

**Appendix 2** Characteristics of studies included in the meta-analysis

Author(s)	Study Design	Population	N	Groups	Risk Factors
Bandholm et al[15]	CC	Recreational athletes/physically active	30	MTSS: 9F, 6M Control: 9F, 6M	Navicular drop difference (mm) Navicular height loaded (mm) Navicular height neutral (mm) Medial longitudinal arch deformation difference (deg) Medial longitudinal arch deformation difference during walking (deg) Medial longitudinal arch angle heel strike (deg) Medial longitudinal arch angle loaded (deg) Medial longitudinal arch angle neutral (deg) Medial longitudinal arch angle push-off (deg)
Bennett et al[16]	PC	Runners	36	MTSS: 13F, 2M Control: 8F, 13M	Active DF (deg) Navicular drop (mm) Rearfoot angle (deg) Resting calcaneal position in stance (deg) Sex (m,f) Tibiofibular varum (deg)
Franklyn et al[10]	CS	Recreational athletes/physically active	57	MTSS: 11F, 12M Control: 16F, 18M	Tibia Measures: Anteroposterior dimension of the medullary region (mm) Anteroposterior width (mm) Amount of elongation (mm <sup>4</sup> ) Cross-sectional area (mm <sup>2</sup> ) Distal width (mm) Lateral length (mm) Maximum second moment of area (mm <sup>4</sup> ) Medial length (mm) Minimum second moment of area (mm <sup>4</sup> ) Mediolateral width (mm) Mediolateral dimension of the medullary region (mm) Polar moment of area (mm <sup>4</sup> ) Proximal width (mm) Radius of gyration Section modulus
Gehlsen & Seger[11]	CC	Recreational athletes/physically active	20	MTSS: 10F Control: 10F	Angular displacement (calcaneus and midline of lower leg (LL) (deg) - slow speed, shoes, contact Angular displacement (deg) - slow speed, shoes, support

Angular displacement (deg) - fast speed, no shoes, contact  
 Angular displacement (deg) - fast speed, no shoes, support  
 Angular displacement (deg) - fast speed, no shoes, takeoff  
 Angular displacement (deg) - slow speed, shoes, takeoff  
 Angular displacement (deg) - fast speed, shoes, contact  
 Angular displacement (deg) - fast speed, shoes, support  
 Angular displacement (deg) - fast speed, shoes, takeoff  
 Angular displacement (deg) - slow speed, no shoes, contact  
 Angular displacement (deg) - slow speed, no shoes, support  
 Angular displacement (deg) - slow speed, no shoes, takeoff  
 DF ROM (deg)  
 DF strength (lb)  
 EV ROM (deg)  
 EV strength (lb)  
 Height (cm)  
 Inversion (INV) ROM (deg)  
 INV strength (lb)  
 Leg length (cm)  
 PF range of motion (PF ROM) (deg)  
 PF strength (lb)  
 Weight (kg)

Hubbard et al[18]

PC

College athletes

146

MTSS: 9F, 20M  
 Control: 30F, 87M

Age (yrs)  
 DF ROM (deg)  
 EV ROM (deg)  
 Females only: age of menstruation (yrs)  
 Females only: have a regular menstrual cycle (yes/no)  
 Females only: take birth control (yes/no)  
 Height (cm)  
 How long subject has been running (yrs)  
 How often change running shoes (per year)  
 INV ROM (deg)  
 Isometric PF (N·kg<sup>-1</sup>)  
 Isometric DF (N·kg<sup>-1</sup>)  
 Isometric INV (N·kg<sup>-1</sup>)  
 Isometric EV (N·kg<sup>-1</sup>)  
 Miles run/week (miles)  
 Navicular drop (mm)  
 PF ROM (deg)  
 Previous history of MTSS (yes/no)  
 Previous history of stress fracture (yes/no)

