Opponent's Report on PhD thesis for final defense

Wenjing Quan: ***Effect of footwear drop on running biomechanics and finite element analysis in recreational runners***

Opponent: Dr. Yan Zhang

Faculty of Sports Science, Ningbo University

General comments:

The submitted thesis presents an original work on the lower limb biomechanical responds of long-distance runners under 2 conditions: 1) after fatigue; 2) with different footwear drop running shoes. The candidate innovatively combined Partial Least Square Algorithm (PLSR), musculoskeletal system modelling and finite element analysis to determine lower limb joint mechanics, muscle force and foot bone stresses. A workflow that integrates experimental measurments and computational simulations was established to model the joint kinematics and kenitics during running fatigue, the muscle contribution when running with different heel drop shoes, and the stress distribution in foot. This research provide clues for prolonged runners to adjust running stratergies while fatigue or using heel-to-toe shoes.

The submitted thesis includes 95 pages, 186 references, 15 tables and 38 figures which is an acceptable and complete project. The structural set up and segmentation are normative. The chapters are divided clearly as they address the 3 main questions mentioned at the beginning of the thesis. The writing is in an academic style. The literature references are regular and comprehensive. The candidate's publication activity related to the thesis.

Detailed comments on each part are as follows:

Literature review:

The literature has been well studied and that the candidate has analytically and critically reviewed her research topic. The thesis contains scientific backgrounds related to the topic. The candidate relied on the scientific results already known when formulating the research objectives. Based on the

comprehensive review, the primary objectives have been identified in her thesis. On this account, the formal requirements meet the standards of the Doctoral School.

Methods:

The candidate approached the objectives with rigorous and well-based techniques, e.g. PLSR, musculoskeletal modelling, and finite element simulation, to investigate the running biomechanics. The standard of processing of obtained data, statistical evaluation of the obtained data are scientific. However, some details are missing and required to be added.

Results:

The measured and computed results from the research are correct. The charts and graphs are clear and understandable. The candidate reported 3 main findings: 1) joint work redistribution took place when fatigue arises due to prolonged running, slowly shifting more power to the hip joint to maintain equilibrium during running; 2) The negative heel shoes lowered Achilles tendon force and flexor hallucis longus force resulting in less injury probability; 3) Shoes with lower drop increase stress levels in the metatarsal and midfoot, particularly during the push-off phase. These are new results contrast to previous research. However, one of the subtitles are supposed to be futured addressed. Please go to “specific questions” part to check.

Discussion and conclusions

The discussion part of the thesis is well-formulated. The candidate extensively discussed and compared her results to the literatures in prestigious journals. Some comments proposed by the candidate is creative and interesting. For example, she stated that the flexor hallucis longus muscle and extensor digitorum longus muscle should be taking into consideration the increased ankle plantarflexion angle and moment, normally resulted from minimalist shoes. The results of our study demonstrated the. Last, The deduct conclusion from the candidate are reasonable.

Specific Questions:

1. As to the finite element model validation, do you use node force or area force to compute ground reaction force?
2. Please confirm which tool ANSYS or ANSYS Workbench you used and uniform in the whole text.
3. In Table 5, some parameters are described by full spelling and some using abbreviations. Plesease uniform in a same way.
4. The subtitle 3.1.2 is required to be revised. I suggest replacing it as “Torque and power”.

Statement

I suggest submitting this thesis to the final defense.

Ningbo, 2023.11.24

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