cm	2
50 – 70 cm	1
Over 75 cm	0.5

A practical way to control fatigue within a day is to build the march around regular short breaks. In one multi-day expedition pattern, groups moved for about 50 minutes and then stopped for 10 minutes, repeating that cycle over 8-10 hour days until camp, which shows a clear use of structured intervals rather than continuous effort (Rosenberg et al., 2021). Other trekking evidence points to even shorter but more frequent micro-breaks: a 3-minute break every hour reduced workload, fatigue, and musculoskeletal complaints during trekking, suggesting that small pauses can lower strain before it compounds (Suarbawa, 2024). More adaptive systems also appear in the literature. In controlled hiking, subjective effort was checked every 10-20 minutes, and participants took 2-3 minute rests whenever exertion rose too high, showing how rest can be tied to real-time intensity rather than only to the clock (Jo et al., 2025). At higher altitude or during harder climbs, stops may also be triggered by breathing stress; one account marks a 30-minute stop when a climber was resting, alongside points where fatigue and lack of oxygen began to appear (Listiarini et al., 2021).

A major tactical error in group management occurs when a column becomes fragmented; during scheduled short stops, the leading group must halt immediately, and the tailing members must rest wherever they are on the trail according to the synchronized timeline. This protocol strictly prevents tailing hikers from spending their designated rest periods trying to "catch up" with the front of the column.

Conversely, nocturnal or brief marches lasting under 6 hours omit scheduled stops entirely. For multi-day expeditions, a major logistical recovery phase termed a "predanak" (extended bivouac/rest period) lasting 12 to 24 hours is integrated into the second half of the expedition. This phase, executed in a sheltered, non-exposed environment, is dedicated to deep physiological recovery, targeted muscle stretching, self-massage, nutritional replenishment, and rigid personal hygiene protocols, including the mandatory replacement of damp trekking layers with clean, dry garments prior to sleep.

Post-Expedition Phase and Return Logistics

A frequent misconception in the planning of multi-day hiking tours is that the primary operational objective is fully accomplished once the group reaches the final geographical destination. In reality, arriving at the target destination represents only a critical segment of the overarching mission architecture. According to the principles of global expeditionary planning, a tour cannot be classified as completely realized until all personnel and technical equipment are safely transported back to the initial staging point or home base from which the operation commenced.

Unless the itinerary was explicitly designed around a circular or two-way pedestrian tactic—where participants return to the starting coordinates on foot—the logistical parameters of the tour remain active

during this final transport phase. It is the absolute responsibility of the organizer to systematically brief participants on the complex details of this concluding phase. Only when the final extraction and return logistics are executed, ensuring that all participants return to their origin healthy, uninjured, and accounted for, can the multi-day organized tour be deemed an operational success.

Acknowledgements: This paper was conceptualized and written out of a necessity to elucidate the structural and operational complexity of one in a series of planned multi-day hiking tours organized by the "Studenti u blokadi" (Students in Blockade) organization in the Republic of Serbia. The author wishes to express deep gratitude and heartfelt support to all members of the organization for their unwavering dedication and collective effort.

***Conflict of interests*:** The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

References

Boller, F., Hunziker, M., Conedera, M., Elsasser, H., & Krebs, P. (2010). Fascinating Remoteness: The Dilemma of Hiking Tourism Development in Peripheral Mountain Areas. *Mountain Research and Development*, 30(4), 320-331. https://doi.org/10.1659/MRD-JOURNAL-D-10-00018.1

Brunyé, T.T., Collier, Z.A., Cantelon, J.A., Holmes, A.E., Wood, M.D., Linkov, I., & Taylor, H.A. (2015). Strategies for Selecting Routes through Real-World Environments: Relative Topography, Initial Route Straightness, and Cardinal Direction. *PLoS ONE, 10*. https://doi.org/10.1371/journal.pone.0124404

Carrillo-Hernández, Y.M., Ríos-Reyes, C.A., & Villarreal-Jaimes, C.A. (2024). Geotourism and Geoeducation: A Holistic Approach for Socioeconomic Development in Rural Areas of Los Santos Municipality, Santander, Colombia. *Geoheritage, 16*. https://doi.org/10.1007/s12371-024-00974-6

Đorđević, M. (1990). *Priručnik za vojnika pešadije*. Beograd, Vojnoizdavački i novinski centar.

Gast, K., Kram, R., & Riemer, R. (2018). Preferred walking speed on rough terrain: is it all about energetics? *Journal of Experimental Biology, 222*. https://doi.org/10.1242/jeb.185447

Genitrini, M., Dotti, F., Bianca, E., & Ferri, A. (2022). Impact of Backpacks on Ergonomics: Biomechanical and Physiological Effects: A Narrative Review. *International Journal of Environmental Research and Public Health*, 19(11), 6737. https://doi.org/10.3390/ijerph19116737

Fattorini, L., Pittiglio, G., Federico, B., Pallicca, A., Bernardi, M., & Rodio, A. (2012). Workload Comparison Between Hiking and Indoor Physical Activity. *The Journal of Strength and Conditioning Research*, 26(10), 2883-2889.

