

REHAB SUMMIT

207: Comprehensive Assessment & Treatment of the Running Athlete

Shaun Goulbourne, DHSc, PT, MTC, OCS, SCS, STC, CSCS

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Non-financial: Shaun Goulbourne is a member of the National Strength and Conditioning Association.

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“Materials that are included in this course may include interventions and modalities that are beyond the authorized practice of your profession. As a licensed professional, you are responsible for reviewing the scope of practice, including activities that are defined in law as beyond the boundaries of practice in accordance with and in compliance with your professions standards. “

Shaun Goulbourne

Athletics

Basketball – England
Basketball – High School
Soccer – Univ. of KY
Coach – Club, HS, ODP
Train – Triathlons, Cross fit

Academics

BHS, MHS, DHSc
CSCS & PT
MTC, STC, OCS, CSCS
Diploma in Osteopractic
Crossfit Instructor L2

Running

- Athlete Assessment
 - Mental
 - Medical
 - Nutritional
 - Posture
 - Movement
 - Functional Tests
- Sport Assessment
 - Injury Prevention
 - Athletic Curriculum
 - Treatments
 - Sport Development

Running

- Method of locomotion allowing humans to move rapidly on foot
- Characterized by an aerial phase in which both feet are above ground
- The legs are kept mostly straight
- There is a Spring mass mechanics in that there are changes in kinetic and potential energy within a stride that occur simultaneously

Running

- Efficient Energy comes from springy tendons and muscle elasticity
- Associated with improved health and life expectancy
- Probably developed to hunt animals
- Competitive running dates back to religious festivals such as the Tailteann Games and Olympic Games 776 BCE
- The worlds most accessible sport

Running

- Popular sport
- Helps Address lifestyle factors including nutrition and sleep that is essential for runners general health
- Running specialization should not be encouraged in youth
- Assessment of runners should be a combination of physical, emotional, psychological, social, and cognitive factors.
- Krabak et al 2019

Evolutional Development in Man

- Nuchal Ligament
 - Tendon like structure that has developed in humans (and other animals) that permits running (enables upright posture and sustaining the weight of the head)
- Abundant sweat glands (don't sweat sitting at desk)
- Strong Achilles Tendons
- Big Knee Joints
- Muscular Glutei Maximi

Primary Prevention Purpose

- Running may stop the process that leads to the development of disease, and other pathological health conditions along with education
- Running may contribute to Risk factor reduction
- Running can create General health promotion

Secondary Prevention Purpose

- Monitoring our runners may assist in Early detection of disease, illness, and other pathological health conditions
- This does not prevent condition but may decrease duration and or severity of disease and thereby improve outcome, including improved quality of life

Tertiary Prevention

- Improved health of our runners may provide ways to limit the degree of disability while improving function in patients with chronic or irreversible disease

Health Promotion and Wellness

- Providing education and support to our runners to make choices that will promote health or improve health.
- The goal of wellness is to give people greater awareness and control in making choices about their own health.

Assessing Dietary Habits

- How many times do you eat per day?
- What do you typically eat in each of those meals/snack?
- How much water do you typically drink per day?
- How much caffeinated beverages do you typically drink per day?
- How many sports drinks do you drink per day?
- Do you use artificial sweeteners?
- Do you eat 5-6 servings of fruits/vegetables per day?
- Do you follow a low Carbohydrate, Paleo, intermittent fasting, or Alkaline diet?

Iron Rich Foods

- Important for our red blood cell volume
- Assess Meat, Fish, and Poultry content in their diet
- May correlate to anemic, dizziness, low blood pressure signs and symptoms

Caffeine

- Caffeine ingestion before running may stimulate dopamine release without inhibiting serotonin, which in turn may reduce central nervous system fatigue.
- Lee JB et al 2019
- Caffeine can also impair sleep quality
- Campo et al, 2019

Dopamine

- Dopamine is a neurotransmitter, a molecule that neurons release to communicate with each other
- Exercise alone can increase the amount of dopamine in certain regions of the brain, and therefore can exert a number of health benefits that can promote positive well being and even counter negative mental stress.
- Dopamine is critical in regulating motivation, memory, reward and attention, while Serotonin affects mood, emotion, sleep, and appetite.
- Depletion of Dopamine can lead to Parkinson's disease
- Exercise might increase your brain's ability to take up serotonin from your blood and increase dopamine production

