Evaluating and Treating the Injured Runner
From the Classroom to the Clinic

SARAH E. JOHNSON, PT, DPT, OCS, COMT
Objectives

1. Complete a subjective examination of an injured runner
2. Complete a table examination of an injured runner
3. Complete a 2-D running analysis of an injured runner
4. Identify and treat common running related musculoskeletal impairments
5. Prescribe an appropriate return to running plan
Subjective Exam

Pain behaviors
Medications
Energy levels
Menstruation
Dietary/Nutrition
  - ↑/↓ weight
  - Fuel / hydration

Training patterns
  - ↑/↓ volume or intensity
  - Surfaces
Shoes
Races
Change in running pattern
Goals
Most common running injuries

- Hip and Pelvis
- Patellofemoral Pain
- IT Band Syndrome
- Foot and Ankle
- Bone Stress Injuries
Hip & Pelvic Injuries

- Hamstring tendinopathy
- Chronic groin pain
- Greater trochanteric pain
- Piriformis syndrome
- Iliopsoas tendinopathy
- Femoroacetabular impingement
- Hip labral tears
- Hip osteoarthritis
Hip & Pelvic Injuries

~11% of running injuries

Evidence indicates that women may be at greater risk

Consider lumbopelvic dysfunction

Control inflammation: Ice: NSAIDs

Activity modification
  ◦ Stop
  ◦ Modify
    ◦ Decrease volume and/or intensity
    ◦ Avoiding hills
    ◦ Increase step rate
    ◦ Body weight-supported running
    ◦ Deep water running

Progressive return

Gait retraining
Proximal Hamstring Tendinopathy

PRESENTATION

Deep buttock pain near ischial tuberosity

Provocation
- Accelerating or running uphill, direct pressure (sitting), end-range hip flex & resisted hip ext

Special tests
- Bent-knee stretch test, modified bent knee stretch test, Puranen-Orava test, MRI (tear)

Differential Dx
- SIJ, ischiogluteal bursitis, obturator internus bursitis, ischifemoral impingement, piriformis syndrome, lumbopelvic dysfunction, acetabular labral tear, stress fracture of pelvis & femoral head

MANAGEMENT

Early
- Correct lumbopelvic dysfunction
- Soft tissue mob (avoid direct pressure to IT)

Progressive loading guidelines

Neuromuscular control exercises
- Glutes

Eccentric exercises
- Hamstring – alter hip flexion angle

Injections
- Corticosteroid, PRP

Surgery
Greater Trochanteric Pain Syndrome

5% of all running injuries

Affects women up to 5x more than men

Includes
- Trochanteric & gluteus medius bursa irritation
- External snapping hip (coxa sultans)
- Gluteus medius & minimus tendon tears & tendinopathy
Greater Trochanteric Pain Syndrome

PRESENTATION

Insidious or increased running volume or intensity, running on cambered surface, high peak hip add in stance

Pain localized to greater trochanter → down thigh

Provocation
- Lying on affected side, crossing legs, SLS, stairs, walking, running, resisted hip abd

Prior or concurrent lumbar symptoms

Special tests
- FABER, Resisted external derotation test, Trendelenburg sign, Resisted hip abduction, MRI

Differential Dx
- OA

MANAGEMENT

Mobs & manips
- Soft tissue, lumbar spine, SIJ

Sleep hygiene

PRE
- Isometric → maximize glute med

Injection

Surgery
Piriformis Syndrome

6-8% patients with LBP and sciatica

Sciatic nerve

Similar loading as glutes when running

- Loading response, eccentric $\rightarrow$ concentric
Piriformis Syndrome

PRESENTATION

Buttock pain, sciatica

Provocation
  ◦ Sitting, palpation. Loading of running/walking

Presents with ER in standing or sitting

Special tests
  ◦ FAIR (side lying, 60 deg flex), Pace test, Beatty test, Piriformis sign, Freiberg test, Single leg step down test (poor eccentric control)

