MIAMI UNIVERSITY
OXFORD, OH • EST. 1809

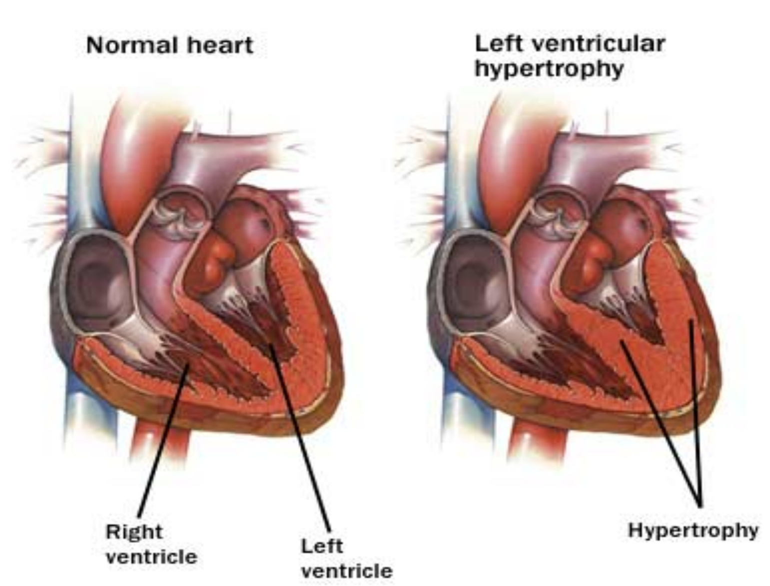
Cardiac Hypertrophy in the Mouse Heart: Exercise and Cold Exposure

B. Lewis and K. Koehler

Abstract

Cardiac hypertrophy is a condition in which genes are triggered to induce an enlargement of the heart. There are two forms of hypertrophy that are of interest: physiological and pathological. Physiological hypertrophy is thought to have a positive effect from having a well-conditioned body and heart from extensive physical activity. This is commonly seen in highly conditioned athletes. Pathological hypertrophy, on the other hand, is a traumatic condition for both the heart and the overall body, commonly resulting from obesity or other severely stressful situations and eventually leading to heart failure. Ultimately, the study is designed to facilitate a better understanding of the gene expression driving the hypertrophy that leads to these changes in the mouse heart. We will utilize a sedentary control group, and then one experimental group each for both long-term and short-term exposure to cold living conditions and exercise. We will then analyze cardiac gene expression, morphology, and metabolic rates for all mouse groups involved in the study at the end of the allotted eight weeks.

Introduction



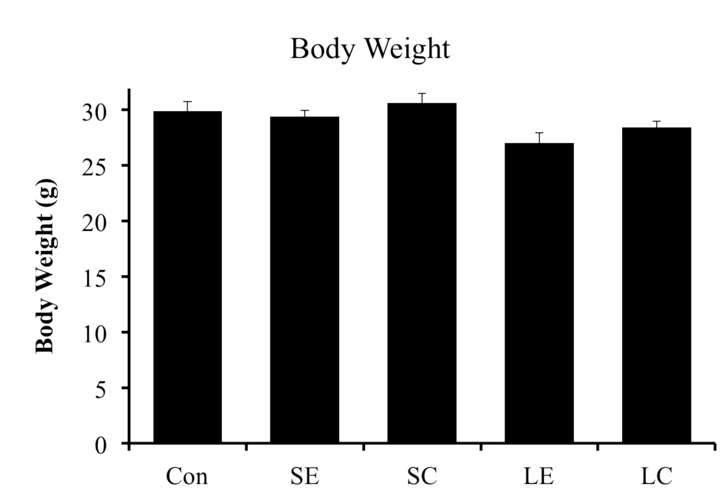
It is often generally accepted that cold exposure for an extended period of time leads to physiological hypertrophy, just as routine cardio exercise would. However, these two separate responses to two different living conditions may occur via different biological processes. Comparisons of the mice's bodily responses to both of these long-term conditions can be made using genetic analyses at the end of the study. Additionally, genetic comparisons of those results to that of the short-term exposure groups can inform us of potential similarities of early hypertrophy pathways even if the later stages are completely independent. Both contributors to physiological hypertrophy, exercise and cold exposure, are likely to increase cardiac efficiency, which will be measured and made comparable by VO_2 analysis at the end of the study. Morphological comparisons of the hearts of each group will be made for further representation of degree of hypertrophy.