Freese, J., Schnell, S., Schäfer, A., Klement, R.J., Krüger, S., Lückemann, L., & Lötzerich, H. (2021). How to dismantle modern stressors: does a short trip to simulated Paleolithic conditions in the wild reduce cortisol levels? *F1000Research, 10*, 238. https://doi.org/10.12688/F1000RESEARCH.50793.1

Fruchart, É. and Rulence-Pâques, P. (2024). Mapping Risk Judgment and Risk Taking in Mountain Hiking: An Information Integration Approach. *Perceptual and Motor Skills*, 131(3), 897-919. https://doi.org/10.1177/00315125241239119

Han, Y. B., Kwon, I. J., Lee, D. T., Hwang, E. J., Kim, J. K., & Cho, E. (2017). Effects of Trekking Pole Use on Metabolic Cost in Novice Hikers on Steep Terrains. *Journal of Sports Science*, 5(5). https://doi.org/10.17265/2332-7839/2017.05.004

Hill, L., Swain, D. P., & Hill, E. L. (2008). Energy Balance during Backpacking. International Journal of Sports Medicine, 29(11), 883-887. https://doi.org/10.1055/s-2008-1038492

Huang, T. W., & Kuo, A. D. (2014). Mechanics and energetics of load carriage during human walking. *The Journal of Experimental Biology, 217*(Pt 4), 605–613. https://doi.org/10.1242/jeb.091587

Jacobson, B. H., Caldwell, B. J., & Kulling, F. A. (1997). Comparison of Hiking Stick Use on Lateral Stability While Balancing with and without a Load. Perceptual and Motor Skills, 85(1), 347-350. https://doi.org/10.2466/pms.1997.85.1.347

Jo, S., Yoo, D., & Jee, Y. (2025). A randomized controlled trial effect of forest hiking on tensor muscle function, erythrocyte factors, and leukocytes' subsets in older adults: a pilot study. *Journal of Exercise Rehabilitation*, 21, 239-252. https://doi.org/10.12965/jer.2550564.282

Lesser, I.A., Prystupa, J.M., Bélanger, L.J., Thomson, C., & Nienhuis, C.P. (2020). A mixed-methods evaluation of a group based trail walking program to reduce anxiety in cancer survivors. *Applied Cancer Research, 40*, 1-10. https://doi.org/10.1186/s41241-020-00094-x

Listiarini, D., Kushartanti, B.W., Ali, M.A., Nugroho, D.P., Rahayu, S., & Kongchulagul, N. (2021). Fatigue and Physical Performance in Recreational Sports. Proceedings of the 4th International Conference on Sports Sciences and Health (ICSSH 2020). 10.2991/ahsr.k.210707.006

Kerouanton, C., Jolivet, L., Perrin-Malterre, C., & Loison, A. (2024). Eye-catching or breath-catching: Role and landscape attributes of pauses differs among hikers' profile when rambling in a French mountainous area. *Journal of Outdoor Recreation and Tourism*. https://doi.org/10.1016/j.jort.2024.100734

Maciejko, A., & Wojtyszyn, B. (2019). Tourism Infrastructure Providing Access to Areas of Protected Landscape and Nature in Poland. Selected Examples. *IOP Conference Series: Materials Science and Engineering, 603*. https://doi.org/10.1088/1757-899X/603/4/042049

Marin, A. (2021). Developing leadership skills through mountain activities. *Discobolul – Physical Education, Sport and Kinetotherapy Journal*. https://doi.org/10.35189/dpeskj.2021.60.2.8

Mellor, A., Dodds, N., Joshi, R., Hall, J. E., Dhillon, S., Hollis, S., Davis, P., Hillebrandt, D., Howard, E., Wilkes, M., Langdana, B., Lee, D., Hinson, N., Williams, T. H., Rowles, J., & Pynn, H. (2015). Faculty of Prehospital Care, Royal College of Surgeons Edinburgh guidance for medical provision for wilderness medicine. Extreme Physiology & Medicine, 4(1). https://doi.org/10.1186/s13728-015-0041-x

Miletić, V., Rajković, Ž., Ilić, V., Manovski, K. (2022). Problemi istraživanja u ekstremnim ambijentalnim uslovima. *IX Međunarodna naučna koferencija "Antropološki i teo-antropološki pogled na fizičke aktivnosti."* Zbornik radova (256-260).

Miletič, V. (2018). Metodika na obučenieto po alpinizъm. Disertaciя. Sofiя, Nacionalna Sportna Akademiя "Vasil Levski".

Miletič, V., Raйkovič, Ž., Йotov, N. (2019). Prestoй i ocelяv prirodata razgleždan črez formula na energiйna efektivnost. Sbornik s dokladi ot naučna konferenciя "Turizъm i sport". Katedra "Turizъm, alpinizъm i orientirane", NSA "Vasil Levski", Sofiя (str. 99-107).

