Summary of Clinical Research Involving The AlterG Anti-Gravity Treadmill®

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At AlterG, we are committed to proper scientific investigation of the potential clinical and athletic performance benefits of using our device. We are pleased to have multiple studies in clinically relevant areas currently underway by independent researchers at highly reputable institutions in the U.S. and Internationally.

Due to the large expansion of the number of installed AlterG Treadmills worldwide, many independently produced studies are proceeding without the knowledge of our company. We encourage researchers to make us aware of concluded studies for inclusion in future Research Summaries.

WHAT'S NEW:

- New published clinical research showing effectiveness of the AlterG Anti-Gravity Treadmill in muscular dystrophy, rehabilitation after total knee arthroplasty, high intensity interval speed training, and osteoarthritis

- New basic science research in cardiovascular and pulmonary physiology, including safe cardiovascular response for elderly individuals exercising after total knee arthroplasty

- An interesting first reported measurements of reduced markers of articular cartilage turnover using AlterG Anti-Gravity Treadmill walking

- EMG comparison of AlterG Anti-Gravity Treadmill vs deep water running

- Multiple prospective clinical studies are continuing data acquisition, including a Level 1 RCT in rehabilitation after total knee arthroplasty.

- Initiating a large randomized trial of AlterG Anti-Gravity Treadmill vs pharmacologic cardiac stress testing in patients unable to do standard cardiac stress testing

- Additional user produced case studies were added to the website, bringing the total number of studies to 45.

- Additional Clinical Protocols were added to the website, now with 11 protocols.
CLINICAL RESEARCH UPDATE


- Studied cardiovascular responses to AlterG Anti-Gravity Treadmill body weight support in 25 healthy males as a prelude to future studies in heart failure patients
- Heart rate decreased, mean arterial pressure unchanged, systolic pressure unchanged, diastolic pressure slight but not significant decrease


- Prospective training program for severely affected muscular dystrophy patients who are unable to do conventional exercise due to weakness
- Improvements in walking distance and dynamic postural balance in all patients
- Supported use of AlterG Anti-Gravity Treadmill as a safe and effective training modality for severely affected individuals with muscular dystrophy


- Prospective pilot study of 29 patients undergoing total knee arthroplasty
- Demonstrated safety and efficacy, with improvements in KOOS, TUG, and pain scores
- High level of compliance by patients with outstanding acceptance from physical therapists
- Foundation for large scale randomized clinical trial which is now underway


- Physiologic study of ventilation correlated to walking speed


- In this interesting observational study, the authors measured serum cartilage oligomeric matrix protein (COMP)- a measure of cartilage catabolism. Participants were measured at their baseline unloaded condition, others were measured with a weighted vest adding 40% body weight, and others were measured on the AlterG Anti-Gravity Treadmill at -40% body weight
- Cardiovascular responses were also measured through heart rate and perceived exertion
- Changes to COMP were noted immediately during exercise
- Walking with unadjusted BW and increased BW resulted in measureable articular cartilage catabolism (via serum COMP); however, walking with decreased BW did not
- It is believed that sustained increases in COMP indicates cartilage breakdown
- AlterG Anti-Gravity Treadmill body weight support for walking may potentially benefit individuals who wish to simultaneously minimize knee joint load and maintain cardiovascular response


- The authors performed a 4 week prospective high intensity interval training program to assess improvements in running speed in trained high level runners
- Participants were randomized to standard treadmill training vs 10% body weight support on the AlterG Anti-Gravity Treadmill
- The 4 week HIIT protocol improved field performance, VO2 max, and submaximal heart rate
- The authors state that AlterG HIIT is an effective method to improve running performance while reducing potentially injurious joint loading seen in standard full body weight HIIT

