Effects of High-Altitude Mountaineering on Mountaineers

Subjects: Public, Environmental & Occupational Health

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Nowadays, with the convenience of international traveling and driven by many individuals' fond dreams of challenging high-altitude exercises, high-altitude mountaineering is becoming increasingly popular worldwide. Therefore, researchers performed a meta-analysis to determine the effects of high-altitude mountaineering on cognitive functions in mountaineers before and after climbing.

high-altitude mountaineering mountaineer cognitive function

1. Introduction

High-altitude mountaineering can bring about a sense of performance achievement and heightened willpower to challenge one's environment [1]. Currently, with the convenience of international travel, high-altitude exercises, such as hiking, mountaineering, and skiing, are no longer just fond dreams for many individuals. High-altitude climbing [2] refers to the act of climbing elevations with altitudes exceeding 3500 m.

Studies have shown that hypobaric and anoxic environments in high-altitude areas affect people's cognitive functions, such as short-term memory, attention span, attention conversion ability, and thinking and judgment ability [3][4][5][6][7], which could be potentially hazardous to individual health, both physically and mentally [8][9]. Such conditions can lead to irrational decisions, leading to falls, frostbite, accidents, fatigue, and death.

However, only a few studies have explored the physiological and cognitive changes that occur during high-altitude exploration [10][11]. In addition, most high-altitude mountaineering studies on cognitive functioning are of small sample size, and the effects of high-altitude mountaineering on cognitive function have not been well documented in a systematical format. In this meta-analysis, the effects of altitude exposure on the cognitive function of mountaineers were systematically reviewed, and applied neuropsychological tests were classified according to their superior cognitive domains. Therefore, the purpose of this meta-analysis was to critically assess the effects of high-altitude mountaineering exercise on cognitive function in terms of executive function, motor speed, memory function, and verbal function in mountaineers.

2. TMB

Three studies in which 56 participants were reported to have the test on TMB were analyzed, and three sets of statistics were generated from the comparison tests of the same groups. As shown in **Table 1**, there was no significant difference between the pre-test and the post-test on the participants' TMB (95% CI, −0.05 to 0.83), and the mean ES was 0.39, $p > 0.05$.

Table 1. Effective size (ES) and forest plot of TMB.

Studies	Weight	Effect Size Random, 95% CI ES	Low	High	Forest Plot Random, 95% CI
Charles	38.31%	0.64	0.04	1.25	
Carole	17.67%	−0.17	−1.15	0.81	
Gregory	44.02%	0.39	−0.16	0.94	
Total	100%	0.39	−0.05	0.83	Test for overall effect: Z = 1.72 ($p > 0.05$)
Heterogeneity: Q = 1.98, df = 2, C = 17.55, $T^2 = -0.001$					

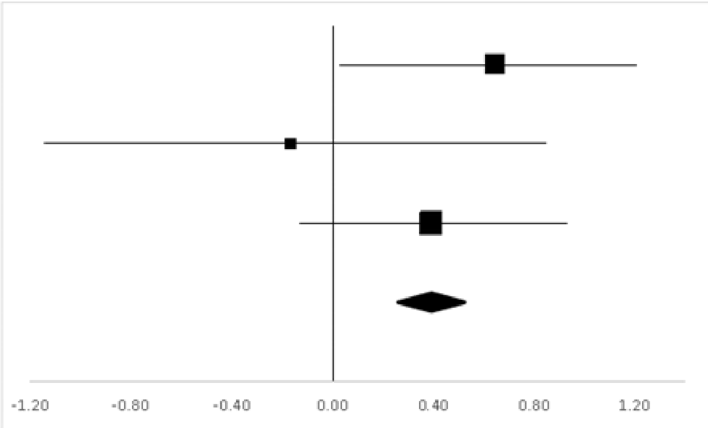

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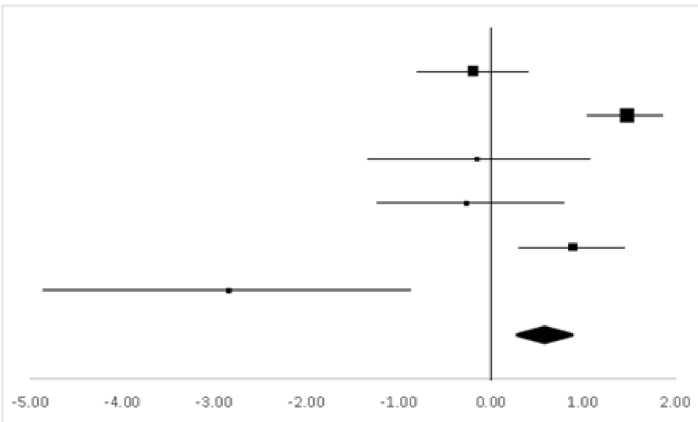
Table 2. ES and forest plot of DSF.

