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## PHYSICAL EXERCISE, BDNF, AND COGNITIVE AGING: SYSTEMIC ANALYSIS AND EVIDENCE SYNTHESIS

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**Aim.** To evaluate the biological mechanisms and clinical evidence linking exercise-induced brain-derived neurotrophic factor (BDNF) modulation with cognitive aging, and to assess physical activity as a modifiable factor for brain health.

**Methods.** A systematic literature analysis was conducted following PRISMA-based principles. Electronic databases (PubMed, Scopus, and Web of Science) were searched for English-language studies published up to 2024 using combinations of the terms “physical activity,” “exercise,” “BDNF,” “cognition,” and “aging.” Eligible studies included original research involving human and animal subjects assessing (1) exercise interventions, (2) BDNF levels or signaling pathways, and/or (3) cognitive outcomes. Review articles, duplicates, and studies lacking relevant outcome data were excluded. Study selection and data analysis were performed independently by two reviewers. Methodological quality was assessed through risk of bias evaluation. Due to methodological heterogeneity (differences in populations, interventions, and outcome measures), findings were synthesized qualitatively.

**Results.** BDNF is a key regulator of neurogenesis, synaptic plasticity, and neuronal survival, particularly in the hippocampus. Physical exercise enhances BDNF expression through activity-dependent mechanisms, including calcium signaling, CREB activation, and increased cerebral perfusion. Both aerobic and resistance exercise improve cognitive function and elevate BDNF levels, with emerging evidence suggesting a nonlinear dose–response relationship. Beneficial effects are observed in aging populations, depression, and early neurodegenerative conditions. However, substantial heterogeneity was observed across studies due to differences in design, sample size, intervention protocols, and BDNF assessment methods.

**Conclusions.** Physical activity is a promising non-pharmacological strategy for maintaining cognitive health. Future studies should emphasize standardized methodologies, longitudinal designs, and personalized exercise prescriptions to clarify the mechanistic role of BDNF across the lifespan.

**Keywords.** Physical exercise; BDNF; cognitive aging; neuroplasticity; neuroprotection; dose–response; neurodegenerative disease; depression.