Differential Dx
  ◦ Lumbar radic, SIJ, intra-articular hip pathology, proximal hamstring tendinopathy, grater trochanter pain syndrome, referral from glute med or QL

MANAGEMENT

Soft tissue mobs, trigger point release

Joint mobs
  ◦ Hip, lumbar spine, sacrum

Avoid aggressive piriformis stretch

Neuromuscular training, rotation exercises
  ◦ Isometrics→isotonics→weight-bearing

Injections
  ◦ Image-guided
  ◦ Corticosteroid, anesthetic, Botox A
Iliopsoas Syndrome

Includes tendinopathy, bursitis, impingement

Function in running
- Terminal stance
  - Eccentric
- Initial swing
  - Concentric

Snapping
- AIIS, Iliopectineal eminence, Lesser trochanter

Impingement
- Femoral head & anterior labrum
Iliopsoas Syndrome

**PRESENTATION**

Anterior hip pain
- LBP

Provocation
- Tender anterior hip jt, resisted hip flex (slight abd and ER), plank
- Snapping: flex/abd/ER→ext/add/IR
- Impingement: FADIR test, may have iliopsoas tightness

Imaging
- Radiographs, MRI

**MANAGEMENT**

Soft tissue mob, trigger points, stretching

Joint mobs
- Hip, lumbar spine, sacrum

Progressive loading guidelines

Hip strengthening

Lumbopelvic stabilization exercises

US-guided injections

Surgery
Chronic Groin Pain

Proximal adductor tendons
Rectus femoris
Rectus abdominis
Athletic pubalgia (sports hernia)
Females during and after pregnancy
# Chronic Groin Pain

## PRESENTATION

**Dull aching pain**
- Proximal adductor tendons & pubic symphysis
- Radiate to lower abdomen, perineum, scrotum

**Provocation**
- Palpation, resisted hip add, PROM hip abd

**Special Tests**
- Adductor squeeze test, decreased hip IR ROM, bent knee fall-out test

**Differential Dx**
- Intraarticular hip pathology, femoral neck or lesser trochanteric bone stress injury

## MANAGEMENT

**Adductor**
- 8-12 wk neuromuscular training
  - Isometric add, standing resisted add, trunk ext, situps, SLS, forward/side lunge, side plank (later stage)
  - Cross-friction massage, stretching

**Bone stress injury**
- No running 6 wks
- Injections

**Surgery**

**Athletic pubalgia**
- Hip add, glutes & deep abdominal strength
- Surgery
Femoroacetabular Impingement

Cam
- Bump on ant or ant/lat femoral head
- Flattening of femoral head-neck junction

Pincer
- Overgrowth of acetabulum
- Acetabular retroversion
- Coxa profunda

Commonly involves both

Can be associated with labral tear and/or chondral damage
FAI

PRESENTATION

Pain in ant & ant/med hip; can also be in lat hip, ant thigh, low back, buttock

Provocation
  ◦ Sitting in a low seat, squatting

Weakness
  ◦ Adductors, abductors, flexors & external rotators

Special tests
  ◦ FADIR, FlexIR, imaging – radiographs, MRI (labral tear found in 68% of asymptomatic people)

MANAGEMENT

Avoid extreme flex, IR, add

Mobs
  ◦ Lateral glides, inf glides/distraction, post capsule

Stretching

Neuromuscular training
  ◦ Glute med & max, PPT or neutral spine

Surgery
  ◦ Post-op rehab
  ◦ Running as early as 8-10 weeks post-op
Labral Tears

Maybe from repetitive hip hyperext and ER in terminal stance in runners
May be associated with iliopsoas impingement
May have traumatic etiology
High incidence of false (+) MRI
8 times more likely >30 yo
Labral Tears

PRESENTATION

Difficulty to distinguish from FAI
- Commonly coexist

“Catching, clicking, giving way”