Studies	Weight	Effect Size Random, 95% CI ES	Low	High	Forest Plot Random, 95% CI
Charles	22.2%	−0.19	−0.79	0.40	
Wu	35.21%	1.47	1.06	1.88	
Philip	6.52%	−0.15	−1.39	1.09	
Carole	9.87%	−0.27	−1.25	0.72	
Gregory	23.47%	0.88	0.31	1.45	
Carine	2.74%	−2.85	−4.81	−0.88	
Total	100%	0.57	0.24	0.90	Test for overall effect: Z = 3.36 ($p < 0.01$)
Heterogeneity: Q = 42.10, df = 5, C = 40.30, $T^2 = 0.92$					



4. DSB

Three sets of statistics were generated from the comparison tests of the same groups, with three articles involving 35 participants tested on DSB. As suggested in **Table 3**, there was no significant difference in DSB (95% CI, −0.83

to 0.30) between the pre-test and the post-test, and the mean ES was −0.26, $p > 0.05$.

Table 3. ES and forest plot of DSB.

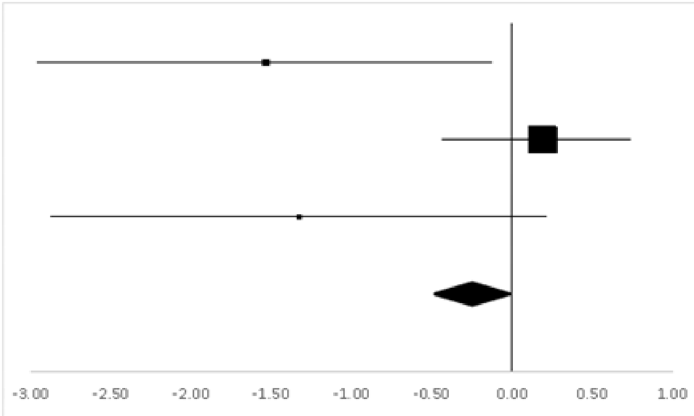
Studies	Weight	Effect Size Random, 95% CI			Forest Plot Random, 95% CI
		ES	Low	High	
Philip	14.92%	−1.54	−2.95	−0.13	
Gregory	72.28%	0.19	−0.36	0.73	
Carine	12.8%	−1.33	−2.86	0.21	
Total	100%	−0.26	−0.83	0.30	Test for overall effect: Z = −0.91 ($p > 0.05$)
Heterogeneity: Q = 7.29, df = 2, C = 7.34, $T^2 = -0.72$					

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Table 4. ES and forest plot of FTL.

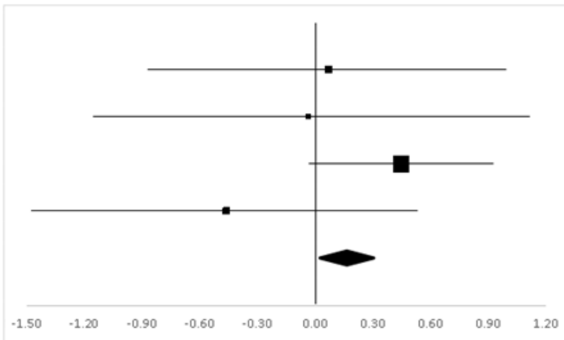
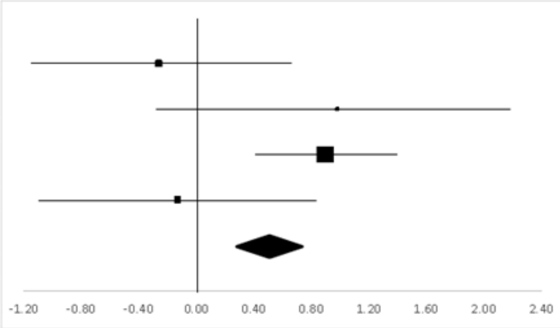
Studies	Weight	Effect Size Random, 95% CI			Forest Plot Random, 95% CI
		ES	Low	High	
Gregor	18.9%	0.07	−0.86	0.99	
Hornbein (Operation)	13.24%	−0.04	−1.17	1.09	
Hornbein (Mountaineers)	51.18%	0.45	−0.03	0.92	
Carole	16.69%	−0.46	−1.46	0.53	
Total	100%	0.16	−0.27	0.59	Test for overall effect: Z = 0.72 ($p > 0.05$)
Heterogeneity: Q = 3.07, df = 3, C = 18.39, $T^2 = 0.004$					

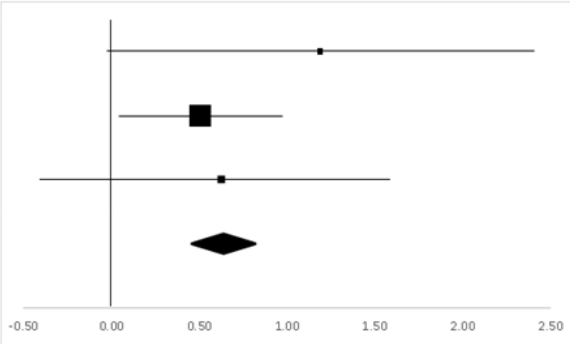
Table 5 shows the findings of four sets of statistics from three studies on FTR. Altogether, 58 participants took the test with two inter-group and two inner-group comparison test designs. The results suggested a significant difference between the pre-test and the post-test in this respect (95% CI, 0.06–0.94), and the mean ES was 0.50, $p < 0.05$.

