

第十三篇：

Effects of Inline Skating Exercise on Symptoms, Executive Functions, and Motor Proficiency in Children With ADHD: A Randomized Controlled Trial

## 論文研究目的彙整

本研究的核心目的在於透過隨機對照試驗（RCT），系統性地評估一項為期12週的直排輪介入計畫，對 6 至 12 歲 ADHD 兒童在多個發展面向的影響。

明確的研究目標包含以下三大重點：

- 評估執行功能（Executive Functions, EFs）的改善情況：這是本研究的主要成效指標（Primary Outcome）。研究重點在於觀察直排輪運動是否能提升 ADHD 兒童的抑制控制（Inhibition）與空間工作記憶（Spatial Working Memory）。
  - 評估 ADHD 核心症狀與動作熟練度的變化：這兩項為本研究的次要成效指標（Secondary Outcomes）。
    - ADHD 症狀：探討直排輪運動是否能緩解由家長報告的過動、衝動及注意力不集中等核心症狀。
    - 動作熟練度（Motor Proficiency）：檢測介入是否能提升精細動作控制、身體協調、手部協調、力量與靈敏度。
  - 驗證介入成效的長期維持性：研究旨在確認在 12 週的介入結束後，所產生的正面影響是否能持續至少 12 週。
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## 研究假設 (Hypotheses)

研究團隊基於上述目的提出了兩項假設：

1. 為期 12 週的直排輪介入將顯著改善 ADHD 兒童的症狀、執行功能與動作熟練度。
2. 在主要分組的 ADHD 兒童中，這些介入效果將能維持至少 12 週。

這項研究補足了過去對於直排輪在 ADHD 族群中治療潛力研究的不足，尤其是結合了有氧運動、認知需求與動作挑戰的獨特特性。

以下為具體的研究結果彙整與原文引用：

### 1. ADHD 核心症狀的改善

- **結果描述：**介入後，介入組（IG）在 ADHD 症狀量表（ADHD Quotient）的得分顯著下降（代表症狀改善），且明顯優於等待對照組（CG）。當對照組在第二階段接受介入後，症狀也得到顯著改善。

- **原文引用：**

"After the intervention, improvements in ADHD symptoms were observed in the IG in comparison with the wait-list CG ( $F=4.59, p=0.043$ ). " "The ADHD quotient at Time 3 differed significantly in the wait-list CG compared with that of at Time 2 (intervention condition;  $t=7.06, p<0.001$ , Cohen's  $d=0.56$ )."

### 2. 執行功能（Executive Functions, EFs）的提升

- **結果描述：**直排輪訓練顯著提升了 ADHD 兒童的抑制控制能力（Stroop 測驗得分增加）以及空間工作記憶（SWM 錯誤減少、策略運用提升）。

- 原文引用：

"Follow-up of the simple main effect revealed improvements on the EFs of the IG (higher color-word scores,  $F=125.17, p<0.001$ ; fewer total errors,  $F=65.53, p<0.001$ ; more favorable strategy utilization,  $F=75.94, p<0.001$ ) after the intervention." "The performance was better in the IG than in the wait-list CG after the intervention (color-word,  $F=15.98, p=0.001$ ; total errors,  $F=5.93, p=0.023$ ; strategy utilization,  $F=5.17, p=0.033$ )."

### 3. 動作熟練度（Motor Proficiency）的增進

- **結果描述：**介入組在總體動作能力（TMC）、精細動作控制（FMC）、手部協調（MC）、身體協調（BC）以及力量與靈敏度（SA）上均表現出顯著進步。

- 原文引用：

"IG had a significantly higher score after the intervention compared with Time 1 (TMC,  $F=17.40, p=0.002$ ; FMC,  $F=19.56, p=0.001$ ; MC,  $F=22.30, p=0.001$ ; BC,  $F=40.29, p<0.001$ ; SA,  $F=128.66, p<0.001$ ). "the IG had a significantly better performance on TMC ( $F=7.02, p=0.015$ ), MC ( $F=10.69, p=0.004$ ), BC ( $F=7.68, p=0.011$ ), and SA ( $F=9.95, p=0.005$ ) after the intervention compared with the wait-list CG."

### 4. 介入成效的維持（Sustainability）

- **結果描述：**介入結束 12 週後（追蹤期），所有改善的指標均能維持穩定，並未出現顯著衰退。

- 原文引用：

"Moreover, the effects appeared to be sustained for at least 12 weeks." "For IG, a comparison between Time 2 and Time 3 revealed no significant difference in BOT-2 outcomes, suggesting that intervention effects were sustained." "The results indicated that the intervention improved the children's symptoms, EFs, and motor proficiency and that improvements in children with ADHD could persist in the long term."

根據本研究的目的與實驗結果，論文內文及摘要彙整出的相關**結論**如下：

## 1. 直排輪作為 ADHD 介入方案的可行性與益處

研究提供初步證據顯示，直排輪是一項可行且有效的身體活動介入方式，能改善 ADHD 兒童的症狀、執行功能與動作表現。

- 原文引用：

"This RCT provides preliminary evidence that inline skating may be a feasible and beneficial PA intervention for children with ADHD." "Inline skating exercise seems to represent a feasible way of improving EFs, symptoms, and motor proficiency in children with ADHD who may not feel comfortable in an organized or competitive atmosphere."

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## 2. 介入成效的全面性

研究結論指出，為期 12 週的直排輪訓練能有效減輕 ADHD 的核心症狀，並顯著提升兒童在抑制控制、空間工作記憶以及各項動作熟練度指標上的表現。

- 原文引用：

"The results indicated that the intervention improved the children's symptoms, EFs, and motor proficiency..." "Children with ADHD in the current study demonstrated improved symptoms, EFs, and motor proficiency (all  $p < 0.05$ ) after 12-week inline skating intervention."

