



Hiking in the Ukrainian Carpathians as a form of active recreation and a means of developing physical endurance among school pupils and university students

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Abstract. The purpose of the study was to assess the effect of a three-day hike in the Ukrainian Carpathians on physical endurance indicators and its recreational effect among school pupils and university students. The participants were 120 young people (60 pupils and 60 students) who completed a three-day, 37 km route (Dilove village – Mount Pip Ivan – Dilove village), with elevations ranging from 350 m to 1,936 m above sea level. Functional status was assessed using the Harvard Step Test, the 12-minute Cooper test, continuous heart-rate monitoring, a Likert-scale questionnaire, and methods of mathematical statistics. After the hike, the Harvard Step Test Index increased significantly ($p < 0.001$), by 12.4% among pupils and 14.2% among students; the Cooper-test distance increased by 8.8% in both groups. Cardiorespiratory measurements recorded more economical effort among students, whose mean heart rate while walking was lower (134.2 ± 8.5 bpm compared with 138.4 ± 9.2 bpm among pupils) and whose pulse returned to 100 bpm sooner ($p < 0.001$). Load intensity correlated positively with gains in endurance ($\rho = 0.74$ among pupils and $\rho = 0.69$ among students), in keeping with a dose-dependent training effect. Subjective assessments likewise pointed to considerable recreational value: more than 88% of participants stated that they experienced psychological recovery, while 91.7% of pupils and 96.7% of students wished to repeat the hike. The practical importance of these results lies in the scientific justification of three-day mountain hikes as an effective way of strengthening physical education. The data may assist teachers and coaches in differentiating physical loads for different age groups, and specialists developing health-enhancement programmes aimed at reducing physical inactivity and improving young people's cardiorespiratory function

Keywords: adaptation; training effect; age differences; sex differences; cardiorespiratory system

Introduction

The relevance of this subject arises from recent changes in students' daily lives, in which the predominance of digital technologies displaces habitual physical activity and creates risks to physical health. This situation increases the need for nature-oriented forms of physical education that

support both physical health and psycho-emotional recovery. Despite the popularity of active tourism, the academic literature provides limited coverage of the systematic effects of sustained physical exertion in specific natural settings on functional status. The development of physical endurance

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while traversing difficult landscapes also requires more detailed and integrated analysis. The natural features of the Ukrainian Carpathians provide appropriate conditions for multi-day walking routes within active recreation programmes. Unlike short excursions, mountain hikes produce a sustained physiological load that can improve young people's aerobic capacity and strengthen overall physiological resilience in a demanding educational environment.

O. Kolotukha (2024) reviewed nature-oriented tourism and active recreation. The researcher linked participation in such activities with greater physical activity, including more daily walking among groups selecting natural routes. The main forms of nature-oriented activity were also systematised, identifying directions for subsequent empirical studies. M. Fesyk (2024) analysed the influence of sports tourism on national-patriotic education in the Volyn region. The study described a positive effect of tourism activities on socially responsible behaviour among adolescents. Questionnaire data and pedagogical observation provided quantitative evidence of positive changes in participants' motivation. V. Petryshyn (2025) considered organisational forms of tourism in adolescents' educational environment and concluded that regular hikes improved physical fitness. The author developed a classification of tourism organisation formats (curricular, extracurricular, and club-based) with practical value for educational institutions.

Е. Rudenko (2024) investigated the problems and prospects of sports tourism development in Ukraine, focusing on Carpathian hiking routes and their role in strengthening young people's endurance. Key barriers to the development of the sector were identified, including financial, material-technical, and staffing constraints, and ways of addressing them were proposed. D.M. Lolowang *et al.* (2025) conducted a systematic review of innovative approaches to physical fitness teaching involving technology and gamification. After analysing 48 sources, the authors identified digital tools that increased student engagement and supported continued physical exercise without loss of motivation. M. Molokáč *et al.* (2022) analysed tourists' preferences when selecting hiking routes. Safety and natural attractiveness were the main criteria. A survey of 387 respondents and cluster analysis distinguished three tourist types with different preferences. A. Federici (2021) focused on safety in outdoor recreation. The study concluded that controlled physical exertion in mountain terrain reduced injury risk and assisted adaptation to stressors. The paper proposed recommendations on gradual load progression and the prevention of hypothermia in the mountains. K. Marsh (2025) evaluated the influence of a mountain-biking programme on social-emotional learning among schoolchildren. The results linked regular outdoor excursions with more responsible attitudes and with the objectives of hiking. A mixed-method approach assessed the programme against four social-emotional skill indicators. R. Puhakka (2021) explored students' participation in outdoor recreational activity and its effect on subjective well-being. Time spent in natural surroundings correlated positively with psychological recovery indicators. Using the standardised REST-Q questionnaire, the researcher noted that the greatest effect occurred after 3-5 hours of continuous time in forest or mountain settings. N. Labuschagné *et al.* (2025) assessed the relationship between active recreation, leisure

boredom, and life satisfaction among students. Regular hiking was associated with lower boredom levels. Correlation analysis linked a one-point reduction in boredom with a 0.34-point increase in life satisfaction ($p < 0.01$).

