

· 综 述 ·

运动康复对功能水平和体质健康影响的研究进展

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摘要 康复的本质是人体功能的恢复与重建,而心肺功能是人体功能的核心,也是体质健康的核心要素。作为现代康复治疗的重要手段之一,运动康复是提升人体功能水平的根本途径,在疾病康复进程中起关键作用。临床上应用较多的运动康复形式包括有氧运动、高强度间歇运动、肌力训练、传统运动功法等。不同运动康复形式均可不同程度地改善人体功能水平,并促进体质健康,主要作用包括调节血压、血脂、血糖,改善平衡和肌力,提升骨密度,增强心肺耐力和步行能力,改善认知和记忆功能,调节情绪,促进心理健康,以及提高生活质量等,共同达到缩短疾病康复进程、提高疾病康复疗效的目标,但不同运动康复形式对功能水平和体质健康的影响维度和程度存在差异。其中,有氧运动主要对心肺耐力、糖脂代谢、情绪调节、认知记忆等维度产生积极影响,作用机制涉及循环中内源性大麻素的增加、脑白质纤维的完整性等。与中等强度有氧运动相比,高强度间歇运动能够更具时效性地改善心肺耐力和心脏代谢健康,作用机制涉及肌肉线粒体产能的增加、骨骼肌部分基因表达的调控等。肌力训练主要通过增加肌肉力量和肌耐力,以改善血糖控制,降低慢性病和死亡风险,尤其适合绝经后女性及超重/肥胖老年人。传统运动功法如太极拳、八段锦等是中医康复的重要治疗手段,在改善平衡、认知和记忆等方面疗效确切,值得临床推广应用。目前关于不同功能障碍和不同疾病状态人群如何选择最佳的运动康复形式和疗程,仍有待后续临床和基础研究进一步阐明。

关键词 运动康复; 功能水平; 心肺耐力; 体质健康

运动康复是现代康复治疗的重要手段,也是提升人体功能水平的根本途径,而良好的功能水平是健康的核心要素。目前,关于运动康复对功能水平和体质健康具有积极影响这一认识在康复医学界已得到广泛认可。但由于运动康复的形式丰富多样,不同类型的康复运动对于功能水平和体质健康的影响维度和程度亦存在差异。本文通过回顾近年来国内外相关领域研究,就不同运动康复形式对人体功能水平和体质健康影响的研究进展作一综述,以期临床运动康复方案的制订提供一定指导。

1 运动康复的定义和基本内涵

古籍《尔雅》云:“康,安也;复,返也”,传统的“康复”意为恢复健康或平安。WHO对健康的最新定义指出,健康不仅是没有疾病,还要有良好的功能水平和活动参与能力,强调功能在健康中的核心地位,而康复的本质即是功能的恢复与重建。

现代康复医学认为,康复是采用各种措施消除或减轻康复对象身心及社会功能障碍,使其功能达到或保持最佳水平,最终重返社会^[1]。运动康复作为康复医学的重要分支,是通过对患者功能水平的

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评估和诊断,制订个性化运动康复处方,并以运动干预为主导,改善、恢复人体功能,进而预防和治疗功能障碍,实现功能水平和健康状态的优化^[2-3]。

临床常见的运动康复分为耐力训练、肌力训练、关节活动训练和协调性训练等,且不同的运动康复形式或疗程对人体功能水平和体质健康影响的程度可能存在差异。

2 功能水平与体质健康的关系

根据WHO对健康的最新定义,人体功能涵盖脏腑生理功能、肢体运动功能、精神心理功能、社会生活能力和适应自然环境的能力等。其中,心肺功能是人体功能的核心,已被美国心脏病协会列为评价人体生命状态的第五大生命体征,认为与人的寿命长短、死亡风险息息相关。

心肺功能是体质健康的核心要素。心肺耐力低下者全因死亡风险明显增加,尤其心血管疾病所致的死亡^[4-7]。VASQUEZ等^[8]对1412名21~35岁成人平均随访(32.5±6.7)年后发现,基线肺功能低下者随访期间心脏病和慢阻肺的风险明显增加,另提高心肺耐力有利于降低全因死亡率和心血管疾病发病率、死亡率^[4,6-7,9]。综上,提高功能水平(尤其心肺功能)是增强体质健康的关键。

3 不同运动康复形式对功能水平和体质健康的影响及可能机制

3.1 有氧运动对功能水平和体质健康的影响及可能机制

有氧运动是在氧气充足的情况下进行的体育锻炼,其特点是运动过程中氧气能够充分酵解体内糖分并消耗体内脂肪,因而对血糖和血脂控制有益。研究表明^[10-11],有氧运动有助于维持和改善功能水平,尤其增强心肺功能,并提升运动能力、神经系统的调节能力和内分泌系统的代谢能力,改善心理和精神状态等。