Special Tests
- FADIR, FlexIR
- Imaging

MANAGEMENT

Activity modification
- Weight-bearing rotation & ext

Neuromuscular training
- Trunk stabilization, glutes, deep lateral rotators, iliopsoas

Return to running
- Gradual, correct mechanics

Injections

Surgery
Osteoarthritis

No associated between hip OA and running

Reduced incidence of OA and THA with long-term recreational running

High impact can speed progression of OA
OA

PRESENTATION

Insidious and progressive pain and stiffness

Pain in buttock, groin and/or thigh
  ◦ Hours after activity

Decreased ROM
  ◦ IR, add
  ◦ 3+ planes limited (Birrell et al.)
  ◦ Combined results (Altman, et al.)
  ◦ Combined results (Youdas, et al.)

Imaging

MANAGEMENT

Neuromuscular training
  ◦ Lumbopelvic & hip

Jt mobs
  ◦ Lateral glides

Cease or modify running
  ◦ Decrease stride length

Injections

Surgery
  ◦ Resurfacing or partial/total replacement

PATELLOFEMORAL PAIN
Patellofemoral Pain

Anterior knee pain

25% of knee injuries that present to SM Clinic

2-3x more women than men

Subchondral bone (disrupted articular cartilage), medial and lateral retinacula, infrapatellar fat pad

Persistent symptoms in up to 91% of patients

Differential Dx: patellar tendinopathy, prepatellar or infrapatellar bursitis, infrapatellar fat pad syndrome, plica syndrome, chondromalacia patellae, pathellofemoral OA, OCD, patellar stress fx, patellar instability, Osgood-Schlatter disease, Sinding-Larsen-Johannson disease
PFP

Local Joint Factors
- Patellar tracking or hypermobility
- Quad weakness
- Delayed VMO activation
  - Relative to VL
- Soft tissue tightness/tension/inflexibility
  - Quads
  - Gastrocs
  - IT band
  - Hamstrings
PFP

Lower Extremity Biomechanics
- Hip muscle dysfunction
  - Abd/ ER weakness
  - Decreased endurance
  - Neuromuscular incoordination
- Foot overpronation
- Gait deviations
  - Increased hip add/ IR
  - Increased peak GRF
  - Heel foot-strike pattern
Training Considerations
- Female
- Novice runners
- Abrupt escalation in exercise
- Increased intensity &/or frequency
- Excessive hill work
  - Downhill
- Not enough recovery time
- High weekly mileage
## PFP Presentation

<table>
<thead>
<tr>
<th>STATIC STANDING</th>
<th>DYNAMIC TESTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Genu valgum or varum</td>
<td>SLS Squat: increased valgus, hip IR</td>
</tr>
<tr>
<td>Squinting patella</td>
<td>Impaired landing: increased valgus, hip IR</td>
</tr>
<tr>
<td>Excessive pronation</td>
<td>Altered gait mechanics: increased hip add, accelerated foot pronation, decreased step rate, increased peak GRF</td>
</tr>
<tr>
<td>Generalized joint laxity</td>
<td></td>
</tr>
</tbody>
</table>
PFP Presentation

SITTING

(+) J-sign

LYING

No swelling, erythema, warmth
VMO and/or quad atrophy
Lateral retinaculum TTP
Excessive lateral glide (>0.5 cm)
(+) lateral patellar tilt
Limited medial or excessive mediolateral mobility
Muscle tightness
  ◦ Popliteal angle, Obers test, Ely test, GN stretch
PFP Management

NSAIDS, modalities for pain
Tailored treatment plan address findings
Strengthening
Stretching
Taping/bracing
Orthotics
Biofeedback
Gait retraining – visual feedback, forefoot strike
Correct training errors/ education
PFP Management

Correct training errors
- Activity modification until pain-free
- Correct training program errors
  - Increasing intensity too quickly
  - Inadequate recovery time
  - Excessive hill work
- Education for safe training
  - Volume increase of 10% per week or up to 30% in 2 weeks

