太极拳可改善老年人与年龄相关的躯体感觉和姿势控制能力下降

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摘要：目的：本研究旨在探讨 16 周太极拳练习对不同年龄组老年人力量、触觉、运动觉及静态姿势控制的影响，填补当前研究中针对 80 岁以上老年人群体数据不足以及缺乏不同年龄组间太极拳效果差异比较的空白。**方法：**通过在当地社区发放宣传资料的方式招募 39 名老年人，按照年龄分为三组，分别为 60-69 岁组（13 人）、70-79 岁组（13 人）、80-89 岁组（13 人）。在 2019 年 8 月至 12 月期间，由一名专业太极拳教练对参与者进行每周 4 次，每次 1 小时的 16 周太极拳教学。每次练习均包含 10 分钟热身、20-40 分钟动作学习或练习以及 10 分钟放松环节。分别在练习前（第 0 周）和练习后（第 17 周）对参与者的肌肉力量、足底触觉、运动觉及静态姿势控制能力进行测量。采用 IsoMed 2000 等速肌力测试仪测量参与者髋关节外展和踝关节跖屈/背屈的肌肉力量；使用 Semmes-Weinstein 单丝测量参与者的足底触觉，测试部位包括大脚趾、第一和第五跖骨、足弓和足跟；采用本体感觉测试设备评估参与者膝关节屈伸和踝关节跖屈/背屈的运动觉；采用 KISTLER 测力台测量并计算参与者前后和内外方向的压力中心均方根，以此反映姿势控制能力。采用 Shapiro-Wilk test 检验所有结局变量的正态性。对于符合正态分布的数据采用 two-way ANOVA；对于非正态分布的数据采用 Scheirer-Ray-Hare 检验。适当时，采用 Bonferroni 校正的分层 t 检验进行事后检验。采用 Cohen's d 评估效应量。所有分析均使用 SAS 9.4 软件进行，显著性水平设定为 0.05。**结果：**最终 37 名参与者完成研究，其中 60-69 岁组 13 人（女性 7 人），70-79 岁组 11 人（女性 7 人），80-89 岁组 13 人（女性 8 人）。Shapiro-Wilk test 检验结果显示，足底触觉数据呈非正态分布，肌肉力量、运动觉和压力中心均方根数据呈正态分布，因此分别采用 Scheirer-Ray-Hare 检验和 two-way ANOVA 进行后续数据分析。肌肉力量方面，相对峰值扭矩结果显示，干预前后所有参与者的肌肉力量均显著增加；踝关节跖屈、背屈和髋关节外展存在显著的组别效应，具体表现为与 60-69 岁组相比，80-89 岁组的踝关节跖屈、背屈和髋关节外展峰值力矩更低；与 70-79 岁组相比，80-89 岁组的踝关节跖屈峰值扭矩更低;70-79 岁组的踝关节背屈峰值扭矩低于 60-69 岁组。在足底触觉方面，第五跖骨存在显著的组别-练习交互作用，具体表现为 80-89 岁

组干预前后触觉阈值降低,60-69 岁组和 70-79 岁组无明显变化；所有参与者干预前后足弓和足跟的触觉阈值均降低；未检测到足底触觉阈值的组别效应。运动觉阈值结果显示，踝关节跖屈和背屈存在显著的组别-练习交互作用，干预前后 80-89 岁组的运动觉阈值显著降低；膝关节屈伸运动觉阈值存在显著的练习效应，所有组别干预前后运动觉阈值均显著降低;踝关节跖屈和背屈存在显著的组别效应，具体表现为 80-89 岁组的踝关节跖屈运动觉阈值高于 60-69 岁组和 70-79 岁组，80-89 岁组的踝关节背屈运动觉阈值高于 60-69 岁组和 70-79 岁组。静态姿势控制方面，压力中心均方根分析结果显示，内外方向压力中心均方根存在显著的组别-练习交互作用，表现为 80-89 岁组干预前后内外方向压力中心均方根显著降低，60-69 岁组和 70-79 岁组无明显变化;未检测到压力中心均方根的组别主效应。**结论：**本研究证实了 80 岁以上老年人的力量和运动觉能力比 60-80 岁老年人更差。太极拳练习可提高老年人的力量、触觉、运动觉和静态姿势控制能力，还能为 80 岁以上老年人带来额外的远端躯体感觉改善，这种改善可能减少姿势晃动，并在一定程度上抵消与年龄相关的功能下降。太极拳是 80 岁以上老年人安全的运动选择，有助于改善其感觉运动控制能力。本研究不仅填补了当前太极拳研究中针对 80 岁以上老年人群体数据不足和不同年龄组效果比较缺失的空白，还为老年人运动干预方案的制定提供了科学依据，在预防老年人跌倒方面具有重要的潜在应用价值。

关键词：太极拳；老年人；感觉运动控制；姿势控制；跌倒预防

Tai Chi Improves Age-Related Declines in Somatosensory Function and Postural Control in Older Adults

