# A KINEMATIC ANALYSIS OF TRUNK ABILITY IN WHEELCHAIR FENCING: A PILOT STUDY

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The purpose of this study was to explore the trunk ability differences between category A and B participants in wheelchair fencing. The result showed that category B participants might perform similar performance as category A participants in maximum lunge velocity, maximum lunge angle and maximum fast return velocity. This result may provide information to International Wheelchair Fencing Committee (IWFC) for the need of research on Wheelchair Fencing Classification (WFC) to clarify the differences between these two categories of participants.

**KEY WORDS:** Wheelchair fencing, Disabled sports, Classification, Paralympics.

**INTRODUCTION:** Classification in disabled sports is referred to the way in which athletes are grouped for competition and is different from classifications in able-bodied sports (Tweedy, 2002; Vanlandewijck, 2006; Vanlandewijck & Chappel, 1996). For example in able-bodied sports, power lifting is classified by body weight, master runners are classified by age, but classification in disabled sports is based on an athlete's ability and disability characteristics. The objective of classification is to provide valid tests or assessments for grouping athletes with a disability or multiple disabilities and make each sport on a 'level playing field'. Classifications for disabled sports aim at promoting equitableness and fair competition. However, in the recent year, there was controversy about the validity of classification system among the Paralympics sports (Firth, 1999; Gil-Agudo, Del Ama-Espinosa, & Crespo-Ruiz, 2010; Tweedy, 2003; van Eijsden-Besseling, 1985; Vanlandewijck, et al., 2004).
Wheelchair fencing has beenan official sport of the Paralympics since the first Olympic Games for the disabled athletes in Roma 1960, and includes two functional classes among three weapons during each summer games. As many other Paralympics sport, WFC is a point scored system and provides a guideline to the classifiers to evaluate the ability of the wheelchair fencers, in which a fencer has higher score, he/she will be classified into a higher category (IWFC, 2009). Therefore, fencers who are in the higher category should have better trunk abilities than the lower category fencers. In the WFC system, classifiers required to assess the wheelchair fencer's trunk strength, range of movement and balance according to six functional tests which imply that is a key factor to identify fencer's ability (IWFC, 2009). Hence, the present investigation attempted to apply biomechanical methods to determine the difference of the trunk movement abilities (trunk angle and trunk speed) between the two category groups (category A and B)

**METHOD:** Eight male and six female Hong Kong elite wheelchair fencers participated in this study (Table 1). They all had over 3 years of fencing experience and five males and four females belonged to the category A, while three males and two females were in the category B. These classifications were based on their participation on previous international competition which was approved by the IWFC.

During the test, the subject was required to perform a lunge toward (attack) the tester and a fast return (defence) away from the tester with maximum speed (Figures 1 and 2).

Table 1. Demographic information

| Fencer ID | Gender | Category | Paralympics experience | Diagnosis |
|---|---|---|---|---|
| 1 | M | A | No | AP |
| 2 | M | A | No | AP |
| 3 | M | A | Yes | PARA |
| 4 | M | A | Yes | PO |
| 5 | M | A | No | PARA – W |
| 6 | M | B | Yes | PARA – W |
| 7 | M | B | Yes | PARA – W |
| 8 | M | B | Yes | PARA – W |
| 9 | F | A | Yes | AP |
| 10 | F | A | Yes | HEMI |
| 11 | F | A | Yes | PARA – W |
| 12 | F | A | Yes | HEMI |
| 13 | F | B | Yes | PARA – W |
| 14 | F | B | No | PARA - W |

AP: Amputee, PARA: Paraplegics, PO: Polio, W: Wheelchair bound, HEMI: Hemiplegic

Figure 1: Lunge (attack)

Figure 2: Fast return (defence)