ILIOTIBIAL BAND
Iliotibial Band Syndrome

2\textsuperscript{nd} most common running injury

Most common reason for lateral knee pain in runners

Slightly higher incidence in female versus male

No contributing factors among: varus and valgus knee, pes planus, pes cavus, Q angle and leg length

Relationship from lumbar spine to anterolateral knee

Upper glute max = frontal plane; lower glute max = transverse plane

No bursa

Synovial fold of the lateral synovial recess; inflammation, hyperplasia, fibrosis, mucoid degeneration
ITBS

Presentation

◦ Deceleration phase of stance
◦ “Impingement zone” ~30 deg knee flex
◦ Increased hip add, knee IR, femur ER (prospective study of female runners)
◦ Compensatory trunk ipsilateral flexion (female runners)
◦ Increased hip IR and knee add (study of male runners)
◦ Narrow foot placement exhibited higher ITB strain, strain rate, hip add (male and female runners)
◦ Hip abductor and/or external rotator weakness
◦ 6-inch step down test
◦ (+) Trendelenburg or compensation
ITBS

Management

- Acute (3 day – 1 week): NSAIDS, Myofascial and trigger point release – ITB, VL, BF, GMax, ice, Ionto with Dex, gait training (walking): activate core and glute muscles, soft landing
- Subacute (3 days – 2 weeks): consider US-guided Corticosteroid injection, manual stretching – ITB, VL & BF, wean ice, stretch ITB and hamstrings (Foam roll?), activate posterolateral hip muscles
- Recovery (1-6 weeks): facilitate anterolateral abdominals and posterolateral hip muscles, standing TherEx and PRE posterolateral hip, stretch ITB, VL, BF
- Return to Running (6 weeks): every other day, avoid hills, motor control cues to core and posterolateral gluteal, 2D motion capture – observe for pelvic control, 6” step down with pelvic control – in front of mirror
- Notes: run softly, easy sprints early, emphasize control for varus knee, pelvis & trunk, avoid overstride

FOOT AND ANKLE
Foot and Ankle

Tendinopathies
- **Achilles tendinopathy, Posterior tibial tendon dysfunction**, Peroneal tendinopathy, Flexor hallucis longus tendinopathy, Anterior tibial tendinopathy

Ligament & Fascia Conditions
- **Plantar fasciopathy, Inversion ankle sprains**, High ankle sprain (syndesmosis injury)

Bone Conditions
- **Bone stress injuries**

Joint Disorders
- Hallux rigidus, Osteochondral defect of the talus, Osteoarthritis

Nerve Disorders
- Interdigital neuralgia/Morton’s neuroma, Tarsal tunnel syndrome, Superficial peroneal neuropathy, Jogger’s foot
Bone Stress Injuries

Results in failure of skeleton to withstand forces from running

Range from radiographic evidence of marrow edema to fracture line

Up to 20% of SM clinic visits

>20% annual incidence in runners

Common sites include tibia, fibula, metatarsals, tarsals, calcaneus, femur
BSI Risk Factors

BIOLOGICAL

Female
Genetics
Meds
  ◦ Anticonvulsants, steroids, antidepressants, antacids, hormones (includes birth control)
Female athlete triad
  ◦ Low energy availability, menstrual dysfunction, low bone mineral density
Dietary
  ◦ Insufficient calcium and VITD

BIOMECHANICAL

Training patterns
  ◦ Volume or changes in intensity
Bone characteristics
  ◦ Thinner cortex, lower bone mineral density
Anatomic considerations
  ◦ Leg length discrepancy, lean mass, foot type, smaller calf cross-sectional area
BSI Presentation

Subjective
- Complete running history
  - Inc running volume, shoe type, shoe mileage, race schedule, any attempted changes to running pattern (foot strike)
- Female runners
  - Triad risk factors
- Medications

Objective
- Focal bony tenderness
- Single-leg hop test
- Local swelling or skin color changes (more advanced cases)
- Specific special tests for anatomical areas
- Imaging
BSI Management