- Case report of a 57 y.o. male experienced marathon runner with severe knee pain and varus thrust from medial knee osteoarthritis.
- He undertook a 14 week training program on the AlterG Anti-Gravity Treadmill
- At conclusion of the training program, his pain was negligible when running at full body weight and 3-D gait analysis showed improvements in his varus thrust
- He was successfully able to run a marathon without pain at 4 months after training on the AlterG Anti-Gravity Treadmill


- Case study of 81 year old man, 14 months post stroke with poor ambulation and balance
- Trained 4x per week for 4 weeks
- Improved walking speed, stride length, walking kinematics, and reduced fall risk


- This technical note shows that there is less than 5% difference between predicted and actual unloading with the most commonly used body weight unloading percentages from 90% to 40%


- Measurement of V02 in elite distance runners across a number of speeds and body

- The results were consistent with prior research, which found that while running on an AlterG Anti-Gravity Treadmill 1) metabolic cost significantly decreases with increasing levels of BWS, 2) metabolic cost significantly increases with increasing velocity, and 3) there is attenuation in the decrease in metabolic cost as BWS increases.

- Outcomes in this study are consistent with previous studies performed in non-elite runners


- Muscle activation in water is dependent on running style
- No difference in muscle activation of gastroc and tibialis anterior with any deep water running style vs. AlterG Anti-Gravity Treadmill
- No difference in muscle activation of rectus femoris in deep water running with high knee style and AlterG Anti-Gravity Treadmill


- 12 week prospective non-randomized clinical trial
- Participants reported significant improvements in knee joint pain and function and demonstrated significant increases in thigh muscle strength.
- Significant reductions in acute knee pain during full weight bearing treadmill walking and required dramatically less LBPP support to walk pain free on the treadmill.
- Data suggest that an LBPP-supported low-load exercise regimen can be used to significantly diminish knee pain, enhance joint function, and increase thigh muscle strength, while safely promoting pain-free walking exercise in overweight patients with knee OA.
Published Studies:

Early studies provide the foundation for the biomechanics of running and walking on the AlterG. They also show that for each individual a “metabolic prescription” can be achieved, thus maintaining metabolic load while reducing the ground reaction forces. More recent studies have focused on clinical rehabilitation topics. The principles shown here can be applied to a wide variety of medical and athletic rehabilitation settings. Here are summary findings:

- Jogging at 4.5mph with 50% body weight support produces the same knee joint reaction force as walking with full body weight
- For any given walking or running speed, weight support reduced metabolic demand by the individual
- For any given amount of weight support, metabolic demand can be increased by increasing walking or running speed
- Ground reaction forces are reduced at all levels of weight support
- Surface EMG electrode activity shows that muscle firing patterns and gait mechanics are maintained for all levels of weight support and speeds.
- Anti-gravity muscles show reduced activation with weight support
- Weight support causes no significant change in Heart Rate, Systolic Blood Pressure, Diastolic Blood Pressure and Mean Arterial Pressure
- Individuals who use Heart Rate to create exercise regimens can continue to do so on the AlterG and they should expect a similar metabolic demand from body weight support as with unsupported exercise
- Dramatic improvements in gait mechanics are seen in children with cerebral palsy who use the AlterG for exercise
- AlterG exercise is very well tolerated by individuals with knee osteoarthritis, and results in a reduction in knee pain when ambulating off the AlterG. An average of 12% body weight support is needed to produce pain relief.


- Confirmed results from other studies demonstrating maintenance of normal muscle firing patterns with body weight support, except for reduced activity during push-off phase
- Also noted that muscle firing patterns revert to pre-exercise within 3 minutes of fullreloading


- Observational biomechanics study evaluated specific loading across the foot using in-shoe sensors
- Foot loading patterns were preserved at 80% to 100% body weight, but patterns shifted towards forefoot loading at increasing levels of body weight support


