

轻度认知障碍老年人一次急性新型改良气功运动的底物代谢变化特征研究

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摘要: **研究目的:** 本研究探讨了泰国孔敬大学 (KKU) 新型改良气功 (KKQ) 运动对轻度认知障碍的老年人一次急性运动的基质代谢变化特征研究, 通过间接测热法测量认知障碍老年人练习一次急性气功的底物代谢指标变化, 分析 KKU 气功运动对脂肪氧化速度和碳水化合物的氧化速率产生的影响, 并探讨气功练习对认知障碍老年人身体代谢方面的潜在效应。为有轻度认知障碍老年人运动锻炼供科学指导, 同时也为孔敬大学新型改良气功的推广发展和科学研究提供数据支撑, 推动这项气功的发展。**研究方法:** 研究招募的受试者共计 60 人 (66.07 ± 4.28 years old), 随机平均分成两组, KKU 气功组 (KQG) 和对照组 (CG), 在实验开始前, 所有受试者经过身体健康评估, 以确保他们没有严重的健康问题, 适合进行 KKU 气功运动。所有受试者接受了口头说明并签署知情同意书。根据蒙特利尔认知评估 (MoCA), 总分为 30 分, 26 分或以上为正常。得分低于 26 分被认为是轻度认知障碍来对受试者进行筛选, 筛选后(KQG 组=22 人), (CG 组=23 人), KQG 组受试者佩戴呼吸气体分析仪(Oxycon mobile V-707270 SBx, Germany)进行 30 分钟的 KKU 气功练习, CG 组进行 30 分钟静坐读书。实验收集气功运动前, 气功运动过程 (30min) 和气功运动后恢复 30 分钟的数据: oxygen uptake (VO₂), carbon dioxide output (VCO₂)、RER、Heart Rate(beats · min⁻¹)。计算并比较能量消耗指标 (能量消耗速率、能量消耗) 及底物代谢指标 (碳水化合物消耗速率、脂肪氧化速度、供能比例、消耗量), 使用重复测量方差分析对数据进行分析。**研究结果:** 1 本研究中, 连续进行 KKU 气功练习时的心率分别是, 5min (104.24±23.24 次/分), 10min (103.40±19.55 次/分), 15min (99.58±14.65 次/分), 20min (99.38±14.03 次/分), 25min (102.82±18.98 次/分), 30min (102.67±18.61 次/分), 恢复时 5min (91.28±12.95)。以往研究称, 安静心率在 119 次/分以下为低强度, 120-149 次/分之间为中等强度。KKU 气功练过程中, 心率范围是 92.4 beat/min-----107.8 beat/min 因此, KKU 气功属于低强度运动。

