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Effectshypertrophy Introduction Aerobic c
including improved cardiorespiratory fitness (A
2005), improved muscle quality (Lee and Ston
recovery (Paneroni et al., 2017), and reduced ca
2021; Kodama et al., 2009). However. adAo9aTD

achieve substantial improvements in these aspects. The American College of Sports Medicine recommends 5–7 days of moderate-intensity aerobic exercise or 3 days of vigorous exercise per week for adults to improve health and prevent disease (Garber et al., 2011). As aerobic capacity and performance improve, higher-intensity aerobic fitness methods are required to elicit training adaptations (Medicine, 2013). Nonetheless, high-intensity training is not suitable for some specific populations, such as the elderly, patients undergoing rehabilitation, or in-season athletes. Therefore, developing a low-intensity training method that can achieve similar benefits to high-intensity training is of great significance.

Blood flow restriction (BFR) training has gained increasing popularity in the fields of sports and rehabilitation (Hughes et al., 2017; Loenneke et al., 2010). This method involves applying an external constricting device to the proximal limbs to partially restrict venous return, thereby creating a hypoxic and stressful environment that promotes physical adaptations (Jessee et al., 2018). Previous meta-analyses have found that BFR resistance training can achieve effects similar to high-intensity resistance exercise, specifically regarding muscle strength and hypertrophy, while minimizing mechanical load (20–30% one repetition maximum) (Centner et al., 2019; Grønfeldt et al., 2020; Lixandrão et al., 2018). This suggests that BFR training may provide a viable alternative to high-intensity resistance training for the development of muscular strength and hypertrophy.

In effect, AT-BFR may offer an effective and practical method to

and selective reporting (Sterne et al., 2019). The assessment of methodological quality was independently conducted by two reviewers (Y.L. and J.Z.), with any discrepancies resolved by consensus with a third reviewer (L. L.). Additionally, potential bias was evaluated through visual inspection of funnel plots and Egger's test.

Data extraction

The following data were extracted: participant demographics (i.e., age, gender, training status), and study characteristics (i.e., training duration, frequency, intensity, volume, occlusion

running, swimming, or rowing), occlusion pressure (<180 mmHg or ≥180 mmHg) on these primary outcomes. The threshold for statistical significance was set at $p < 0.05$.

The meta-analysis involved some deviations from the registered protocol. To enhance homogeneity, the analysis focused on a more consistent participant group, specifically younger adults. Furthermore, subgroup analyses were conducted only when each

Egger's test revealed no significant publication bias for VO_{2max} (b = 2.38, t = 1.85, p = 0.09), while it was not applicable for muscle strength

95%CI: [-0.09, 0.56], p = 0.162). The I^2 statistic indicated minimal heterogeneity (0%).

The sensitivity analysis revealed no significant changes, with effect sizes and heterogeneity remaining stable after excluding individual studies, further confirming the robustness and reliability of the results (see Supplementary Material 5). Subgroup analyses were conducted if at least three relatively homogeneous datasets were available for each subgroup. A total of 13 subgroup analyses were

Regarding training duration, while the studies included in this meta-analysis ranged from 2 to 8 weeks, even short-term (2–4 weeks) training was effective in significantly improving aerobic capacity and strength, making it suitable for athletes requiring rapid recovery or performance maintenance. A training frequency of 2–6 days per week was also effective, demonstrating the flexibility of AT-BFR in various training programs. Regarding cuff pressure, no significant impact on training outcomes was observed within the 90–240 mmHg range. However, for

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