

The Study of Joint Kinematics and Kinetics in Single-Leg Drop Landing (SDL) with and without Dual-Tasking and Ankle Tape Applied

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BACKGROUND

- SDL assesses biomechanical risk factors for ACL injuries (Fan et al., 2021)
- Ankle taping: common technique to reduce ankle sprain risk by 50-70% by restricting ankle range of motion (Zwiers et al., 2016)
- Changes in ankle ROM could alter lower limb biomechanics (Theisen & Day, 2019)
- Dual-tasking (DT) in sports involves cognitive-motor interference, adding neurocognitive load (Leone et al., 2017)
- Stroop test + SDL:
 - Increase peak knee internal rotation (IR) and peak ground reaction force (GRF) (Kajiwara et al., 2019)
 - Increase ACL injury risk
- The effects of ankle taping on lower limb biomechanics during SDL under dual-tasking remain underexplored

OBJECTIVES

- To examine the effects of ankle taping on the lower limb kinematics and kinetics during single-leg drop landing
- To investigate the interaction effects of ankle taping on the lower limb kinematics and kinetics during single-leg drop landing with or without the dual-task condition

METHODOLOGY

Participants: 24 healthy subjects

- Age: 25.6±3.65 years; BMI: 23.9±2.30 (mean ± SD)
- Participating in sports at least once/week, >1 hrs (Biese et al., 2018)

Dual-task

- Stroop Colour Word Test – SCWT (Giesche et al., 2019)
- Interference inhibitory control

IMUs x 7

- Hip, knee, ankle kinematics

Force Plate (FP)

- Vertical ground Reaction Force (vGRF)

Counterbalanced Conditions

- Simple SDL – no ankle taping and no dual-tasking (SDL)
- SDL with ankle taping (AT)
- SDL with dual-tasking (DT)
- SDL with ankle taping & dual-tasking (ATDT)