3.1.1 提升功能状态,促进康复和减少疾病复发 脑卒中后进行有氧运动训练可有效提高患者心肺耐力和步行能力,改善其抑郁状态、执行能力及记忆力,从而提升患者的功能状态和生活质量^[12]。系统回顾研究显示,心脏术后早期有氧运动可显著提高患者心脏功能和有氧能力,对心脏康复有益^[13]。一项纳入536例Ⅰ~Ⅲ期结肠癌幸存者的队列研究显示^[14],有氧运动可有效减少内脏脂肪组织含量,从而降低结肠癌复发风险。

3.1.2 改善运动功能,降低死亡风险 有氧运动可

有效提升人体功能状态,改善运动功能。《新英格兰医学杂志》发布的一项研究显示,6个月的有氧训练可使肥胖老年人的体质量下降9%,步速提高9%,SF-36评分提高14%,提示有氧运动可显著提升老年人的步行能力和平衡能力,从而改善其生活质量^[15]。由于老年人步速缓慢与全因死亡风险增加显著相关^[16],推测有氧运动可能通过减重和改善平衡等实现老年人步速的提高,进而降低其全因死亡风险,但这一推测仍有待后续研究佐证。

3.1.3 改善情绪,促进心理健康 循环中内源性大麻素(endocannabinoids, eCBs)的增加可能是有氧运动产生欣快感的基础,eCBs能与大脑海马体中的特定受体四氢大麻酚(THC)结合,对记忆和情绪起关键作用,从而对心理健康、认知和记忆产生有益影响^[17]。研究显示:12周中等强度有氧运动,可使受试人群的血浆花生四烯酸乙醇胺(ANA,一种主要的内源性大麻素)和体质量显著下降($P<0.01$),愤怒和焦虑情绪显著改善($P<0.01$),心肺耐力显著增强($P<0.05$),且12.2%的体质量变化和13.1%的愤怒改善可由ANA的变化解释,证实有氧运动后的体质量减轻和情绪改善的机制涉及内源性大麻素代谢信号传导的变化^[18]。另研究表明,有氧运动能够上调大麻素受体I活性并释放内源性大麻素,进而改善视觉记忆、执行功能和心理运动速度^[19]。综上,有氧运动可能通过eCBs释放的增加对人的情绪、记忆、心理等起到正向调控作用。

3.1.4 改善认知功能,促进脑健康 研究显示,每周45 min、连续10周的中等强度舞蹈练习可提高老年人认知功能,改善短期记忆和执行功能,且这一益处在于停止练习后的5个月仍得以保持^[20]。LUDYGA等^[21]让51名大学生进行中等强度跑步锻炼后阅读文章的同时进行自由回忆测试,结果发现:与运动前相比,受试者在抑制任务上的反应时间更短,在即时和延迟回忆测试中能够回忆起更多的单词,提示中等强度有氧运动有助于改善短期和长期语言记忆以及抑制控制。

研究显示,老年人的心肺耐力每增加1 METs,发生认知障碍的相对危险度下降7%^[22]。研究发现,心肺耐力水平越高,脑白质纤维的完整性越好,而脑白质纤维的完整性又与执行功能表现相关,提示轻度认知障碍患者通过增加体力活动来提高心肺耐力,将有助于改善其认知功能^[23]。综上,规律有氧运动有利于提升心肺耐力,维持脑白质纤维完整性,从而改善大脑的认知、记忆和执行功能,但具体机制有待后续研究阐明。

3.2 高强度间歇运动对功能水平和体质健康的影响及可能机制

高强度间歇运动(high intensity interval training, HIIT)是以大于无氧阈的负荷强度进行多次持续时间为几秒到几分钟的高强度短期爆发训练,并在每组训练之间不足以完全恢复的静息或低强度间歇的训练方法。HIIT是改善心血管和肌肉健康、增加瘦体质量及骨矿物质含量的有效手段,能够改善心脏代谢和肌肉骨骼健康^[24]。