Acute healing phase

- Goal: pain-free ambulation and no pain with exam
- Nonimpact loading
  - Deep water running
  - Antigravity TM
- Good caloric intake
- Adequate Calcium and VitD
- Specific recommendations per anatomical site

RUNNING ANALYSIS
2-Dimensional Running Analysis

Frontal and sagittal planes
Inexpensive and clinically relevant
Correlate with subjective and objective exams
  ◦ Recent injury
  ◦ Musculoskeletal findings
  ◦ Training errors
2-D Running Analysis

TREADMILL

Kinematic values are similar to running over ground

Differences
- Muscle activation patterns
- Joint forces

Running velocity
- Match to pace at which symptoms are felt
- OR “long run” speed

CAMERAS

Image resolution
- 720p HD or 1080p HD

Temporal resolution
- Most cameras 30 fps
- 120 Hz (fps) + recommended
- 100 fps ECU Lab
2-D Running Analysis

VIEWS

2 fixed orthogonal (right) angles
  ◦ (lateral and posterior used in article)
Reproducible camera location
Zoom in on foot and ankle
Zoom out on whole body
2-D Running Analysis

MARKERS

Retroreflective tap-based markers OR bright colored tape
Applied directly to skin OR to tight running clothes

C7 SP
PSIS
ASIS
Greater trochanter
Lateral knee joint line
Lateral malleolus
Midpoint of the calf
Superior & inferior of heel shoe counter
Head of 5th metatarsal
2-D Running Analysis

WARM-UP

6-10 minutes

OR when runner reports onset of symptoms

ANALYSIS PLAN

#1 Be consistent!

#2 Be systematic
  ◦ Distal to proximal

Software
  ◦ Dartfish
  ◦ HUDL
  ◦ Kinovea
Phases of Running
Side View

FOOT STRIKE

Forefoot strike
Midfoot strike
Rear foot (heel) strike

Foot strike patterns during running (2a – Rearfoot pattern; 2b – Midfoot pattern; 2c – Forefoot pattern).

M.O. de Almeida et al. / Physical Therapy in Sport 16 (2015) 29–33
Side View

FOOT INCLINATION ANGLE

Angle created by the sole of the shoe and treadmill at initial contact (1\textsuperscript{st} frame when the foot hits the ground)

N/A for FFS and midfoot strike

Higher angle = higher GRF $\rightarrow$ injury?

May correlate with overstriding

HIGH (A) VERSUS LOW (B)
Side View

TIBIA ANGLE

Evaluated at the moment of loading response (as the shoe begins to deform)

(A) Extended tibia
- Lateral knee joint marker is posterior to lateral malleolus marker
- Not ideal in runners with impact related injuries

(B) Vertical tibia
- Lateral knee joint marker is directly over the lateral malleolus marker

(C) Flexed tibia
- Lateral knee joint marker is anterior to the lateral malleolus marker
Side View

KNEE FLEXION

Evaluated during stance
Find the frame with the greatest angle
~45 deg midstance
<40 deg may be associated with PFP
Knee stiffness with reduced or increased knee flexion angle may be associated with tibial stress fractures

LIMITED KNEE FLEX (A) VS. NORMAL (B)
Side View

HIP EXTENSION

Evaluated in late stance
Correlate with speed and stride length
Observe for compensations associated with decreased hip ext
  ◦ Increased lumbar ext
  ◦ Bounding to increase float time
  ◦ Overstriding
  ◦ Increased cadence to increased speed
Side View

TRUNK LEAN

Increased trunk lean promoted in running magazines

Not well studied
Side View

OVERSTRIDING

The foot lands in front of the person’s center of mass
  - Reaching: hip flex & knee ext before I.C.