Two-way Repeated Measures ANOVA – Post Hoc Pairwise

- Taping X Tasking Interaction Effects

Ankle Taping

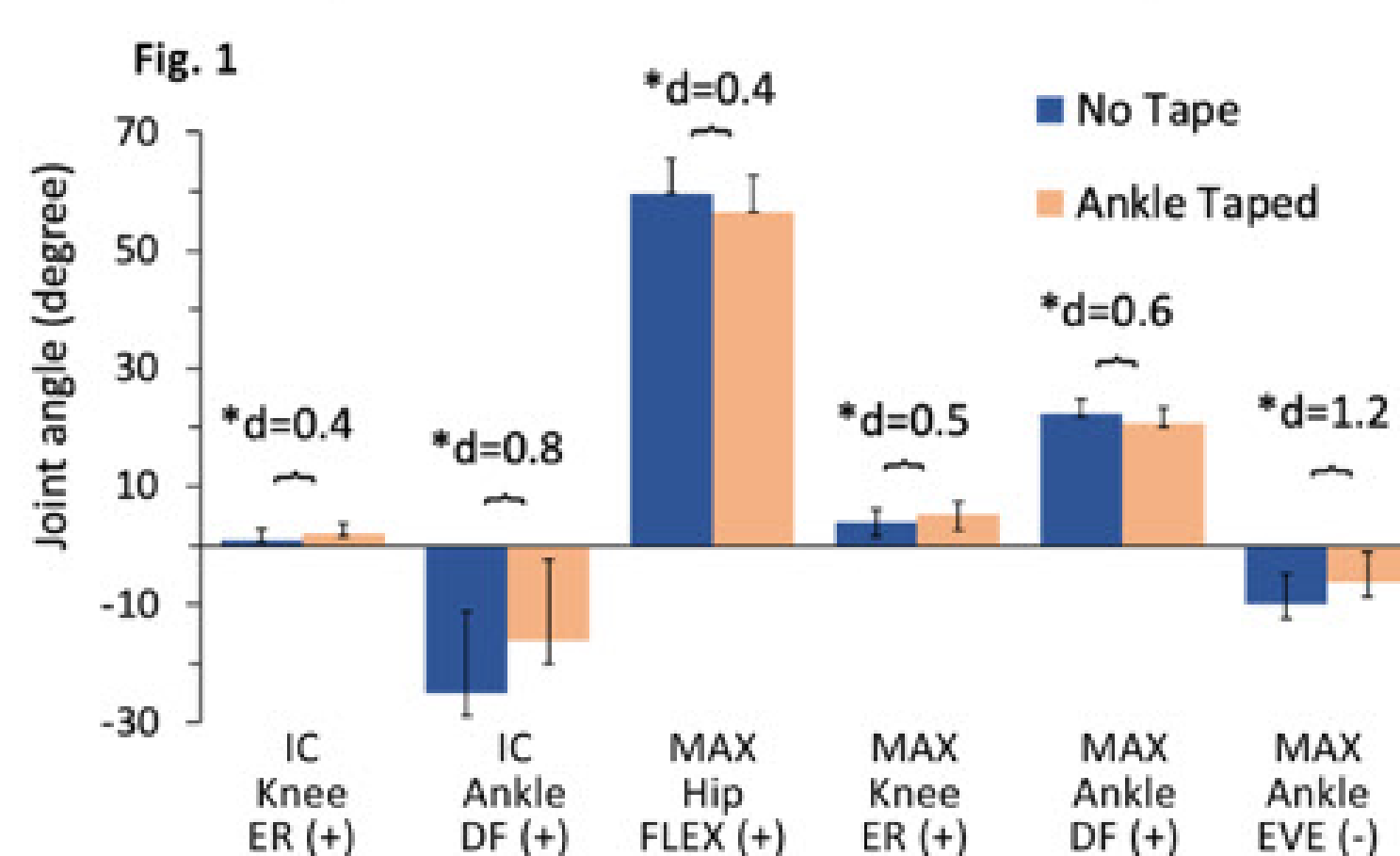
- Rigid tape 38mm



FINDINGS