Nutrition

- Nutrition related contributors include body mass and anthropometry, capacity to use fuels, particularly carbohydrates to produce ATP economically over the duration of the event, and maintenance of reasonable hydration status in the face of sweat losses induced by exercise intensity and the environment.
- Race nutrition strategies include CHO rich eating in the hours or days prior to the event to store glycogen in amounts sufficient for event fuel needs, and in some cases, in race consumption of CHO and fluid to offset event losses.
- Beneficial CHO intakes range from small amounts to high rate intake of 75-90g/hour in the long races.
- A personalized plan should balance the benefits of fluid and CHO consumed with practical opportunities, against the time, cost, and risk of gut discomfort.
- In hot environments, prerace hyper-hydration or cooling strategies may provide a small but useful offset to accrued thermal challenge and fluid deficit
- Sports foods may assist in meeting training/race nutrition plans, with caffeine, and perhaps nitrates being used as evidence based performance supplements.
- Burke et al. 2004

Nitric Oxide promoting Foods

- Beets (21% increase after 45 minutes)
 - Kroll JL et al. 2018
- Garlic activates nitric oxide synthase (40% increase within an hour of consumption)
 - Morihara et al. 2002
- Meat (Coenzyme Q10) preserves nitric oxide in the body
- Dark Chocolate
- Leafy Greens (spinach, arugula, kale, and cabbage)

Nitric Oxide promoting Foods

- Citrus fruits
- Pomegranate
- Nuts and seeds
- Watermelon
- Red wine

Signs of Dehydration

- | | |
|---------------------------------|-------------------------------------|
| • Mild | • Severe |
| – Thirst, dry mouth, dry lips | – As above |
| • Moderate | – Rapid weak pulse |
| – Very dry mouth, cracked lips, | – Rapid breathing |
| – Sunken eyes | – Confusion, lethargy, irritability |
| – Poor skin turgor | – Cold hands and feet |
| – Postural hypotension | – Unable to cry or urinate |
| – Headaches | |

Assess Sleep Habits

- Exercise has been shown improve sleep
- There are multiple possibilities on why exercises improves sleep
- Can you get to sleep at night?
- Systemic Disease:
 - Are there any unexplained fevers, night sweats, or unexplained perspiration?

Sleep

The included studies implemented several sleep interventions, including sleep extension and napping, sleep hygiene, and post-exercise recovery strategies. Evidence suggests that sleep extension had the most beneficial effects on subsequent performance. Consistent with previous research, these results suggest that sleep plays an important role in some, but not all, aspects of athletes' performance and recovery.

Bonnar D et al. Sleep interventions designed to improve athletic performance and recovery: a systematic review of current approaches. *S Sports Med.* 2018 Mar; 48(3): 683-703.

Sleep

- Sleep disturbance occur in 1/3 of the US population
- Insufficient sleep is a public health problem
- Physical Therapists agree that sleep is important for health and poor sleep impairs function
- Sleep is important for the proper function of the body, including immune function, tissue healing, pain modulation, cardiovascular health, cognitive function, and learning and memory.
- Healthy individuals who sleep less than 6 hours or more than 8 hours each night had a higher risk of mortality compared with those with adequate sleep (6-8 hours)

General Survey

- BMI (height(cm)/weight(kg) >18.5 <25
- Classification (endo, meso, ecto)
- Obvious deformities (Valgus, Varus, spinal)
- Muscle Atrophy
- Posture (Static can dictate dynamic)
- Movement Patterns and running mechanics
- Skin, hair, and nails
- Vital signs and sounds

Lung Sounds

- <https://youtu.be/2NvBk61ngDY>

Heart Sounds

- https://youtu.be/jG_4ibPnr9U

Auscultations

Heart Sounds

- Murmur – whooshing or swishing
- Gallop – three or four sounds
- Click – before, during, or immediately after each heart beat
- Irregular – changing rhythm

Bowel Sounds

Normal, hypo, or hyperactive (bubbling)