2 KKU 气功运动对认知障碍老年人底物代谢的影响: Fat oxidation rate (g/min), 在 KKU 气功练习过程中先上升再下降, 气功组 (KQG) 对比对照组(CG), 在气功练习的 5min,10min. 和恢复时的 5min 具有显著性, ($P<0.05$), Carbohydrate oxidation rate (g/min), 在整个 KKU 气功练习过程中 KQG 始终高于 CG, 并且对比对照组, 在练习的 5-30 分钟过程中, 均有显著性 ($P<0.05$)。KKU 气功组 RER 数据先降低后升高, KKU 气功练习开始的前 10 分钟, 我们观察到 RER 值为 0.88, 这表明身体主要依赖脂肪氧化来提供能量, 处于脂肪代谢为主的状态。这是因为在低强度运动初期, 身体主要通过有氧代谢从脂肪储备中释放脂肪酸, 然后进行脂肪氧化以满足能量需求。然而, 随着气功练习的进行, RER 值逐渐增加, 接近 1.0。这意味着身体开始更多地依赖碳水化合物氧化来提供能量, 而脂肪氧化速率相对下降。3 KKU 气功练习一遍的时间是 15min,我们在 30 分钟的练习过程中进行 2 遍 KKU 气功重复练习。研究发现, 练习第二遍时的脂肪氧化速度显著低于练习第 1 遍。我们分析, 造成这种情况的原因主要是由于练习第一遍时身体刚进入运动状态, 而连续练习第二遍时, 身体状态趋于稳定, 因此连续练习第二遍的能耗低于第 1 遍。4 KKU 气功组组内对比 Fat oxidation rate (g/min)和 Carbohydrate oxidation rate (g/min), 结果显示在 KKU 气功练习的 30 分钟内, 除了基线数据, 其余时间点均具有显著性 ($P<0.05$), 由此可见, 低强度的有氧气功练习中, 身体主要依赖有氧代谢来供应能量。在低强度 30 分钟的急性气功练习中, 由于运动强度不高, 脂肪氧化速率可能相对较高, 但碳水化合物氧化速率更高。这导致了底物利用率中碳水化合物的占比较大。这表明在急性气功练习过程中, 认知障碍老年人更倾向于利用碳水化合物作为主要的能源来源。 **研究结论:** 1 KKU 气功属于低强度的有氧运动.2 在 KKU 气功 30 分钟的急性练习过程中, 练习第一遍比练习第二遍脂肪氧化速度更快, 这可能与身体在第一遍练习时更加适应运动状态有关。这一发现为进一步研究气功练习的长期效应和训练适应性提供了线索。3 对于急性 30 分钟的低强度 KKU 气功练习, 碳水化合物氧化速度大于脂肪氧化速度, 碳水化合物能够更高效地提供能量, 适合满足低强度、持续较短时间的运动需求。身体会根据运动强度和时长来调整底物利用率, 以满足不同的能量需求。4 急性新型改良气功运动对于轻度认知障碍的老年人来说, 其底物代谢有显著的影响。气功练习可显著提高碳水化合物氧化速率, 而脂肪氧化速率相对较少受到影响。这表明气功运动在认知障碍老年人身体代谢方面可能具有积极的效应, 为认知障碍管理和预防提供了潜在的非药物干预途径。

关键词: 底物利用率, 认知障碍, 老年人, 气功

A Study on the Characteristics of Substrate Metabolism Changes in Mild Cognitive Impairment Elderly During Acute Novel Modified Qigong Exercise

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Abstract: Research Purpose: This study aimed to investigate the substrate metabolism changes in elderly individuals with mild cognitive impairment during acute exercise of a novel modified Qigong (KKQ) at Khon Kaen University (KKU) in Thailand. The study utilized indirect calorimetry to measure the changes in substrate metabolism indicators of elderly individuals with cognitive impairment after a single acute Qigong exercise. The effects of KKU Qigong exercise on the rates of fat oxidation and carbohydrate oxidation were analyzed, and the potential metabolic effects of Qigong practice in elderly individuals with cognitive impairment were explored. The research aims to provide scientific guidance for exercise training in elderly individuals with mild cognitive impairment and to support the promotion and development of the novel modified Qigong at Khon Kaen University, contributing to the advancement of this Qigong practice through scientific research. **Research Method:** A total of 60 participants (66.07 ± 4.28 years old) were recruited for the study and randomly divided into two groups: the KKU Qigong Group (KQG) and the Control Group (CG). Prior to the experiment, all participants underwent a physical health assessment to ensure they did not have any significant health issues and were suitable for KKU Qigong exercise. All participants received verbal instructions and signed informed consent forms. The Montreal Cognitive Assessment (MoCA) was used to assess cognitive function, with a total score of 30 points, and a score of 26 or above was considered normal. Participants with scores below 26 were identified as having mild cognitive impairment and selected for the study. After screening, the KQG group consisted of 22 participants, and the CG group consisted of 23 participants. In the KQG group, participants wore a respiratory gas analysis device (Oxycon mobile V-707270 SBx, Germany) during a 30-minute KKU Qigong exercise session, while the CG group engaged in 30 minutes of sedentary reading. Data were

collected before the Qigong exercise, during the exercise (30 minutes), and during a 30-minute recovery period after the exercise. Parameters measured included oxygen uptake (VO_2), carbon dioxide output (VCO_2), respiratory exchange ratio (RER), and heart rate (beats per minute). Energy expenditure indices (energy expenditure rate, total energy expenditure) and substrate metabolism indices (carbohydrate oxidation rate, fat oxidation rate, energy substrate contribution ratio, and consumption) were calculated and compared between the two groups. The data were analyzed using repeated measures analysis of variance (ANOVA).