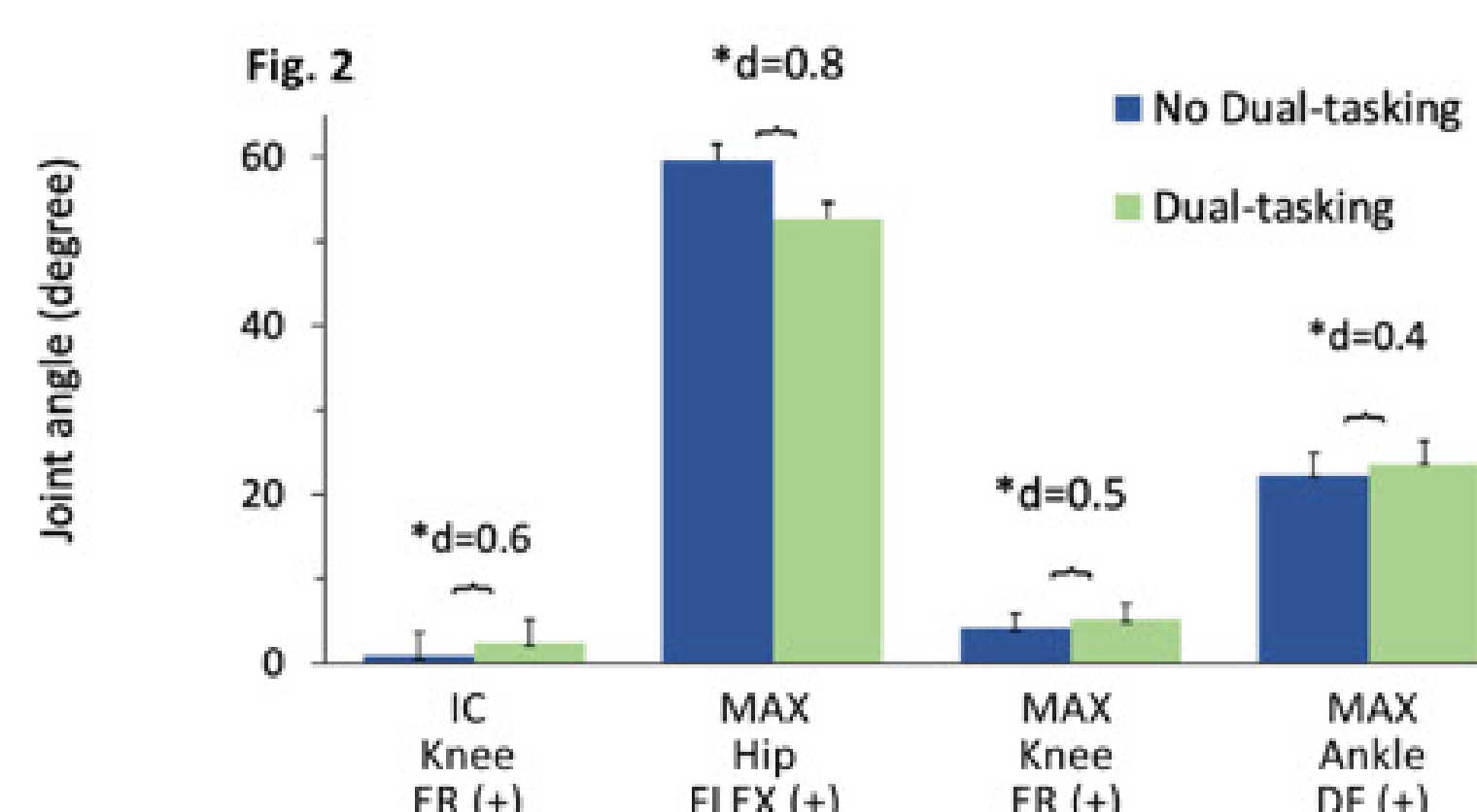
Comparison of Mean Values (P<0.05) between Taping and Dual-tasking Interaction at Initial contact (IC) or maximum (MAX) during Landing Phase (within 500ms post IC)