Nevertheless, the literature provided insufficient quantitative evidence on changes in physical endurance, including heart rate, recovery indicators, and aerobic capacity, among school pupils and university students after an intensive three-day high-altitude hike in the Ukrainian Carpathians. A discrepancy remained between the stated importance of active tourism in educational programmes and the absence of empirical data on the graded effect of such activities on endurance development. Previous works were also limited by their reliance primarily on subjective assessment methods, such as questionnaires and reflection, without standardised physiological tests. The study aimed to determine how a three-day hike in the Ukrainian Carpathians affected physical endurance indicators and the recreational effect among school pupils and university students. The objectives were to assess changes in physical endurance using the Cooper test and the Harvard Step Test before and after the hike; analyse the physiological load during the route using heart-rate indicators and pulse-recovery speed; identify differences in participants' adaptive responses by age and sex; and assess subjective indicators of the recreational effect and psychological recovery using questionnaire data.

Materials and Methods

The study was conducted from May to October 2025. The study comprised three successive stages: preparatory (01.05.2025-31.05.2025), involving sample formation, medical examination, and initial testing of endurance indicators; main (01.06.2025-31.08.2025) – a series of identical three-day hikes for separate small groups of participants (15-20 individuals) under comparable load and safety conditions; and final (01.09.2025-30.10.2025) – repeat testing three days after each group returned, followed by the collection, systematisation, and statistical processing of the results. This period covered a series of identical three-day hikes for different groups of participants, together with preliminary testing, data collection, and statistical processing. The sample comprised 120 participants divided into two groups: school pupils (60 participants aged 14-17 years, including 30 boys and 30 girls) and university students (60 participants aged 18-25 years, including 30 male and 30 female students). All participants attended secondary or higher education institutions in Ivano-Frankivsk. Inclusion criteria were the absence of medical contraindications to sports tourism, confirmed by a medical certificate; voluntary written consent to participate, with parental or legal representative consent for minors; and no regular participation in organised mountain hikes during the preceding 12 months. Exclusion criteria were chronic cardiovascular or respiratory disease, acute inflammatory conditions at the beginning of the study, and musculoskeletal injuries limiting physical activity. The sampling method was non-random (purposive); groups were formed by selecting all individuals who met the inclusion criteria and had applied to take part in the hiking programme. Ethical requirements were observed throughout data collection. Participation was voluntary and required informed consent. Data

anonymity and confidentiality were ensured in accordance with national legislation. All procedures complied with ethical standards for studies involving human participants under The Declaration of Helsinki (2024).

The study programme involved a three-day mountain hike along the route Dilove village – Mount Pip Ivan – Dilove village, covering 37 km, with a mean daily distance of approximately 12–14 km and elevations ranging from 350 m to 1,936 m above sea level. Walking time was 5–7 hours per day, with breaks every 45 minutes at a pace of 2.5–3.0 km/h. The daily dietary provision had a uniform target energy value of 3,500 kcal, the fluid intake target was 2.5 L, and all participants received a complete set of specialised equipment. Physical endurance was tested two weeks before the hike and three days afterwards using the Harvard Step Test (step height 40/50 cm, 5 min, 30 steps/min), with calculation of the Harvard Step Test Index (HSTI) according to the standard formula, and the 12-minute Cooper test conducted in a stadium. During the hike, heart rate (HR) was monitored in 30% of participants using Polar H10 heart-rate monitors and Garmin Fenix 7 watches; mean and maximum values and recovery time to 100 bpm were recorded. A five-point Likert-scale survey of subjective condition was administered to all 120 participants three days after the hike. Participants rated their agreement (from 1 “strongly disagree” – to 5 “strongly agree”), with the statements: “my physical condition improved”, “my fatigue level decreased”, “I experienced psychological recovery”, and “I was satisfied with the recreation”. Responses were grouped as follows: scores of 1–2 were classified as “disagree”, a score of 3 – as “neutral/difficult to answer”, and scores of 4–5 – as “agree”. The limitations of the study included a relatively short post-load observation period, the influence of individual metabolism on dietary assimilation, and variable high-altitude weather conditions that could alter hiking intensity.

Statistical analysis was performed in IBM SPSS Statistics version 28.0 (IBM Corp., USA). Distributional

normality for quantitative variables was tested using the Shapiro-Wilk test. Where distributions were normal ($p > 0.05$), paired Student's t-tests were applied to compare pre- and post-hike indicators within each group, and independent-samples t-tests were applied to compare pupils and students. Variables whose distributions differed from normality ($p \leq 0.05$) were analysed using the non-parametric Wilcoxon signed-rank test for related samples and the Mann-Whitney U test for independent samples. Statistical significance was set at $\alpha = 0.05$. Confidence intervals for mean differences were calculated at the 95% confidence level. The correlation between load intensity (mean HR during the hike) and the increase in endurance indicators (Δ HSTI) was assessed using Spearman's rank correlation coefficient. No correction for multiple-comparison error was applied because no more than three comparisons were performed within any single hypothesis.