Morsiani, M., Robazza, C., Di Liborio, M., Ruiz, M.C., & Bortoli, L. (2023). Passion in hiking guides affects their group management skills and functional psychobiosocial experiences. *Heliyon, 9*. https://doi.org/10.1016/j.heliyon.2023.e18388

Pastrana, E.A., Anchondo, E.L., & Zizaldra, I. (2015). A look at springs in mexican border desert as a possible site for hiking. *Nóesis: Revista de Ciencias Sociales y Humanidades, 24*, 98-111. https://doi.org/10.20983/NOESIS.2015.12.7

Pico, A. M. P., Álvarez, E. M., Martínez, R., & Mayordomo, R. (2019). Importance of Sock Type in the Development of Foot Lesions on Low-Difficulty, Short Hikes. *International Journal of Environmental Research and Public Health*, 16(10), 1871. https://doi.org/10.3390/ijerph16101871

Pigman, J., Sullivan, W. J., Leigh, S. R., & Hosick, P. A. (2017). The Effect of a Backpack Hip Strap on Energy Expenditure While Walking. *Human Factors*, 59(8), 1214-1221. https://doi.org/10.1177/0018720817730179

Rosenberg, A., Lynch, P., & Radmann, A. (2021). Sustainability Comes to Life. Nature-Based Adventure Tourism in Norway. *Frontiers in Sports and Active Living, 3*. https://doi.org/10.3389/fspor.2021.686459

Savić, D. (2023). *Metodološke perspektive biografskih istraživanja u društvenim naukama*. Banja Luka, Fakultet političkih nauka, Univerziteta u Banjoj Luci. https://doi.org/10.5281/zenodo.16908853

Scarf, P.A. (2007). Route choice in mountain navigation, Naismith's rule, and the equivalence of distance and climb. *Journal of Sports Sciences, 25*, 719 - 726. https://doi.org/10.1080/02640410600874906

Schmidt, S., & S. G. Schmidt, B. (2023). PQCDSM-Logic in Maintenance (TPM) and Mountaineering. *Tehnički glasnik*. https://doi.org/10.31803/tg-20230518082456

Smith, N., Kinnafick, F., & Saunders, B. (2017). Coping Strategies Used During an Extreme Antarctic Expedition. *Journal of Human Performance in Extreme Environments*, 13(1). https://doi.org/10.7771/2327-2937.1078

Sprent, R.F., Haworth, J., Cavazzi, S., & Ilyankou, I. (2024). Multi-Criteria Framework for Routing on Access Land: A Case Study on Dartmoor National Park. *ISPRS Int. J. Geo Inf., 13*, 130. https://doi.org/10.3390/ijgi13040130

Stonehouse, P., & Furman, N. (2022). A Reverence for Time: Mindful Approaches to Land-based Travel Calculations. *Journal of Outdoor Recreation Education and Leadership*, 14(3), 107–113. https://doi.org/10.18666/jorel-2022-11195

Suarbawa, I.K. (2024). Ergonomics Intervention at Conservation Tourism Trekking Activities to Decrease Tourists\' Risk of Fatigue and Musculoskeletal Disorders (MSDs). *International Journal for Research in Applied Science and Engineering Technology, 2*(6). https://doi.org/10.22214/ijraset.2024.63099

Taylor, K.L., Fitzsimons, C.F., & Mutrie, N. (2010). Objective and subjective assessments of normal walking pace, in comparison with that recommended for moderate intensity physical activity. *International Journal of Exercise Science, 3*, 87 - 96. https://doi.org/10.70252/bura5885

Hosick, P. A., Pigman, J., Sullivan, W. J., & Leigh, S. R. (2017). The Effect of a Backpack Hip Strap on Energy Expenditure While Walking. *Medicine & Science in Sports & Exercise*, 49(5S), 745. https://doi.org/10.1249/01.mss.0000518981.48476.b8

Višnjić, D., Jovanović, A., Miletić, K. (2004). Teorija i metodika fizičkog vaspitanja. Beograd, Univerzitet u Beogradu, Fakultet sporta i fizičkog vaspitanja. ISBN 9788690558506.

Wang, H. H., Tsai, W. C., Chang, C. Y., Hung, M. H., Tu, J. H., Wu, T., & Chen, C. H. (2023). Effect of Load Carriage Lifestyle on Kinematics and Kinetics of Gait. *Applied bionics and biomechanics*, *2023*, 8022635. https://doi.org/10.1155/2023/8022635

Yang, M., Van Coillie, F.M., Liu, M., DE WULF, R., Hens, L., & Ou, X. (2014). A GIS Approach to Estimating Tourists' Off-road Use in a Mountainous Protected Area of Northwest Yunnan, China. *Mountain Research and Development*, 34(2), 107-117. https://doi.org/10.1659/MRD-JOURNAL-D-13-00041.1

Yousef, A. M., Ali, S. E., & Ahmed, S. A. (2019). Effect of front pack and backpack load on pulmonary function among 9-12-year-old Saudi girls. *Physical Therapy and Rehabilitation*, 6(1), 6. https://doi.org/10.7243/2055-2386-6-6