Table 1. Inputs to the electronic databases (all databases). Lines 1-3) were combined using "AND" with lines 4) and 5)

Search words
1) orthot* OR insert OR wedge OR orthos$ OR insole OR skive
2) foot* OR feet OR shoe$ OR footwear OR motion control shoe OR Nike free OR pronation control OR heel*
3) tape OR taping OR augmented Dye OR low-dye OR low dye
4) electromyograph$ OR EMG OR IEMG OR muscle function
5) Walk* OR run* OR gait OR locomotion or jog*

Table 2. Quality assessment criteria checklists

Criteria
First stage: EMG reporting
1) Surface sensors (shape, material, size, inter-electrode distance)
2) Adequate skin preparation
3) Fixation of the sensors was described or reference was made to guidelines for sensor placement
4) Sensor location was based on SENIAM guidelines or a justified alternative (orientation over the muscle belly was made with consideration of fibre direction and with respect to tendons and the motor point, inter-electrode distance was reported)
5) Appropriate signal processing (including specification where applicable of full or half-wave rectification or window size of RMS[23])
6) Walking or running velocity was controlled (not just reported)
7) Adequate description of normalisation procedure if applicable
Fine-wire EMG studies were excluded if insufficient details of the intramuscular wire electrodes (type and material) and procedures (insertion approach and method of establishing a correct insertion) were reported[23]
Second stage
Immediate effects studies
1) Statement of an aim/hypothesis
2) Participant characteristics reported
3) Outcomes described in the introduction or methods
4) Device material reported
5) Clear description of the main findings
6) Variability reported (within written results or figures)
7) Actual p values stated (or <0.001)
8) Participant blinding (e.g. sham FO)
9) Assessor blinding
10) Appropriate statistics (including checking data for normality and sphericity where appropriate)
11) Control condition a true control
12) Randomisation of the order conditions were tested
13) Power calculation performed
Additional criteria for studies on the effects of devices over time
14) A description of the intervention (including duration)
15) Comparable participant characteristics across groups
16) Compliance

Table 3. Summary of studies on the effect of footwear (n=22) and taping (n=1) on lower limb muscle activity

Authors	Participant characteristics	Device	Muscles	Walking or running	Variables	Main findings	QA scores, 1st and 2nd stage (%)
Bucheker et al. (2012)[38]	10 overweight males: 32.0 ±7.9 years, 1.792 ±0.058 m, 91.3 ±7.0 kg	Masai Barefoot Technology, participant's own shoes as control	BF, MG, VL	Walking (15 m walkway)	Intensity (amplitude) and co-activation indices	• In midstance mean intensities of VL ($p < 0.05$) and VL and MG co-activation ($p < 0.05$) increased with MBT • In terminal stance mean intensities of VL ($p < 0.05$), MG ($p < 0.05$), and VL and MG co-activation ($p < 0.05$) increased in MBT	71, 62
Burgess and Swinton (2012)[39]	23 healthy, recreationally active females: 20.8 ±1.3 years, 1.654 ±0.056 m, 62.9 ±11.9 kg	Barefoot, Fitflop™ and flip flop treadmill walking, stair climbing and zigzag walk around cones	BF, Glut Med, MG, RF	Treadmill walking (1.34 m/s)	Normalised mean RMS	• No significant differences between footwear conditions	86, 62
Chen et al. (2018)[40]	Ten healthy males: 25.58 ±3.64 years, 1.737 ±0.02 m, 59.86 ± 3.80 kg	Barefoot, sports shoes (Roshe Run, Nike Inc., Oregon, United States) and flip-flops (flat rubber sole, Flipper, Adidas, Germany)	BF, GM, PL, TA, VL	Walking (10 m walkway)	Co-contraction index	• No significant differences between conditions in co-contraction for any muscle pairs	71, 62

