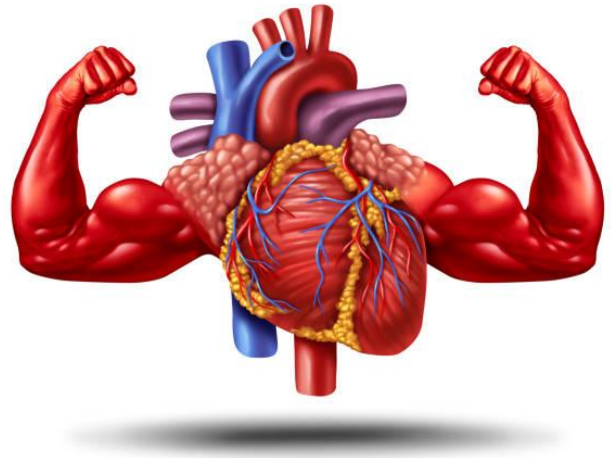
# 409 Honors Project: Blood Flow Restriction

By Abigail Walker

# What is blood flow restriction?

Also known as…

- Kaatsu
- Occlusion training
- Hypoxic training

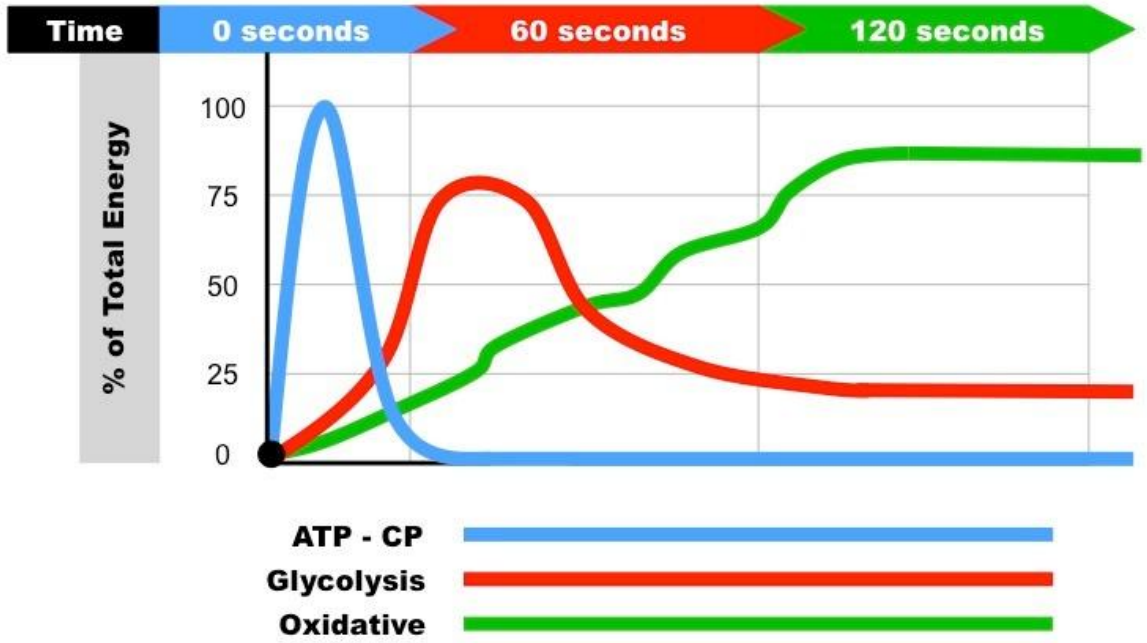


https://www.istockphoto.com/photos/blood-flow-muscle

- Pressurized cuff around an extremity to <u>restrict blood flow</u>
  - Elastic or nylon
  - Inflated to 40-80% of arterial occlusion pressure
  - 20-40% of 1RM
  - If low intensity on lifts, higher pressure may be warranted (ex: 20% of 1RM and 80% AOP)
  - 75 reps across 4 sets or 3-5 to failure
  - 30-60 sec rest periods
  - 2-3 sessions per week

