

a potential mechanism for preventing disuse atrophy and aiding rehabilitation, going beyond HMB's effects on rates of protein synthesis and degradation.

Other studies evaluating HMB supplementation during periods of relative disuse or tissue trauma (e.g. during recovery from surgery) have yielded similar results. Differences in maintenance of muscle cross-sectional area after total knee arthroplasty in older patients (aged 65–80 years) were not statistically significant different from each other ($p > 0.05$), but a group supplemented with 2.4 g HMB + 14 g Glutamine + 14 g Arginine had larger absolute changes ($9.1 \pm 16.6\%$) when compared to control ($-3.6 \pm 33.8\%$). In terms of muscle strength, the group supplemented with HMB did successfully attenuate the losses in muscle strength 14 days after surgery compared to the effects in the were observed in the control group [154]. Among older female patients with hip fracture, 81.3% of patients taking an HMB-containing supplement were ambulating by days 15 and 30 after surgery vs 26.7% of patients in the control group. Muscle strength was also significantly higher in the HMB vs the control group by day 30 after surgery [155]. HMB supplementation also showed better protection of muscle mass and strength compared to the control group at three months after hip replacement in a separate study of sarcopenic patients with hip fracture [97].

In summary, HMB supplementation may be useful for attenuation the loss of muscle mass and strength because of disuse atrophy in older adult populations or following surgical intervention and tissue trauma. However, the study data are limited, and additional research will be needed especially in younger populations.

13. Efficacy of HMB in combination with other nutrients

There are a number of studies demonstrating the additive or synergistic effect when HMB is combined with other nutrients. These effects may result from combining nutrients that act through different mechanisms, aid in absorption, or provide a limiting nutrient required to maximize exercise performance.

13.1. HMB plus probiotics

In athletes, supplementation of certain probiotic strains has been shown to increase nutrient absorption, exercise performance [156,157], and recovery from muscle-damaging exercise [158]. The probiotic *Weizmannia coagulans* GBI-30, 6086 (BC30) has been shown to increase amino acid absorption from animal and plant proteins [159,160]. In a separate study, when this probiotic strain was combined with HMB-Ca and HMB-FA, the combination improved peak HMB levels by 16% and total HMB exposure by 19% following supplementation [161]. Moreover, HMB-FA supplementation during intense military training significantly reduced inflammation, and co-administration with BC30 for four weeks synergistically improved the beneficial effects on muscle integrity [162] and the anti-inflammatory effects of IL-10. The beneficial effectiveness of co-administering BC30 with HMB may either be a result of the increased exposure of HMB to tissue and plasma, or due to the anti-inflammatory and anti-oxidant synergistic properties of the probiotic strain. More research is needed to fully explore these ideas.