Cheung et al. (2009)[36]	20 novice F runners, rearfoot pronation >6°, 25.8 ±3.7 years, BMI: 20.54 ±1.27 kg·m/2	"Supernova control", (Adidas), designed to check excessive pronation; "Supernova cushion" (Adidas, control), designed to reduce impact rate	VL, VM	Treadmill running (10 km)	EMG onset timing and median frequency	• VM activated ~5.3% (95% CI 4.5 to 6.1) of a duty cycle earlier than VL with motion control shoe • Neutral shoe: delay in VM activation by ~4.6% (95% CI 3.9 to 5.3) of a duty cycle compared with VL	83, 54
Cheung et al. (2010)[33]	20 novice F runners, rearfoot pronation >6°, 25.8 ±3.7 years, BMI: 20.54 ±1.27 kg·m/2	"Supernova control", (Adidas, motion control), designed to check excessive pronation; "Supernova cushion" (Adidas, neutral), designed to reduce impact rate	PL, TA	Treadmill running (10 km)	Normalised RMS and median frequency	• Positive correlations between RMS EMG and running mileage in TA and PL in neutral shoe condition ($p < 0.001$) • Median frequency dropped in both shoe conditions with mileage, but significantly larger drop in neutral shoe than motion control shoe ($p < 0.001$ for PL, $p = 0.074$ for TA)	86, 54
Elkjaer et al. (2011)[41]	10 healthy males: 24.5 ± 3.8 years, BMI = 24.03 ± 1.09 kg·m/2	Reebook EasyTone® ET Calibrator; neutral Nike Lunarglide +2 (control)	BF, Glut Max, LG, TA, VL	Treadmill walking	Peaks and integrated	• No significant differences between footwear conditions	57, 62

Forghany et al. (2014)[7]	20 healthy subjects (12 M): 33.1 ± 8.4 years, 1.71 m ±0.04 m, 68.9 kg ±12.1, BMI 23.6 ± 4.1 kg·m/2	Rollover shoe, flat control shoe (same leather upper and last as rollover shoe), flat control footwear weighted to equivalent of the rollover shoe and MBT shoe. All insoles were removed and replaced with a 1.2 mm poron insole.	Lateral BF, ES (right), Glut Max, MG, RF, SOL, TA	Walking (10 m course)	Peak EMG and integral of the signal	• Maximum at initial contact for TA: -29% for MBT, -22% for rollover shoe vs. control • iEMG: TA -17% both MBT and rollover vs. control; SOL +13% MBT, +8% rollover, MG +8% for MBT	50, 62
Franklin et al. (2018)[42]	70 healthy males (age range 20–87 years). YOUNG<40 years (n =20), MID>40 years and<70 years (n =30) and OLD>70 years (n = 20)	Minimalist shoe (Product ID: 2169, Two Barefeet Boarding Co.), control shoe (Style Code: 10001, Hobos Womens, Style Code: 50109, Hobos Mens), barefoot and own shoes	MG, PL, TA	Walking	Mean amplitude acros gait cycle and at separate phases of gait cycle (EMG only normalised in graphs)	• Higher amplitude of GM in minimalist shoe and own shoe vs. control in YOUNG and MID group but not old. • Lower amplitude of PL in minimalist shoe vs. own shoe and control in YOUNG and MID group but not old. • Lower amplitude of TA in minimalist shoe vs. own shoe and control across gait cycle and at initial double support • Slower walking speed in minimalist shoe vs. own shoe and control, but less <5% difference	67, 69