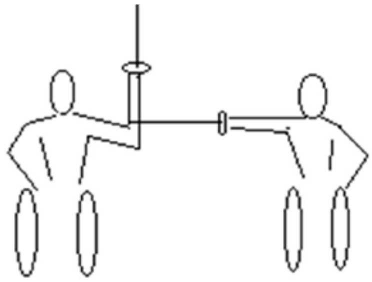

Figure 3: Fencing distance normalization

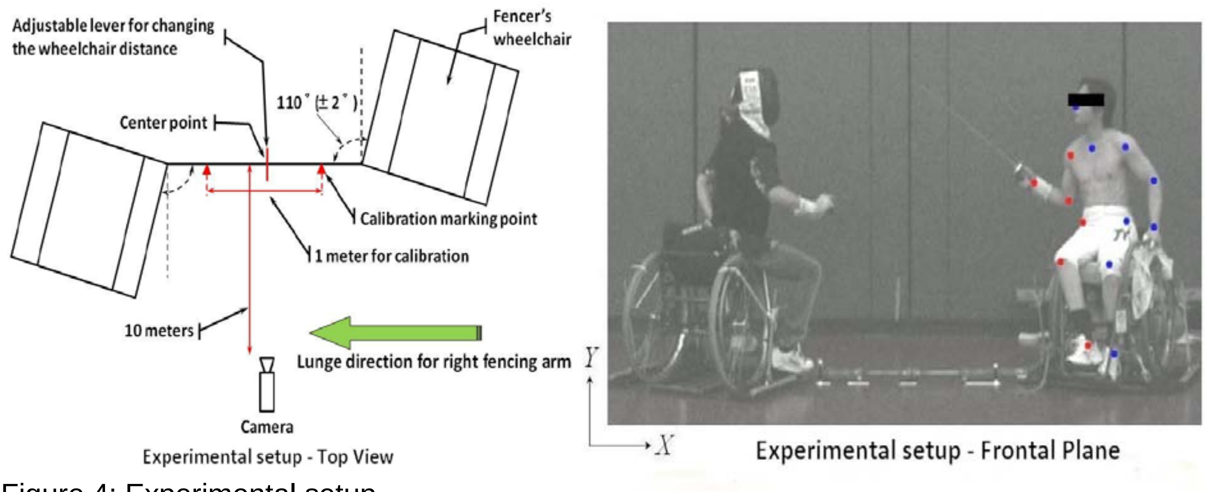


Figure 4: Experimental setup

There were five trials per movement with only the fastest being used for statistical analysis. Moreover, the fencing distance between subject and the tester during the assessment was normalized and the experimental setup were as in Figures 3 and 4 respectively, which is a standard procedure, following the official rules of the International Wheelchair Fencing Committee.

Although wheelchair fencing technique can be very dynamic, the trunk movements mainly focus on forward and backward in sagittal plane, hence, the analysis was done in two dimensions. In the present study, motions were videotaped by utilizing a Sony 3CCD (DCR-TRV950E) digital video camera recorder and the motion data were further computed by Peak Motus® Motion Measurement System (Peak Performance Technologies). Statistical analysis was run in SPSS version 16.0 (SPSS Inc., Chicago, IL). Due the small simple size, the tested variables were computed by the non-parametric Mann-Whitney method to compare the differences between category A and B, furthermore, the tested variables were 1) Maximum Velocity of Trunk 2) Maximum Angle of Trunk in Lunge and Fast return as Figure 5a and 5b.

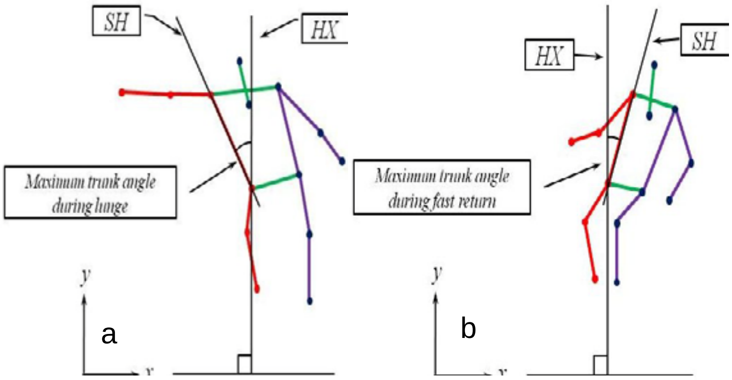


Figure 5: Definition of maximum trunk angle and velocity. In the trials, sterna notch was defined as a reference point to calculate the trunk speed (a) Lunge (b) Fast return. The segmental model used in present study is defined as SH: the line from the shoulder of the fencing arm to the lilac crest of the fencing arm; HX: the vertical line perpendicular to the ground through the hip joint. Furthermore, the angle of experimental result would minus the angle of initial position for normalization.