Results

Changes in physical endurance indicators among school pupils and university students before and after a three-day hike in the Ukrainian Carpathians

Mountain hiking imposes a specific load on the cardiorespiratory system through the combined effects of sustained muscular work, hypoxia, and temperature variation (Mozolev, 2025). Adaptation to these conditions depends on circulatory-regulation mechanisms that differ by age: chronotropic responses predominate among adolescents, whereas inotropic mechanisms assume a greater role among adults (Perrin-Malterre *et al.*, 2021). Regular participation in sports tourism promotes improvement in physical fitness (Khomenko, 2023). Pupils and students differ in morphofunctional maturity, which determines their adaptive reserves. Sex differences affect absolute endurance indicators, although relative gains in adaptive values may be similar in both sexes. Table 1 presents changes in endurance among the groups during the experiment.

Table 1. Endurance indicators among school pupils and university students before and after a three-day hike in the Ukrainian Carpathians (M $\pm$ SD)

Group	Indicator	Before the hike	After the hike	Absolute increase	Relative increase (%)
Pupils (aged 14–17 years) (n = 60)	HSTI, conventional units	68.4 $\pm$ 8.2	76.9 $\pm$ 7.5	+8.5	+12.4
	Cooper test, m	2,150 $\pm$ 230	2,340 $\pm$ 210	+190	+8.8
Students (aged 18–25 years) (n = 60)	HSTI, conventional units	74.2 $\pm$ 7.8	84.7 $\pm$ 7.1	+10.5	+14.2
	Cooper test, m	2,380 $\pm$ 250	2,590 $\pm$ 230	+210	+8.8

Source: compiled by the authors based on the experimental data

The changes in the indicators point to a marked training effect of the mountain hike in both participant groups. The identical relative increase in Cooper-test distance suggests that three days of intensive aerobic activity at altitude stimulate oxygen-transport function irrespective of age and initial fitness level. Short mountain hikes may therefore offer a practical way of rapidly mobilising young people's aerobic reserves. By contrast, HSTI was more sensitive to age differences, which may be linked to the greater morphofunctional maturity of the students. In the 18–25 age group, a marked positive trend in recovery processes was observed, indicating better autonomic

regulation of heart rate and more effective utilisation of inotropic mechanisms for myocardial adaptation to exercise compared with adolescents. Among students, the increase in the recovery index exceeded the rate of increase in aerobic capacity, whereas among pupils, the two indicators changed more evenly. The hike imposed a greater stress load on the younger group, for whom functional recovery and the attainment of supercompensation required more time. The results suggest that a three-day hike in the Carpathians provides recreational benefits and can strengthen physical education. Table 2 presents the analysis by sex.

Table 2. Endurance indicators by sex and age (M ± SD)

Subgroup (n = 30)	Indicator	Before the hike	After the hike	Increase
Male pupils	HSTI	72.1 ± 7.6	81.3 ± 6.9	+9.2
Female pupils	HSTI	64.7 ± 7.9	72.5 ± 7.3	+7.8
Male pupils	Cooper test (m)	2,310 ± 210	2,510 ± 190	+200
Female pupils	Cooper test (m)	1,990 ± 190	2,170 ± 180	+180
Male students	HSTI	78.4 ± 7.1	89.8 ± 6.5	+11.4
Female students	HSTI	70.0 ± 7.3	79.6 ± 6.8	+9.6
Male students	Cooper test (m)	2,570 ± 230	2,800 ± 210	+230
Female students	Cooper test (m)	2,190 ± 210	2,380 ± 200	+190

Note: each subgroup comprised n = 30 participants

Source: compiled by the authors based on the experimental data

Male pupils and male students had consistently higher absolute values at each stage of the experiment. This difference corresponds to physiological sexual dimorphism: a larger cardiac volume, higher haemoglobin concentration, and greater skeletal muscle mass support more intensive oxygen delivery during exertion. Despite substantial differences in baseline values, the changes in aerobic endurance measured by the Cooper test were almost identical for males and females. Similar relative rates of improvement suggest that the capacity to develop aerobic performance in response to mountain exertion is not confined by sex. Female pupils and female students responded to the stimulus as effectively as their male counterparts, in proportion to their respective functional limits.

The difference in recovery speed, measured by HSTI, in favour of male pupils and male students warrants separate attention. Their more rapid return to normal HR may be associated with a stronger sympathoadrenal response, accelerating functional stabilisation after exercise stops. Female pupils and female students exhibited a more gradual adaptation, possibly linked to hormonal features that help prevent excessive depletion of resources during prolonged work. Although both sexes experienced a training effect, their biological recovery patterns therefore differed and should be borne in mind when rest periods on the route are planned. Changes within each subgroup were statistically significant according to the paired t-test (all $p < 0.001$). Table 3 compares age groups separately for males and females.