Associated with increased risk of tibial stress fx

Differentiate stride length vs overstride

At loading response draw a vertical line from lateral malleolus
  - Anterior to pelvis = overstride
VERTICAL DISPLACEMENT OF COM

“Bounding”

Predictive of peak knee extensor moment, peak vertical GRF, braking impulse

Increased work

Compare frames from highest point in float to lowest point in stance

Increase cadence by 10% to decrease vertical displacement of COM
Posterior View

BASE OF SUPPORT

L/R feet shouldn’t overlap at contact

“cross-over sign”

“scissoring gait”

Linked to tibial stress fractures, IT band syndrome

Associated with increased hip add and overpronation
Posterior View

HEEL EVERSION

Foot pronation – difficulty to measure in 2-D

Eversion – measured as vertical alignment of heel markers

Rate of pronation

- Higher correlates with injuries
  - Tibial stress fractures
  - PFP
  - Achilles tendonopathy
Posterior View

FOOT PROGRESSION ANGLE

Difficult to assess in 2-D

Typical
- Lateral aspect of shoe visible
- 5-10 deg

Toe-in
- Associated with LE IR

Toe-out
- Less association with injury
- Abnormal flexibility
Posterior View

HEEL WHIPS

Compare plantar surface of shoe at initial swing with point of max rotation
Posterior View

KNEE WINDOW

Narrow: association with excessive hip add, hip IR and knee valgus

Wide: association with knee varus

Inaccurate if increased soft tissue or baggie clothes
Posterior View

PELVIC DROP

Compare PSIS markers in stance

Hip extension and abductor weakness or fatigue

Symmetry
Additional Variables

Auditory
- Louder = increased GRF
- Asymmetries

Shaking of TM

Cadence
- Count heel strikes on one foot for 1-minute = stride rate
- Multiply by 2 = step rate
Therapeutic ex. for runners (Willy)

Goals of therapeutic exercise

1) Increase neuromuscular performance: Endurance and neuromuscular control of musculature
2) Promote appropriate neuromuscular control of mechanics
3) Increase flexibility or extensibility
4) Promote healing i.e., opposite of hinder healing

**Ideal: Do all 4 things at the same time**

Promote compliance
1) Minimize equipment required
2) Stick with no more than 3 exercises
3) Perform exercises prior to running
Effect of strength training on performance
Karsten et al., IJSPP, May 2015

Randomized recreational runners into endurance only or endurance plus strength training

6 weeks, 2x per week, 4 exercises: 4 sets of 4 reps, 80% 1-RM:
- Romanian dead lift
- Squat
- Calf raises
- Lunges

5-k performance: 45 sec ± 24 faster 5k, no change for the Endurance-only group
“Ok, so I’ll just strength train in the early season” Ronnestad 2015

25 weeks strength training

Large increases in aerobic power and VO2 max

8 weeks of cessation of strength training

Aerobic power and VO2 max decline
THE EFFECTIVENESS OF EXERCISE INTERVENTIONS TO PREVENT SPORTS INJURIES

By Lauersen et al. in British Journal of Sports Medicine, 2014

- No benefit of stretching
- Injuries prevented by training proprioception or strength

26,610 subjects
3464 injuries

1\(^{1/3}\)
Strength training reduces sports injuries to less than one third

50%
Overuse injuries could be almost halved by adequate strength training
To gain strength, intensity must be ≥65% 1RM

Steps to determine 1RM (MVC)

1. Perform 10 repetitions with enough resistance so that last rep is to failure
2. That level of resistance corresponds to 75% of 1RM
3. Multiply by 1.334 to get 1RM
You’ve ruled out a serious injury and you’re wondering...

“Should I load it?”

Have you tried to load it?
- No
- Yes
  - Are you sure?
    - No
    - Yes
      - Have you tried loading it in another way?
        - No
        - Yes
          - Have you tried a lighter load?
            - No
            - Yes
              - Even just isometrics?
                - No
                - Yes
                  - Have you tried loading another region for now?
                    - No
                    - Yes
                      - No you haven’t
                        - LOAD IT!!!!!

The Science PT @erikmeira
How much pain is ok? Consider the structure!