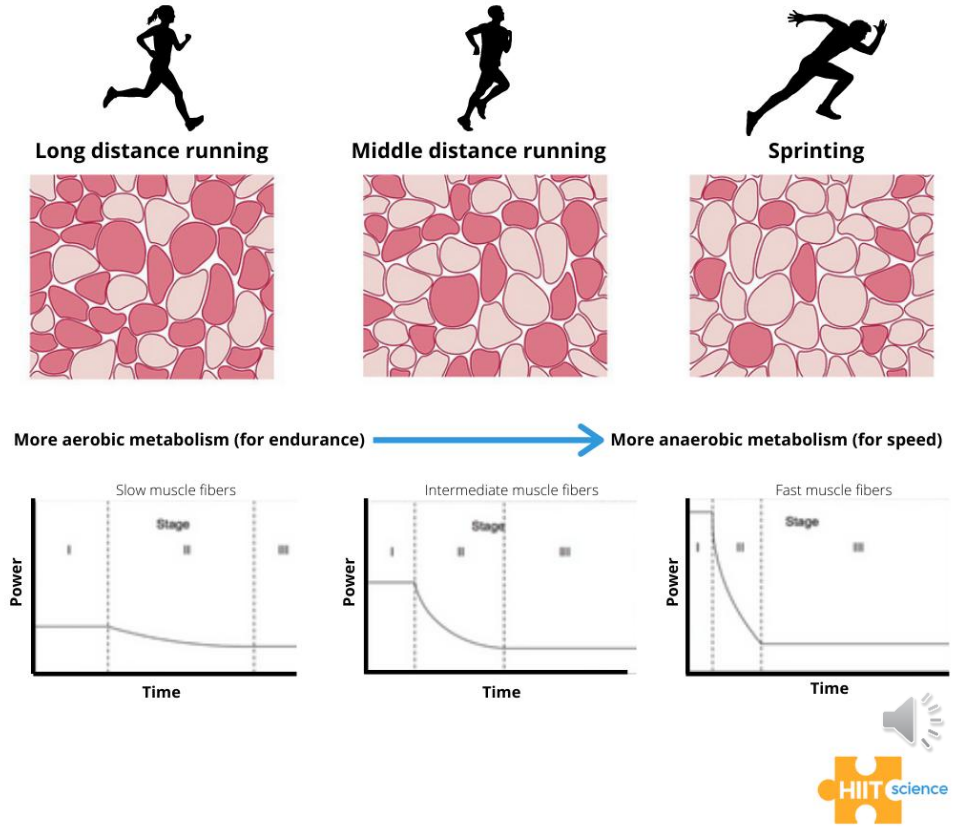
- Can be used with resistance exercise, aerobic exercise, or passively