Table 5. ES and forest plot of FTR.

Studies	Effect Size Weight	Random, 95% CI ES	Low	High	Forest Plot Random, 95% CI
Gregor	19.4%	−0.26	−1.19	0.67	
Hornbein (Operation)	12.35%	0.98	−0.22	2.18	
Hornbein (Mountaineers)	50.63%	0.89	0.4	1.39	
Carole	17.62%	−0.13	−1.11	0.85	
Total	100%	0.50	0.06	0.94	Test for overall effect: Z = −2.22 ($p < 0.05$)
Heterogeneity: Q = 7.38, df = 3, C = 17.73, $T^2 = -0.25$					

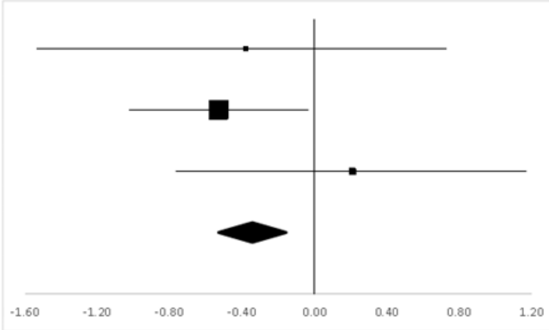
The findings from the WMSV participated in by 49 test-takers, as reported in two studies, indicated a significant difference between the pre-test and the post-test (95% CI, 0.14–1.12), with the mean ES being 0.63, $p < 0.05$ (**Table 6**). In this category, two studies with a within-subject design and one study with a between-subject design contributed to the three sets of statistics from which the results were generated.

Table 6. ES and forest plot of the WMSV.

Studies	Effect Size Weight	Random, 95% CI ES	Low	High	Forest Plot Random, 95% CI
Hornbein (Operation)	14.51%	1.18	−0.04	2.41	
Hornbein (Mountaineers)	64.69%	0.51	0.03	0.98	
Carole	20.8%	0.62	−0.38	1.63	
Total	100%	0.63	0.14	1.12	Test for overall effect: Z = 2.52 ($p < 0.05$)
Heterogeneity: Q = 0.9, df = 2, C = 11.28, $T^2 = -0.1$					

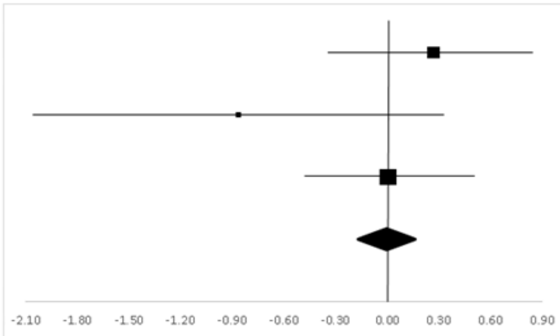
...en-subject design reported 49 participants' behaviors, and there was no significant difference between the pre-test and the post-test (95% CI, −0.38 to 0.13). The mean ES was −0.35, $p > 0.05$ (**Table 7**).

Table 7. ES and forest plot of AST-Ver.

Studies	Effect Size: Weight	Random, 95% CI: ES	Low	High	Forest Plot: Random, 95% CI
Hornbein (Operation)	16.1%	−0.38	−1.52	0.76	
Hornbein (Mountaineers)	62.88%	−0.53	−1.01	−0.05	
Carole	21.01%	0.21	−0.77	1.19	
Total	100%	−0.35	–0.83	0.13	Test for overall effect: Z = −1.43 ($p > 0.05$)
Heterogeneity: Q = 1.84, df = 2, C = 12.07, $T^2 = −0.01$					

statistics … e **8**. There … n ES was 0, $p > 0.05$.

Table 8. ES and forest plot of AST-Vis.

Studies	Effect Size: Weight	Random, 95% CI: ES	Low	High	Forest Plot: Random, 95% CI
Charles	37.22%	0.27	−0.33	0.86	
Hornbein (Operation)	11.94%	−0.87	−2.05	0.32	
Hornbein (Mountaineers)	50.84%	0	−0.47	0.47	
Total	100%	0	−0.43	0.42	Test for overall effect: Z = −0.02 ($p > 0.05$)
Heterogeneity: Q = 2.83, df = 2, C = 18.28, $T^2 = 0.05$					

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