3.2.1 增强心肺功能,降低术后并发症发生率 研究发现,HIIT和中等强度持续训练(moderate intensity continuous training, MICT)均可显著改善身体成分、最大摄氧量和总胆固醇水平,但HIIT在一次干预中耗时更少(平均少于9.7 min)^[25];在等能耗的情况下,HIIT改善心肺耐力的效果明显优于MICT,且更具时效性地改善心肺耐力和心脏代谢健康^[26]。HIIT还可有效提升脑卒中合并冠心病患者的心功能、运动耐力和日常生活活动能力^[27]。HIIT可显著增加肺癌术前患者的峰值摄氧量和6 min步行距离,改善患者心肺功能;与普通护理组相比,HIIT康复组的术后并发症发生率明显降低($P=0.018$)^[28]。

3.2.2 提高有氧能力,降低心血管风险 研究发现,HIIT可降低高血压患者的静息血压,究其机制,HIIT主要通过调节骨骼肌中部分基因的表达来提高机体运动能力^[29];对上调基因的本体分析显示,显著丰富的基因种类包括“葡萄糖代谢”“细胞外基质”“血管生成”和“线粒体膜”等^[30]。

3.2.3 改善胰岛素敏感性,维持血糖稳定 随年龄增长,肌肉线粒体产能逐渐下降,导致肌肉代谢血糖的能力下降,从而增加糖尿病患病风险。梅奥诊所的研究发现,HIIT具有逆转细胞产能下降的能力^[31];3个月的HIIT训练可使65~80岁、18~30岁2组受试者的线粒体产能分别提升69%和49%,耗氧量分别增加17%和28%,从而改善胰岛素敏感性,维持血糖稳定;其作用机制涉及骨骼肌糖原储存的波动,以及对肌肉血流量增加时从血液中提取葡萄糖能力的维持作用^[32]。对于具有2型糖尿病患病风险的人群,HIIT可明显改善反映血糖变异性的连续血糖监测衍生标志物以及反映内皮细胞损伤的生物标志物^[33]。研究发现,HIIT可通过上调胰岛素抵抗指数、下调胰岛素抵抗蛋白浓度,改善糖尿病前期男性的胰岛素抵抗^[34]。与MICT相比,HIIT基础呼吸交换率、胰岛素敏感性和肌肉线粒体含量可产生更多有益影响^[35-36]。

3.3 肌力训练对功能水平和体质健康的影响

随年龄增长,肌肉的质量和功能逐渐下降。从35岁起,肌肉质量约以每年1%~2%的速度减少,而肌肉功能的下降速度较肌肉质量更为显著。肌力训练是运用各种康复训练方法增强肌肉力量和肌耐力,从而改善肢体运动功能的一种手段。肌力训练可促进肌肉功能恢复,预防骨关节疾病及患者术后肌萎缩,同时改善胰岛素敏感性,对维持人的行动能力和健康至关重要。

3.3.1 改善血糖控制,降低糖尿病和心血管风险 肌肉质量和力量的增加与糖尿病风险降低有关,糖尿病的发病与握力和肌肉质量的下降存在相关性,故可将肌肉力量作为糖尿病预防的干预目标^[37]。在改善血糖控制方面,抗阻训练可能比有氧运动更有效,对1型和2型糖尿病均有改善作用^[38-39]。一项纳入35 754名健康女性的前瞻性队列研究显示^[40],与未进行力量训练的女性相比,参与力量训练者的2型糖尿病患病率和心血管疾病患病风险分别降低30%和17%。

3.3.2 改善握力,降低慢性病和死亡风险 握力是各种慢性病和全因死亡率的可靠预测因子,肥胖、体力活动不足与握力快速下降有关^[41];坚持适度的肌力训练有助于减重和改善握力,进而降低慢性病和死亡风险。研究显示,每周进行2次肌力训练可使慢性阻塞性肺疾病患者的全因死亡率降低29%;对于慢性阻塞性肺疾病患者而言,增加肌力训练与更高的生存率相关,且这一相关性独立于有氧运动及其他潜在混杂因素^[42]。

3.3.3 提升骨密度,改善生活质量 Meta分析显示,抗阻训练可增加老年人的肌肉力量和质量,维持骨密度,提高生活质量,在改善心理健康和身体疼痛方面尤为有效^[43]。循证医学推荐绝经后骨密度降低的老年女性进行力量训练(证据等级:B级)^[44]。此外,超重和肥胖老年人在减重期间进行抗阻训练,更有利于减少髋关节和股骨颈的骨密度损失^[45]。

3.4 传统运动功法对功能水平和体质健康的影响

作为中医康复的重要治疗手段,传统运动功法外练形体、内养精神,注重意守、调息和动形的协调统一,主要包括太极拳、八段锦、五禽戏、易筋经、六字诀等,在疾病康复中发挥重要作用^[46]。