Table 3. Comparison of increases in endurance indicators between pupils and students by sex (independent-samples t-test)

Subgroups	Indicator	Difference in increases	95% CI	t-value	p-value
Male pupils – male students	ΔHSTI	2.2	[1.1; 3.3]	3.71	<0.001
Female pupils – female students	ΔHSTI	1.8	[0.8; 2.8]	3.32	0.002
Male pupils – male students	ΔCooper (m)	30	[10; 50]	2.98	0.004
Female pupils – female students	ΔCooper (m)	10	[-8; 28]	1.09	0.278

Note: square brackets contain the 95% confidence interval for the difference in mean increases between groups; each sex-based subgroup comprised 30 participants – male pupils, male students, female pupils, and female students; an interval that does not cross zero represents a statistically significant difference at $\alpha = 0.05$

Source: compiled by the authors based on the experimental data

The statistical results varied by age category. Significant differences in HSTI increases for both male and female comparisons point to more intensive recovery processes among university students than among school pupils. This pattern accords with greater functional maturity of autonomic mechanisms regulating heart rhythm at the age of 18–25 years and, consequently, faster stabilisation after the route. Cooper-test results differed in the male comparison: male students improved more rapidly than male pupils, whereas no statistically significant difference emerged between female students and female pupils. This may reflect earlier stabilisation of female aerobic potential, while males retain considerable scope for increasing endurance into university age.

Baseline HSTI values placed students in the “above average” category and pupils in the “average” category. After the experiment, students reached the “high” category, while pupils reached “above average”. A similar change occurred in the Cooper test: students moved from “good” to “excellent”, while pupils improved from “below average” to

“average”. These data indicate an overall improvement in young people’s functional status after participation in the mountain hike. Improvement in physical fitness across all subgroups reinforces the value of high-altitude natural factors for mobilising aerobic reserve. However, the results should be interpreted as a composite effect, including repeated testing, mobilisation of volitional effort, and individual adaptation, rather than solely as a consequence of muscular activity. Faster recovery among students than pupils suggests more efficient cardiovascular activity, a central feature of adaptive processes in a more mature organism. However, similar relative changes between male and female pupils, and between male and female students, provide little evidence of a pronounced sex-specific difference in the overall rate of endurance improvement after outdoor recreation.

Analysis of physiological load during the mountain route using heart rate and recovery time indicators

Adaptation of the cardiovascular system to regular aerobic physical loads is expressed as a reduction in heart rate

during resting and during standard submaximal work (Kashelyuk, 2021). Heart rate is an objective indicator of physical-load intensity during hiking trips (Telford & Potter, 2011). Real-time HR monitoring traced the cardiovascular response to movement through mountain terrain with varied relief and elevation changes. The state of the autonomic nervous system determines the rate of HR recovery after muscular work ceases (Bilyk, 2025).

In sports tourism, working HR values of 120-150 bpm correspond to an aerobic-load zone conducive to endurance development. Values above 160 bpm signal a shift towards a mixed aerobic-anaerobic zone and may hasten fatigue. The time required for HR to recover after activity ends characterises autonomic regulation and training status: faster return towards resting values corresponds to better conditioning. Among young people without regular physical training, HR commonly

returns to 100 bpm within 5-10 minutes; among trained individuals, this period is reduced to 2-4 minutes. The training effect on endurance depends on the intensity of effort within the aerobic energy-supply zone. O. Olkhovyi *et al.* (2024) linked mean load intensity, represented by mean HR while completing the route, with post-hike gains in endurance, in keeping with a dose-dependent effect. The optimal mean HR range for developing endurance was 130-150 bpm among students, whereas for pupils aged 14-17 years it was 120-140 bpm because of age-related differences in heart-rhythm regulation. The present study continuously monitored HR in 36 randomly selected participants, comprising 18 pupils and 18 students. Recording took place from 08:00 to 18:00 on all three days of the hike, using the mean HR for each hour of walking. Table 4 presents mean HR values and recovery times for the two groups.

Table 4. Heart rate and recovery-time indicators during the three-day hike (M ± SD)

Indicator	Pupils (n = 18)	Students (n = 18)	Difference	p-value
Mean HR per hour of walking, bpm	138.4 ± 9.2	134.2 ± 8.5	-4.2	0.042
Maximum HR (on ascents), bpm	172.6 ± 8.7	168.3 ± 7.9	-4.3	0.038
Recovery time to 100 bpm, min	6.8 ± 1.4	5.2 ± 1.1	-1.6	<0.001

Source: compiled by the authors based on the experimental data

Cardiometric monitoring data for both groups remained within the aerobic energy-supply zone. Students had lower mean and maximum HR values, corresponding to more economical cardiac work than among pupils. This difference is associated with greater maturity of adaptive mechanisms at 18-25 years: an equivalent amount of work was completed under less functional strain. The largest inter-group difference concerned pulse-recovery speed. Faster return of HR towards normal values among students is compatible with better autonomic regulation and stronger parasympathetic

influence after physical activity. The longer recovery period among pupils may be explained by sympathicotonia characteristic of adolescence, resulting in a higher “physiological cost” of traversing mountain terrain. These results point to substantial functional reserves among students. Among pupils, the same physical activity acts as a stronger stimulus and should be accounted for when selecting walking pace and rest duration on difficult sections of the route. Hourly mean values were subsequently analysed to clarify HR changes during each day of the hike; Table 5 presents the results.