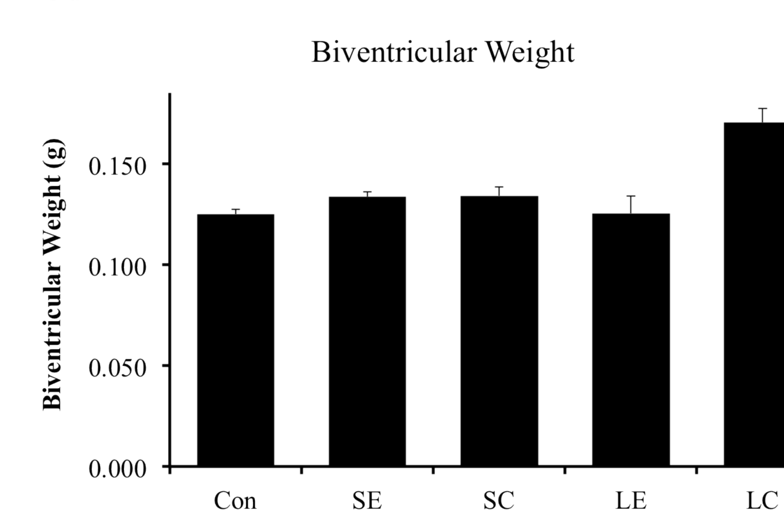
Photo:
Mayo Clinic. (2012). *Left Ventricular Hypertrophy.* Riverside Online

