INFLUENCE OF SEAT HEIGHT ON PITCH ANGLE AND PUSHRIM KINETICS DURING A WHEELIE ACTIVITY

[1,2]Po-Chou Lin, [1]Fong-Chin Su, Kenton R Kaufman[2] and Kai-Nan An[2]
[1]Institute of Biomedical Engineering, National Cheng Kung University, Tainan, TAIWAN; email: fcsu@mail.ncku.edu.tw
[2]Biomechanics and Motion Lab, Div. of Orthopedic Research, Mayo Clinic, Rochester, MN, USA

INTRODUCTION
A wheelie is a high level skill performed when the user pops the front casters off the ground and keeps balance on the rear wheel. The pitch angle is the tilt angle of the rear wheel axle when maintaining the wheelie . Bonaparte et al. suggested wheelie performers appear to use a proactive balance strategy in maintaining a stationary wheelie[1]. The seat height affects manual wheelchair propulsion[2, 3]. Pushrim kinetics plays a very important role in wheelie activity, but the influence of seat height has not been studied. Therefore, the purpose of this study was to compare the pushrim kinetics of individuals in different seat height when performing a wheelie.

METHODS
Five experience spinal cord injury males (age 26.6±1.5 years old, weight 64.7±6.3kg, and height 171.3±5.2cm) participated in this study. A six-camera Expert Vision™ motion analysis system (Motion Analysis Corp, CA, USA) was used to collect the three-dimensional trajectory data of 8 markers placed on the wheelchair. A standard type manual wheelchair instrumented with a six-component load cell was used to collect the forces and moments applied on the hand-rim by users. Subjects were requested to keep their balance as stable as possible during tests which lasted 10 seconds at each of three different seat heights. The standardized seat height adjusted by a suitable seat cushion, were defined as 80, 60 and 40 degrees of elbow flexion for low, neutral and high seat positions, respectively, when the hands were placed on top-dead-center of the rim. We defined the time after 3 minutes as the balance phase when maintaining wheelie balance. Statistical analysis using ANOVA with repeated measurement was used to compare the pitch angles and pushrim kinetics among the different seat heights.

RESULTS AND DISCUSSION
Increased seat height decreased the peak pitch angle which occurred durring popping the wheelchair up and the mean pitch angle during the balance phase (Figure 1). Because the center of mass (COM) of the whole user-wheelchair system was moved from the front of the axle to the top, the angle between the vertical through the rear axle and a line connecting the rear axle and the system COM is less in the high seat which will cause a lower pitch angle. The maximum peak tangential and axial components of applied handrim contact forces occurred at the neutral seat position (Table 1). At this position, bodyweight compensation helped to keep the wheelie balanced and may increase more than other seat positions. The peak radial force on the pushrim was largest at the high seat position, because less elbow flexion resulted in a larger radial force to push on the hand rim. In contrast, the mean tangential and axial forces were significantly smaller at the high seat position. The high seat position results in not only a lower effective biomechanical mechanism in wheelchair propulsion but also lower effective (tangential) force in peak force and mean force during the balance phase of a wheelie activity. We suggest that the effective force is used to against the stability of the wheelchair.

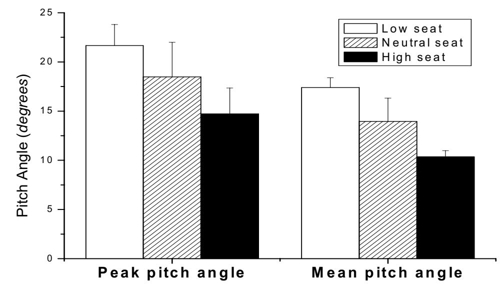

Figure 1: Mean pitch angle when keeping wheelie balance and peak pitch angle.

CONCLUSIONS
The results indicate that the seat height significantly affects the pushrim kinetics in during a wheelie activity. Our findings show that the effective force may be compensated by the body weight.to maintain the wheelie balance force.

REFERENCES
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Table 1: Peak applied handrim contact force in wheelie activity.

	Peak force in whole wheelie activity			Mean force when keep in balance phase		
	Radial	Tangential	Axial	Radial	Tangential	Axial
High seat	56.83 ± 1.17	23.41 ± 13.83	12.76 ± 3.37	41.43 ± 1.99	5.69 ± 1.12	3.19 ± 1.57
Neutral seat	36.08 ± 6.46	59.85 ± 9.06	23.95 ± 4.38	18.25 ± 5.57	27.82 ± 3.87	5.24 ± 1.73
Low seat	38.18 ± 5.78	53.78 ± 7.21	18.83 ± 5.16	28.45 ± 4.74	27.43 ± 2.98	5.54 ± 1.97