- Observational study of cardiovascular responses to AlterG exercise after unilateral total knee arthroplasty
- Demonstrated cardiovascular safety of AlterG exercise in this population
- Older adults with TKA demonstrated lower heart rate, systolic blood pressure, oxygen consumption and minute ventilation levels when walking under lower body positive pressure conditions.
- AlterG exercise enabled TKA patients to walk at faster speeds and/or to tolerate greater incline which may be important in the rehabilitation of these patients
• Gait and functional improvements are seen in several adult neurologic conditions such as Parkinson's Disease and muscular dystrophy


• Prospective training program for severely affected muscular dystrophy patients who are unable to do conventional exercise due to weakness

• Improvements in walking distance and dynamic postural balance in all patients

• Supported use of AlterG Anti-Gravity Treadmill as a safe and effective training modality for severely affected individuals with muscular dystrophy


• Physiologic study of ventilation correlated to walking speed


• 25 obese adults with moderate knee osteoarthritis pain participated in a 12 week AlterG exercise program, twice a week for 25 minutes each session

• A mean level of 17.9% LBPP (i.e. 16.1 kg) was effective in reducing knee joint pain during initial walking

• Strength levels for the quadriceps and hamstring muscle groups increased significantly following the 12-week program

• Significant improvements were found in all KOOS subscales, indicating a reduction in knee OA symptoms and improvement in functional abilities

• Knee pain during walking significantly decreased, with some participants experiencing complete pain relief. Pain was reduced to a point where the addition of LBPP support was no longer required to reach minimal pain levels

• This thesis is being prepared for publication in a peer-reviewed journal

Evans, JM et al: Cardiovascular regulation during body unweighting by lower body positive pressure. Aviat Space Environ. Med. 2013, 84:1140-1146

• Investigated specific role of sympathetic control of cardiovascular function with lower body positive pressure


• Authors also measured pressure in mmHg at various body weight reductions for each subject. Pressure required will of course vary by subject's weight and body mass, but roughly 30-40mm Hg pressure is needed for a 20% reduction in body weight.

• Fluid shifts from the legs to the abdomen and thorax with lower body positive pressure support. There was a slight increase in systolic blood pressure, no change in diastolic blood pressure, slight decrease in heart rate, all of which can be expected with the fluid shift.


• Removal of up to 20% bodyweight did not alter metabolic responses (VO2, HR, RER) during jogging. Prescribed cardiovascular training intensities can be achieved with a reduction in ground reaction forces in individuals who are overweight, obese or injured.

The American College of Sports Medicine established equations used to predict VO2 for individuals walking or running at 100% body weight.

The current study was designed to measure actual VO2 with body weight support on the AlterG at 100%, 90%, and 80% body weight.

Measured VO2 with body weight support was significantly less than predicted for the 100% body weight condition, thus the ACSM equations cannot be used accurately on the AlterG.


VO2 is maintained on the AlterG at speeds relevant to the elite runner. Previous studies on other treadmills questioned whether the elite runner could maintain VO2 with body weight support.

Overspeed running mechanics are maintained.

The AlterG offers the additional advantage over conventional training of reduced joint impact forces, theoretically preserving joint health over the long-term.


The authors performed a 4 week prospective high intensity interval training program to assess improvements in running speed in trained high level runners.

Participants were randomized to standard treadmill training vs 10% body weight support on the AlterG Treadmill.

The 4 week HIIT protocol improved field performance, VO2 max, and submaximal heart rate.

The authors state that AlterG HIIT is an effective method to improve running performance while reducing potentially injurious joint loading seen in standard full body weight HIIT.

Grabowski, Alena and Kram, Rodger: Effects of Velocity and Weight Support on Ground Reaction Forces and Metabolic Power During Running.


This study was performed at the University of Colorado, and validated several core.


This study uses similar methods to the running study by Dr. Grabowski referenced above but now focusing on individuals during walking. Proof of basic principles during walking is very important for the post-injury, post-operative, and other groups who would not be expected to run on the AlterG.

Many combinations of velocity and BW resulted in similar aerobic demands, yet walking faster with weight support lowered peak GRFs compared to normal weight walking.