Lung Sounds

- Clear to Auscultation
- Rales – discontinuous clicking or rattling sounds
- Rhonchi – continuous low pitched rattling, resembling snoring
- Wheezes – high pitched whistling
- Crackles – short explosive sounds
- Diminished
- Absent
- Stridor – harsh, noisy, squeaking sounds that happen with every breath

Blood Pressure

Blood Pressure

- Ensure relaxation for accurate reading
 - Patient not holding or bracing themselves but supported
 - 2nd reading better than 1st

Blood Pressures

- Normal Systolic 90-119, Diastolic 60-79
- Prehypertension Systolic 120-139, Diastolic 80-89
- Stage 1 Hypertension Systolic 140-159, Diastolic 90-99
- Stage 2 Hypertension Systolic >160, Diastolic >100

Blood Pressure

- In a clinical setting, Exercise or activity should be reduced or stopped if the systolic pressure exceeds 200 mmHg or if diastolic pressure exceeds 100 mmHg

Pulse Pressure

- The difference between the systolic and diastolic and normally 40mmHg
- Widened pulse pressure is a sign of stiffening of the aorta and aging. Between 60-80 is a yellow flag and is a risk for new onset of atrial fibrillation
 - Also an increase risk of stroke and heart failure
- Narrowing of the pulse pressure can suggest CHF or a significant blood loss
- A high pulse pressure >60 and bradycardia is a sign of increased intracranial pressure and requires immediate medical attention

Blood Pressure

- With exercise, pulse pressure increases with the intensity of exercise
- SBP increases and DBP stays the same
- A difference of SBP 80-100 should be evaluated carefully and should return to normal in 3 to 10 minutes
- A difference of SBP 10mmHg between limbs may indicate vascular problem (Thoracic Outlet Syndrome)
- Systolic BP should be 10-20% greater in the legs than the arms
- If the legs are lower than arms, it would be considered abnormal

Blood Pressures

- Brachial
 - Supine
 - Sitting
 - Standing
- Ankle
 - Ankle Brachial Index Reading
 - Systolic Ankle/Systolic arm
 - 1-1.3 Normal
 - 0.8 – 0.9 mild peripheral arterial occlusive disorder
 - 0.5-0.8 moderate peripheral arterial occlusive disorder
 - <0.5 Severe peripheral arterial occlusive disease, critical limb ischemia
 - <0.2 Ischemic or gangrenous extremity

Blood Pressure

- Postural Orthostatic Hypotension
- A decrease in SBP of at least 20 mmHg and or a increase in diastolic pressure of at least 10 mmHg
 - The client should lie supine for at least 5 minutes before measure
 - At least 1 minute wait is recommended between position changes

Orthostatic Hypotension

- <https://youtu.be/Qzj0EmFV2to>

Signs of Respiratory Dysfunction

- Respiratory rate, depth, and effort of breathing (normal 12-20)
 - Tachypnea, dyspnea, gasping respirations
- Breathing Patterns
- Cyanosis
- Pallor or Redness of skin during activity
- Clubbing
- Nicotine stains on fingers or hands
- Retraction of intercostals, supraclavicular, or suprasternal spaces
- Use of accessory muscles
- Nasal flaring
- Tracheal tug
 - downward pull towards sternum observed in aneurysm of the Aorta
- Chest wall shape
 - Barrell, pectus excavatum, pectus carinatum, kyphosis, scoliosis
- Cough
- Sputum
 - Frothy, red tinged, green, or yellow pathological

Core Body Temperature

- 96.8 to 99.5 is the normal range
- Hyperthermia is greater than 100.4 degrees
- Hypothermia is less than 95 degrees

RUNNING MECHANICS

Phases

- Stance (most injuries and performance increase occur during this phase, tightening the string)
 - Absorption (Eccentric)
 - Propulsion (Concentric and reflexive)
 - Shortening this phase potentially decreases injury and improves performance
 - This is decreasing the amortization phase
 - This is plyometric training
- Swing
 - Initial (Concentric and reflexive)
 - Terminal (Eccentric) (most hamstring injuries occur here)

Hamstring injury

- Hamstring injuries are highly prevalent in many running based sports, and predominantly affect the long head of biceps femoris.
- Re-injury rates are also high
- The large eccentric contraction characterized by peak musculotendon strain (stretch) and negative work during late swing phase is widely suggested to be potentially injurious.
- There are large hamstring loads from large joint torques and ground reaction forces during early stance that may also cause injury.