					Take vitamins (yes/no) Tibial varum (deg) Wear orthotics (yes/no) Weight (kg)
Madeley et al[7]	CC	Recreational athletes/physically active	60	MTSS: 14F, 16M Control: 14F, 16M	BMI (kg/m <sup>2</sup> ) Height (m) Standing heel raise (#)
Messier & Pittala[12]	CC	Runners	36	MTSS: 17 Control: 19 (sex not reported)	Apparent leg length difference (%>0.64 cm) DF ROM (deg) Foot print Hamstring flexibility (% abnormal) Lower leg flexibility (% abnormal) Max pronation (deg) Max pronation velocity (deg/s) PF ROM (deg) Q angle (deg) Running terrain (% hills, crowned roads, trails) Sit and reach (cm) Time to max pronation (ms) Total rearfoot movement (deg) True leg length difference (not reported)
Moen et al[8]	CC	Military	35	MTSS: 15M Control: 15M	Ankle DF (deg) Ankle PF (deg) BMI (kg/m <sup>2</sup> ) Duration of complaints (days) Hallux flexion (deg) Hallux extion (deg) Height (cm) Hip ER ROM (deg) Hip IR ROM (deg) Knee ext (deg) Knee flex (deg) Lean calf girth (cm) Max calf girth (cm) Navicular drop >0.5cm (yes/no) Pre-rehab symptom free running distance (m) Sports Rated Activity Scale at baseline (0-100) Standing foot angle <140deg (yes/no) Subtalar EV (deg) Subtalar INV (deg)
Raissi et al[19]	PC	College students in a	66	MTSS: 10F, 3M	Achilles angle (deg)

		physically active course		Control: 53 (sex not reported)	Anterior location of previous pain (%) BMI (kg/m <sup>2</sup> ) Duration of MTSS (hours) Duration of professional activity (unit not reported) Height (m) Intercondylar distance of femur (mm) Intermaleolar distance (mm) Length of weekly physical activity (%) Navicular drop (mm) Positive history of professional activity (%) Past history of pain (%) Q-angle (deg) Tibia angle (deg)
Rathleff et al[20]	CC	Recreational athletes/physically active	28	MTSS: 10F, 4M Control: 10F, 4M	Dynamic navicular drop (mm) FPI-6 Preferred walking speed (km/h) Static navicular drop (mm) Velocity of dynamic navicular drop (mm/sec) Visual analog scale – during activity (cm) Visual analog scale – pain at rest (cm)
Viitasalo & Kvist[14]	CC	Recreational athletes/physically active	48	MTSS: 13M ("bad" MTSS), 22M ("slight" MTSS) ("bad" and "slight" groups were combined for data analysis) Controls: 13M	Achilles angle, treadmill running – before touch down, during full support during full support – minimum, during full support –maximum, after heel takeoff, at the ball of the foot takeoff Angular displacement, treadmill running – before touch down-during full support, during full support min-during full support max, during full support-after heel takeoff, after heel takeoff-at the ball of the foot takeoff Passive subtalar EV (deg) Passive subtalar INV (deg) Passive subtalar sum (deg) Standing feet diagonal – leg angle, calcaneus angle, Achilles angle (deg) Standing normal – leg angle, calcaneus angle, Achilles angle (deg) Standing heels together – leg angle, calcaneus angle, Achilles angle (deg)
Yagi et al[9]	PC	Runners	244	MTSS: 44F, 58M Control: 54F, 88M	BMI (kg/m <sup>2</sup> ) Height (cm) Hip abduction strength (N) Hip ER ROM (deg) Hip IR ROM (deg) Intercondylar and intermalleolar interval (mm)

					Navicular drop (mm) Passive ankle DF – knee ext (deg) Passive ankle DF – knee flex (deg) Q-angle (deg) Straight leg raise (deg) Weight (kg)
Yates & White[4]	PC	Military	112	MTSS: 18F, 22M Control: 16F, 56M	Ankle DF - knee extension (deg) Ankle DF - knee flexion (deg) BMI (kg/m <sup>2</sup> ) FPI (-16-16) FPI (supinated, normal, pronated, highly pronated) Previous history of MTSS (yes, no) Sex (m,f) Weekly exercise (hrs) Weekly weightbearing exs (hrs) Weekly weightbearing exs excluding walking (hrs)

---

BMI: body mass index, CC: case-control, CS: cross-sectional, DF: dorsiflexion, ER: external rotation, EV: eversion, f: female, FPI: foot posture index, INV: inversion, IR: internal rotation, m: male, PC: prospective cohort, Q-angle: quadriceps angle, ROM: range of motion