JOHNSON HEALTH TECH: VO2 MASK FOR BIOMECHANICS RESEARCH

Team Members: Victoria Heiligenthal, Rachel Krueger, Jakob Knauss, Adrienne Rasmussen, Tommy Kriewaldt, Sinan Ozturk
Client: Johnson Health Tech, Staci Quam and Grace Johnson
Advisors: James Trevathan and Kip Ludwig
BME Design 200/300 Fall 2021

ABSTRACT

VO_2 max testing has become an integral tool used in multiple research areas that allows cardiovascular fitness and health of a test subject to be determined. Although VO_2 max masks are successful at providing accurate results, comfort is compromised for subjects with glasses since they do not fit over the VO_2 mask, causing them to have a difficult time during the testing process. A new design that adds extension pieces to the sides of the mask has been developed to hold the glasses in place. The qualitative testing results of this design and the current mask used by the client can be compared statistically to show if the new design is more compatible with glasses compared to the original mask.

INTRODUCTION

Background

- Johnson Health Tech, a company that manufactures and develops exercise equipment
- Utilize a biomechanics lab to test equipment
- Motivation: allow users to wear glasses during testing
- Impact: inclusive of all participants during testing

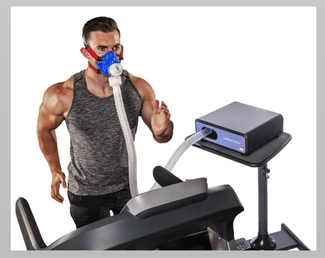


Figure 1: VO_2 max test
korr technology vo2 max testing - Bing images

Problem Statement

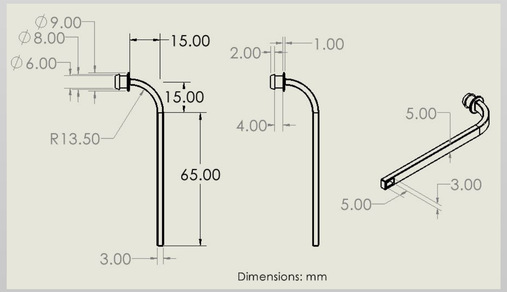
- VO_2 max testing is an important measure of cardiovascular fitness for athletes
  - Oxygen intake and carbon dioxide output
  - More oxygen equals more energy
- No current masks for users with glasses

DESIGN SPECIFICATIONS

- Allow subjects to wear glasses while performing VO_2 max testing
- No air leakage from the mask
- Design must be user friendly
- Production cost does not exceed $400
- Design must withstand up to 20 minutes of high intensity testing
- Can be cleaned between uses without damaging the device or impacting results

FINAL DESIGN

- Standard blue silicon mask used
- Extension pieces extend toward the legs of glasses
- Slit on extension piece with velcro secures glasses
- Clear plastic piece modified to connect extension piece to mask



Figures 2 and 3: The final design (left) and the dimensions of the design (right)

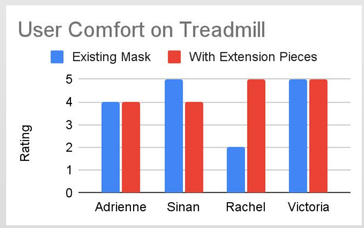
TESTING

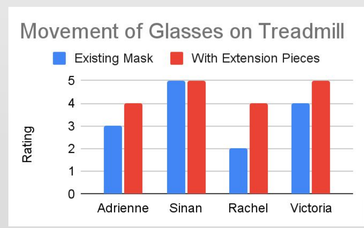
- Functional testing over equivalency testing
- Each team member completed short aerobic testing on the bike, treadmill, and elliptical
- Criteria were rated on a five-point scale to test mask functionality
- The testing outlined was developed and followed by the team [1]

Figure 4: Images during testing with the VO_2 mask and extension pieces

RESULTS

- Large movement of glasses was only observed during the treadmill test
- Wilcoxon Signed Rank Test [2]
  - Statistical analysis that would be used if sufficient data were available
  - Sample size (4) was too small to run test
  - Bar graphs show ratings for each subject with and without our extension pieces





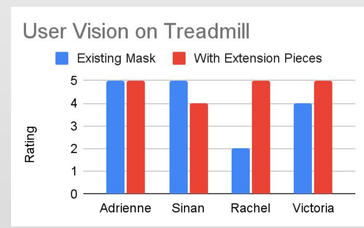


Figure 6: Ratings for user comfort, movement of glasses, and user vision for the treadmill test

CONCLUSION

- Encouraged by design's ability to restrict vertical movement of the glasses
- Production costs totalled to $86.64
- Original functionality of mask was maintained

FUTURE WORK

- Expand sample size to run Wilcoxon test
- Test mask on subjects outside of team
- Investigate alternative designs to mask itself
- Complete true VO_2 max testing

ACKNOWLEDGMENTS

- Staci Quam and Grace Johnson from Johnson Health Tech
- Our advisors, Dr. Kip Ludwig and Dr. James Trevathan

REFERENCES

- [1] V. Heiligenthal, R. Krueger, J. Knauss, A. Rasmussen, T. Kriewaldt, and S. Ozturk, "Testing Outline." Dec. 05, 2021. Accessed: Dec. 05, 2021. [Online]. Available: https://docs.google.com/document/d/1Bq2pSYxMYMo2MBVukLRDebboMR8lWaqNTFlMWz3vLec/edit?usp=sharing
- [2] S. Glen, "Wilcoxon Signed Rank Test: Definition, How to Run, SPSS", Accessed: Dec. 04, 2021. [Online]. Available: https://www.statisticshowto.com/wilcoxon-signed-rank-test/