# Review: Energy Systems and Muscle Fiber Types




https://www.movementstrengthandconditioning.com/blog/energy-systems

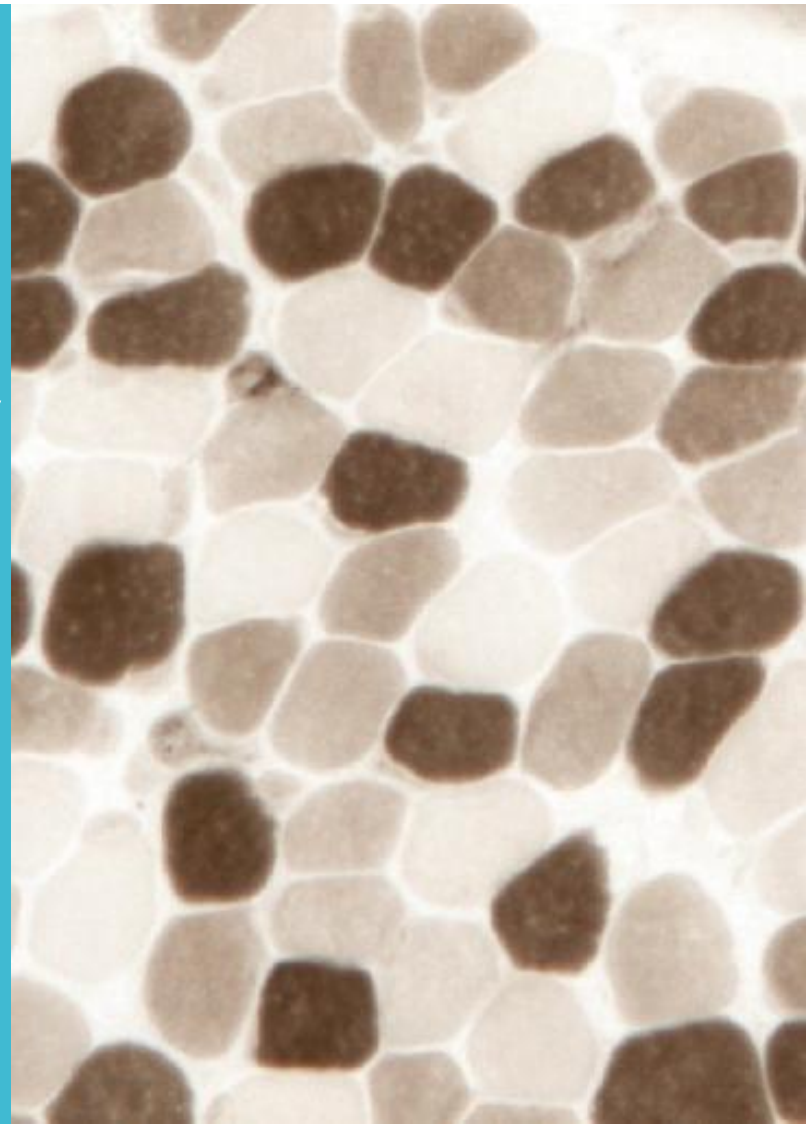
## Determinants of speed/ power




Bellinger Lievens et al.
https://hiitscience.com/muscle-fibre-typology-individual-response-training/

# Energy Systems and Fiber Types

- At low intensity (loads) like used in BFR, normally mostly oxidative energy system and type I fibers
- With BFR, more anaerobic energy systems and type II fibers
  - Less blood flow = less oxygen to muscle
    - Needs to rely on anaerobic mechanisms



https://link.springer.com/chapter/10.1007/978-3-030-11425-1_33

# Results of BFR with Resistance Exercise

According to systematic reviews and metanalyses…

Compared to Low Load Resistance Exercise

- Increase in hypertrophy
- Increase in strength
- Increase in power

- Specific values vary by study

Compared to High Load Resistance Exercise

- Comparable increases in hypertrophy
- Less increase in strength
- Less increase in power

- Specific values vary by study

# Hypertrophy

Hypertrophy = increase in muscle size

- Initially due to edema (transient)
  - Occurs in normal RT
- Results shown 2 and 10 days post training with BFR

# Responses of BFR with RT

- Responses dependent on type of exercise
  - Intensity and dynamic, isometric, etc
  - Shown to be increased post exercise blood flow changes with dynamic handgrip, decreased with isometric
  - Studies show varying conclusions
- Increased post exercise blood flow changes could be due to venous compliance, increased metabolic products and decreased O2 which cause increase in blood flow
  - Recruitment of fast twitch fibers at lower intensities
  - Metabolic products play a role in signaling VEGF up regulation
- Stress on capillaries prompts angiogenesis
- Normally increase in HR and SV w slight MAP increase
  - Increases more so than same low intensity non BFR exercise, but values less than high intensity resistance training

# BFR with Aerobic Training

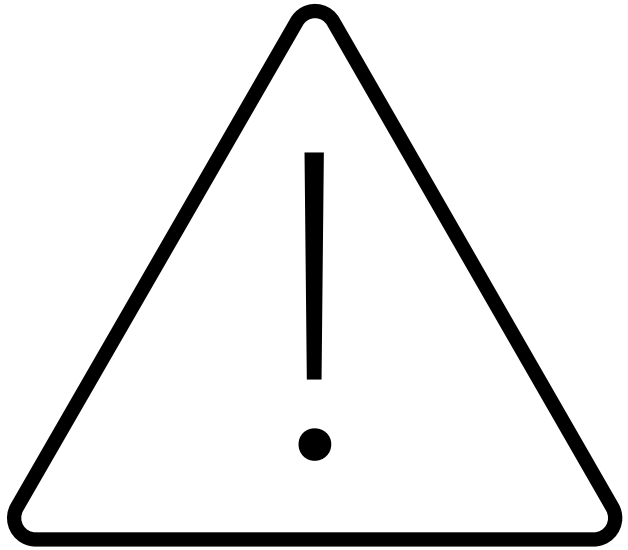
- Usually with walking or cycling
- At ~45% HRR
- Increases in strength and hypertrophy
  - 7-27% and 3-7%
- Could improve aerobic capacity
- Most effective after 6 weeks
- Could be applied after AT, shown to improve VO2 max