Table 5. Changes in mean HR (bpm) by day of the hike (M ± SD)

Group	Day 1	Day 2	Day 3	Δ Day 3 – Day 1	p-value (Day 1 / Day 3)
Pupils (n = 18)	142.1 ± 9.8	138.9 ± 9.3	134.2 ± 8.8	-7.9	0.008
Students (n = 18)	137.5 ± 8.9	134.8 ± 8.4	130.3 ± 8.1	-7.2	0.012

Source: compiled by the authors based on the experimental data

Across the three days, mean HR gradually decreased in both groups. The steady decline in working pulse points to rapid adaptation to the combination of physical load and high-altitude conditions. Cardiac strain was greatest during the first half of the first day, when participants negotiated the most difficult terrain and underwent initial acclimatisation. By the third day, the chronotropic response had stabilised noticeably: peak HR values on sections with a comparable gradient were substantially lower than at the outset. This pattern illustrates the ability of young people to adapt rapidly to hypoxia and physical exertion. By the end of the hike, the lower pulse cost of completing the route

marked more economical physiological functioning. The steady decrease in mean HR in both groups also illustrates the short-term training effect of mountain hiking on autonomic regulation of heart rhythm. These data suggest that three days represent the minimum period over which an initial adaptive response becomes apparent through more efficient cardiac performance during standard muscular work on the route. The relationship between load intensity and the training effect was assessed by calculating Spearman's correlation coefficient for mean HR during the hike and the post-hike increase in HSTI; the values are presented in Table 6.

Table 6. Correlation between mean HR (bpm) and the post-hike increase in HSTI (ΔHSTI)

Group	Mean HR, M ± SD	ΔHSTI, M ± SD	p (Spearman)	p-value
Pupils (n = 18)	138.4 ± 9.2	8.5 ± 2.1	0.74	<0.001
Students (n = 18)	134.2 ± 8.5	10.5 ± 2.3	0.69	0.002

Source: compiled by the authors based on the experimental data

The correlation coefficient between mean HR and the increase in HSTI was $\rho = 0.74$ among pupils ($p < 0.001$) and $\rho = 0.69$ among students ($p = 0.002$). Both values represent a strong positive relationship: participants with a higher mean HR during the hike, and therefore a higher working intensity, achieved a greater increase in endurance. The relationship was linear across the HR range of 125–145 bpm. Where mean HR exceeded 150 bpm, which occurred in four pupils, HSTI no longer rose proportionately, suggesting proximity to an individual anaerobic threshold and possible overload. Exercise above 85% of maximum HR is known to overactivate the sympathetic component and impair adaptation in young people without specialised training. As only a small number of participants in this study reached this level, the overall correlation remained strong. No student exceeded a mean HR of 158 bpm, which may explain the slightly lower, though still strong, coefficient in the student group ($\rho = 0.69$). Further analysis revealed that in pupils with an average HR below 130 bpm ($n = 4$), the increase in HSTI was only 5.2 ± 1.4 units, whereas in those whose average HR was in the range of 135–145 bpm ($n = 10$), the increase reached 9.8 ± 1.7 units. The corresponding values among students were 7.6 ± 1.5 units at HR < 130 bpm ($n = 6$) and 11.9 ± 1.9 units at HR 130–140 bpm ($n = 9$). Thus, the training effect was dose-dependent: effort intensity within the aerobic zone affected the increase in endurance. In this sample, larger HSTI increases occurred among participants whose mean HR exceeded 130 bpm.

Physiological load during the three-day hike in the Ukrainian Carpathians was characterised by a mean HR of 130–140 bpm, within the aerobic zone for endurance development. Pupils had higher absolute HR values and longer recovery times than students. Mean HR declined progressively in both groups over the three days, marking acute adaptation. Its correlation with the increase in HSTI was strongly positive ($\rho = 0.74$ among pupils and $\rho = 0.69$ among students), providing evidence of a dose-dependent training effect.

Comparison of the training and recreational effects of hiking among school pupils and university students

Health-enhancing recreational activity in natural surroundings aids recovery of physical and psychological resources through the combination of physical activity and exposure to natural factors (Halamay, 2021). During multi-day hiking trips, cardiovascular function improves through more economical work and faster recovery processes (Skaliy *et al.*, 2023). Balanced use of forest areas for active recreation can increase physical activity in the population without disturbing ecological balance (Brovi-na & Sallaku, 2024). Regular participation by children and adolescents in active tourism activities also produces statistically significant improvements in cardiorespiratory endurance and overall physical working capacity (Martínez-Redecillas *et al.*, 2026). Table 7 presents the medians (Me) and interquartile ranges (IQR) for responses in the pupil and student groups.

Table 7. Post-hike participant survey results (Me [IQR])

Statement	Pupils (n = 60)	Students (n = 60)	p (Mann-Whitney U test)
My physical condition improved	4 [4; 5]	5 [4; 5]	0.031
My fatigue level decreased	4 [3; 4]	4 [4; 5]	0.008
I experienced psychological recovery	5 [4; 5]	5 [5; 5]	0.042
I was satisfied with the recreation	5 [4; 5]	5 [5; 5]	0.023

Note: square brackets contain the interquartile range (IQR), comprising the first (Q1) and third (Q3) quartiles [Q1; Q3], this interval covers the central 50% of participants' responses; the median (Me) is shown before the brackets

Source: compiled by the authors based on the experimental data

According to Table 7, the hike had a positive effect in both groups, with higher assessments among students. Students gave higher median ratings for most indicators and a narrower interquartile range (IQR), suggesting greater convergence in their responses; all four statements also differed

significantly between groups ($p < 0.05$). Although pupils expressed satisfaction with the hike, their responses were more variable, while students were more uniform in assessing its positive effect on physical and psychological condition. Table 8 presents the percentage distribution of responses.

