EFFECT OF GRADE AND SEX ON PATELLOFEMORAL JOINT STRESS DURING UPHILL RUNNING

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Summary

Patellofemoral pain (PFP) is common among long-distance runners, especially females, and is associated with increased patellofemoral joint stress (PFJS). This study examined how running grade and sex affect PFJS. Twenty-two recreational runners (10F, 12M) completed three 10-minute running trials at 0%, 5%, and 10% inclines, with speeds determined by the individual's lactate threshold. Results reveal an increasing grade reduced PFJS ($p < 0.001$), though no sex-dependent effects were observed ($p = 0.403$). These findings suggest that uphill running may help reduce PFJS and alleviate PFP.

Introduction

Patellofemoral pain (PFP) is one of the most common injuries in long-distance running and is estimated to develop at a 2-time higher rate in females than males [1]. One risk factor suspected of contributing to PFP is high or repetitive loading that increases patellofemoral joint stress (PFJS), characterized by the compressive force acting on the patella relative to the patellofemoral contact area [2]. Thus, modifying factors to reduce PFJS may help alleviate PFP symptoms. Previous studies suggest that increasing running grade reduces PFJS through a decrease in compressive force, but this study was limited by short running bouts (1-minute) and included untrained participants [3]. Additionally, despite the higher incidence of PFP in females, few studies have investigated sex differences in PFJS. Therefore, this study aimed to investigate the effects of grade and sex on PFJS during uphill running. It was hypothesized that PFJS would decrease as grade increases, and females would have a larger peak PFJS.

Methods

Twenty-two healthy, recreational runners (10F/12M) completed three 10-minute running trials on a force-instrumented treadmill (Bertec, 1000 Hz) of varying inclines in a randomized order: 0% grade, 5% grade (2.9°), and 10% grade (5.7°). The 0% grade trial was conducted at 80% of participant speed at lactate turn point (determined by a previously administered lactate threshold test). Speeds for the incline trials were selected to match the oxygen cost of the level ground trial. An 8-camera motion capture system recorded lower-extremity marker trajectories (Motion Analysis Corp., 200 Hz). An inverse dynamics approach was used to calculate knee extensor moment in Visual 3D (HAS-Motion), and a custom MATLAB script was written to calculate PFJS (Figure 1), based on previously validated models [4,5]. Calculations of PFJS required inputs of knee flexion angle and extensor moment to determine patellofemoral contact area and joint reaction force. The effect of sex and grade on peak PFJS were evaluated using a one-way repeated measures ANCOVA with a covariate of speed.

Results and Discussion

A decrease in PFJS was observed with an increased uphill running grade ($p < 0.001$). Post-hoc tests revealed significant differences between grades 1 & 2 and grades 1 & 3 (Table 1). No significant effect of sex was found ($p = 0.403$).

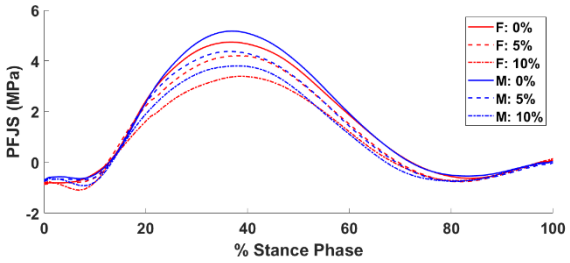

Figure 1: Average PFJS (MPa) across stance.

Conclusions

Results indicate an increased grade reduces PFJS during uphill running, supporting previous findings. Additionally, the running bout of 10-minutes could be more representative of true uphill running biomechanics. Graded running could offer opportunities to maintain training status while reducing PFP. Contrary to previous work, males were reported as having higher peak stress values than females. This is potentially due to the control of oxygen cost (rather than speed) across trials. Future work should consider this method when further investigating the potential injury risk across sex.

Acknowledgments

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References

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Table 1. Peak Patellofemoral Joint Stress across 0%, 5% and 10% graded uphill running (n=22); Average (±SD).

	Grade 1: 0%	Grade 2: 5%	Grade 3: 10%	*p-value*
Female PFJS (MPa)	4.78 (±0.99)	4.25 (±0.90)	3.42 (±0.68)	-
Male PFJS (MPa)	5.20 (±1.25)	4.33 (±1.05)	3.90 (±1.08)	-
Combined PFJS (MPa)	5.01 (±1.14)	4.30 (±0.97)[a]	3.68 (±0.94)[a]	$p < 0.001$

[a] difference compared to grade 1 (0 %)