Foot Strike

- Absorption phase (Eccentric)
- Foot Hits the ground
- Hip is extending from maximal flexion
- Knee is flexed
- Ankle is slightly in front of the body

Mid-stance

- The lower extremity is in knee flexion directly underneath the trunk, pelvis, and hips.
- Propulsion begins here with hip extension, knee extension, and ankle plantar flexion (Triple Extension)
- Triple Extension exercises should be helpful

Propulsion phase

- With a mid/forefoot strike, loading the gastro-soleus complex from shock absorption will serve to aid in reflexive plantar flexion from mid-stance to toe off and loading the quadriceps will aid in reflexive knee extension
- Hip extensors pulls the ground underneath the body, pulling the runner forward
- The knee is flexed and the ankle is in dorsiflexion

Swing Phase

- Hip and knee flexion occur during the initial phase with a combination of stretch reflexes and concentric muscle action
- Mid-swing is when the limb is directly underneath the trunk, pelvis, and hip
- Terminal swing then begins as hip flexion continues to the point of activation of the stretch reflex of the hip extensors.
- Might not want to inhibit this stretch reflex with static stretching

Upper extremity Function

- Provides balance to the opposing lower extremity
- Elbow joint flexed to 90 degrees or less
- Hands swing from the hips to mid chest
- Shoulder moving from minimal shoulder flexion to 45 degrees of extension

Trunk

- The trunk also rotates in conjunction with arm swing.
- The trunk/core is the Balance point for all limbs.
- Trunk remains mostly stable with little motion except for slight rotation as excessive movement would contribute to transverse motion and wasted energy
- Stabilizing core activities should be beneficial

Heel Strike

- Heel striking is associated with higher rates of injury due to inefficient shock absorption and inefficient biomechanical compensation for these forces
- Secondary to larger axial and transvers plane movements
- Increase internal rotation of the tibia, knee, and hip
- Daoud AL et al 2012. Foot strike and injury rates in endurance runners: a retrospective study. *Medicine and Science in Sports and Exercise*. 44(7): 1325-1334

Mid/forefoot strikers

- There does tend to be a greater percentage of mid/forefoot strikers running in the elite fields, particularly in the faster racers and the winning individuals or groups.
- Cavanagh, PR (1990). *Biomechanics of Distance Running*. Champaign, IL. Human Kinetics Books.

Athletes with Achilles Tendinitis

- Reduced Peroneus Longus muscle activation
- Reduced Medial gastrocnemius muscle activation
- Increased hip adduction impulse
- Delayed onset of gluteus medius and maximus
- Shorter duration of gluteus maximums and medius activation
- Earlier offset time of gluteus maximus
- Reduced leg stiffness
- Plyometrics or weight loss might be beneficial
- Sancho I et al, 2019

Hips

- Biomechanical factors associated with elite versus recreational runners include increased hip function, use, and stride length.
- There is also decreased ground contact time (plyometrics)
- Weyand PG et al(2010). Faster top running speeds are achieved with greater ground forces not more rapid leg movements. J App Phys. 89 (5): 1991-1999.

Hips

- An increased velocity likely comes from the increased **range of motion** in hip flexion and extension, allowing time for greater acceleration and velocity.
- Hip extensors and hip extension have been linked to more powerful knee extension during toe-off, which contributes to propulsion (proximal stability)
- Cavanagh, PR (1990). Biomechanics of Distance Running. Champaign, IL. Human Kinetics Books.

Biomechanics

- Use the core to keep posture upright and stable (proximal stability)
- Stride
 - Stride rates are extremely consistent across professional runners, between 185 and 200 steps per minute.
 - Stride Length is the separator

High Performance Endurance Running

- High performance runners have an increased vertical velocity of the center of mass and a flight time that was 11% longer than the recreational group.
- High performance runners have a forefoot strike pattern, they contact the ground with their foot closer to their body and they have a larger ankle moment.
- Preece SJ et al 2019.