Table 8. Percentage of participants who agreed with the statements (%)

Statement	Pupils (% agreeing)	Students (% agreeing)	Difference (percentage points)
My physical condition improved	78.3	91.7	+13.4
My fatigue level decreased	68.3	85.0	+16.7
I experienced psychological recovery	88.3	96.7	+8.4
I was satisfied with the recreation	91.7	98.3	+6.6

Source: compiled by the authors based on the experimental data

Subjective assessments of the hike were generally positive among the young participants. Psychological recovery and overall satisfaction received the highest ratings, pointing to the considerable recreational value of mountain routes in both age groups. Students provided a greater proportion of positive assessments across all indicators, which may relate to stronger awareness of the effect

of physical activity and better adaptation to the load. The difference in responses on reduced fatigue is particularly informative: the lower proportion of pupils agreeing with this statement points to a greater “physiological cost” of the hike for adolescents. For pupils, the three-day route represented an intensive physical challenge primarily; for students, it functioned more effectively as a form of

recovery. The near-unanimous satisfaction among students favours the inclusion of such activity in the educational process as a means of counteracting academic exhaustion. Low levels of negative assessment (scores of 1-2) in both groups are compatible with the safety and appropriateness of the selected route for the participants.

Despite the physical difficulty, the psychological effect of time spent in natural surroundings remained an important motivation for future participation in tourism. Responses were then analysed by sex, with the proportions agreeing with each statement among male and female pupils and students presented in Table 9.

Table 9. Percentage agreeing with statements, by sex and age (%)

Statement	Male pupils (n = 30)	Female pupils (n = 30)	Male students (n = 30)	Female students (n = 30)
My physical condition improved	83.3	73.3	93.3	90.0
My fatigue level decreased	73.3	63.3	86.7	83.3
I experienced psychological recovery	90.0	86.7	96.7	96.7
I was satisfied with the recreation	93.3	90.0	100.0	96.7

Source: compiled by the authors based on the experimental data

Within the pupil group, male pupils had a higher percentage of agreement than female pupils for every statement. The differences were 10.0 percentage points for improved physical condition, 10.0 percentage points for reduced fatigue, 3.3 percentage points for psychological recovery, and 3.3 percentage points for satisfaction. Sex differences were less pronounced in the student group. Male students had slightly higher values for improved physical

condition and satisfaction, while both student subgroups gave the same response level for psychological recovery. The difference in reduced fatigue was 3.4 percentage points. The highest value across all subgroups occurred among male students for satisfaction with the recreation (100%). Participants were also asked whether they wished to take part in a similar hike during the next season; Table 10 presents their responses.

Table 10. Willingness to repeat the hike in the next season

Response	Pupils (n = 60)	Students (n = 60)
Yes	55 (91.7%)	58 (96.7%)
No	3 (5.0%)	2 (3.3%)
Undecided	2 (3.3%)	0 (0.0%)

Source: compiled by the author based on the experimental data

Most participants in both groups wished to repeat the hike: 91.7% of pupils and 96.7% of students. Repeat participation was declined by 5.0% of pupils and 3.3% of students. A small number of pupils remained undecided, whereas no students selected this response. Those declining included two female pupils, one male pupil, one female student, and one male student; their reasons were lack of time (three participants) and insufficient physical fitness (two participants). Taken together, the survey responses point to a marked recreational effect of the three-day hike in the Ukrainian Carpathians in both groups. Students rated improvement in physical condition, reduced fatigue, and psychological recovery more highly than pupils. More than 90% of participants in both groups were satisfied with the recreation. In the pupil group, male pupils rated the recreational effect more highly than female pupils, while differences between male and female students were minimal. The available data therefore justify viewing a three-day hike in the Ukrainian Carpathians as a potentially effective form of active recreation and a means of short-term improvement in young people's physical endurance. Graded aerobic exertion in mountain terrain appeared to mobilise adaptive resources and improve overall physical working capacity.

Discussion

After the three-day hike in the Ukrainian Carpathians, physical endurance improved among both adolescents and university students. The principal results were increased Cooper-test and HSTI values, higher absolute indicators

and faster HR recovery in the student group, and a strong relationship between load intensity, represented by mean HR, and gains in endurance. These results agree with O. Mozolev *et al.* (2020), who documented a 10-15% increase in aerobic endurance after hiking trips. The HSTI increase in the present study (12.4-14.2%) fell within this range. Comparison with O. Mozolev *et al.* (2020) also points to age-related differences in adaptation, as university students had a substantially greater capacity to mobilise functional reserves than adolescents.