3.4.1 改善平衡能力,提高骨密度 研究显示:与平衡康复训练相比,12周的太极云手训练更有利于改善脑卒中后平衡功能障碍患者的平衡能力、运动功能、跌倒效能和抑郁情况^[47-48]。对跌倒高危风险人群,太极拳练习可使短期内跌倒和损伤相关跌倒

的发生率分别降低43%和50%^[49]。另Meta分析显示,太极拳可有效减少特殊人群(如老年人、围绝经期和绝经后女性、骨关节炎患者和癌症幸存者)腰椎和股骨颈近端区域的骨密度损失,对维持骨密度有益^[50]。

3.4.2 改善认知和记忆功能 太极拳和八段锦可减缓衰老导致的记忆衰退进程,有利于改善记忆功能,预防认知功能衰退^[51-52]。研究显示,12周的太极拳或八段锦练习均可显著提高脑岛、颞内叶和壳核的灰质体积,提示太极拳和八段锦运动可能有助于预防老年人记忆缺陷^[53]。

3.4.3 促进心理健康,提高睡眠质量 系统综述结果显示,太极对于不同人群的抑郁、焦虑、一般压力管理和运动自我效能都可产生有益影响;八段锦则有利于改善生活质量、睡眠质量、平衡能力、握力、躯干柔韧性、收缩压、舒张压以及静息心率^[54-55]。Meta分析显示,太极拳还有利于改善老年人自我评价的睡眠质量^[56]。

4 小结与展望

不同运动康复形式功效亦不同。有氧运动主要对心肺耐力、糖脂代谢、情绪调节、认知记忆等产生积极影响。与MICT相比,HIIT更为省时高效,可有效提升有氧和无氧能力,降低心血管风险和术后肺并发症发生率。肌力训练主要通过增加肌肉力量和肌耐力,以改善血糖控制,降低慢性病和死亡风险。太极拳等功法对于改善老年人平衡能力、预防跌倒疗效确切,但大部分研究的干预疗程较短,可考虑增加干预时长以探讨中长期疗效。

综上,不同运动康复形式可从不同角度提升功能水平,达到缩短康复进程、提高康复疗效的作用。目前关于不同功能障碍和不同疾病状态人群如何选择最佳的运动康复形式和疗程,仍有待后续临床和基础研究进一步阐明。

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Research Progress on the Effect of Exercise Rehabilitation on Functional Level and Physical Fitness

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ABSTRACT The essence of rehabilitation is the recovery and reconstruction of body function, and cardiopulmonary function is not only the core of body function, but also the core element of physical fitness. As one of the important interventions of modern rehabilitation treatment, exercise rehabilitation is the fundamental way to improve the level of body function, and plays a key role in the process of disease rehabilitation. The forms of exercise rehabilitation are widely used in clinic including aerobic exercise, high intensity interval training, muscle strength training, and traditional exercise and so on. Different forms of exercise rehabilitation can improve the level of body function and promote physical fitness in varying degrees. The main functions include regulating blood pressure, blood lipids and blood glucose, improving balance and muscle strength, increasing bone mineral density, enhancing cardiorespiratory fitness and walking ability, improving cognitive and memory functions, regulating emotions, promoting mental health, and improving the quality of life, etc., so as to achieve the goal of shortening the process of disease rehabilitation and improving its curative effect. However, there are differences in the dimensions and degrees of the influence of different forms of exercise rehabilitation on functional level and physical fitness. Among them, aerobic exercise mainly has a positive impact on cardiorespiratory fitness, glucose and lipid metabolism, emotional regulation, cognition and memory and other dimensions, and its mechanism involves the increase of endogenous cannabinoid in circulation and the integrity of white matter fibers and so on. Compared with moderate intensity aerobic exercise, high intensity interval training can improve cardiorespiratory fitness and cardiac metabolic health more timely and its mechanism involves the increase of muscle mitochondrial production capacity and the regulation of partial gene expression in skeletal muscle. Muscle strength training can improve blood glucose control and reduce the risk of chronic diseases and death by increasing muscle strength and endurance, especially for postmenopausal women and overweight/obese elderly. Traditional exercises, such as Taijiquan and Baduanjin, are important interventions of rehabilitation in traditional Chinese medicine, which have definite effect in improving balance, cognition and memory, and are worthy of clinical promotion and application. At present, how to choose the best form of exercise rehabilitation and the best course of treatment for people with different functional disorders and different disease status remains to be further clarified by follow-up clinical and basic research.

KEY WORDS exercise rehabilitation; functional level; cardiorespiratory fitness; physical fitness

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