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Abstract: Objective: This study was designed to investigate the effects of 16 weeks of Tai Chi training on strength, tactile sensation, kinesthesia, and static postural control in older adults across distinct age strata. It further sought to address critical gaps in the current literature, specifically the paucity of data on adults aged 80 years and above, as well as the absence of comparative analyses regarding the efficacy of Tai Chi across different age groups. **Methods:** Thirty-nine older adults were recruited via distribution of promotional materials in local communities and stratified into three age groups: 60–69 years (n=13), 70–79 years (n=13), and 80–89 years (n=13). From August to December 2019, a certified Tai Chi instructor delivered 16 weeks of Tai Chi training (4 sessions/week, 1 hour/session). Each session comprised a

10-minute warm-up, 20–40 minutes of movement instruction/practice, and a 10-minute cool-down. The participants' muscle strength, plantar tactile sensation, kinesthesia, and static postural control ability were measured before the practice (Week 0) and after the practice (Week 17), respectively. Muscle strength of hip abduction and ankle plantarflexion/dorsiflexion was measured using an IsoMed 2000 isokinetic dynamometer; plantar tactile sensation of the participants was assessed with Semmes-Weinstein monofilaments, with test sites including the big toe, first and fifth metatarsals, arch, and heel; kinesthesia of knee flexion/extension and ankle plantarflexion/dorsiflexion was evaluated using a proprioception testing device; the root mean square (RMS) of the center of pressure (COP) in the anteroposterior and mediolateral directions was measured and calculated with a KISTLER force platform to reflect postural control ability. The Shapiro-Wilk test was employed to test the normality of all outcome variables. Two-way ANOVA was utilized for normally distributed data, and the Scheirer-Ray-Hare test for non-normally distributed data. Post-hoc analyses (stratified t-tests with Bonferroni correction) were performed as needed. Effect size was quantified via Cohen’s d. All analyses were conducted in SAS 9.4, with $\alpha = 0.05$. **Results:** Thirty-seven participants completed the study protocol, stratified as follows: 60–69 years (n=13, 7 females), 70–79 years (n=11, 7 females), and 80–89 years (n=13, 8 females).The Shapiro-Wilk test was used to assess the normality of outcome variables, revealing that plantar tactile sensation data exhibited a non-normal distribution, whereas those of muscle strength, kinesthesia, and the root mean square (RMS) of the center of pressure (COP) conformed to a normal distribution. Therefore, the Scheirer-Ray-Hare test and two-way analysis of variance (ANOVA) were employed for subsequent data analyses, respectively. For muscle strength, relative peak torque data demonstrated a significant increase in muscle strength across all participants pre- to post-intervention. Significant group main effects were observed for ankle plantarflexion, ankle dorsiflexion, and hip abduction: the 80–89 years group exhibited lower peak torques in ankle plantarflexion, ankle dorsiflexion, and hip abduction relative to the 60–69 years group; the 80–89 years group had lower ankle plantarflexion peak torque in comparison to the 70–79 years group; and the 70–79 years group showed lower ankle dorsiflexion peak torque when compared with the 60–69 years group. For plantar tactile sensation, a significant group-by-intervention interaction was observed at the fifth metatarsal: the 80–89 years group exhibited a significant reduction in tactile threshold pre- to post-intervention, whereas no significant changes were observed in the 60–69 years and 70–79 years groups. All participants demonstrated a significant reduction in tactile thresholds at

the arch and heel post-intervention, and no significant group main effect on plantar tactile thresholds was identified. For kinesthesia thresholds, significant group-by-intervention interactions were observed for ankle plantarflexion and dorsiflexion, with the 80–89 years group exhibiting a significant reduction in kinesthesia threshold pre- to post-intervention. A significant intervention effect was noted for knee flexion/extension kinesthesia threshold, as all groups demonstrated a significant decrease in kinesthesia threshold post-intervention. Significant group main effects were identified for ankle plantarflexion and dorsiflexion: the 80–89 years group had significantly higher kinesthesia thresholds in ankle plantarflexion and dorsiflexion relative to both the 60–69 years and 70–79 years groups. For static postural control, analysis of the root mean square (RMS) of the center of pressure (COP) revealed a significant group-by-intervention interaction in the mediolateral direction: the 80–89 years group exhibited a significant decrease in mediolateral COP RMS pre- to post-intervention, whereas no significant changes were observed in the 60–69 years and 70–79 years groups. No significant main group effect on COP RMS was identified. **Conclusion:** This study provides evidence confirming that the strength and kinesthetic abilities of adults aged 80 years and above are inferior to those of adults aged 60–80 years. Tai Chi training exerts a beneficial effect on improving older adults' strength, tactile sensation, kinesthesia, and static postural control. It further yields additional enhancements in distal somatosensory function for adults aged 80 years and above—these enhancements may mitigate postural sway and partially counteract age-related functional decline. Tai Chi represents a safe exercise modality for adults aged 80 years and above, which contributes to the enhancement of their sensorimotor control. This study not only addresses the gaps in current Tai Chi-related research, including the paucity of data on adults aged 80 years and above and the absence of comparative analyses regarding the efficacy of Tai Chi across different age groups, but also establishes a scientific foundation for developing exercise intervention programs for older adults. Additionally, it holds significant potential utility in fall prevention among older adults.

Keywords: Tai Chi; Older Adults; Sensorimotor Control; Postural Control; Fall Prevention

分论坛 2：太极拳对心理健康的干预效果及机制研究