The results are also comparable to those of J.K. Boggs (2024), who analysed the influence of an extracurricular adventure-education programme on upper-secondary pupils' attitudes towards active outdoor recreation. That study noted increased physical activity after a four-day programme and greater interest in tourism. A comparable response occurred in the present study: 91.7% of pupils expressed willingness to repeat the hike. However, J.K. Boggs (2024) did not measure objective physiological indicators such as HR or endurance-test results. Here, subjective ratings were accompanied by quantitative data, strengthening the conclusions. C.L. Brown (2021) conducted a pilot study of a mountain-biking adventure-therapy programme for lower-secondary pupils. The researcher observed that the eight-week programme improved psychosocial adaptation but did not produce statistically significant changes in physical endurance, attributing this to insufficient load intensity. Unlike the study by C.L. Brown (2021), the present study identified significant endurance changes,

which may be linked to mountain terrain and sustained aerobic exertion of 5-7 hours per day over three days. The terrain and the extent of physical activity, therefore, appear important for obtaining a training effect, with the duration and intensity of the hike playing a central role.

R. Jasmanedi *et al.* (2025) compared the physical fitness of pupils living in different landscape zones. The researchers documented substantially higher physical-condition indicators among young people who lived in or spent active time in mountain areas than among their peers from plain or coastal regions. The presented results correspond to those of R. Jasmanedi *et al.* (2025): three days at altitude in the Carpathians were associated with appreciable improvements in endurance-test performance. Whereas that earlier study focused on continuous exposure to the residential environment, the present data suggest that a short, intensive hike can produce a comparable adaptive effect. E.R. Malones (2024), addressing implementation of the Global Action Plan on Physical Activity, stressed the importance of integrating health-enhancing activity into young people's daily schedules to improve overall health and working capacity. The researcher linked purposeful physical activity (Physical Activity for Health and Fitness) directly with subjective well-being. In the current study, high ratings of psychological recovery (93-97% agreement) and the willingness of more than 91% of participants to repeat the hike reinforce the proposition of E.R. Malones (2024) that well-organised physical activity is perceived by young people not as an onerous load but as a means of restoring personal resources. The present data also supplement the results of E.R. Malones (2024) with quantitative changes in HR, permitting a more precise appraisal of the physiological cost of such recreational activities.

B. Zhijing *et al.* (2025) assessed the influence of recreational cycling tours on the cardiorespiratory status of Chinese students. The researchers documented that a five-day tour reduced resting HR by 8-10 bpm and increased vital capacity. In the present study, HR during the route decreased by 7.9 bpm among pupils and 7.2 bpm among students, close to the range described by B. Zhijing *et al.* (2025). The studies differ in the mode of travel: cycling imposes a somewhat different load, with lower impact on joints but higher movement speeds. Despite this difference, cardiorespiratory adaptation was similar. M.I.R. Suarlam *et al.* (2026) compared the physical fitness of primary-school pupils from rural and urban settings. Their data associated rural residence, in a more natural environment, with better endurance among pupils. Although all participants in the present study were urban residents of Ivano-Frankivsk, after the three-day hike, their endurance indicators reached the levels observed by M.I.R. Suarlam *et al.* (2026) among rural pupils. This suggests that even short-term exposure to a natural mountain setting can partially reduce fitness differences associated with permanent living conditions. M. Cășăneanu *et al.* (2025) assessed the role of climbing-wall exercise in children's balance development. Although their study concerned a different form of activity, the authors noted activation of muscle groups rarely recruited in daily activity during exercise involving vertical movement. In the conducted study, participants with lower initial fitness achieved substantial relative increases in indicators. Changes within

individual subgroups follow the principle of "lower initial reserves" described by M. Cășăneanu *et al.* (2025), whereby an organism with lower baseline fitness responds more strongly to an intensive new stimulus.

D.O. Mudzakir *et al.* (2025) compared physical fitness and motivation to learn among pupils attending "nature schools" and conventional schools. Their results associated nature-school attendance with greater motivation for physical activity and better endurance. The participants in the presented study had no previous organised hiking experience, yet after the three-day walking route, 88-97% stated that they experienced psychological recovery, reflecting a positive response to outdoor activity. D.O. Mudzakir *et al.* also noted that female pupils experienced a stronger effect of contact with nature and achieved a greater relative increase in the Harvard Step Test Index. Comparison with earlier studies highlights several patterns. A three-day mountain hike markedly improved participants' endurance, in agreement with O. Mozolev (2025) and B. Zhijing (2025). Students aged 18-25 years had better adaptive capacity than pupils aged 14-17 years, which aligns with the conclusions of D.O. Mudzakir (2025) on age-related features of cardiovascular function.

Subjective assessments of the recreational effect also merit attention. The present approach combined physiological measurements, namely the Harvard Step Test, Cooper test, and HR monitoring, with an extensive questionnaire. Unlike the work of O. Mozolev (2025) and E.R. Malones (2024), which relied mainly on qualitative methods, and that of B. Zhijing (2025) and M.I.R. Suarlam (2026), which focused on physiological indicators without the subjective component, this study identified parallel positive changes in perceived well-being and objective endurance. Both age groups achieved the same relative increase in Cooper-test distance (8.8%), corresponding to a proportional change in aerobic capacity irrespective of age. Recovery measured by HSTI was more age-dependent: the increase among students (14.2%) exceeded that among pupils (12.4%), a pattern not described by either O. Mozolev *et al.* (2020) or B. Zhijing *et al.* (2025). Overall, the results correspond to most of the works discussed in relation to the positive effect of nature-oriented load on cardiorespiratory function and subjective well-being. They also distinguish age- and sex-related features of adaptation that should be addressed when comparable activities are organised. The strong positive correlation between mean HR during the hike and the increase in endurance is compatible with a dose-dependent training effect.