Goryachev et al. (2011)[27]	14 females with symptomatic bilateral medial compartment knee OA for ≥6 months, 59.9 ±6.2 years, 1.607 ±0.06 m, 77.4 ±8.9 kg	APOS shoes in "functional neutral configuration", without elements, lateral 1.2 cm, medial 0.8 cm (both elements).	BF, LG, MG, ST, TA, VL, VM	Walking (10 m walkway)	ARV, normalized activity duration and peak	• In less symptomatic leg, almost all muscles varied significantly with COP in at least one phase of stance • In more symptomatic leg, significant differences in ARV across COP configurations for LG in terminal stance, pre-swing and terminal contact, for TA in pre-swing and for VL at contact • Training element of the study did not meet inclusion criteria	50, 69
Goto and Abe (2017)[43]	17 females (19.3 ±0.9 years, 1.577 ±0.04 m, 20.2 ±1.8 kg/m2)	Ladies leather safety footwear (670 g; longitudinal stiffness 35.8 N; MIDORI ANZEN Co., Ltd., Tokyo, Japan, hard sole and hard-resin toe cap). Control sports shoes: (470 g; longitudinal stiffness 14.7 N; Bridgestone Corporation, Tokyo, Japan, soft sole, no toe cap).	BF, LG, TA, VL	Treadmill walking	Mean EMG amplitude of safety shoes normalised to amplitude of control shoes	• Significantly higher amplitude of safety shoes for BF (114.3% ±20.7%, p= 0.01), TA (105.8% ±10.8%, p=0.04) and VL (129.5% ±47.1%, p=0.02) vs. control (100%). No significant difference in LG amplitude in safety shoes (103.3% ±7.7%, p=0.09) vs. control (100%)	83, 69
Horsak and Baca (2013)[44]	7 M, 5 F: 25 ±4 years; 1.72 ±0.11 m; 67 ±11 kg	Reebok Easy Tone® (Reenew model), 2 weeks familiarisation. Participant's own shoes as control	VL, VM	Walking	Mean amplitude	• No significant differences between footwear conditions	67, 54

Horsak et al. (2015)[45]	Reanalysed data: 7 M, 5 F; 25 ± 6 years; 1.74 ±0.07 m; 68 ±10 kg and 7 M, 5 F: 25 ±4 years; 1.72 ±0.11 m; 67 ±11 kg	Reebok Easy Tone® (Reenew model), 2 weeks familiarisation and MBT shoe. Participant's own shoes as control	BF, Glut Med, MG, PL, TA, VM, VL	Walking (10 m walkway)	Mean amplitude, co-contraction indices	• No significant difference in mean muscle activity between unstable shoes and control • Increased co-contraction of vastii and gastrocnemius muscle in MBT, (Cohen's d 0.5-0.9)	71, 54
Kelly et al. (2010)[46]	13 male, recreational runners 31.7 ±4.9 years, 1.817 ±0.046 m, 81.6 ±5.9 kg	Augmented low Dye taping, control taping and Adidas Response Cushion running shoes	Glut Med, VL, VM	Treadmill running (6 mins)	Peak and average EMG signal amplitude, onset time, and burst duration	• Delayed onset of the EMG signal of all muscles with taping, moderate to large effect size	83, 77
Koyama et al. (2012)[47]	6 healthy males: 26.3 ± 5.3 years; 1.72 ± 0.05 m; 68.0 ±6.1 kg	Shape-ups (SKECHERS, USA) vs. normal walking shoe	RF, VL, BF, TA, SOL, MG	Treadmill walking at 3, 4, 5, 6, and 7 km/h (3 mins)	Integrated EMG (iEMG) calculated relative to control shoe	• Significantly higher iEMG of MG (6–16%, $p < 0.05$) and SOL (8–23%, $p < 0.01$) in Shape-ups across speeds. • Tendency towards higher iEMG in Shape-ups vs. control in RF, VL, BF and TA	86, 54
Nigg et al. (2006)[48]	5 M and 3 F: 28.0 ±3.6 years, 1.695 m ±0.064 m, 70.1 ±7.5 kg. Free of LE pain/ injury 6+ months prior to testing and never used MBT shoe before	Control: Adidas SuperNova running shoe (mass: 358 g). Experimental: MBT (mass: 650 g), rounded shoe-sole design in AP direction.	BF, Glut Med, MG, TA, VM	Walking (lab) and quiet standing	Intensity, wavelet analysis	• No significant differences changes in EMG intensity • Trend for reduced intensity of TA (-26% ±24%) and BF of (-55% ±60%), • Trend for increased intensity of MG (+52% ±82%), VM (+4% ± 13%) and Glut Med (+16% ± 25%)	86, 62