Weight and Power

- Vertical and leg stiffness were increased as velocity increased but remained unaltered when load was changed (more power)
- As load increased there was longer contact times, reduced flight times, reduced stride frequency and step length (less ability to overcome force)
- Navaro et al. 2019

Getting our athletes faster

- Improve Shoulder extension strength
- Improve core stability
- Improve hip mobility
- Improve leg power
- Improve forefoot strike close to the body
- Improve stride length
- Decreased body weight?

Performance Improvement

- Training, footwear, nutrition, racing strategies (drafting) have all been shown to reduce metabolic cost of distance running.
- Kipp et al. 2019
- Nike Vaporfly 4% with full length carbon fiber plate provided improved performance versus Adidas Boost and Nike Zoom streak shoe
- Hunter et al, 2019.

Weight and Power

Athlete 1

WORK

- Force times Distance
- 200 pounds times 5 miles
- 1000 pound*miles

Athlete 2

WORK

- Force times Distance
- 100 pound times 5 miles
- 500 pound*miles

Weight and Power

Athlete 1

- Power
- Force times Distance/time
- 200 pounds times 5 miles 30 minutes
- 33.3 pound*miles/minute

Athlete 2

- Power
- Force times Distance/time
- 100 pound times 5 miles 30 minutes
- 16.67 pound*miles/minute

Weight and Power

Athlete 1

- Improving Power (10%)
- 36.6 pm/m
- 200 pounds times 5 miles/ 36.6
- 27 minute 5 mile run

Athlete 2

- Improving Power (10%)
- 18.3 pm/m
- 100 pounds times 5 miles/ 18.3
- 27 minute 5 mile run

Weight and Power

Athlete 1

- Decreasing weight by 10%
- 180 pounds
- 180 pounds times 5 miles/ 33.3
- 27 minute 5 mile run

Athlete 2

- Decreasing weight by 10%
- 90 pounds
- 100 pounds times 5 miles/ 16.7
- 27 minute 5 mile run

Weight and Power

Athlete 1

- Decreasing weight by 10% and improving power by 10%
- 180 pounds
- 180 pounds times 5 miles/ 36.7
- 24.5 minute 5 mile run

Athlete 2

- Decreasing weight by 10% and improving power by 10%
- 90 pounds
- 100 pounds times 5 miles/ 18.3
- 24.5 minute 5 mile run

Weight Loss

- 10% calorie reduction per day for a week and monitor performance
- Reduce non essential calories (fried foods)
- Reduce poor quality calories
- Per dietary assessment

Shoulder Extension Strength

- Pull ups
- Kipping Pull Ups
- Muscle Ups
- Bent Over Rows

Standing Postural Strengthening

- Rowing
- Pull Downs (shoulder extension)
- ER Pull outs
- Reverse Flys
- Standing Y's (Shoulder flexion)
- Trunk Rotation

Prone Plank Lab

- Prone Low Plank
 - Hold
 - Scapula Protraction/Retraction
 - Pelvic Tilts
 - Rotation
 - Forward Shoulder Presses
 - Vertical Shoulder Presses
 - Leg Raises
 - Spider Man
 - Low to High Plank
 - Walk Out
 - Walk Up
 - Crow Pose
 - Head Stand
 - Hand Stand

Side and Supine Plank

- Side Plank (+ feet elevated)
 - Hold
 - Pelvic Tilts
 - Bridges
 - Leg Raises
 - Vertical Row to Shoulder Press
- Supine High Plank
 - Hold
 - Pelvic Tilts
 - Bridges
 - Marches
 - Vertical Reaches

Hip Mobility

- Couch Stretch (Hip Flexors)
- Frog Pose (adductors)
- Door way Stretch (Hamstrings)
- ITBand stretch

Hip and ankle Strength/Mobility

- Pistol Squats
- Deep Single leg box squats
- Bulgarian Lunges

Hip Strength

- Deadlifts
- Glut Ham Machine
- Front Squats
- Goal 10% improvement per week
- 5 sets of 15 repetitions

Hip Power

- Cleans
- Snatches
- Broad Jumps
- Horizontal Leaps
- Horizontal Hops
- Goal 10% improvement per week
- 1 set of 6 repetitions