Conclusions

Following the three-day hike in the Ukrainian Carpathians, statistically significant improvements occurred in young people's physical endurance indicators ($p < 0.001$). Among pupils aged 14-17 years, the relative increase in the Harvard Step Test Index was 12.4%; among students aged 18-25 years – 14.2%, while Cooper-test performance increased by 8.8% in both groups. Students achieved higher absolute results throughout the study and recovered their HR more rapidly. The sex-based analysis yielded similar relative increases in male and female participants, although male subgroups had higher absolute values. Physiological load during the route remained in the aerobic zone; pupils

had a higher mean HR and a longer recovery period than students. The progressive reduction in mean HR by 7.2-7.9 bpm and recovery to 100 bpm within 5.2-6.8 minutes point to a more economical physiological response and mobilisation of the participants' adaptive resources.

The correlation between mean HR during the hike and the increase in the Harvard Step Test Index was strongly positive: $\rho = 0.74$ among pupils ($p < 0.001$) and $\rho = 0.69$ among students ($p = 0.002$). Pupils with a mean HR of 135-145 bpm ($n = 10$) achieved an HSTI increase of 9.8 ± 1.7 units, whereas pupils with HR below 130 bpm ($n = 4$) increased by only 5.2 ± 1.4 units. Among students, the increase was 11.9 ± 1.9 units at HR 130-140 bpm ($n = 9$) and 7.6 ± 1.5 units at HR below 130 bpm ($n = 6$). Questionnaire responses confirmed a marked recreational effect of the hike, with the student group giving higher subjective ratings for every criterion. Improved physical condition was selected by 78.3% of pupils and 91.7% of students; reduced fatigue by 68.3% and 85.0%, respectively. Psychological recovery received the highest values, with agreement among 88.3% of pupils and 96.7% of students. Overall satisfaction with active recreation was also very high, at 91.7% and 98.3%, corresponding to willingness to participate in similar activities again among 91.7% of pupils and 96.7% of students. These data point to a

stable positive attitude towards hiking as a means of recovery and health enhancement.

The combination of intensive aerobic exertion and time in a high-altitude environment provides a strong stimulus for improving young people's cardiorespiratory function. The observed pattern of the training effect justifies the use of hiking as a scientifically grounded means of addressing physical inactivity in contemporary education. These observations justify incorporating multi-day routes into physical education programmes to increase functional reserves among pupils and students. Further research should extend mountain routes to 5-7 days to assess the course of adaptive changes and the duration of the effect more fully. A control group would also strengthen comparative analysis of endurance indicators and permit more precise separation of the effect of physical load from associated factors.

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Conflict of Interest

None.

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Піші походи в Українських Карпатах як засіб активної рекреації та розвитку фізичної витривалості учнівської та студентської молоді

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Анотація. Метою дослідження була оцінка впливу триденного пішого походу в Українських Карпатах на показники фізичної витривалості та рекреаційний ефект для учнівської та студентської молоді. У дослідженні взяли участь 120 осіб (60 учнів та 60 студентів), які пройшли триденний маршрут (с. Ділове – г. Піп Іван Мармароський – с. Ділове) загальною протяжністю 37 км із перепадом висот від 350 м до 1 936 м н.р.м. Для оцінки функціонального стану використовувалися Гарвардський степ-тест, 12-хвилинний тест Купера, безперервний моніторинг частоти серцевих скорочень, опитування за шкалою Лікерта та методи математичної статистики. За результатами дослідження після походу зафіксовано статистично значуще ($p < 0,001$) зростання індексу Гарвардського степ-тесту на 12,4 % в учнів та 14,2 % у студентів, а також збільшення дистанції у тесті Купера на 8,8 % в обох групах. Аналіз кардіореспіраторної системи показав, що студенти працювали економніше, продемонструвавши нижчу середню частоту серцевих скорочень під час руху ($134,2 \pm 8,5$ уд./хв проти $138,4 \pm 9,2$ уд./хв в учнів) та швидше відновлення пульсу до рівня 100 уд./хв ($p < 0,001$). Встановлено позитивний кореляційний зв'язок між інтенсивністю навантаження та приростом показників витривалості ($\rho = 0,74$ в учнів та $\rho = 0,69$ у студентів), що підтверджує дозозалежність тренувального ефекту. Суб'єктивна оцінка підтвердила високий рекреаційний потенціал заходу: понад 88 % учасників відзначили психологічне відновлення, а 91,7 % учнів та 96,7 % студентів висловили бажання повторити похід. Практична значимість результатів полягає в науковому обґрунтуванні триденних гірських походів як ефективного засобу інтенсифікації фізичного виховання. Отримані дані будуть корисними для вчителів та тренерів при диференціації фізичних навантажень для різних вікових груп, а також для фахівців, які займаються розробкою оздоровчих програм, спрямованих на подолання гіподинамії та зміцнення кардіореспіраторної системи молоді

Ключові слова: адаптація; тренувальний ефект; вікові відмінності; гендерні відмінності; кардіореспіраторна система