- Hip & knee abduction – No significant difference (p>0.05) across all conditions



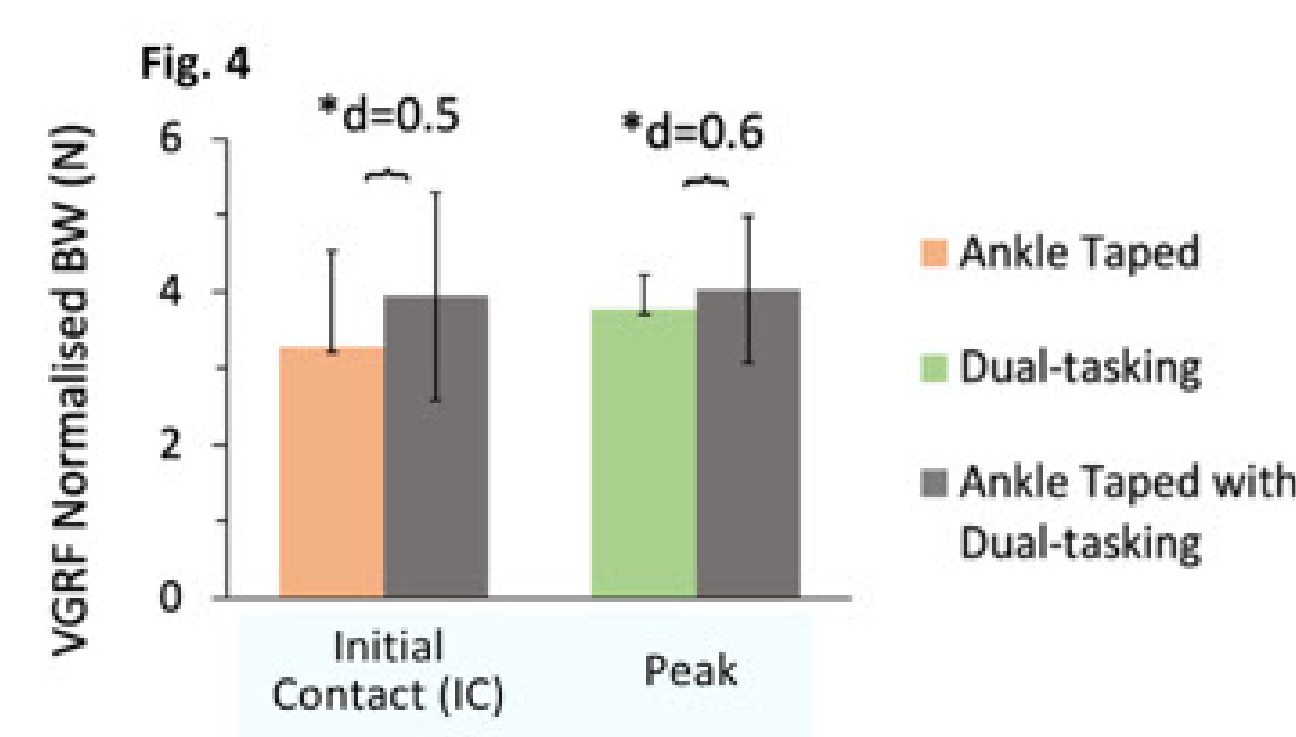
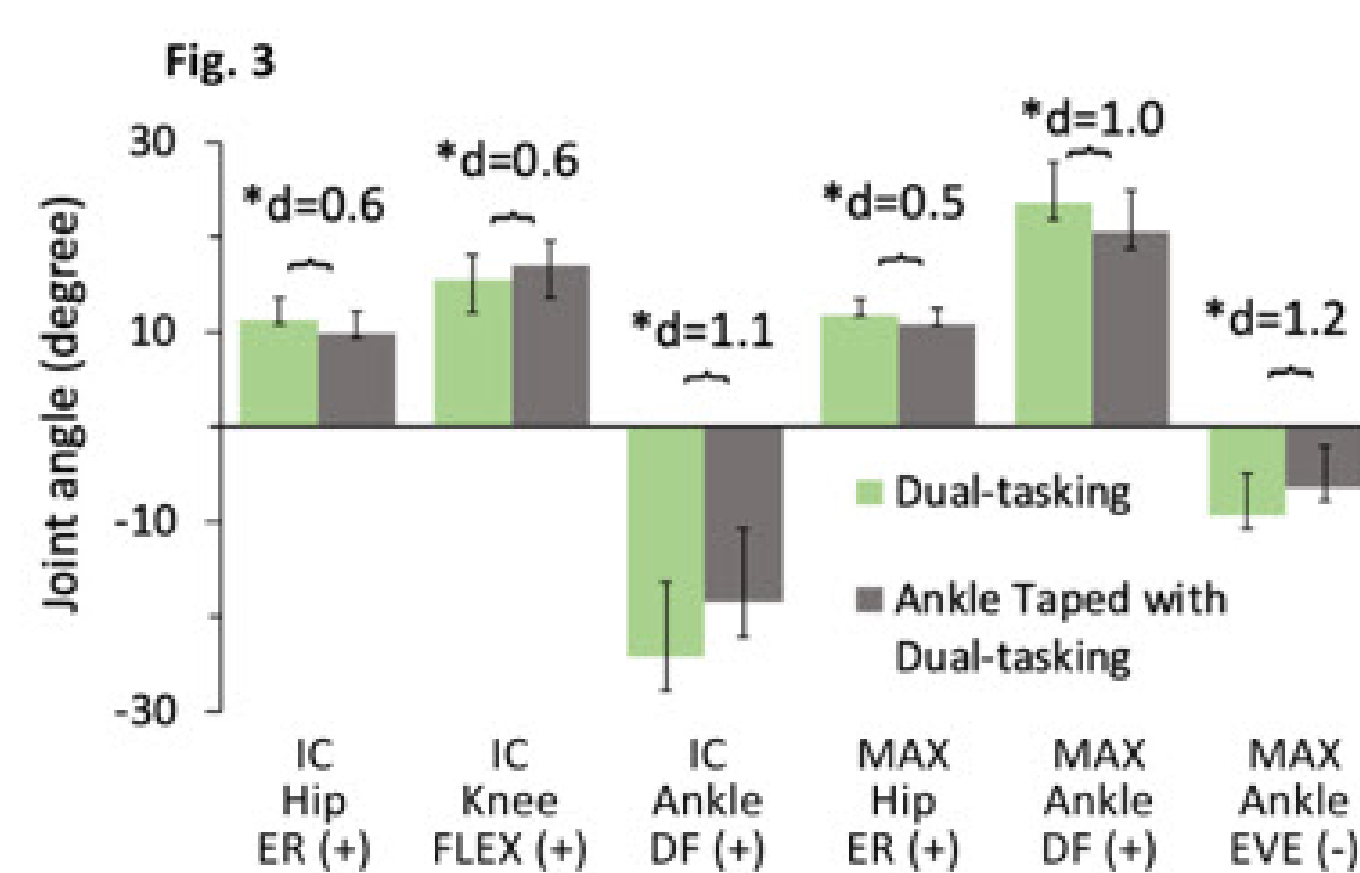
Ankle Taping (AT) compared to simple SDL (Fig. 1)

- Restricted max ankle ROM
- ↓ **MAX hip flexion** → ↑ Force to knee
- ↑ **Knee ER** → ↑ ACL injury risks (Santos et al., 2023)



Dual-tasking (DT) compared to simple SDL (Fig. 2)

- ↓ **Hip flexion** → ↑ Knee loading
- ↑ **Knee ER** → ↑ ACL injury risks (Santos et al., 2023)
- ↑ **Ankle dorsiflexion** for force dissipation



Note. IC = initial contact, MAX = maximum, ER = external rotation, FLEX = flexion, DF = dorsiflexion, EVE = eversion, *sig. diff (P < 0.05), error bar: 95% confidence interval, d = effect size (Cohen's d)