O'Connor and Hamill (2004)[35]	10 healthy, recreationally active males, 27 ±5 years, 1.72 ±0.07 m, 72.6 ±5.3 kg. Only 4 subjects with full sets of data for TP	EVA with a durometer of 45 (Shore A). Neutral shoes constructed with heel height 2.5 cm. For 8° varus configuration, the medial aspect of the midsole at the heel was 3-cm thick, and lateral aspect 2 cm thick. Dimensions reversed for valgus shoe.	LG, MG, PL, SOL, TA, TP	Running (30 m walkway)	Integrated EMG (iEMG), mean amplitude, onset and offset	• No significant differences between footwear conditions	71, 54
O'Connor et al. (2006)[34]	10 healthy, recreationally active males, 27 ±5 years, 1.72 ±0.07 m, 72.6 ±5.3 kg. Only 4 subjects with full sets of data for TP. Same subjects and materials as O'Connor and Hamill (2004)	EVA with a durometer of 45 (Shore A). Neutral shoes constructed with heel height 2.5 cm. For 8° varus configuration, the medial aspect of the midsole at the heel was 3-cm thick, and lateral aspect 2 cm thick. Dimensions reversed for valgus shoe.	LG, MG, PL, SOL, TA, TP	Treadmill running (5 mins)	Mean amplitude, onset and offset	• Significantly less mean EMG activity in the TA and SOL in the neutral shoe vs. either wedged shoe • TA amplitude increased 16% in varus (medial wedge) shoe vs. neutral shoe	71, 69

Price et al. (2013)[50]	15 healthy females: 29 ±6.7 years, 1.671 ±0.042 m, 62.6 ±6.9 kg,	Earth sandal (control), FitFlop, Masai Barefoot Technology, Reebok Easy-Tone and Skechers Tone-Ups	BF, MG, PL, RF, SOL, TA	Walking (lab)	Median RMS for phase	• Fitflop, Reebok and Skechers increased PL activity during pre-swing, whereas MBT increased MG and decreased TA activity in loading response and mid-stance • Increased PL activity in loading response in MBT vs. control • SOL activation during midstance was lower in Fitflop and Skechers than MBT and control	86, 77
Price et al. (2014)[49]	15 M: 30 ±8 years, BMI: 25.9 ±4.5 kg·m/2; 13 F: 37.8 ±12.4 years, BMI: 23.0 ±4.7 kg·m/2	Barefoot. Flip-flop (Havaiana Brazil), EVA midsole. Fit-flop: Walkstar I. for females, Dass for males, multi-density EVA in heel, midfoot and toe. Rubber outsole	PL, TA	Walking (lab)	Amplitude	• No significant differences between footwear conditions	83, 62
Sacco (2012)[51]	25 healthy females with no experience of MBT (21.8 ±3.0 years, 1.610 ± 00.4 m, 52.6 ±5.3 kg)	Barefoot, MBT (501 g), and standard tennis shoe (Rainha System, Alpargatas, Brazil, 171 g, neutral strike).	BF, Glut Med, LG, TA, VL	Walking (10 m walkway)	Peak, time of peak and integral of the envelope	• Less peak TA amplitude in MBT vs. standard shoe and barefoot ($p < 0.01$) • Walking with the MBT shoe did not increase muscle activity when compared to walking with the standard shoe	83, 62

Scott et al. (2012)[32]	28 adults with flat feet (14 M/F), 21.2 ±3.8 years, 1.71 ±0.1 m, 73.3 ±16.0 kg	Standard flexible shoe (Dunlop Volley), stability running shoe (Nike Air Structure Triax +10, range of features aimed at controlling moderate pronation) and barefoot	MG, TA (surface), PL, TP (fine-wire)	Walking (9 m walkway)	Time of peak amplitude and peak amplitude	• Both styles of footwear increased TA peak amplitude and decreased PL peak amplitude vs. barefoot • Little difference between footwear conditions	83, 69
Sobhani et al. (2013)[52]	16 healthy runners (8 M/F), 29 ±9 years, 1.771 ±0.093 m, 69.8 ±11 kg	Standard shoe (apex/rolling point 53% of shoe length, proximal to metatarsal region, 467 ± 87 g). Modified rocker shoe (rolling point 65%, 805 ±157 g)	LG, MG, SOL, TA	Slow running and walking (10 m lab)	Peak and time of peak (%)	• Significant delay of EMG peak, ~2% ($p< 0.001$) in triceps surae walking with rocker shoes • No change in peak amplitude of triceps surae in running/walking • Peak amplitude of TA increased 20%, 64.7 mV, $p< 0.001$) walking with rocker shoes	67, 69
Sobhani et al. (2015)[30]	13 Achilles tendinopathy patients (11 F), 48 ±14.5 years, 1.72 ±0.07 m, 77 ±14 kg. Achilles tendinopathy 4 months to 9 years (mean 22.5 months, median 11.5 months)	Standard shoe (apex/rolling point 53% of shoe length, proximal to metatarsal region, 467 ± 87 g). Modified rocker shoe (rolling point 65%, 805 ±157 g)	LG, MG, SOL, TA	Slow running and walking (10 m lab)	Peak and time of peak (%)	• Peak activity of TA increased (61.77 µV, 35%) for walking with rocker shoes ($p= 0.015$)• Delay of ~4% of the gait cycle in time of peak activity of LG ($p= 0.001$) in running	67, 62