# Passive BFR

- Passive BFR= BFR without exercise
- Not well researched yet
- Could be used to offset atrophy and loss of strength and muscle mass in recoveries
- Ischemia – reperfusion cycles
- Shown to improve oxidative capacity of skeletal muscle
- Improves endothelial–dependent vasodilation and vascular conductance
- Needs further research for recommended pressures, durations, sets, etc

# Risks

- Lots of factors to be considered
  - Medical history
  - Injury
  - Time since surgery
  - Duration of restriction
  - Pressure inflated to
  - Width of cuff
  - Exercise selection (sets, reps, load?)
  - Sex and race
    - Black participants and males require greater pressure than women and white participants (Jessee, M.B., Buckner, S.L., Dankel, S.J. et al.)
- Numbness after fairly documented
- Venous congestion and distension - valve damage?

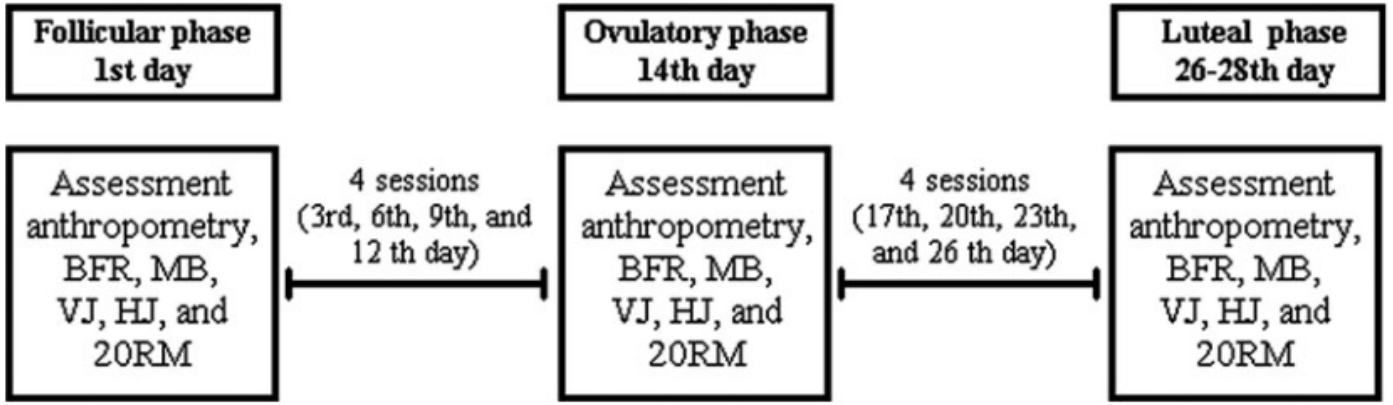


# BFR in Eumenorrheic Women Study

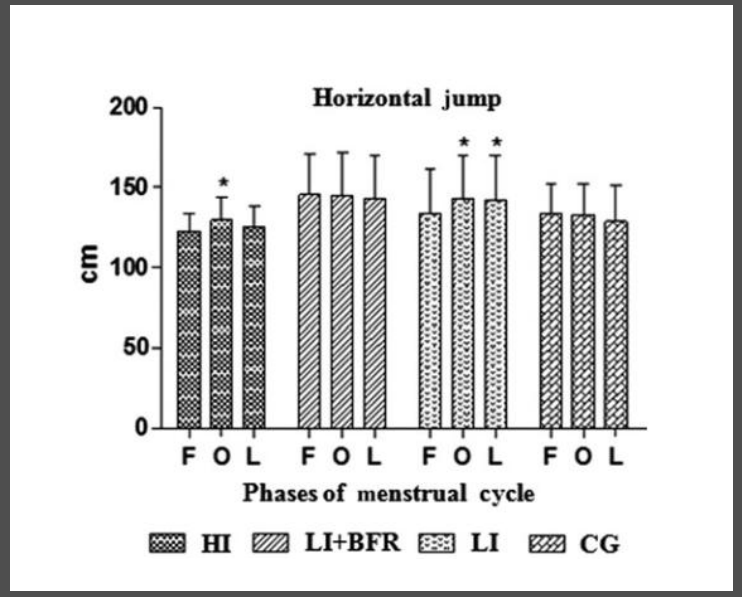
- Assessed impact of BFR and menstrual phase on muscular power and strength
- 40 untrained eumenorrheic women between the ages of 18-40
- Four groups for routines
  - high intensity strength training (80% of 1RM)
    - 4x8 at 80% 1RM
  - low intensity strength training (20% 1RM) with BFR
    - 1x30 and 3x15 of each at 20% 1RM
  - low intensity strength training (20% 1RM)
    - 1x30 and 3x15 of each at 20% 1RM
  - control group with regular activities of daily living