Running Injury Assessment

- Subjective
 - Area of Pain
 - Time of Running Specific Stress (phase of running or phase of training)
- Objective
 - Standing Posture
 - Spinal Curve and Pelvic Position
 - Hip, Knee, tibia, and foot position
 - Functional Movement Tests
 - Multi-segment Flexion/Extension
 - Overhead Squat
 - Overhead Walking Lunges or Marching
 - Multi-segment rotation
 - Multi-segment side bending
 - Stability
 - Low Plank
 - Power
 - Broad Jump and Single Leg Hop Distance
 - Flexibility
 - Thomas
 - SLR
 - Range of motion
 - Hip AB/AD/ER/IR
 - Ankle Dorsiflexion

Running Related Injuries

- Sudden changes in training load may play a key role in the development of running related injuries
- What is the runners load capacity?
- Significantly more runners were injured when they increased their weekly running distance by 20-60% compared to those who increased their distance by less than 20%
- How much did you run last week and how did your body respond?
- Damstad et al 2019

Running Status and History Study

- Of 312 participants in this study 80% reported injuries
- Four most common injuries was
- IT Band Syndrome (34%)
- Plantar fasciitis (30%)
- Strained thigh (25%)
- Medial Tibial Stress Syndrome (22%)
- Weingand et al 2019

Biomechanics

- Hip weakness is a common finding in sedentary females with PFPS
- Poor Hip Position leads to poor Knee and Ankle Position
- Tight Hip Flexors are a predictor of PFPS
- More lordosis, more pelvic tilt, more hip IR?
- Magalheas et al 2010

Biomechanics

- Researchers determined that those athletes with more foot pronation had much greater statistical probability of sustaining ITB syndrome, Achilles tendinitis, tibial stress fracture, tibial periostitis, and plantar fascia
- Busseuil C et al 1998

Novice Runners

- Novice runners are less economical and more prone to injury compared to well trained runners
- After some training, the novice runner's Hip ER moment increased significantly
- Improving running endurance does not necessarily lead to changes in running kinematics or kinetics
- It takes specific training to improve running economy and lower injury risk
- Mass et al 2019

Rec runners with/out knee related injuries

- The injured group ran with greater contralateral pelvic drop, femoral adduction, and hip adduction at mid-stance, and smaller foot inclination at initial contact (increased dorsiflexion preparing for heel strike)

Rec runners with/out knee related injuries

- Knee and hip ab/adduction ROMs during the stance phase are predictors of running economy, accounting for 44% of Running Economy variance.
- Running Training Prescription should consider a relationship between these parameters to ensure optimal technique and, consequently, to improve RE in recreational long distance runners.
- Pizzulo F et al 2019

Running Requirements

- Greater Balance
- Greater Muscle Strength
- Greater Joint Range of motion
- Ground Reaction force has been shown to up to 250% of body weight
- Mann et al. 1989

Running Requirements

- 10 degrees of Hip extension and 50 degrees of hip Flexion
- Knee range is 40 to 125 degrees of flexion
- Ankle Dorsiflexion and Plantarflexion is 25 degrees
- Medial and Lateral rotation at the hip
- Counter trunk rotation

Running Mechanics

- We are built to run, hunt, and gather
- We need to play sports if we do not hunt or gather
- We destroy our Talent with sitting
- Ability is limited by strength, power, and mobility

Running Progression

- Should not run if you can not:
- Squat
- SLS Balance
- SL S Squat
- Squat Jump
- Leap
- Hop
- Plank
- Plank with opposite arm and Leg Lift
- Trunk Rotate

Running Performance Goals

As needed

- Improve Nutrition and Hydration
- Eliminate taught muscle knots
- Improve Neutral Feet
- Improve Ankle Dorsiflexion
- Improve Hip Flexion and Extension
- Improve Pelvic Position
- Improve Multisegment F/E/R/S
- Improve Shoulder Retraction
- Improve Squat and SL Squats
- Improve SLS Balance and stability
- Improve Jumps, Leaps, and Hops
- Improve 4 Way Planks static and dynamic

Continuing Education Credits

Access the Rehab Summit Evaluation on August 1st:

- An email will be sent to your registered email address
- An evaluation link will also be available on RehabSummit.com

Once you have completed the evaluation, you can choose to print, download, or email the certificate for your records.

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