Analysis of the Effect of Body Posture and Load on the Back Angle and Moment during Weightlifting

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INTRODUCTION

- Improper lifting is one of the most common causes of low back injury in the workplace, accounting for 15 to 25 percent of injuries covered by workers' compensation. [1]
- This injury not only impacts the health of workers, it also results in economic burdens in different industries due to loss in productivity, absenteeism and medical costs. [2]
- In order to increase injury prevention, physiotherapists often recommend when lifting to use the squat technique, however most workers tend to use the stoop lift technique.[3]

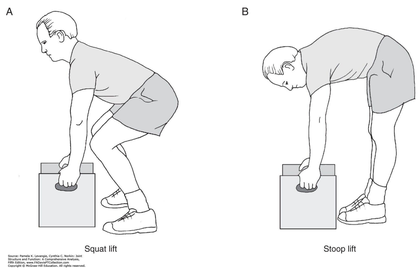

Figure 1: Illustration of the two weightlifting techniques being compared, where image A is the squat lift and image B is the stoop lift.

- **The purpose of this study is to evaluate the effect of weightlifting on the body when using the squat lift technique and the stoop lift technique to determine if the advised lift is best for injury prevention.**

METHODS

- A VICON motion capture system was used to collect data for markers placed on the subject following the VICON full body modelling with plug-in gait.
- The subject stood on one AMTI force plate and lifted 3 differents loads weighing 15lbs, 25lbs and 50lbs and completed 3 trials for each load.
- The data was collected for two variations of weight lifting: a squat weight-lift and a stoop weight-lift.

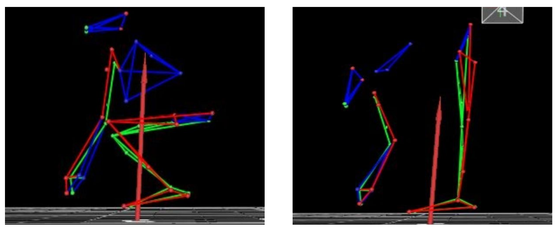

Figure 2: VICON stick figure showing subject in squat and stoop position.

Figure 3: Position of markers on the subject.

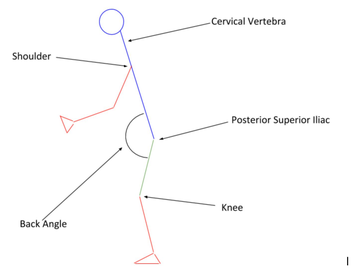

Figure 5: Stick figure showing back angle and position of markers used for our analysis

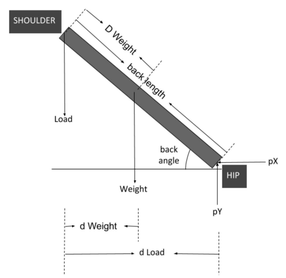

Figure 6: Free body diagram of the back

RESULTS & DISCUSSION

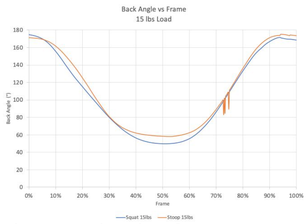

Figure 7: Back angle vs frame percentage graph for the 15 lbs load trial.

Figure 8: Back angle vs frame percentage graph for the 25 lbs load trial.

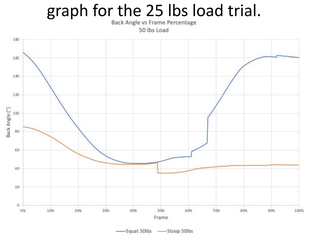

Figure 9: Back angle vs frame percentage graph for the 50 lbs load trial.

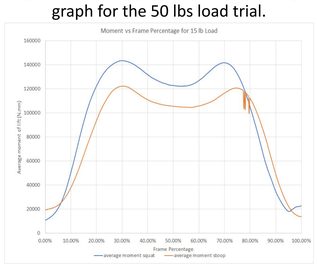

Figure 10: Back Moment vs Frame Percentage Graph for 15 lb Load

- The back angle shown in figure 7, 8 and 9 is the average back angle for the three trials.
- The back angle for the squat lift ranges from 170 degrees to 50 degrees whereas the back angle for the stoop lift ranges from 85 degrees to 40 degrees.
- As the weight increases,there is a clear difference for the graphs of the back angle for the squat lift and the stoop lift.
- The general shape of the graph of the squat lift stays the same with increased weight and the shape of the graph of the stoop lift trends closer to a straight line as weight increases.
- The back angle vs frame percentage graphs for the squad and stoop 15 lbs load are almost similar because the subject was lifting a small load.
- When lifting a larger load, the subject moves the load further away from the body which makes it easier and more comfortable to carry the load but doing so decreases the range of motion of the back resulting in a smaller back angle as shown in figure 8 and 9.[4]

- The moment of the back shown in figures 10, 11 and 12 is the average moment for the squat and stoop lifts for the three trials.
- As the weight increases, the shape of the graphs of the squat lift and stoop lift trends toward a straight line.
- The net moment around the back lift is consistently equal or greater than the net moment around the back for

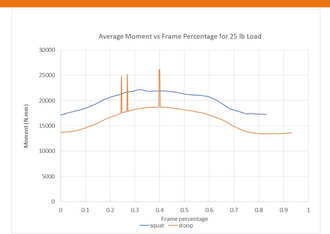

Figure 11: Back Moment vs Frame Percentage Graph for 25 lb Load

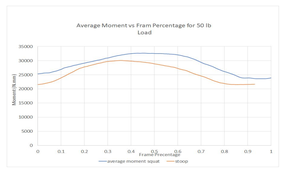

Figure 12: Back Moment vs Frame Percentage Graph for 50 lb Load

- the stoop lift even as the weight increases.
- Due to the similarities in the moment graphs, some other factors which could help in determining the best lift is an analysis of the horizontal distance of the lifter's centre of gravity for both lift types and vertical distance of the lifter's descent to the load for both lift types.
- When using the squat technique, the load is closer to the body which decreases the moment around the back whereas when using the stoop technique, the load is further away from the body which increases the moment around the back.[4] However, as the weight of the load increases, the further away from the body the load will be lifted

The hypothesis was that the back angle would range somewhere from 180 degrees to 45 degrees for the squat lift and 180 degrees to 40 degrees for the stoop lift. The back moment would be greater for the squat lift than for the stoop lift and the moment would generally decrease as the weight of the load increases. There is no significant difference in the back angle and moment between the stoop and squat technique when the load is very small. Differences in the back angle for the squat and stoop lift are seen when the weight of the load increases which is why we recommend the squat lifting technique for heavier loads.

Note: As the weight of the load increased, the speed at which the subject lifted the weights also increased for both the stoop and squat technique. [4]

SUMMARY & CONCLUSIONS

The range of the back angle for the stoop lift was less than the range of the angle for the squat lift as the weight of the load was increased. The net moment of the squat lift was equal to or greater than the net moment of the stoop lift, for each increased weightlifting trial. From these results, we recommend that the squat position as the best method for lifting loads. This in line with results from some previous studies on the efficacy of squat lifting over stoop lifting. We also recommend the examination of other factors such as the horizontal distance of the lifter's centre of gravity and the vertical distance of the lifter's descent to the load as measures of determining which lift is best for injury prevention.

REFERENCES

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[4] Hwang, Seonhong & Kim, Young & Kim, Youngho. (2009). Lower extremity joint kinetics and lumbar curvature during squat and stoop lifting. BMC musculoskeletal disorders. 10. 15. 10.1186/1471-2474-10-15.