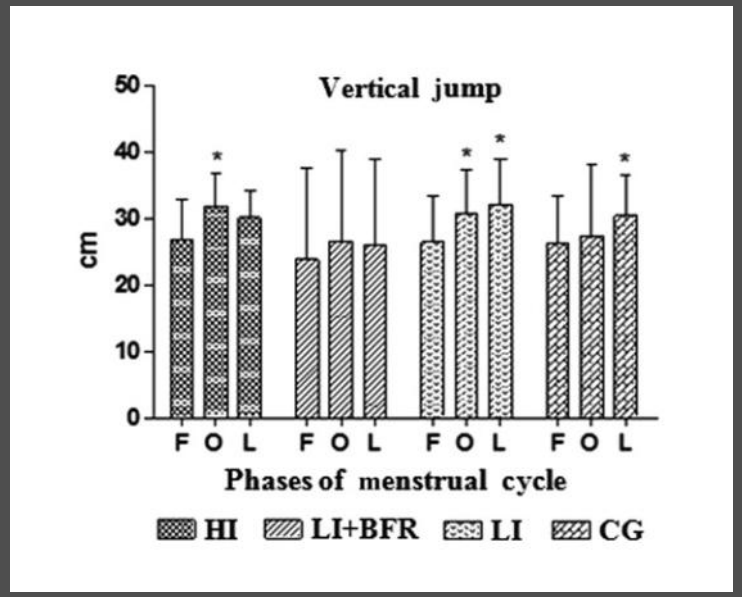
# BFR in Eumenorrheic Women Continued

- Assessed muscular power and strength using medicine ball throws, horizontal and vertical jump tests, 1RM tests, and submaximal strength test of bicep curls and knee extensions
- Tested in the follicular, ovulatory, and luteal phases
- 8 training sessions with 48-72 hours in between
  - 4 in the follicular and ovulatory phases, and 4 in the follicular and luteal phases




