INTRODUCTION
With the recent increase in visibility of the Paralympics, many individuals with disabilities have become interested in participating in physical activity and sport, including adaptive rowing. Fixed seat adaptive rowing is an ideal adaptive sport for those with lower body mobility issues. However, both recreational and competitive able bodied rowers have historically high incidences of musculoskeletal injury and back pain [1]. Our long term goal is to limit injuries to adaptive rowers. Kinematic and kinetic investigations have identified large compressive forces as the key injury risk factor [2]. Peak and average force produced, by able bodied rowers through the drive phase of the stroke, at the oar or ergometer handle, are directly related to compressive loading of the lower back [3]. The aim of this research was to identify the peak and average forces employed by rowers in the three adaptive rowing setups: Legs, trunk and arms [LTA], trunk and arms [TA], and arms and shoulders [AS].

METHODS
An indoor rowing ergometer study was designed to identify the kinetics of the LTA, TA, and AS setups. Male (n= 9, 81.6 ± 7.0 kg and 184.9 ± 4.3 cm) and female (n=8, 63.3 ± 6.6 kg, and 162.8 ± 6.2 cm) able bodied athletes from the Laurentian University Varsity Rowing team served as test subjects. A Concept2 Model C ergometer with PM4 monitor was equipped with a WinTech rowing adaptive 7800L fixed seat and straps to complete the three adaptive setups. An ‘S’ type strain gauge was calibrated and employed to capture pull force (600 Hz) at the ergometer handle. The peak force and average force produced during the rowing stroke were determined in LABVIEW and averaged over each trial. Peak and average force were compared between gender and rowing setup using a repeated measures ANOVA with follow-up paired T-Tests in SPSS.

RESULTS
Male participants were observed to produce more peak and average force at the ergometer handle than females (p<0.05) for each ergometer setup. In addition, male and female rowers produced a greater peak and average force with the LTA>TA>AS (p<0.05). Interestingly, the average force produced at the handle differed for gender when comparing between setups (p<0.05).

DISCUSSION AND CONCLUSIONS
Handle force production differences between gender are well supported in the literature for the able bodied stroke [4]. Anterior pelvic rotation has been reported within the literature as being significantly greater in female rowers than male [4]. This kinematic difference may account for the more consistent handle force produced by female rowers across setups that eliminated leg action. Male rowers showed greater drops in handle force in adaptive setups, possibly because they generate a greater percentage of force at the handle through leg involvement. Peak and average force production influence loading of the lower back during the adaptive rowing stroke. The forces observed for each of the adaptive rowing setups were high and, in combination with adverse postures, muscular weakness, or fatigue may represent mechanical risk factors to the adaptive rowing population.

REFERENCES

ACKNOWLEDGEMENTS
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Table 1: Comparison of observed peak handle forces (Newtons) between setups and gender. Differences: † p<0.05 between genders for each setup, and *p<0.05 between setups.

<table>
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<tr>
<th></th>
<th>LTA</th>
<th>TA</th>
<th>AS</th>
</tr>
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<tbody>
<tr>
<td>Peak</td>
<td>Average</td>
<td>Peak</td>
<td>Average</td>
</tr>
<tr>
<td>Men</td>
<td>1035 ±96.9†*</td>
<td>640 ±56†*</td>
<td>838 ±110.8†*</td>
</tr>
<tr>
<td>Women</td>
<td>696 ±104.5†*</td>
<td>420 ±65†*</td>
<td>526 ±126.3†*</td>
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