Dual-tasking with or without Ankle Taping (Fig. 3 & 4)

- **Ankle taping** ↑ **IC Knee flexion** & **IC ankle dorsiflexion**
 - Improved force dissipation at IC
- **Ankle taping** ↓ **MAX ankle dorsiflexion** & **eversion**
 - Restricted MAX ankle ROM
- **Ankle taping** ↑ **peak vGRF**
 - ↓ Force dissipation at MAX → ↑ Joint loading
- **Ankle taping** ↓ **IC & MAX hip ER**
 - Larger hip ER is associated with ACL injury (Ishida et al., 2021)
 - Reduce hip ER May protect against rotational ACL injury

Intraclass Correlation (ICC) across Trials:

- Excellent (0.9) – Knee abduction
- Good (0.7–0.8) – Hip flexion & abduction, knee external rotation (ER), ankle dorsiflexion, VGRF
- Moderate to good (0.6–0.7) – Hip ER, ankle inversion/eversion

CONCLUSION

- Both **ankle taping** and **dual-tasking** alter landing biomechanics
 - ↑ **Knee ER** compared to **simple SDL**
 - Potentially ↑ **ACL injury risks**

- **Ankle Taping** under **Dual-tasking**
 - ↓ **Hip ER** → Potentially ↓ **ACL injury risks**
 - ↑ **Peak vGRF** → ↑ **Joint loading**
 - Complex relationship regarding injury risks

- Training programs should incorporate **cognitive tasks** into **landing drills** for injury prevention
- **Training with ankle taped** (if necessary in game situation) and correct landing mechanism to **adapt altered biomechanics**
- Prioritise comprehensive landing **training programs** for **long-term injury prevention** over taping

REFERENCES

- Biese, K. M., Pietrosimone, L. E., Andrejchak, M., Lynall, R. C., Wikstrom, E. A., & Padua, D. A. (2018). Preliminary investigation on the effect of cognition on Jump-Landing performance using a clinically relevant setup. *Measurement in Physical Education and Exercise Science*, 23(1), 78–88. <https://doi.org/10.1080/1091367X.2018.1518875>
- Fan, B., Xia, H., Xu, J., Li, Q., & Shuli, P. B. (2021). IMU-based knee flexion, abduction and internal rotation estimation during drop landing and cutting tasks. *Journal of Biomechanics*, 124, 110549. <https://doi.org/10.1016/j.jbiomech.2021.110549>
- Ishida, T., Koshino, Y., Yamamoto, M., Ueno, R., Taniguchi, S., Ino, T., Kasahara, S., Samukawa, M., & Tohyama, H. (2021). Larger hip external rotation motion is associated with larger knee abduction and internal rotation motions during a drop vertical jump. *Sports Biomechanics*, 1–15. <https://doi.org/10.1080/14763141.2021.1881951>
- Kajiwara, M., Kanamori, A., Kadono, H., Endo, Y., Kobayashi, Y., Hyodo, K., Takahashi, T., Arai, N., Taniguchi, Y., Yoshioka, T., & Yamazaki, M. (2019). Knee biomechanics changes under dual-task during single-leg drop landing. *Journal of Experimental Orthopaedics*, 6(1). <https://doi.org/10.1186/s40634-019-0170-z>
- Leone, C., Feys, P., Moudjidian, L., D'Amico, E., Zappia, M., & Patti, F. (2017). Cognitive-motor dual-task interference: A systematic review of neural correlates. *Neuroscience & Biobehavioral Reviews*, 75, 348–360. <https://doi.org/10.1016/j.neubiorev.2017.01.010>
- Santos, C. F., Bastos, R., Andrade, R., Pereira, R., Parente, M. P. L., Jorge, R. N., & Espregueira-Mendes, J. (2023). Revisiting the role of knee external rotation in Non-Contact ACL mechanism of injury. *Applied Sciences*, 13(6), 3802. <https://doi.org/10.3390/app13063802>
- Theisen, A., & Day, J. (2019). Chronic ankle instability leads to lower extremity kinematic changes during landing tasks: a systematic review. <https://pmc.ncbi.nlm.nih.gov/articles/PMC6355117/>
- Zwiers, R., Vuurberg, G., Blankevoort, L., & Kerkhoffs, G. M. M. J. (2016). Taping and bracing in the prevention of ankle sprains: current concepts. *Journal of ISAKOS Joint Disorders & Orthopaedic Sports Medicine*, 1(6), 304–310. <https://doi.org/10.1136/jisakos-2016-000104>