*ARV= average rectified value, LE= lower extremity, M= male, F= female, RMS= root mean square, TP= tibialis posterior, TA= tibialis anterior, SOL= soleus, PL= peroneus longus, MG= medial gastrocnemius, LG= lateral gastrocnemius, AT= Achilles tendinopathy, VL= vastus lateralis, VM= vastus medialis, BF= biceps femoris, Glut Med= gluteus medius, Glut Max= gluteus maximus, ES= erector spinae, RF= rectus femoris, ST= semitendinosus, MBT= Masai Barefoot Technology, OA= osteoarthritis. QA= quality assessment, for first and second stage ((number of satisfied criteria/number of applicable criteria)*100).*

Table 4. Summary of studies on the effect of foot orthoses (n=8) on lower limb muscle activity

Authors	Participant characteristics	Device	Muscles	Walking or running	Variables	Main findings	QA scores, 1st and 2nd stage (%)
Akuzawa et al. (2016)[53]	10 healthy males: 25 ± 5.0 years, 1.68 ± 0.06 m, 61.5 ± 7.8 kg	Shoe (Calcetto Le3, Asics, Japan), shoe + prefabricated orthosis (Athlete grip7, Winning One Inc., Japan), barefoot	TP, FDL, PL	Walking	Amplitude as %MVC in contact, midstance and propulsion phase	• Significant reduction ($p<0.036$) in TP activity in propulsion phase with orthoses relative to barefoot but not relative to shoe • No significant difference in FDL and PL EMG between conditions	57, 62
Baur et al. (2011)[29]	99 runners with running-related overuse symptoms. 50 M, 49 F. CO: 37.1 ±8.3 years, 1.74 ±0.09 m, 68.8 ±13.6 kg. Ort: 37.3 ± 8.2 years, 1.73 ±0.09 m, 66.8 ±11.6 kg	Custom, MLA support (25 mm), a detorsion wedge in the forefoot (lateral post, 3 mm), and a bowl-shaped heel. 8 week intervention	PL	Treadmill running	Activation time and mean amplitude	• Sig ($p= 0.001$) increase in preactivation amplitude of 22% ± 48% (95% CI = 9%–32%) in OR compared with CO	71, 75
Kelly et al. (2011)[54]	12 male recreational athletes (31.2 ±3.8 years, 76 ±3.9 kg, 1.808 ±0.04 m)	Prefabricated Formthotics (Foot Science International)	MG, PL, TA, VM	Treadmill running	Burst duration and average RMS amplitude	• Lower RMS signal amplitude VM (-13.3%, $p< 0.02$) and MG (-10.7%, $p< 0.05$), increased PL burst duration (+14.7%, $p< 0.05$), running with orthoses	86, 54