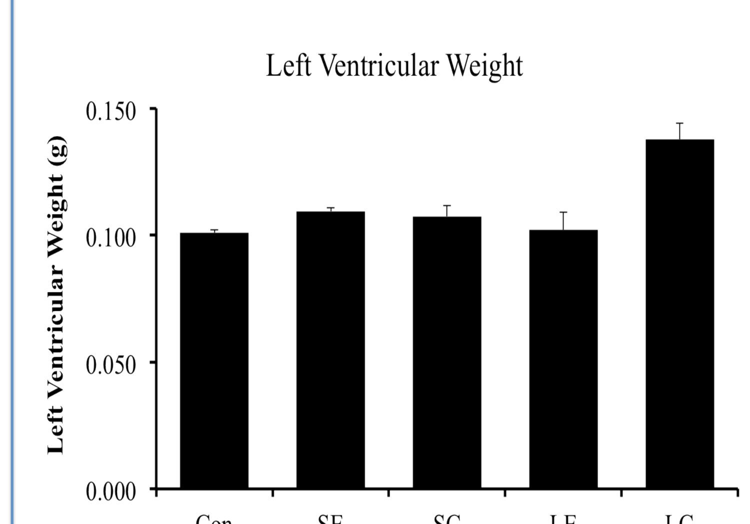
Methods

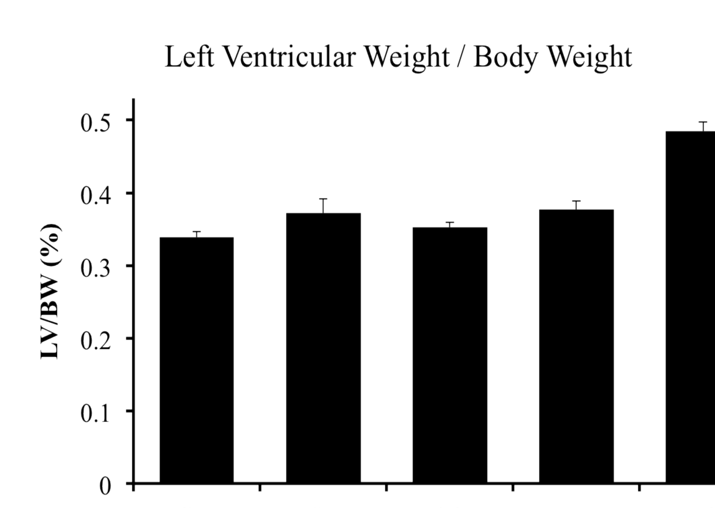
- Five groups of six mice each:
  - The long cold (LC) group lived sedentarily in cold exposure for 8 weeks
  - The long exercise (LE) group lived at room temperature and was exercised five times each week for 8 weeks
  - The short cold (SC) group lived sedentarily at room temperature for 8 weeks; were exposed to cold for 3 hours on the last two days of experiment
  - The short exercise (SE) group lived sedentarily at room temperature for 8 weeks; were exercised for one hour on last two days
  - The control group lived sedentarily at room temperature for 8 weeks
- Each group was given the same amount of food and water and was exposed to the same 12 hour light and 12 hour dark cycles. The long exercise group was exercised on a treadmill at 25 m/min for 45 minutes. The long cold and short cold groups were kept in an oxygen flow refrigerator at 4 degrees Celsius
- Each mouse was weighed, metabolic measurements were taken for the control, long exercise, and long cold groups, lean and fat mass were measured, and the hearts of each mouse were extracted to measure biventricular and left ventricular weights

