EFFECTS OF INCREASED Q-FACTOR ON KNEE BIOMECHANICS DURING STATIONARY CYCLING

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SUMMARY

Q-Factor (QF) refers to the frontal-plane inter-pedal distance of a bicycle or cycle ergometer. The purpose of this research was to examine the effects of increasing QF on frontal plane knee biomechanics during cycling.

INTRODUCTION

Peak internal knee abduction moment (KAbM) is often used as a common surrogate loading variable for medial knee compartment during walking [1] and cycling [2]. Increased step-width has been shown to reduce KAbM in level walking, stair ascent, and stair descent. Q-Factor (QF) refers to the inter-pedal distance in cycling [3] and is similar to step-width in gait. It is unknown if increased QF will result in a similar reduction of KAbM in literature. Therefore, the purpose of this research was to examine the effects of increasing QF and workrate on frontal plane knee biomechanics during cycling.

METHODS

Sixteen recreationally active young adults (8 males, 8 females) participated in this study. A 12-camera motion analysis system (240Hz) was used for three-dimensional kinematic data collection. Two customized instrumented bike pedals were used to collect pedal reaction forces (PRF, 1200 Hz). Participants cycled on a stationary cycle ergometer. QF was increased using three pairs of pedal extenders. The participants pedaled at a cadence of 80 RPM and workrates of 80 W, 120 W, and 160 W for two minutes, in each of four QFs: QF of 150mm (Q1), QF of 192mm (Q2), QF of 234mm (Q3), and QF of 276mm (Q4).

RESULTS AND DISCUSSION

Peak KAbM increased 47%, 56%, and 56% as QF increased from Q1 to Q4 at the three respective workrates (all $p \leq 0.001$, Table 1). At each QF, peak KAbM increased significantly with increased workrate (all $p \leq 0.001$, Table 1). The medial PRF increased with increased QF (all $p \leq 0.008$,) and workrate (all $p \leq 0.001$). Peak knee extension moment was not changed with increased QF but increased with increased workrate (all $p \leq 0.001$).

The differences between decreased KAbM with wider step-width in gait and increased KAbM with wider QF seem to be in part attributable to the lack of manipulation of whole-body center of mass (COM) by the lower extremity in cycling to effectively reduce the frontal-plane PRF moment arm. In cycling, whole-body COM does not shift significantly relative to the base of support due to constraint from the seat and cycling movement. Therefore, as QF increased, an increased frontal-plane moment arm, coupled with increased frontal plane PRF vector - mainly due to increased medial GRF, may have contributed to the increase of KAbM, without the compensation of whole-body COM shift.

CONCLUSIONS

As QF increased, peak KAbM increased, suggesting increased medial compartment loading of the knee. However, increasing QF did not change peak sagittal plane loading of the knee. QF modulation may allow for greater control over frontal plane joint loading when using stationary cycling for exercise or rehabilitation purposes.

REFERENCES

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Table 1: Peak Knee Abduction Moment (Nm), Medial PRF (N), and Knee Extension Moment during stationary cycling.

	Workrate (W)	Q1	Q2	Q3	Q4	Workrate	Q-Factor	Interaction
Knee Abduction Moment	80	-9.3±3.0	-11.0±4.0	-12.7±3.9[1]	-13.7±4.8[1,2]			
	120[a]	-12.0±4.31	-14.6±5.6[1]	-16.7±5.5[1,2]	-18.7±5.3[1,2]	**p < 0.001**	**p < 0.001**	**0.020**
	160[a,b]	-13.9±3.9	-18.1±5.5[1]	-19.8±6.3[1]	-21.7±6.5[1,2]			
	Q-Factor Test		α	α,β	α,β,γ			
Medial PRF (N)	80	-33.2±10.8	-38.7±9.2	-42.9±9.1[1]	-48.5±12.5[1,2]			
	120[a]	-42.8±12.0	-52.8±12.6[1]	-60.2±14.9[1]	-67.6±14.6[1,2]	**p < 0.001**	**p < 0.001**	**0.016**
	160[a,b]	-50.6±12.5	-66.0±14.9[1]	-72.5±17.7[1]	-79.9±18.5[1,2]			
	Q-Factor Test		α	α,β	α,β,γ			
Knee Extension Moment	80	21.3±9.1	22.2±8.1	21.8±9.5	23.9±10.3			
	120[a]	29.2±10.0	29.0±9.1	30.7±13.0	33.1±12.2	**p < 0.001**	0.146	0.332
	160[a,b]	32.5±12.3	35.6±12.2	35.2±13.4	35.9±12.8			

Note: [a]: significantly different from 80W, [b]: significantly different from 120W [α]: significantly different from Q150, [β]: significantly different from Q192, [γ]: significantly different from Q234. [1]: significantly different from Q150 at same work load, [2]: significantly different from Q192 at same work load, [3]: significantly different from Q234 at same work load.