Research Results:

1. In this study, the heart rate during continuous KKU Qigong exercise was as follows: 5 minutes (104.24 ± 23.24 beats/min), 10 minutes (103.40 ± 19.55 beats/min), 15 minutes (99.58 ± 14.65 beats/min), 20 minutes (99.38 ± 14.03 beats/min), 25 minutes (102.82 ± 18.98 beats/min), 30 minutes (102.67 ± 18.61 beats/min), and 5 minutes during recovery (91.28 ± 12.95 beats/min). Previous research has defined heart rates below 119 beats/min as low-intensity and 120-149 beats/min as moderate-intensity. The heart rate range during KKU Qigong exercise was 92.4 beats/min to 107.8 beats/min, indicating that KKU Qigong belongs to low-intensity exercise.
2. The impact of KKU Qigong exercise on substrate metabolism in elderly individuals with cognitive impairment: Fat oxidation rate (g/min) showed an initial increase followed by a decrease during KKU Qigong exercise, and the differences between the KKU Qigong Group (KQG) and the Control Group (CG) were significant at 5 minutes, 10 minutes, and 5 minutes during recovery ($P < 0.05$). Carbohydrate oxidation rate (g/min) remained higher in KQG compared to CG throughout the KKU Qigong exercise, and significant differences were observed between the two groups during the 5-30 minutes of exercise ($P < 0.05$). RER data in KQG decreased initially and then increased during the exercise. At the start of KKU Qigong exercise, the RER value was 0.88, indicating a predominant reliance on fat oxidation for energy supply during the initial phase of low-intensity exercise. As the exercise progressed, the RER value gradually increased, approaching 1.0, signifying a shift towards greater reliance on carbohydrate oxidation for energy supply, with a relative decline in fat oxidation rate.
3. The KKU Qigong exercise was performed twice consecutively during the 30-minute exercise session. The study found that the fat oxidation rate during the second Qigong exercise was significantly lower than during the first exercise. This was attributed to the fact that the body was in an already activated state during the first exercise, while during the second consecutive exercise, the body's metabolic state tended to stabilize,

leading to a lower energy expenditure during the second exercise.⁴ Within the KKU Qigong Group, significant differences were observed in Fat oxidation rate (g/min) and Carbohydrate oxidation rate (g/min) during the 30-minute KKU Qigong exercise, except for the baseline data ($P < 0.05$). This indicates that during low-intensity aerobic Qigong exercise, the body primarily relies on aerobic metabolism for energy supply. In the acute 30-minute Qigong exercise, the fat oxidation rate may be relatively high due to the low exercise intensity, but the carbohydrate oxidation rate is even higher. This results in a larger proportion of carbohydrates in substrate utilization. This suggests that elderly individuals with cognitive impairment tend to utilize carbohydrates as their primary energy source during acute Qigong exercise.

Research Conclusion: 1. KKU Qigong belongs to low-intensity aerobic exercise. 2. During the 30-minute acute KKU Qigong exercise, the fat oxidation rate was faster in the first exercise session compared to the second exercise session. This finding may be attributed to the body's better adaptation to the exercise during the first session. This discovery provides valuable clues for further investigating the long-term effects and training adaptability of Qigong practice. 3. In the acute 30-minute low-intensity KKU Qigong exercise, the carbohydrate oxidation rate was higher than the fat oxidation rate, indicating that carbohydrates can more efficiently provide energy, making them suitable for meeting the energy demands of low-intensity and short-duration exercises. The body adjusts substrate utilization according to exercise intensity and duration to meet different energy demands. 4. Acute exercise of the novel modified Qigong has significant effects on substrate metabolism in elderly individuals with mild cognitive impairment. Qigong practice significantly increases carbohydrate oxidation rate, while the fat oxidation rate is relatively less affected. This suggests that Qigong exercise may have positive effects on the body's metabolism in elderly individuals with cognitive impairment, providing a potential non-pharmacological intervention approach for cognitive impairment management and prevention.

Key words: Substrate metabolism, mild cognitive impairment, Older Adults, Qigong