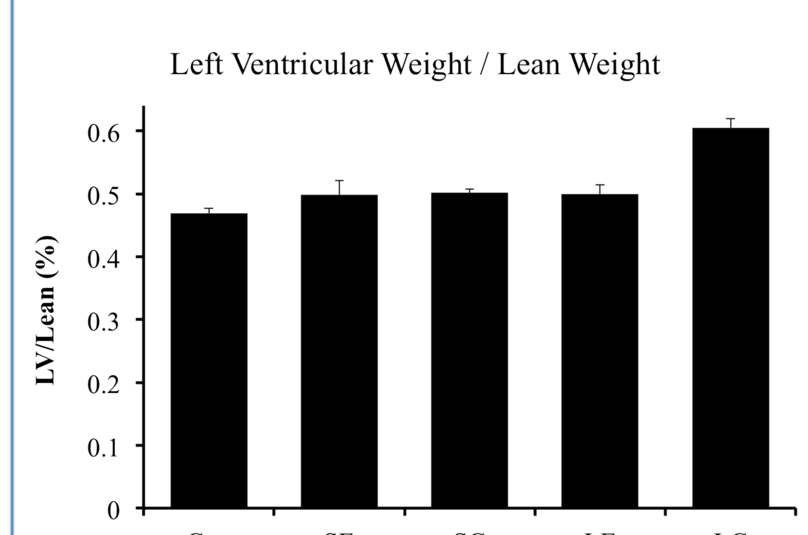
Results: Weight Measurements









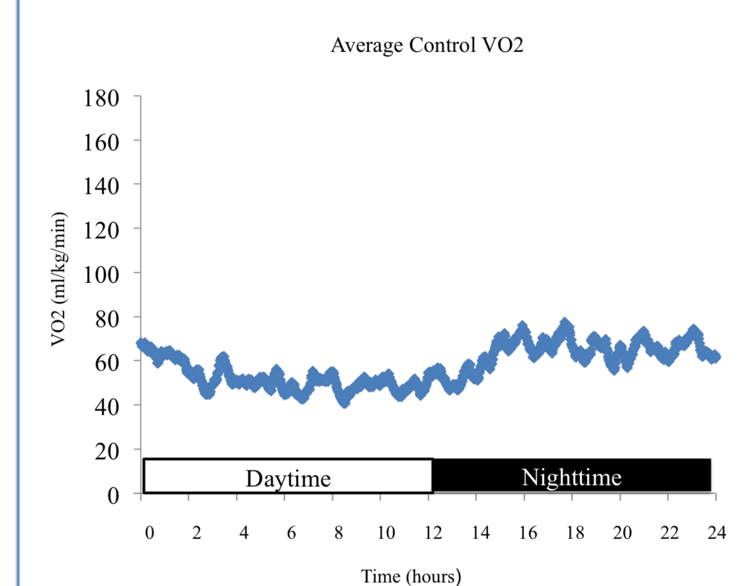


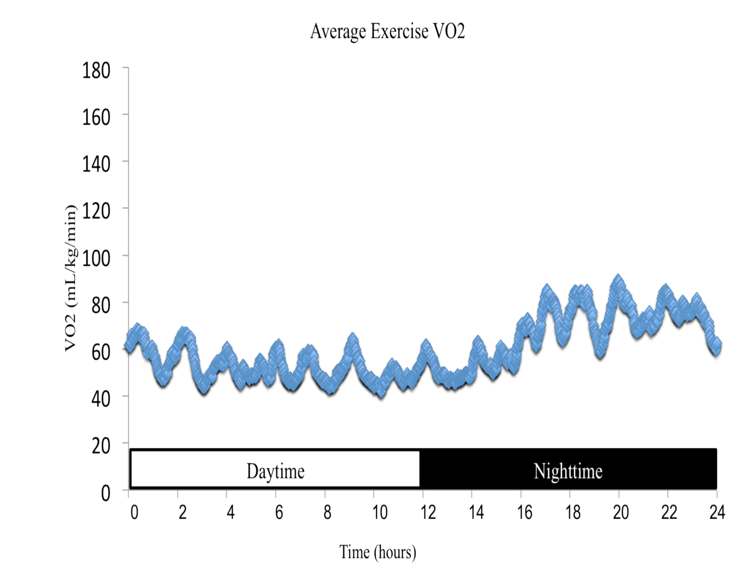
Graphs 1-5: comparison of the body weight, biventricular weight, left ventricular weight, and the left ventricular weight relative to the lean weight and body weight among the experimental and control groups. The biventricular and left ventricular weights for the LC group were significantly higher than for all other groups, which held constant. The ratios of biventricular and left ventricular weights to lean body mass were also significantly higher for the LC group.

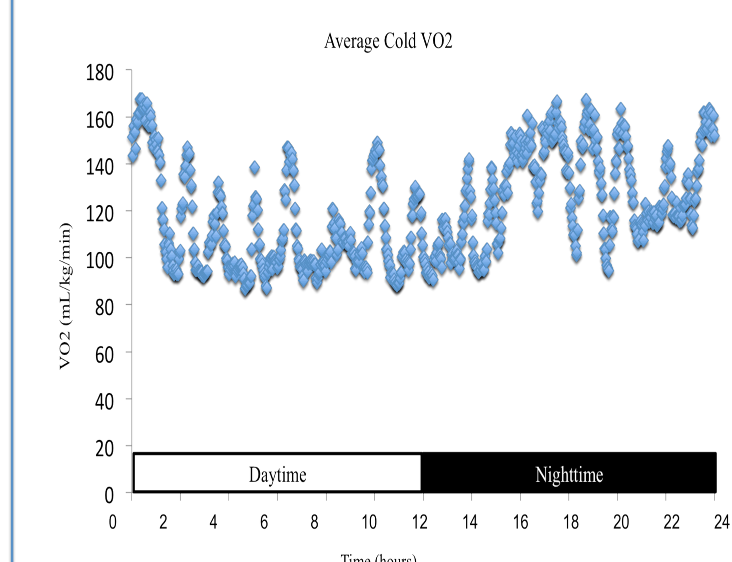
Objectives

- Establish whether or not cold exposure is a viable contributor to physiological hypertrophy
- Determine genetic and metabolic similarities of cold and exercise related hypertrophy incidences
- Investigate specific gene pathways involved in cardiac hypertrophy

Results: Average VO2 Graphs







Graphs 6-8: The average VO2 results for the control, long-term exercise, and long-term cold exposure groups over 24 hours. The difference between the control group and the exercise group is minimal, but the cold exposure group has significantly higher VO2 measurements.

Further Investigation

The next step in our experiment is to examine specific genes in order to determine the pathway of cold exposure on cardiac hypertrophy and examine genetic similarities and differences between cold and exercise on cardiac hypertrophy. This genomic investigation is possible through Next-Generation Sequencing provided by Illumina. The process involves a *sequencing by synthesis* technology that records the addition of labeled nucleotides to DNA samples and produces DNA sequences for comparison.

Acknowledgements

Lab Mentor: Doctor Paul Schaeffer
Funding: Illumina

illumina