Maharaj et al. (2018)[2]	18 adults with flat feet recruited: 5 F, 13 M (14 included in analysis) 26 ±5 years, 1.70 ±0.11 m, 71.3 ±12.6 kg	Shoe:(Gel Lyte 33, Ascics, Japan), shoe + Custom FO: ¾ length semi-rigid 4 mm polypropylene thermoplastic shell with vinyl covering, 4 mm medial skive at 15° and a 5° extrinsic rear foot post, barefoot	TP	Treadmill walking	Amplitude as % of max at preferred walking speed	• Reduced TP activity with shoe and shoe + FO vs. barefoot in early stance (1-12%) and late stance (19-22%), main effect of condition ($p \leq 0.01$), but no significant difference between shoe and shoe + FO.	100, 54
Mills et al. (2012)[28]	40 patients with knee pain. 27 mobile (foot): 28.67 ±6.13 years, 1.696 ±0.149 m, 71.03 ± 11.97 kg. 13 less mobile: 31.15 ±4.41 years, 1.71 ±0.0841 m, 71.15 ± 11.22 kg	Prefabricated EVA FOs with varying hardnesses	BF, Glut Med, MG, RF, SOL, TA, VM, VL	Treadmill jogging (3 min intervals)	Peaks and temporal (offset only reported?)	• Orthoses, regardless of comfort, had no immediate effect on lower limb EMG or kinematics compared with baseline shoe conditions • Moderate difference in VL peak amplitude ($p= 0.007$) between most and least comfortable orthosis, greatest increase in peak amplitude in least comfortable	71, 69

Murley et al. (2010)[9]	30 adults with flat feet, 21.8 ±4.3 years, 1.71 ±0.1 m, 73.3 ±15.5 kg	Modified prefabricated FO: ¾ length, medial heel wedge under heel, arch support heat-moulded to individual. Custom FO: ¾ length, posted at 20° inverted, heel supported by EVA wedge, plaster cast modifications to contour shell to arch	MG, PL, TA, TP	Walking (9 m walkway)	Time of peak amplitude; (RMS); peak amplitude	• In contact phase TP amplitude decreased with prefabricated orthosis (peak amplitude -19%, p= 0.007; RMS amplitude -22%, p= 0.002) and custom orthosis (peak amplitude -12%, p= 0.001, RMS amplitude -13%, p= 0.001), vs. shoe-only • During midstance/ propulsive phase PL EMG amplitude increased with prefabricated orthosis, vs. shoe-only (peak amplitude +21%, p= 0.024; RMS amplitude +24%, p= 0.019) and custom orthosis (peak amplitude +16%, p= 0.028)	57, 85
Murley and Bird (2006)[21]	Pronated foot type: 10 F, 5 M, 23 ±5 years, 1.702 ±0.09 m and 69.9 ±14.4 kg	3 pairs of rigid custom-made foot orthoses (posted at 0°, 15° and 30° inverted)	MG, PL, SOL, TA	Walking (walkway)	Maximum amplitude as % of MVC, onset	• Increased maximum TA amplitude using shoe only (+30%), 0° (+33%), 15° (+38%) and 30° (+30%) inverted orthoses conditions vs. barefoot ($p < 0.01$)• PL maximum amplitude increased using the 15° inverted orthosis condition vs. barefoot (+21%, p= 0.04), trend for an increase vs. shoe only	57, 62

Telfer et al. (2013)[18]	12 pronated and 12 gender matched controls 29.9 ±8.7years, 1.71 m ± 0.08, 71.6 ±10.7 kg	9 variations: level of external rearfoot posting modified from 6° lateral to 10° medial in 2° increments.	BF, LG, MG, PL, SOL, TA, VL, VM	Walking (indoor walkway, length?)	Peaks and means	• No main effects due to posting level • Group effects customised FOs reducing above knee muscle activity in pronated foot types compared to normal foot types (BF mean p= 0.022; VL peak p< 0.001; VM peak p= 0.009; VM mean p= 0.001) • Interaction effect peak MG (p= 0.034) and peak SOL p= 0.015)	100, 85

*LE= lower extremity, M= male, F= female, RMS= root mean square, TP= tibialis posterior, TA= tibialis anterior, SOL= soleus, PL= peroneus longus, MG= medial gastrocnemius, LG= lateral gastrocnemius, AT= Achilles tendinopathy, VL= vastus lateralis, VM= vastus medialis, BF = biceps femoris, Glut Med= gluteus medius, ES= erector spinae, RF= rectus femoris, CO= control, FO= foot orthosis, MLA= medial longitudinal arch, EVA= Ethyl Vinyl Acetate. QA= quality assessment, for first and second stage ((number of satisfied criteria/number of applicable criteria)*100).*

Figure 1. Study selection flow chart