1. The pain is allowed to reach 5 on the NPRS during the activity.
2. The pain after completion of the activity is allowed to reach 5 on the NPRS.
3. The pain the morning after the activity should not exceed a 5 on the NPRS.
4. Pain and stiffness is not allowed to increase from week to week.

Silbernagel and Crossley, 2015
## Return to Running – Loading Program
Adapted from James, 1978

<table>
<thead>
<tr>
<th>Week</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
<th>Sunday</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Walk 30 min: alternating 1.5 min fast, 1.5 min normal</td>
<td>X-train</td>
<td>Walk 30 min: alternating 1.5 min fast, 1.5 min normal</td>
<td>X-train</td>
<td>Walk 30 min: alternating 1.5 min fast, 1.5 min normal</td>
<td>X-train</td>
<td>X-train</td>
</tr>
<tr>
<td>2</td>
<td>21 min: alternating 1 min walk, 2 min run</td>
<td>X-train</td>
<td>21 min: alternating 1 min walk, 2 min run</td>
<td>X-train</td>
<td>21 min: alternating 1 min walk, 2 min run</td>
<td>X-train</td>
<td>X-train</td>
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<tr>
<td>3</td>
<td>28 min: alternating 1 min walk, 3 min run</td>
<td>X-train</td>
<td>28 min: alternating 1 min walk, 3 min run</td>
<td>X-train</td>
<td>28 min: alternating 1 min walk, 3 min run</td>
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<td>28 min: alternating 1 min walk, 3 min run</td>
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<tr>
<td>4</td>
<td>X-train</td>
<td>28 min: Alternating 1 min walk, 5 min run</td>
<td>X-train</td>
<td>28 min: Alternating 1 min walk, 5 min run</td>
<td>X-train</td>
<td>28 min: Alternating 1 min walk, 5 min run</td>
<td>X-train</td>
</tr>
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</table>
Run Less Run Faster (FAST) 3+2 Program

<table>
<thead>
<tr>
<th>Sunday</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wednesday</th>
<th>Thursday</th>
<th>Friday</th>
<th>Saturday</th>
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</thead>
<tbody>
<tr>
<td>Off</td>
<td>X-train hard</td>
<td>Speed work / Track repeats 2x1600 @ 6:57, RI: 60 sec 2x800 @ 3:21, RI: 60 sec</td>
<td>X-train hard</td>
<td>Tempo run 1 mi easy 5 mi 7:45 min/mi 1 mi easy</td>
<td>Off</td>
<td>Long run 13 mi 8:26 min/mi</td>
</tr>
<tr>
<td>ZONE</td>
<td>HEART RATE (PERCENT OF LACTATE THRESHOLD)</td>
<td>PERCEIVED EFFORT</td>
<td>PACE</td>
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<tr>
<td>ZONE 1</td>
<td>75–80</td>
<td>1–2</td>
<td>Pace range corresponding to Zone 1 heart rate range OR McMillan Recovery Run Pace</td>
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<td></td>
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<tr>
<td>ZONE 2</td>
<td>81–89</td>
<td>3–4</td>
<td>Pace range corresponding to Zone 2 heart rate range OR McMillan Easy/Long Run Pace</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ZONE 3</td>
<td>96–100</td>
<td>5.5–6</td>
<td>Pace range corresponding to Zone 3 heart rate range OR McMillan Tempo Run Pace</td>
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<tr>
<td>ZONE 4</td>
<td>102–105</td>
<td>7–8</td>
<td>Pace range corresponding to Zone 4 heart rate range OR McMillan Speed Pace for 1200–1000m Intervals</td>
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<tr>
<td>ZONE 5</td>
<td>106+</td>
<td>9–10</td>
<td>Pace range corresponding to Zone 5 heart rate range OR McMillan Speed/Sprint Pace for 600–100m Intervals</td>
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McMillan Running Calculator
"I should stop running until that pain goes away," said no runner ever.