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### 3. 成效的長期持續性

研究強調，直排輪運動所帶來的正面影響不僅限於訓練期間，其效果在停止訓練後仍可維持至少 12 週。

- 原文引用：

"Inline skating intervention seems to have long-term beneficial effects in children with ADHD." "Moreover, the effects appeared to be sustained for at least 12 weeks."

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### 4. 效應強度的客觀評估

雖然研究結果具有統計學上的顯著意義，但結論也謹慎地提到，部分測量指標的改善幅度（Effect Size）屬於中等至微小。

- 原文引用：

"While the observed improvements in ADHD symptoms, EFs, and motor proficiency were statistically significant, the magnitude of change was moderate to small in some measures."

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### 5. 未來研究方向

由於本研究規模較小，研究者結論建議未來需要更大規模的研究來進一步評估直排輪的長期療效與實務意義。

- 原文引用：

"However, larger studies are needed to further evaluate its long-term efficacy." "Future research should examine long-term follow-ups, larger samples, and additional measures of functional impact to better assess the practical significance of these changes."

## 研究限制彙整

- **受試者樣本侷限性**：樣本數較小（n=24），且研究對象僅限於 6 至 12 歲的國小**男性**學童，這限制了結果推廣至不同年齡層或女性學童的可能性。

"First, our participants comprised only elementary school children, with limitations in terms of sample size (n=24), age range (6 – 12 years), and gender (male)."

- **藥物使用未受控**：研究過程中並未嚴格控制受試者的藥物使用情況，也未追蹤在實驗結束前藥物狀態是否發生變動。

"Second, we did not control for medication use and whether medication status changed for any of the participant before the endpoint."

- **評估工具數量有限**：對於執行功能與動作熟練度的評估僅限於三項測驗（BOT-2, SCWT, SWM），可能無法全面捕捉 ADHD 兒童的所有細微變化。

"Third, our assessment of motor proficiency and EFs was limited to only three tests: BOT-2, SCWT, and SWM."

- **運動強度缺乏監測：**研究中並未具體測量或記錄學童在進行直排輪運動時的實際生理運動強度。

"Fourth, the exercise intensity of inline skating exercise was not measured."

- **對照組設計的侷限：**研究使用了「待介入對照組」（Wait-list control group），但若與「其他運動項目組」進行比較，將更能確認直排輪的獨特療效。

"Fifth, a more appropriate CG (e.g., a different sport) should be considered."

- **症狀評估的主觀偏誤：**ADHD 症狀的嚴重程度僅透過家長報告來評估，這可能存在評分者的主觀偏見。

"Sixth, ADHD symptom severity was assessed solely through parent reports, which may be prone to rater bias."

- **臨床意義的侷限性：**雖然結果具備統計顯著性，但實際效應值（Effect sizes）並不夠大，這暗示其臨床相關性可能有限。

"Finally, the actual effect sizes are not large, which suggests limited clinical relevance."

## 學術意義與價值 (Academic Significance/Value)

- **填補研究空白：**過去關於直排輪的研究多聚焦於一般發展兒童，本研究彌補了直排輪在 ADHD 族群治療潛力探討上的不足。

"Although various physical activities have demonstrated benefits for children with ADHD, inline skating remains underexplored in this population. Prior studies have mainly focused on TD children [22], leaving a gap in understanding its therapeutic potential."

- **支持動作與認知發展的關聯理論**：本研究驗證了動作技巧掌握與執行功能進步之間的正向聯繫，為「以動作為基礎的介入」提供了理論支持。

"This inline skating training program is based on the rationale that motor skills mastery has a positive link to executive functioning..."

- **提供隨機對照試驗 (RCT) 之初步證據**：透過嚴謹的 RCT 設計，為直排輪改善 ADHD 症狀、執行功能與動作熟練度提供了初步且具科學基礎的實證。

"This RCT provides preliminary evidence that inline skating may be a feasible and beneficial PA intervention for children with ADHD."

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## 臨床應用意義與價值 (Clinical Application/Value)

- **作為整合性的替代或輔助療法**：直排輪結合了有氧運動、認知需求與動作挑戰，能同時針對 ADHD 兒童的多重缺陷（症狀、執行功能、動作技能）進行介入。

"Physical activities have been recognized as a promising alternative or adjunctive treatment, as they are often associated with improvements in symptoms, EFs, and motor skills in individuals with ADHD."

- **高動機與心理益處**：直排輪具備新奇感與「刺激因素」（thrill factor），能吸引容易因單調任務而分心的 ADHD 兒童，進而提高參與動機與練習持續性。

"Unlike more conventional sports, inline skating has a novelty and thrill factor that appeals to children with ADHD, who often struggle with task persistence."

- **環境限制低且具高度可行性**：直排輪場地限制較少，且運動強度可根據個體需求靈活調整，非常適合作為社區或學校推廣的運動介入項目。

"As such, inline skating exercise seems to represent a feasible way of improving EFs, symptoms, and motor proficiency in children with ADHD"



who may not feel comfortable in an organized or competitive atmosphere."

- **潛在的生理機制調節：**直排輪的節律性與動態特性可能有助於調節多巴胺與去甲腎上腺素水平，進而支持情緒調節與過動症狀的緩解。

"The activity's rhythmic and dynamic nature may support emotional regulation and reduce hyperactivity by regulating dopamine and norepinephrine levels."