**RESULTS:** Table 2 shows the descriptive results, furthermore Table 3 showed that there are no significant differences between category A and B fencers on maximum lunge velocity, lunge angle and fast return velocity, whereas category A fencers could perform significant larger fast return angle in contrast to category B fencers.

Table 2. Descriptive results

| | N | Minimum | Maximum | Mean | SD |
|---|---|---|---|---|---|
| Cat A Max Lunge Velocity | 9 | 1.04 | 2.01 | 1.47 | 0.28 |
| Cat B Max Lunge Velocity | 5 | 1.30 | 1.51 | 1.39 | 0.08 |
| Cat A Max Lunge Angle | 9 | 33.5 | 50.5 | 44.6 | 5.63 |
| Cat B Max Lunge Angle | 5 | 33.0 | 46.5 | 39.8 | 5.79 |
| Cat A Max Fast Return Velocity | 9 | 0.77 | 1.52 | 1.20 | 0.28 |
| Cat B Max Fast Return Velocity | 5 | 0.91 | 1.43 | 1.11 | 0.22 |
| Cat A Max Fast Return Angle | 9 | 42.0 | 108.0 | 64.6 | 21.43 |
| Cat B Max Fast Return Angle | 5 | 30.0 | 53.0 | 40.2 | 8.58 |

Remark: The units of Velocity and Angle are in m/s and degree respectively

Table 3. Non-Parametric Mann-Whitney U test

| | Max. Lunge Velocity (m/s) | Max. Lunge Angle (degree) | Max. Fast Return Velocity (m/s) | Max. Fast Return Angle (degree) |
|---|---|---|---|---|
| Z | - 0.535 | - 1.535 | - 0.601 | - 2.469 |
| Asymp. Sig. | 0.593 | 0.125 | 0.548 | 0.014* |

* P < 0.05

**DISCUSSION:** The purpose of the WFC aimed to classify the fencer's functional abilities with a serial of assessments. Hence, classified participants should have functional differences between categories A and B. In the present study, the maximum trunk velocity and angle in lunge and fast return were assumed as the functional determinants for justifying the outcome of the WFC. However, the results showed that the maximum fast return angle was the only differences between category A and B fencers in the entire tested determinants.

Lunge and fast return are two of the fundamental movements in wheelchair fencing which respect for attack and avoidance of being hit respectively. Hence, the ability to perform a fast and far in this two fundamental movements was critical to wheelchair fencer. When the wheelchair participants perceived this ability, it will encourage the training quality and the competition tactic strategy of victory. Nowadays, WFC is an integrated classification which allows athletes with different disabilities like amputee, polio, cerebral palsy and paraplegics to compete together (IWFC, 2009), so the range that their impairment could affect performance could be very broad. Nevertheless, our results showed that category A and B fencers in the present study could perform similar abilities. The present investigator doubted that it may be due to sports specificity for wheelchair fencing; participants have to perform movement on the wheelchair, so that the lower limb ability will cause negligible limitation for wheelchair fencing whereas trunk control will be a weighty indicator. More and more, although the maximum speed and angle of trunk movement were assumed as an important functional determinant in this study, it didn't represent this is a sensitive indicator to descript the differences between these two categories of fencer, because there is much additional research remains required like sitting balance or the functional agility on wheelchair.

**CONCLUSION:** This study was the first in the literature to explore trunk ability differences between category A and B fencer in wheelchair fencing, and the result showed that category B fencers could perform a similar trunk performance in most of the tested parameters as category A. This result may provide information to International Wheelchair Fencing Committee for the need of research on WFC to clarify the differences between these two categories of participants.

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