A. L. S. Gil et al



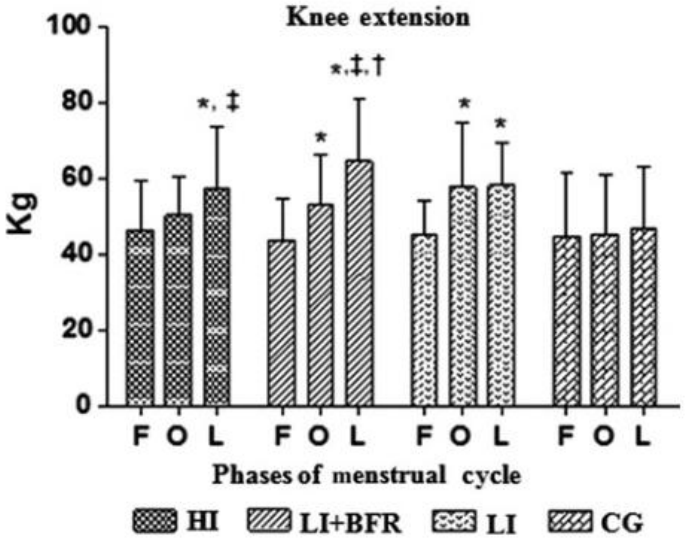
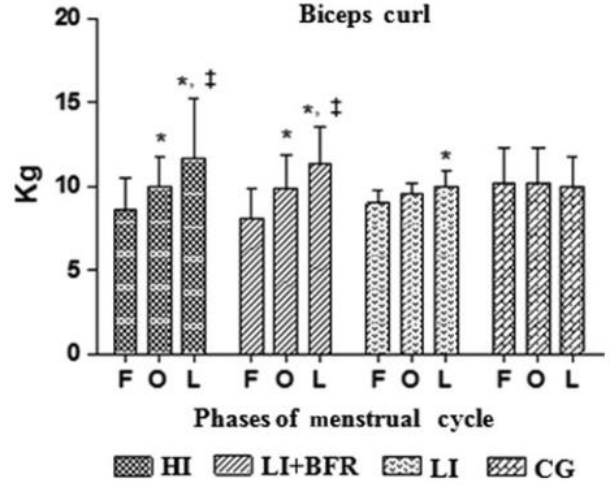
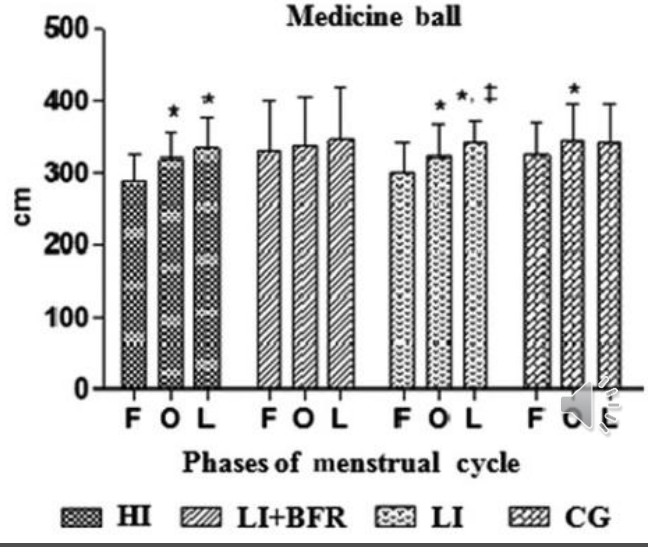




**Figure 6** Comparative analysis of the submaximal strength of knee extension test among the study groups. F, follicular phase; O, ovulatory phase; L, luteal phase; HI, high-intensity group; LI + BFR, low-intensity + blood flow restriction group; LI, low-intensity group; CG, control group. *Significant difference among the follicular versus ovulatory phases and follicular versus luteal phases; ‡Significant difference among the ovulatory versus luteal phases; †Significant difference between groups LI + BFR versus CG.