Manipulating velocity and weight support during walking with the AlterG may be a highly effective strategy for rehabilitation, recovery following surgery, and gait re-training.


For walking up to 3.5mph: a 25% reduction in body weight requires approximately a 0.5 mph increase in walking speed for the same VO2.

For running up to 9.0mph: a 25% reduction in body weight requires a 3mph increase in running speed for the same VO2.

Relationship between HR and VO2 is not changed with support, thus runners who use HR as an indicator of training intensity can continue to do so on AlterG with weight support.


Compared lower body positive pressure on AlterG Anti-Gravity Treadmill to head-up tilt for fluid volume shifts, cardiac output, blood pressure, heart rate.
10 healthy women, average age 70, participated in an 8 week AlterG exercise study

All women in this series demonstrated improvements in balance, mobility, and lower extremity strength

This study provides the foundation for follow-on studies focused on specific physical impairments


The purpose of this study is to investigate how lower extremity muscles are influenced by body weight (BW) support during running at different speeds. Reducing BW leads to a reduction in muscle activity with no changes in muscle activity patterns.


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Measurement of VO2 in elite distance runners across a number of speeds and body weight support levels

The results were consistent with prior research, which found that while running on an AlterG Anti-Gravity Treadmill, 1) metabolic cost significantly decreases with increasing levels of BWS, 2) metabolic cost significantly increases with increasing velocity, and 3) there is attenuation in the decrease in metabolic cost as BWS increases.

Outcomes in this study are consistent with previous studies performed in non-elite runners

- Muscle activation in water is dependent on running style
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- EMG activity of rectus femoris, biceps femoris, gastrocnemius, and tibialis anterior
- Increased speed at any given body weight support level increased muscle activity for all groups
- Increased body weight support at any given speed decreased muscle activity of the rectus, gastroc, and tibialis anterior but had no significant effect on the biceps femoris


- 12 week prospective non-randomized clinical trial
- Participants reported significant improvements in knee joint pain and function and demonstrated significant increases in thigh muscle strength.
- Significant reductions in acute knee pain during full weight bearing treadmill walking and required dramatically less LBPP support to walk pain-free on the treadmill.
- Data suggest that an LBPP-supported low-load exercise regimen can be used to significantly diminish knee pain, enhance joint function, and increase thigh muscle strength, while safely promoting pain-free walking exercise in overweight patients with knee OA.

- Possible to achieve VO2max with body weight unloading
- Ground reaction forces reduced
- Significant increase in time to exhaustion with AlterG training
- Improves running economy


- Confirmed results from other studies demonstrating maintenance of normal muscle firing patterns with body weight support, except for reduced activity during push-off phase
- Also noted that muscle firing patterns revert to pre-exercise within 3 minutes of full reloading


- Observational biomechanics study evaluated specific loading across the foot using in-shoe sensors
- Foot loading patterns were preserved at 80% to 100% body weight, but patterns shifted towards forefoot loading at increasing levels of body weight support


- Study evaluated pain responses to exercise for individuals with knee osteoarthritis on AlterG Anti-Gravity Treadmill
- Pain relief consistently achieved, on average required 12% body weight support


- Observational study of cardiovascular responses to AlterG exercise after unilateral total knee arthroplasty
- Demonstrated cardiovascular safety of AlterG exercise in this population
- Older adults with TKA demonstrated lower heart rate, systolic blood pressure, oxygen consumption and minute ventilation levels when walking under lower body positive pressure conditions.
- AlterG exercise enabled TKA patients to walk at faster speeds and/or to tolerate greater incline which may be important in the rehabilitation of these patients


- Individuals are able to perform closed chain walking and jogging early on in the postoperative period after Achilles tendon repair, maintaining a training effect in spite of partial weight bearing
- Authors proposed 85% BW as a benchmark to return patients to unsupported training