A. L. S. Gil et al.

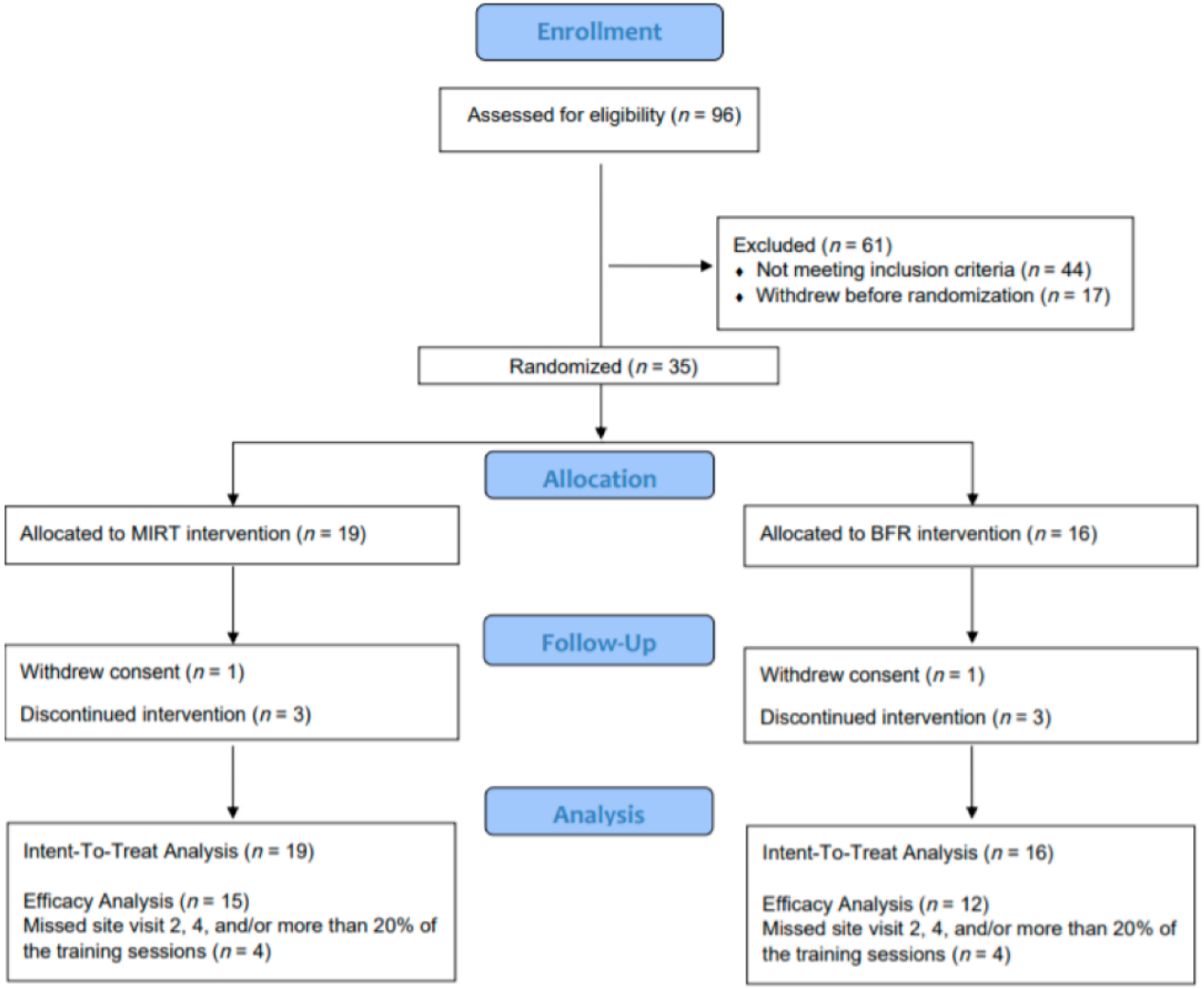


# Results of BFR in Eumenorrheic Women

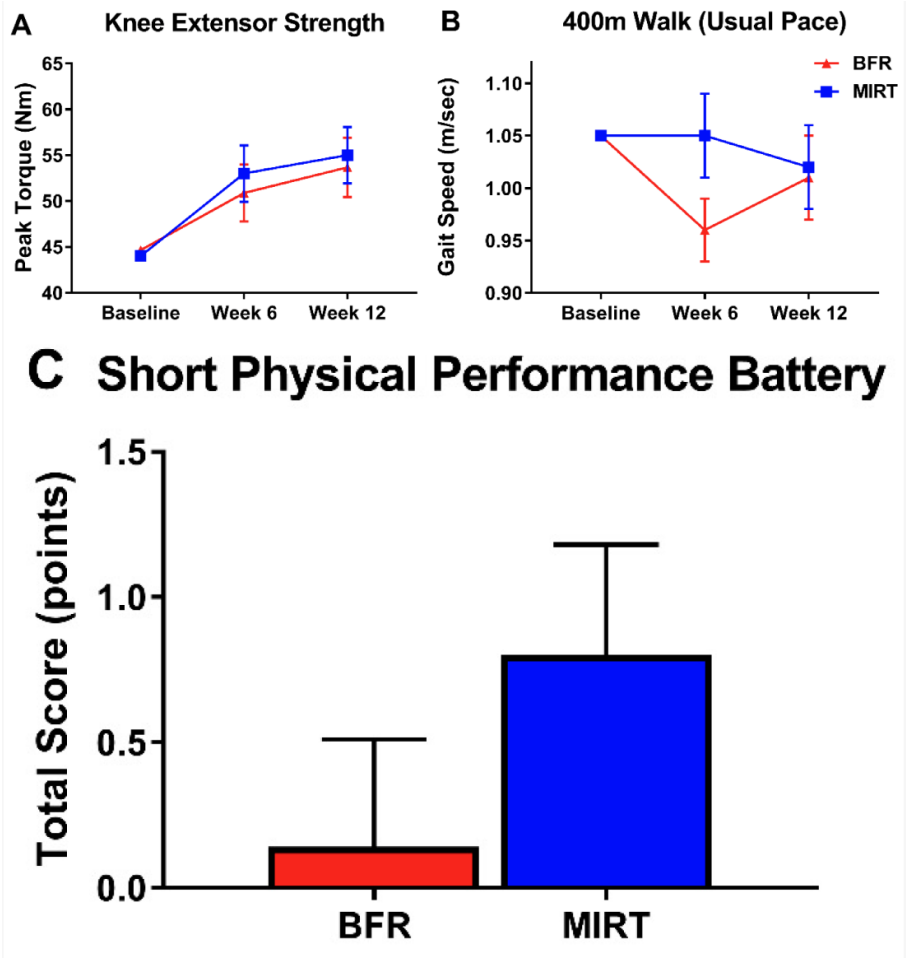
- Increase in power in both the high and low intensity groups, but not the BFR group
  - BFR does not improve performance in muscular power tests
- BFR of the lower limbs causes a significant improvement
- Data suggests that using BFR at a low intensity on women during the ovulatory and luteal phases can help to improve submaximal strength of the lower extremity

# Blood-Flow Restriction Resistance Exercise for Older Adults with Knee Osteoarthritis: A Pilot Randomized Clinical Trial




Harper SA, Roberts LM, Layne AS, Jaeger BC, Gardner AK, Sibille KT, Wu SS, Vincent KR, Fillingim RB, Manini TM, et al.

# BFR with Knee Osteoarthritis




Harper SA, Roberts LM, Layne AS, Jaeger BC, Gardner AK, Sibille KT, Wu SS, Vincent KR, Fillingim RB, Manini TM, et al.

- Improvements in strength with both conditions
- More reports of knee pain in MIRT vs BFR (14 vs 3)
- Conclusion: BFR may be less effective than MIRT when used in older adults with osteoarthritis, but is a viable treatment method.

# Continuing Questions

- Question of optimal pressure for RT, AT, and passive BFR
  - How may a standard be established with such interpersonal variation?
- Passive BFR- pressure, duration, sets, reps, frequency, and so on
  - What kind of studies could provide evidence for this?
- Long term effects- valve damage, blood pressure, lasting adaptations, etc
  - Other potential long-term effects?
- Variation by muscle group used in study
- Applications with COVID
- Post exercise and chronic BP responses

# Conclusion

# References


- Pictures:
- https://www.vanthielmd.com/the-cutting-edge-in-training-and-rehab-blood-flow-restriction-therapy/
- https://www.istockphoto.com/photos/blood-flow-muscle
- https://link.springer.com/chapter/10.1007/978-3-030-11425-1_33
- https://www.movementstrengthandconditioning.com/blog/energy-systems
- https://hiitscience.com/muscle-fibre-typology-individual-response-training/

- Studies:
- Ana L. S. Gil , Gabriel R. Neto, Maria S. C. Sousa, Ingrid Dias, Jeferson Vianna, Rodolfo A. M. Nunes and Jefferson S. Novaes, et al. Effect of strength training with blood flow restriction on muscle power and submaximal strength in eumenorrheic women. Scandinavian Society of Clinical Physiology and Nuclear Medicine 2015, https://onlinelibrary.wiley.com/doi/epdf/10.1111/cpf.12291
- Jessee, M.B., Buckner, S.L., Dankel, S.J. et al. The Influence of Cuff Width, Sex, and Race on Arterial Occlusion: Implications for Blood Flow Restriction Research. Sports Med 46, 913–921 (2016). https://doi.org/10.1007/s40279-016-0473-5
- OA: Harper SA, Roberts LM, Layne AS, Jaeger BC, Gardner AK, Sibille KT, Wu SS, Vincent KR, Fillingim RB, Manini TM, et al. Blood-Flow Restriction Resistance Exercise for Older Adults with Knee Osteoarthritis: A Pilot Randomized Clinical Trial. *Journal of Clinical Medicine*. 2019; 8(2):265. https://doi.org/10.3390/jcm8020265

- Reading list
- https://www.frontiersin.org/journals/physiology/articles/10.3389/fphys.2019.00533/full
- https://journals.lww.com/nsca-jscr/fulltext/2013/10000/Exercise_and_Blood_Flow_Restriction.37.aspx
- Potential safety issues: https://onlinelibrary.wiley.com/doi/full/10.1111/j.1600-0838.2010.01290.x